

Development in the Anthropocene

The tough task of working towards planetary well-being with low-income households



Montagu Murray, JC Pauw (Eds)

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This book is dedicated to every low-income household working towards planetary well-being.

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Abbreviations and acronyms

3D	three-dimensional
4IR	Fourth Industrial Revolution
AEL	Atmospheric Emission License
AI	artificial intelligence
AIAO	Anthropogenic Impact Accounting Ontology
APPA	Atmospheric Pollution Prevention Act of 1965
AQMP	Air Quality Management Programme
AWG	Anthropocene Working Group
BBM	Building Block Methodology
CA2SIG	Climate Action and Accounting Special Interest Group
CCS	Carbon Capture and Storage
CCTV	closed-circuit television
CEPAUR	Centro de Estudio e Promoción de Asuntos Urbanos [Center for the Study and Promotion of Urban Affairs] ("Dag Hammarskjöld")
ChatGPT	Chat Generative Pre-trained Transformer
CHICS	Community Household Interface Care and Support
CHS	comprehensive household survey
CMB	chemical mass balance
CONNEPP	Consultative National Environmental Policy Process
COP 18	Conference of the Parties 18
COPD	chronic obstructive pulmonary disorder
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DEAT	Department of Environmental Affairs and Tourism

DFFE	Department of Forestry, Fisheries and the Environment
DIY	do-it-yourself
DPSEEA	Driving force-Pressure-State-Exposure-Effect-Action
DRC	Dutch Reformed Church
DRIFT	Downstream Response to Imposed Flow Transformations
DSI	Department of Science and Innovation
DST	Department of Science and Technology
DWAF	Department of Water Affairs and Forestry
ECD	early childhood development
EIA	environmental impact assessment
ELU	Existing Lawful Water Use
EMP	environmental management plan
EPR	Extended Producer Responsibility
ESEM	Earth Systems Engineering and Management
ESG	Environmental, Social and Governance
FGD	flue gas desulphurisation
FRP	financial recovery plan
GC	Green CHICS
GDP	gross domestic product
GHS	Globally Harmonized System for the Classification and Labelling of Chemicals
GIDS	Gender Identity Development Service
GN	General Notice
GNP	gross national product
GNR	General Notice of Regulation
GSSP	Global Stratotype Section and Point
GTS	geological time scale

HVAPA	Industrial Highveld Air Quality Priority Area
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IAP2	International Association for Public Participation
IARIW	International Association for Research in Income and Wealth
ICP-MS	Inductively coupled plasma-mass spectrometry
ICS	International Commission on Stratigraphy
ICSA	InnerCHANGE South Africa
ID	identity document
IDP	Integrated Development Plan
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IP&WM	Integrated Pollution and Waste Management
IRENA	International Renewable Energy Agency
IUGS	International Union of Geologic Sciences
IWRM	integrated water resource management
LMICs	low-and middle-income countries
LPG	liquefied petroleum gas
LUS	Land Use Scheme
MDG	Millennium Development Goal
MES	Minimum Emissions Standards
MRF	material recovery facility
NAAQS	National Ambient Air Quality Standards

NAQMP	National Air Quality Management Programme
NBER	National Bureau of Economic Research
NCF	Nurturing Care Framework
NDP	National Development Plan
NEB	National Environmental Body
NEMA	National Environmental Management Act
NEM: AQA	National Environmental Management: Air Quality Act
NFAQM	National Framework for Air Quality Management
NGO	non-governmental organisation
NNMF	non-negative matrix factorisation
NO2	nitrogen dioxide
NOx	nitrogen oxides
NPO	non-profit organisation
NWA	National Water Act of 1998
NWMS	The National Waste Management Strategy
NWRS	National Water Resource Strategy
NWU	North-West University
OECD	Organisation for Economic Cooperation and Development
OWL	Web Ontology Language
PCA	principal component analysis
PDG	Planetary Development Goal
Piqola	Particular Impact on Quality of Life Assessment
PIRLS	Progress in International Reading Literacy Study
PM	particle matter
PM10	Particulate Matter 10 micrometres
PMF	positive matrix factorisation

PPG	photoplethysmography
PSDF	Provincial Spatial Development Framework
PWG	Planetary Well-being Goal
QOLA	Quality of Life Assessment
QR	quick response
R	Core Team behind the R software
RSA	South Africa (Republic of)
RDP	Reconstruction and Development Programme
S@S	household waste: separated at source
SAAQIS	South African Air Quality Information System
SAHRC	South African Human Rights Commission
SARS	Severe Acute Respiratory Syndrome
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
Sasol	South African Synthetic Oil Limited
SAWIS	South African Waste Information System
SDF	Spatial Development Framework
SDG	Sustainable Development Goal
SIM	Social Indicator Movement
SMS	short message service
SO2	sulphur dioxide
SOx	a compound formed by sulphur and oxygen
SPF	spray polyurethane foam
SPLUMA	Spatial Planning and Land Use Management Act 16 of 2013
SQS	Subcommission on Quaternary Stratigraphy
STEM	science, technology, engineering, and mathematics
SWH	solar water heater
SWOT	strengths weaknesses opportunities threats

TBVC	Transkei, Bophuthatswana, Venda, Ciskei
TIA	Technology and Innovation Agency
TIMSS	Trends in International Mathematics and Science Study
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSD	United Nations Statistics Division
URCSA	Uniting Reformed Church in Southern Africa
US	United States
US EPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
VR	virtual reality
WBCSD	World Business Council on Sustainable Development
WBPA	Waterberg-Bojanala Priority Area
WD-XRF	Wavelength Dispersive X-ray Fluorescence
WHO	World Health Organization
WPATH	World Professional Association for Transgender Health
WRI	World Resources Institute
WSF	waste sorting facility
XRF	X-ray Fluorescence
YRBSS	Youth Risk Behavior Surveillance System

Overview

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The pith of this book is interventions to collaboratively better the lives of low-income households with their development on a local scale. These interventions are co-created with communities by a not-for-profit company based in South Africa. Successful interventions to provide more efficient and less polluting energy, treatment of waste, and sanitation are discussed here. Access to water is also discussed. They all contribute to planetary well-being in their small way. These are not the only developmental topics: early childhood development (ECD), artificial intelligence (AI), policymaking, urban planning, intervention models, and research tools are also on the table.

The book is scholarly and practical. It takes scientific literature in several fields as well as situations on the ground in South Africa into account. The 29 contributing authors (including the editors) comprise scientific researchers at universities, full-time research consultants, fieldworkers, and philosophers. Seven universities are represented.

The context is as wide as they come: from heaven above (Chapter 2) to geological epochs below (the Anthropocene as discussed in Chapter 1), from global trends such as the Fourth Industrial Revolution (4IR) (Chapter 8) to intimate autoethnographic personal histories (Chapters 13 and 14) as well

as Philosophy, Economics and Chemistry. Chemistry comes in, for example, when we deal with standards for ambient air in various contexts.

The main message of this book should be that the context may be as important as the intervention. That makes the task tough, as alluded to in the book's title. Sure enough, the context comprises the physical (even global) and socio-political environment (including government policy). But when an intervention is planned, the practical context also entails being present in communities, thorough interaction, research, conceptual labour, and careful preparation. To make this concrete: the best stove to provide for cooking and heating in an informal settlement depends not only on the stove but on the family who will benefit from it, the house in which it is to be installed (see Chapters 4, 9, and 12), plus its emissions and other factors. In Chapter 6, it is reported that a successful sanitation project must dig deeper than the toilet and sewerage system, but also pay attention to factors such as fear of sorcery and the cultural meaning of discarded clothes. Therefore, the task is tough because successful interventions comprise more than just a quick consultation to tick a box and install a device. Chapter 6 argues for an understanding of the lifeworld of the community in which one is involved. Chapter 9 warns against a facile treatment of consultation.

So, the successful interventions described in this book can be compared to the tip of an iceberg or the visible trunk of a tree above the ground.

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The first two chapters fall under the heading *Philosophical Considerations.* However, philosophy is decidedly present in other chapters, such as Chapters 6 and 14. Chapter 6, which deals with empirical research about sanitation in urban and rural settings, has a strong philosophical component from the phenomenological tradition. Chapter 14 exhibits the critical attitude that characterises the philosopher.

Concern for the poor under the banner of *development* is never disinterested ideologically. For example, some might want

poverty eradicated to create more consumers of their products. In this book, however, the Christian faith and philosophy, and ethics in general, are undeniably present (see Chapters 2, 11, 13, 14, and 15) without compromising scholarly standards. Here the reader will find a concern for the future of life on Earth. There is a passion for the well-being of those who can barely meet their daily needs. The concluding sentence of the book is a plea for taking personal responsibility.

The second part of the book is devoted to discussions of various *Specific Interventions* in which a specific organisation, namely Nova Institute, was involved, along with the lessons learned. Several cases of specific hard-to-achieve or tough organisational interventions in the fields of clean air and health (Chapter 3), clean energy (Chapter 4), waste (Chapter 5), sanitation (Chapter 6), and early childhood education (Chapter 7) are presented as case studies. But in a sense, the whole book is a case study of a self-financed, independent organisation that works with households and other stakeholders at bettering the lives of low-income communities. It discusses practical examples of ground-level projects and developmental instruments, which are worth studying by similar-sized institutes, but also by large publicly funded bodies in the field of development. We hope to count them as readers of this book. Some challenges are similar regardless of whether the public interest body is large or small. In a project, for example, helping a community living in informal housing in an informal settlement to adopt a new way of meeting their needs for heating and cooking (see Chapter 4), science, statistics, economics, literacy, activism, town planning, and technology must work together. Nova's interventions flow from meticulous multidisciplinary research. This is a tough task. A special kind of consultant or consultancy body is needed. So, in discussing Nova's modi operandi (planning and managing interventions) and the deep thinking behind it, the book is also a contribution to Development Theory. In several chapters, the debt that authors owe to the Chilean economist and sociologist Manfred Max-Neef is apparent.

The real and often unhealthy and dirty environment in which low-income communities live looms large. An important aspect of the book is the concern for the environment, locally and globally, without becoming merely fashionable. The entire Earth is a big concern. However, the authors avoid trendiness. They value critical thinking, conceptual excellence, and methodological innovation (see Chapter 12).

In addition to specific interventions, the third part of the book is dedicated to *Transversal Issues* that typically feature in development work in a country such as South Africa. The best way to work with a community amidst the tension between consultation and collaboration is discussed in Chapter 9. True support of low-income families will flourish only if policy can be influenced, which raises the question of whether policy is informed by scientific evidence in South Africa. This is discussed in Chapter 10. The well-being of poor communities cannot come to the fore unless there are equitable service provision and spatial justice. This is the subject of Chapter 11. The burning issue of how much low-income households can benefit from the 4IR is discussed in Chapter 8.

Part 4 comprises two *Autoethnographic Chapters* (Chapters 13 and 14), where the reader meets two of the Nova directors in their cultural settings. Strong views highlight the complexities that we are faced with.

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Each chapter stands on its own. The authors are the authors in the full sense of the word. The careful reader will be able to discern a general trend in the book, but also observe differences between the views of the authors as is normal in scholarship. The editors provided footnotes to help the reader cross-reference information.

Chapter 1 introduces the overall vision of planetary well-being as signalled in the title of the book, *Development in the Anthropocene – The tough task of working towards planetary well-being with low-income households*. Montagu Murray argues in a philosophical vein that our evolving understanding of the implications of living in the time of the Anthropocene

calls for Planetary Well-being Goals that build upon, but can also improve, the Sustainable Development Goals (SDGs) of the United Nations (UN). The chapter shows that the idea of sustainable development must be reconsidered. The current epoch requires new thinking leading to a qualitatively and not only quantitatively better life and planetary well-being within an integrated system of humans and nature. The choice of *planetary well-being* instead of *sustainable development* is important for understanding the aim of the book. Montagu Murray introduces the ideas of the Australian public intellectual and thinker Clive Hamilton that feature prominently in the next chapter. The climax of the chapter is the identification of the Planetary Well-being Goals. Murray writes that planetary well-being goals (PWGs) can include many of the sustainable development goals (SDGs). "What must be asked in the case of each goal, target, and indicator, is not if it contributes to sustainable development, but if it contributes to planetary well-being".

Chapter 2 plays out at the intersection between Philosophy and Theology. Sytse Strijbos works towards his message by using two contrasts: the contrast between modernity and faith, and the contrast between climate alarmism (Hamilton) and eco-modernism (Allenby). The key point of the analysis is that these parties are inescapably caught in a conflict that cannot hope for a resolution. This is because they are rooted in modernity (arguably initiated by the English philosopher Francis Bacon [1561-1626]). Modernity disconnects the Earth from its relationship with Heaven and the Creator of Heaven and Earth. This chapter forces the reader to consider their position on the relationship between faith and technology.

Unlike much of the literature, Chapter 3, written by Christiaan Pauw and his co-authors, contextualises actions to decrease air pollution right inside the low-income home. The chapter provides a substantial exposition of the most important technical and intervention-related aspects that everyone interested in mitigating air pollution with public health in mind should understand. It is an ideal exposition for students as well

as officials who need to know the basics regarding clean air as a developmental and health issue.

The important Chapter 4, written by Kristy Langerman and her co-authors, links with the previous chapter in that we are still, as it were, inside the low-income home. Energy needs are on the agenda. A major contribution of the chapter is insights into intervention design. Important lessons to be gained from the way in which Nova plans interventions come to the fore in the cases discussed, as improving on interventions that are plagued by low adoption rates and households abandoning them after a short period of use. Nova's model is called the 'rational life cycle approach'. The various stages in such interventions are explained. The authors conclude, amongst others, that sustainability needs to be understood from the recipients' perspective as improving a household's ability to sustainably actualise their domestic energy needs.

In Chapter 5, Catherina Schenck, Antionette van der Merwe and Pierre Reyneke report on successful pilot projects in several provinces helping low-income families cope with waste handling where public waste removal services fail. The authors situate the need for waste handling within the situation of the planet as well as a progressive view of the economy. The idea is that a linear economy, where all production leads to waste, should be replaced with an economy that is circular and recycling. This is another example of where a Nova intervention is built upon thorough research and where those involved in applying the intervention are learning in the process.

Chapter 6 is based on both empirical research and philosophical understanding. Attie van Niekerk, Betsie le Roux, and Antionette van der Merwe apply the concepts of *lifeworld*, *sense of place* and *consciousness* to better understand the relationship between people, their environment, and the technologies (in this case sanitation) that they use. They present two case studies to illustrate how such philosophical theories can be applied. There is another aspect of this chapter that typifies this book and the way in which Nova works. The project was aimed at developing systems to improve the

situation in African communities, so African ways of thinking must be respected.

The family is central to the development. Chapter 7, written by Nicolette Roman, Catherine Senyolo and Antionette van der Merwe, is a case study of a project that differs from the other cases that the reader encounters in the book. This time it does not pertain to the physical environment, but to the social environment in the home, school, and church. The family is central to development in the Anthropocene. The case deals with early childhood development and the optimal way of organising interventions with this aim together with communities and their churches. This curriculum's core strengths are parental agency, the collaboration between the family and the early childhood development (ECD) centre, and whole-child development. Read between the lines and you will see that the project discussed here did not always run smoothly. Again, there is much to be learned from hitches.

Chapter 8 by Christiaan Pauw is a sober but optimistic exploration of the contribution the so-called Fourth Industrial Revolution (4IR) can make to bettering the lives of low-income families. Nova identified 25 elements that facilitate the actualisation of fundamental human needs in the context of the household as a complex system. This instrument is used on which to hang the investigation. In general, the fruits of the 4IR benefited well-off families more than low-income families. However, in the field of learning, opportunities do exist for low-income families to benefit from this industrial revolution. Pauw also considers the economic and political implications of 4IR and concludes that it is too early to say how this will turn out in this context.

Chapter 9 is a provocative picture of the inadequacy of half-baked consultation in the context of so-called wicked problems. Niké Wesch, Selna Cornelius and Jako Viviers set out a well-known hierarchy of consultation. This forms the background of a comparison between two cases using a strengths, weaknesses, opportunities, and threats (SWOT) analysis, intending to compare the SWOT posed by varying

levels of public participation. The research contributes insights to the discourse on effective decision-making strategies and empowering communities through participatory engagement. As in other chapters, a project installing semi-continuous stoves in low-income households is in the offing.

The long Chapter 10 deals with a deceptively simple question of whether environmental policy in South Africa is evidence-based. In an articulated case study, the four authors deal with four aspects of this question: First, evidence-based policy theory, and then the respective policies for air quality (also see Chapters 3 and 4), waste (also see Chapter 5), and water. After conducting conceptual work on the definitions of policy and evidence, they investigate what happened in South Africa in the 21st century in these three fields. They conclude that the role of evidence in this area of policymaking depends on the historical context and the level of physical detail involved. For example, when standards for ambient air quality are to be determined, scientific evidence plays a bigger role than when a white paper is written.

Chapter 11, written by Caroline Newton and her co-authors, emphasises the existence of inequalities and poses the question of how deteriorating services contribute to social injustice, specifically spatial injustice. This chapter shares a concern for policy with the previous one. A theoretical scene-setting is followed by analyses of information gathered from Nova's work in two townships. This is augmented by a study of policies. The findings reveal significant inequities in access to services, highlighting challenges in access to water, electricity, waste disposal, and housing. Spatial justice and service rendering must be seen against demographics and South Africa's past.

Chapter 12 by Valerie Møller and Montagu Murray is a contribution to Quality-of-Life studies and the Social Indicator Movement (SIM). It also provides a picture of interventions in practice. It is a chapter rich in ideas and information. Readers are, for example, given the opportunity to become au fait once more with the working of stoves providing energy to low-income

households. The authors discuss, amongst others, instruments developed by Nova and applied with great success in its projects. The Nova Institute follows an intervention life cycle approach in intervention development that requires assessing the feasibility of interventions or intervention combinations before proceeding to larger-scale implementation, as also explicated in Chapter 4. This chapter scrutinises the process and results followed in feasibility assessments of interventions in two townships aimed at replacing or reducing wood use, the burning of domestic waste, and the use of paraffin. The feasibility assessments are conducted with a novel tool that Nova developed, the *Particular impact on quality-of-life assessment* (Piqola) tool. The instrument is also featured in Chapters 4 and 9.

Chapters 13 and 14 present personal stories of people in whose lives Nova plays an important role – Luc Kabongo and Christiaan Pauw. They are both directors of Nova. As they tell their stories, they also cast light on broader societal and even political issues – hence the concept of autoethnography. Luc Kabongo is a missionary who chose to live with those to whom he aims to proclaim the gospel in a very practical sense by helping them to change their material lives for the better. This is the spirit that he shares with Nova. Christiaan Pauw also has a faith background and has a passion for making people's lives better. Still, he is allergic to the hegemonic way in which certain ideas seem to dominate environmentalism. This resulted in a certain scepticism of leading ideas and idols. He describes his road to hesitancy regarding aspects of the environmentalist grand narrative.

Chapter 15, written by the editors, draws the most important strings together. They show that the book gives substance to the aphorism *Think Globally, Act Locally.* Under the rubric of *Think Globally,* they pay attention to the first word in our title, "Development". A proper conclusion to the book requires an explication of the concept with emphasis on how the concept is advanced in our analyses. In this, the care for and integrity of the global environment is essential and carries implications for the integrity of well-meaning agents who understand their place in creation. Under the *Act Locally* part, some of Nova's

interventions working together with low-income families and other stakeholders, are recounted. This is a tough task requiring technology: both physical and process technology. The editors also mention how science supports the interventions and the importance of collaboration with communities.

Part One

Philosophical considerations

Chapter 1

Planetary well-being as development goal in the Anthropocene

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Abstract

The 2030 Agenda for Sustainable Development, which sets out 17 goals with a comprehensive vision for sustainable development globally, was adopted by all the countries in the United Nations in 2015. The 17 Sustainable Development Goals (SDGs) build upon, but are also an improvement on, the eight Millennium Development Goals (MDGs) adopted by UN member states in September 2000. In this chapter, it will be argued that our evolving understanding of the implications of living in the time of the Anthropocene calls for Planetary Well-being Goals (PWGs) that build upon, but can also improve, the SDGs. Planetary well-being can be defined as the highest attainable standard of well-being for human and living non-human beings within the integrated Earth system. The meaning of this concept will be explored, drawing on disciplines such as Philosophy, Development Studies, Quality of Life Studies, Sociology, Geology, and Theology. The analysis is further informed by personal experiences in development work and quality-of-life impact assessments. The chapter concludes with a list of possible PWGs and some of the most pertinent complexities to navigate going forward.

Keywords: Anthropocene, planetary well-being, quality-of-life studies, SDGs, social indicator research, sustainable development

1. Introduction

The 2030 Agenda for Sustainable Development sets out 17 goals with a comprehensive vision for sustainable development globally. It was adopted by all the countries in the United Nations (UN) in 2015 (UN, 2015a). The 17 Sustainable Development Goals (SDGs) build upon, but are also an improvement on, the eight Millennium Development Goals (MDGs) adopted by UN member states in September 2000 (UN, 2000).

In this chapter, it will be reasoned that our evolving understanding of the implications of living in the time of the Anthropocene calls for the rethinking of how humans approach development. The challenge for development in the Anthropocene is to improve human quality of life in such a manner that non-human life and the sustenance of the processes that underlie the well-being of the Earth system are at the same time conserved, restored, and, where possible, endorsed. This calls for an all-inclusive development goal of *planetary well-being*, which is more appropriate than *sustainable development* in the Anthropocene, as this chapter hopes to show.

Planetary well-being can be defined as the highest attainable standard of well-being for human and living non-human beings within the integrated Earth system. This chapter will not attempt to provide a broad overview of the planetary well-being concept. It has a more specific aim; namely, to explore why planetary well-being is a more appropriate all-inclusive development goal for the Anthropocene than sustainable development. Thus, rethinking the concept of development is aimed at how Planetary Well Being Goals (PWGs) and indicators can build upon and improve the UN SDGs and indicators. The chapter concludes with some ideas on navigating complexity in our approach to development going forward.

2. Our evolving understanding of the implications of being in a new geological epoch

The Anthropocene is a proposed new geological epoch to be added to the official geological time scale (GTS). A growing group of scientists argue that the Anthropocene epoch should follow the Holocene epoch and begin in the mid-20th century (Encyclopaedia Britannica, 2024). Lewis and Maslin (2015, p. 171) think that the impacts of human activity will probably be observable in the geological stratigraphic record for millions of years into the future, which suggests that a new epoch has begun. According to the Anthropocene Working Group (AWG) of the International Union of Geological Sciences (IUGS), the Anthropocene "has emerged as a popular scientific term used by scientists, the scientifically engaged public and the media to designate the period of Earth's history during which humans have a decisive influence on the state, dynamics and future of the Earth System" (Stratigraphy.org., 2024). The working group voted to recommend the Anthropocene as a formal geologic epoch in 2016 at the 35th International Geological Congress. For this interval to be made official, it must first be adopted by the IUGS and the International Commission on Stratigraphy (ICS) (Encyclopaedia Britannica, 2024).

Lewis and Maslin (2015) describe how human activity has altered the land surface, oceans and atmosphere, and re-ordered life on Earth. They explain how the beginning of the Anthropocene as a formal geological unit of time requires the location of a global marker of an event in stratigraphic material. Such material can be "rock, sediment, or glacier ice, known as a Global Stratotype Section and Point (GSSP), plus other auxiliary stratigraphic markers indicating changes to the Earth system" (Lewis & Maslin, 2015, p. 173). The evidence suggests that two dates appear to conform to the criteria to mark the beginning of the Anthropocene, namely 1610 and 1964 (Lewis & Maslin 2015, p. 175). The choice of either of these dates has significant political implications. If the Orbis spike[1] of 1610 is taken as the

1 A clear dip in carbon dioxide levels deduced to have occurred around 1610.

start of the Anthropocene (ibid), it would imply that colonialism, global trade, and coal brought about the Anthropocene, which has implications for the relationships between higher-income countries that have benefited from coal use from the time of the industrial revolution and countries that have been colonialised and started fossil fuel use more recently. If the bomb spike of 1964 is taken as the start of the Anthropocene, it emphasises elite-driven technological development that threatens planet-wide destruction.[2] Thus, the event or date chosen as the inception of the Anthropocene affects the stories which people construct about the ongoing development of human societies (Lewis & Maslin, 2015, pp. 177-178).

Hamilton thinks that the Anthropocene is "not just the continued spread of human impacts on the landscape or further modification to ecosystems, but rather a rupture in the functioning of the Earth System as a whole, so much so that the Earth has now entered a new geological epoch" (Hamilton, 2017, Chapter 1 The Anthropocene Rupture). Levis and Maslin (2015, p. 179) agree that human actions are driving far-reaching changes to the life-supporting infrastructure of Earth. They predict that recognition of the impact that humans have in the Anthropocene may well have increasing philosophical, social, economic, and political implications over the coming decades.

On 5 March 2024, *The New York Times* first reported that the Subcommission on Quaternary Stratigraphy (SQS) voted against the proposal to create an Anthropocene epoch (Zhong, 2024). Twelve members of the Subcommission voted against it, and only four voted in favour of it (Witze, 2024). However, a day after the first report, on 6 March 2024, the chair of the SQS, Jan Zalasiewicz, and one of the group's vice-chairs, Martin Head, said in a press statement that they are asking for the vote to be annulled. They alleged that "the voting has been performed in contravention of the statutes of the International Commission on Stratigraphy (ICS), including statutes governing the eligibility to vote" (Witze, 2024). Witze (2024) believes that the public and scientific discussions on the meaning of the Anthropocene

2 The bomb spike of 1964 refers to the peak in radionuclide fallout from nuclear weapons testing in that year.

will continue while the SQS and the ICS sort out how to handle Zalasiewicz and Head's request for a vote annulment.

The notion of this chapter is that, regardless of whether the Anthropocene is officially added to the geological timescale as a new geological epoch or not, it has become a concept that is used by scientists and broader society alike, to describe the growing understanding that humans and the Earth have entered a new phase of unprecedented human impact on the Earth system. This calls for the rethinking of how we humans approach development.

3. Rethinking our approach to development

Francis Fukuyama (2014, p. 7) notes that to study development is to study the change in human societies over time. The *Cambridge Dictionary* defines development as the process in which someone or something grows or changes and becomes more advanced (Cambridge Dictionary, 2025). If these two broad definitions of development are combined, it suggests that development has to do with a transition from one state to another, and the supposition is that the subsequent state is qualitatively better than the original state. Applied to humans, it would mean that human development is the process whereby individuals and societies transition to a qualitatively better state.

This definition is well-suited to explore the fundamental questions that underlie the complexities of an attempt to better understand and rethink our approach to development. Questions such as: "What is the original state that individuals and societies believe they must transition from? Why is the original state qualitatively inferior to the desirable state? How can we know that our evaluation of these states is accurate? These are the types of questions that philosophers study. As Sirgy et al. (2006, p. 352) put it: "Answers to the question 'What is it?' give us an ontology…Answers to the question 'What good is it?' give us an axiology…Answers to the question 'How do you know?' give us an epistemology."

The concept of well-being in Western philosophy originally evolved around two perspectives, hedonism and eudaimonism (Grénman et al., 2023; Sirgy et al., 2006, p. 384). Hedonism postulates that the pursuit of pleasure is the greatest good; and happiness is the total of hedonic moments. On the contrary, eudaimonism posits that a life of virtue should be pursued. Aristotle's definition of eudaimonia holds that true happiness is found by leading a virtuous life and doing what is worth doing (Grénman et al., 2023; Sirgy et al., 2006, p. 384). In the case of hedonism, it is qualitatively better to be happy than unhappy, and in the case of eudaimonism, it is qualitatively better to live a virtuous life than to lead an immoral life.

The process whereby individuals and societies transition to a qualitatively better state is not only the study object of Western philosophy. The meaning of development defined this way is an existential anthropological question that is universally contemplated in philosophical traditions as well as in religious traditions, including the monotheistic faith traditions, especially also in the Christian faith.

Although opinions and perspectives of theologians differ considerably, the Reformed tradition of Christian anthropology has a broad notion of what the undesirable original state of humans is, what a qualitatively better state is, and what is needed to transition to such a state. Humans are created in the image of God, but because of sin, find themselves in an undesirable state. A qualitative better state is a restored relationship with God. This is not achieved by human agency alone. The transition to such a state is made possible by Jesus Christ, God's revelation to humanity (Berkhof, 2007; McGrath, 2011; Pannenberg, 1991).

According to Dwivedi et al. (2007, Abstract), the "distinctively Western concept of development as progress has evolved from the Augustinian notion of the ascent of humanity from the City of Man to the City of God guided by divine providence to the ideas of progress in the Enlightenment, to social evolution, modernity, and the unfolding of human potential". Rist (2002, p. 33) describes how Augustine builds on

the ideas of Aristotle, and further how he took over and applied to humanity the metaphor frequently used by pagan writers, "which compared the Empire to a man passing from youth to maturity and then ineluctably entering old age". Augustine's work had a considerable influence on the history of development and opened the way to a linear view of history (Rist, 2002, p. 34).

General philosophical and theological reflection on the meaning of a good life underlies the worldview of the Western approach to development, but it must be distinguished from the way in which modern development thinking has evolved after the First and Second World Wars. Before the World Wars, the trade from the 15th century onwards and the colonisation that followed established a *mode of global accumulation,* setting in motion the process of development in modern Europe. Conversely, in the opinion of Dwivedi et al. (2007), it laid the foundation for the underdevelopment of the conquered and colonialised territories in the Americas, Africa and Asia.

Foundational work in the measurement of national income, starting in the late 1920s, was conducted by Simon Kuznets, the third Nobel laureate in economics, who played a leading role in the early development of the United States' (US) official measures of national income. Kuznets was a founder of the National Bureau of Economic Research (NBER), and subsequently the International Association for Research in Income and Wealth (IARIW) (Sirgy et al., 2006). But it was the inauguration speech of the American President Harry S. Truman in 1949 that launched the development age (Dwivedi et al., 2007; Rist, 2002, p. 71; Sachs, 1999, p. 3). According to Rist, it was the Fourth Point of President Truman's speech that caught the most attention in the media:

> Fourth, we must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas.... Greater production is the key to prosperity and peace. And the key to greater production is a wider and more vigorous application of

> modern scientific and technical knowledge.... On the basis of these four major courses of action we hope to help create the conditions that will lead eventually to personal freedom and happiness for all mankind (Rist, 2002, p. 3).

According to Rist (2002, p. 74), it is of particular significance that the adjective 'underdeveloped' appears at the end of the opening paragraph of Point Four, for the first time used as a synonym for *an economically backward* area. Therefore, underdevelopment is not the opposite of development, but its embryonic form, and "...an acceleration of growth was thus the only logical way of bridging the gap".

Sachs (1999, p. 28) observes that Truman's speech points to a new worldview, where the degree of civilisation in a country could be measured by the level of its production: "There was no longer any reason to limit the domain of development to resources only. From now on, people and whole societies could, or even should, be seen as the objects of development".

This mode of thinking laid the foundation for a new approach to development, where international effort and collective enterprise, based upon an increase in production and better use of the world's natural and human resources, should result in everyone becoming richer and more prosperous: "The key to prosperity and happiness was increased production, not endless debate about the organisation of society, ownership of the means of production, or the role of the State" (Rist, 2002, p. 76). Therefore, Point Four of President Truman's speech imposed a new standard, whereby the US stood right at the top: namely, gross domestic product (GDP) (Rist, 2002, p. 76). Sachs (1999, p. 5) calls this an *anti-colonial imperialism*, where development was the conceptual vehicle that allowed the US to behave as the herald of national self-determination while at the same time founding a new type of worldwide domination.

Suddenly, a concept that has since become indispensable was established, cramming the immeasurable diversity of the globe's South into one single category - the underdeveloped. That Truman coined a new word was not a matter of accident but the precise expression of a worldview: for him, all the

peoples of the world were moving along the same track, some faster, some slower, but all in the same direction (Sachs, 1999, p. 28).

But gradually, the emphasis on GDP as the principal measure for the level of a country's development came under critique. The 1960s saw the beginnings of the use of social indicators: Olson, the coordinator of *Toward a Social Report,* pointed out the inadequacy of economic indicators, such as the GDP, to reflect the well-being of nations. Indicators are needed, he said, to inform public policy respecting social problems and to provide insight into how different measures of national well-being are changing. QOL studies arose within the movement to advance the use of social indicators in research and in informing public policy (Sirgy et al., 2006, pp. 364-365).

The *Dag Hammarskjöld Report, What Now: Another Development*, was published in 1975. The report aimed to set the direction for 'another development' qualitatively better than a blind focus on gross national product (GNP) and other purely economic indicators of development. Development, according to the report, should be geared towards the satisfaction of human needs, beginning with the eradication of poverty. The other novelty in the Hammarskjöld Report, according to Rist (2002, p. 156), was that it considered *development* as a global phenomenon concerning not only the developing nations but also the industrialised countries. In 1985, a project was initiated by the Dag Hammarskjöld Foundation and the Alternatives Centre (CEPAUR) in Chile that further worked out the concept of *Human Scale Development*. The project was directed by Manfred Max-Neef (Max-Neef et al., 1991). Max-Neef et al. formulated a new theory of needs for development that, to a significant extent, overcomes the deficiencies of the basic needs approach (Cruz et al., 2009; Murray & Pauw, 2022). Max-Neef et al.'s work made a significant contribution in articulating the manner in which human quality of life is related to the possibilities of humans to actualise their fundamental human needs (Murray & Pauw, 2022).

A further advancement in development thinking was the insight that human quality of life and the well-being of the environment are interrelated. The first time that *development* and *environment* were considered together as a matter of serious consideration, was in the *Our Common Future*, report led by Brundtland, a doctor who had for a time been Minister of the Environment and was then Prime Minister of Norway: "Ecological damage was long seen as a regrettable, but necessary cost of growth, and as justifiable in terms of the benefits of 'development'. The two phenomena were treated as separate but reconcilable. This is no longer possible" (Rist, 2002, p. 179). The Brundtland Report defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (ARE, n.d.).

At the beginning of the new millennium, when world leaders gathered at the United Nations to shape a broad vision to fight poverty, the emphasis on environmental sustainability was included as Goal 7: Ensure environmental sustainability (UN, 2000).

In 2015, the Millennium Development Goals (MDGs) were followed by the 2030 Agenda for Sustainable Development. The 2015 Millennium Development Goal Report concludes:

> A bold new agenda is emerging to transform the world to better meet human needs and the requirements of economic transformation, while protecting the environment, ensuring peace and realizing human rights. At the core of this agenda is sustainable development, which must become a living reality for every person on the planet (UN, 2015).

Sachs (1999) and Rist (2002) are both critical about the ability of sustainable development to harmonise or achieve positive human and ecological outcomes simultaneously.

According to Sachs (1999, p. 60), the Brundtland Report "incorporated concern for the environment into the concept of development by erecting 'sustainable development' as the

conceptual roof for both violating and healing the environment". He says that the ecological crisis can be read as a clash of the timescale of modernity and the timescales that govern life and the Earth (Sachs, 1999, p. 189). The new concept, sustainable development, subtly shifted the locus of sustainability from nature to development: "instead of nature, development becomes the object of concern, and instead of development, nature becomes the critical factor to be watched" (Sachs, 1999, p. 81). Rist (2002, p. 184) agrees, noting that development makes it possible to increase production by using up reserves at a rate dependent not upon their necessary replacement time but on the state of existing technology.

From the discussion thus far, it can be argued that the 'concept of development' has itself developed in the last century to become qualitatively better by including new insights without abandoning insights of previous phases. The emphasis on GDP, despite many shortcomings, was qualitatively better than the colonial era, insofar as it opened opportunities for developing countries to participate more actively in trade and international fora and gradually take up a more important role in international affairs. The human needs approach was qualitatively better than solely focusing on GDP, and the way in which people such as Max-Neef and Amartya Sen further developed the human needs and capabilities approaches, articulating their importance for human quality of life, is a further development. Likewise, the emphasis on sustainable development adds the insight that human quality of life cannot be pursued without consideration of the environment. But sustainable development, as was argued, has its shortcomings, and the Anthropocene is the time to move to the next qualitatively better development ambition, namely, planetary well-being. Thus, the evolution in the understanding of the concept of human development (specifically how it unfolded in the Western philosophical tradition), can be summarised in broadly six phases: (1) pre-modern, (2) colonial trade, (3) modern GDP, (4) human needs, (5) sustainable development, and (6) planetary well-being.

Before further discussing planetary well-being as an appropriate development goal for the Anthropocene, two

assertions made thus far need further explanation; namely: i) human development is the process whereby individuals and societies transition to a qualitatively better state, and ii) there was an evolution in the last century whereby the general understanding of the concept of development has evolved and became qualitatively better.

The evaluation that there was qualitative progress in the past century in the understanding of what development entails should not be seen as a claim that development always progresses forward in a linear manner, or as a motion of confidence in human capabilities to avoid environmental disaster through the application of human ingenuity and technology.

Cruz et al. (2009, pp. 2021-2022) describe how there was a 'chrematistic turn' that only emerged in modern times, with the free-market institution, which was a reductionist turn away from Aristotle's classic distinction between *oikonomia* (the art of household management) and *chrematistics* (the art of acquisition). In pre-modern times, commerce was just one amongst four main ways in which human societies ordered their *oikonomic* process: Self-sufficiency (production for self-consumption); reciprocity (based on reciprocal actions within and across different social groups); redistribution (whereby the product is redistributed amongst the members of a group) and commerce (chrematistics). In these societies, use-value was more important than exchange value per se (Cruz et al., 2009, p. 2022).

Thus, the mode of global accumulation and the growth drive, as it manifested in colonialism and the development drive after the World Wars, was more reductionist than the art of living and living well as proposed by Aristotle's eudaimonic approach to a good life. It can be argued that the emphasis on growth as an end in itself and resulting behaviour such as consumerism, stands closer to the hedonistic tradition, whereas an emphasis on human needs and capabilities, and planetary well-being coincides with the eudaimonic interpretation of a virtuous life. The concept of sustainable development is

interesting in this regard when assessing it against these broad traditions, since it depends on what is understood by 'development'. If *sustainable development* means that economic growth must be sustained, it implies that sustained growth is the answer to a good life for the largest number of people. However, if *development* in *sustainable development* means to become something qualitatively better, the concept can include the broader description of *oikonomia* as articulated by Aristotle.

The notion to *transition to a qualitatively better state,* as proposed here as part of the definition of human development, is significant. It can be argued that the hedonic approach, whereby an increase in the number of hedonic moments amplifies happiness, emphasises the *quantitative*. Likewise, the fixation on economic growth as an end in itself, and the idea that increasing consumption of goods and services purchased in the market is always a desirable goal, focuses on *quantitative growth* through increased consumption. In contrast, the eudaimonic approach has a *qualitative* focus on a broad range of aspects and characteristics that constitute a virtuous life. Similarly, the concepts of fundamental human needs and capabilities and planetary well-being include *qualitative attributes* that constitute a good life. However, it is important to note that the *qualitative approaches* do not exclude *quantitative aspects*. In other words, the eudaimonic approach does not generally disallow enjoyment of life, but it criticises the view that maximum enjoyment is the way to a good life.

As mentioned above, the assertion that there has generally been progress in the last century in our understanding of what human development entails should not be taken as a motion of confidence in human capabilities to avoid environmental disaster through the application of human ingenuity and technology. There are numerous views about the impact that humans have on Earth in the time of human-induced climate change. Hamilton (2017) identifies "deniers and religious fundamentalism, deep greens and ecocentric philosophers, ecomodernism, and avatars of the ruling system and its intellectual apologists" (Hamilton, 2017, Do doubt

everything). However, he chooses an approach that he dubs 'new anthropocentrism':

> At the heart of the new anthropocentrism stands the "embedded subject," a character who expresses the double truth of the human in the Anthropocene, that is, the possessor of autonomy but one always guided and constrained by its assimilation into the processes that govern the Earth System.…The new anthropocentric self does not float free like the modern subject, but is always woven into nature, a knot in the fabric of nature. Embeddedness in the new view is neither local nor abstractly universal but defines an agency that is planetary, immersed in an Earth-world built by us out of nature but constrained by it, enjoying autonomy and power but increasingly up against an opponent that resists our autonomy and tightens the constraints (Hamilton, 2017, The new anthropocentrism).

Hamilton (2017) emphasises that new anthropocentrism should not be misunderstood as close to ecomodernism that remains entrenched in the humanist tradition in which human spontaneity and creativity make the future. The Anthropocene has brought a new understanding, which is "anti-humanist because it recognises the hard constraints on world-making imposed by a finite and untameable Earth" (Hamilton, 2017, The new anthropocentrism versus ecomodernism). He pleads for an ontology founded on human-distinctiveness-within-networks rather than an ontology that deprives humans of their unique form of agency: "The task now is not to reject the subject-object division but to understand the particular form that subjectivity has taken and what it must become".

The notion of this chapter is that *what we must become*, as Hamilton (2017) puts it, must be something qualitatively better. Furthermore, the assertion is that planetary well-being has emerged as the most appropriate development goal to strive for in the Anthropocene.

4. Planetary well-being as development goal

The definition of planetary well-being proposed in this chapter is that it is the highest attainable standard of well-being for human and living non-human beings within the integrated Earth system. This definition is closer to the definition of Antó et al. (2021) than to Elo et al. (2023).

Antó et al. (2021, p. 1) define planetary well-being as "the highest attainable standard of well-being for human and non-human beings and their social and natural systems". The definition proposed by this chapter specifies that well-being pertains to the well-being of human and *living* non-human beings within the *integrated Earth system*.

Kortetmäki et al. (2023, p. 23) define planetary well-being as a state in which the integrity of Earth system and ecosystem processes remains unimpaired to a degree that lineages can persist to the future as parts of ecosystems, and organisms (human and non-human) can realise their typical characteristics and capacities. Although the comprehensive work of Kortetmäki et al.'s (2023) *Interdisciplinary Perspectives on Planetary Well-being*, has to be appreciated, the reference in several of the articles of this work to a *non-anthropocentric* approach has to be critically evaluated. As argued earlier in this chapter, the view of Hamilton (2017) that an ontology founded on human-distinctiveness-within-networks rather than an ontology that deprives humans of their unique form of agency should be supported. Thus, while the insight of Kortetmäki et al. (2023) that the Earth system includes non-human beings and processes that are inherently valuable should be applauded, the use of the term *non-anthropocentric* leads the discussion in the wrong direction. As was argued in the previous paragraph, there has been an evolution in the interpretation of development. In each case, the insights of previous development paradigms were not abandoned but rather expanded. And in each case, the next concept builds on the insights of the previous concepts. Using the term *non-anthropocentric*, in the time of the Anthropocene is misleading. Understandably, this term is used by some to emphasise that the object of study should shift from being

focused on humans alone to a focus on the Earth system and to acknowledge non-human beings as inherently valuable in their own right. However, non-human beings cannot participate as agents in setting and evaluating progress towards planetary well-being development goals – it is humans who determine these goals. It is futile to disregard the importance of human quality of life and agency in planetary well-being. The endeavour should not be to make humans less important and non-humans more important, but to acknowledge the importance of sustaining the well-being of humans and living non-human beings within the integrated Earth system. Despite the critique regarding the interpretation of Kortetmäki et al. (2023) of the non-anthropocentric emphasis of the planetary well-being concept, their assessment that planetary well-being takes a systems- and process-oriented approach should be appreciated.

A further difference between the definition of planetary well-being that this chapter proposes and the definition of Kortetmäki et al. (2023), is that Kortetmäki and her co-authors emphasise the integrity of Earth system processes (such as the global climate and biogeochemical cycles of elements) and ecosystem-level processes (such as succession and pollination) instead of organismal well-being. They argue that at the organism level, "all life is rife with conflicts such as predator-prey relations, and consequently not all organisms can 'be well' all the time". This view cannot be accepted unconditionally. Although it is important to protect species, the rights and well-being of individual humans and individual living non-human beings remain important, and the dilemma caused by the rift between individuals and species cannot be solved by ignoring the existence and intrinsic value of individual lives. The task of working towards well-being becomes more difficult and more complex in the Anthropocene. Whereas the emphasis on justice in previous development paradigms included the consideration of equality between nations and individuals, and later also acknowledging the rights of future generations, with planetary well-being a further insight has emerged, namely that living non-human beings also have rights that should be respected

and that humans and living non-human beings are dependent on the integrated Earth system.

There is no universal guideline that will suffice to solve these complexities. However, this chapter contends that an understanding of what planetary well-being entails, and commitment to work towards all-inclusive planetary well-being goals, can assist individuals, social institutions, industries, and countries to perform things qualitatively better. The debate on what "qualitatively better" entails in each case and the weighing of trade-offs between the clashing needs of humans amongst themselves and the needs of humans and living non-human beings will only intensify. The reaction to this increase in complexity can trigger various responses. One extreme attitude is *over-optimism*, the belief that these complexities can be solved by human ingenuity and technology. Another extreme position is *fatalism*, a pessimistic conviction that humanity is doomed because of climate change and environmental exploitation and that there is nothing that can be undertaken to change the catastrophic fate that awaits humanity and other species. The approach of this chapter is somewhere in between these extremes. Although it is an exceptionally tough task to work towards planetary well-being, all is not lost. It is possible for individuals, societies, and nations to grow qualitatively to "something better". Thus, development does not mean quantitative economic growth, although such growth is not excluded. Development means to grow into something qualitatively better. Therefore, the notion is that planetary well-being as a development goal is a qualitatively better goal to strive for in the Anthropocene than the previous development goals proposed since the times of colonialism and the two World Wars. Importantly, the claim that development has taken place; in other words, that transition to a qualitatively better state has taken place, has to be based on evidence. This calls for planetary well-being goal indicators.

5. Towards planetary well-being goal indicators

The concept of *planetary well-being* includes human well-being and the well-being of living non-human beings within

the integrated Earth system. Therefore, the establishment of relevant indicators should include indicators that measure human well-being, as well as indicators that measure the well-being of living non-human beings, and the supportive Earth system processes.

As was reasoned earlier in this chapter, there was an evolution in the understanding of the concept *human development* in the last century, whereby the emergence of new insights leads to qualitative improvements, without abandoning the insights of previous phases. This means that the establishment of planetary well-being indicators must build on the work that has been performed in the past century. The most comprehensive set of indicators that planetary well-being indicators can build on is the UN SDGs (UNDESA, 2023).

De la Rosa Ruiz and Carrascal Domínguez (2022) provide a comprehensive list of conventions that contributed to the creation of the SDGs. In the First United Nations Development Decade (1960 to 1970), programmes were created to eliminate illiteracy, hunger and disease and promote inclusive education. The United Nations Development Programme (UNDP) was created during this decade in 1965. When the first measures were evaluated, it was noted that the set goals had not been reached. Therefore, the Second United Nations Development Decade (1971 to 1980) was proclaimed, which contains terminology, ideas and approaches that are linked to the SDGs, such as goals, targets, reviews, and assessments. The Third (1981 to 1990) and Fourth (1991 to 2000) United Nations Development Decades set out new strategies to achieve the Millennium Development Goals (UN, 2000). Several conferences laid the ground for UNDP work for the SDGs including the World Summit for Children, the United Nations Conference on Environment and Development, the World Conference on Human Rights, the International Conference on Population and Development, the World Summit for Social Development, the Fourth World Conference for Women, and the Second United Nations Conference on Human Settlements (De la Rosa Ruiz & Carrascal Dominguez, 2022, pp. 100-102). The UN Department of Economic and Social Affairs (UNDESA) describes the history

of the SDGs, stating that the SDGs build on decades of work by countries and the UN, including the work of their department (UN, 2015).

At the beginning of the new millennium, world leaders gathered at the United Nations to shape a broad vision to fight poverty in its many dimensions. This led to the eight Millennium Development Goals (MDGs) (UN, 2000). The eight goals were: Goal 1: Eradicate extreme poverty and hunger; Goal 2: Achieve universal primary education; Goal 3: Promote gender equality and empower women; Goal 4: Reduce child mortality; Goal 5: Improve maternal health; Goal 6: Combat HIV/AIDS, malaria and other diseases; Goal 7: Ensure environmental sustainability; and Goal 8: Develop a global partnership for development (UN, 2000). The Millennium Development Goals Report of 2015 (UN, 2015b) states:

> Although significant achievements have been made on many of the MDG targets worldwide, progress has been uneven across regions and countries, leaving significant gaps. The gaps mentioned include persisting gender inequality, gaps between the poorest and richest households, and between rural and urban areas, climate change and environmental degradation undermine progress achieved, and poor people suffer the most, conflicts remain the biggest threat to human development, and millions of poor people still live in poverty and hunger, without access to basic services (UN, 2015b).

The MDGs were followed by the 2030 Agenda for Sustainable Development, adopted by all United Nations members in 2015 (UN, 2015a), which created 17 Sustainable Development Goals (SDGs). They were created with the aim of peace and prosperity for people and the planet (UN, 2015a). The short titles of the 17 SDGs are: No poverty (SDG 1); Zero hunger (SDG 2); Good health and well-being (SDG 3); Quality education (SDG 4); Gender equality (SDG 5); Clean water and sanitation (SDG 6); Affordable and clean energy (SDG 7); Decent work and economic growth (SDG 8); Industry, innovation and infrastructure (SDG

9); Reduced inequalities (SDG 10); Sustainable cities and communities (SDG 11); Responsible consumption and production (SDG 12); Climate action (SDG 13); Life below water (SDG 14); Life on land (SDG 15); Peace, justice, and strong institutions (SDG 16); and Partnerships for the goals (SDG 17) (UN, 2015a).

Each of the 17 goals has targets, and each target has indicators used to measure progress towards reaching the targets. The targets are either outcome targets (circumstances to be attained) or means of implementation targets (Bartram et al., 2018). The SDGs are a qualitative improvement on the MDGs, but some targets and indicators are still in the paradigm that understands development as economic growth, in the tradition of Harry Truman and that ultimately divides the world into Developed and Developing countries. Compare, for example, SDG Targets 8.1 and 17.2:

> *SDG 8.1: Sustainable Economic Growth*
>
> Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries (ICCROM, 2025).
>
> Target 17.19: Further develop measurements of progress
>
> By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries (UNStats, 2025).

It does not fall within the scope of this chapter to evaluate the comprehensive list of SDG goals, targets, and indicators. The argument is that in the time of the Anthropocene, we need to incorporate the emerging understanding that humans and living non-human beings are part of the integrated Earth system. This requires that human development be defined as the process whereby individuals and societies transition to a qualitatively better state. A qualitative better state can include quantitative growth, but importantly, it does not depend on quantitative

growth. This is a more appropriate definition for development than definitions that presuppose economic growth as the only way to further human development.

As was argued earlier in this chapter, the emergence of new insights leads to qualitative improvements, without abandoning all of the insights of previous phases. Therefore, planetary well-being indicators can refer to many of the SDGs. What has to be asked in the case of each goal, target, and indicator, is not if it contributes to sustainable development, but if it contributes to planetary well-being. The shift to planetary well-being as the ultimate goal, as opposed to sustainable development or human quality of life, does not entail taking on a non-anthropocentric approach, but rather realising that we have entered an epoch that is more anthropocentric than ever before. The challenge is not to shift the focus from human well-being towards non-human well-being. It is rather to realise that in pursuit of every human development goal, there are planetary well-being implications. Therefore, human development should be planned, designed, executed, and monitored in such a manner that planetary well-being goals are considered and optimised.

Furthermore, what must be worked out in more detail are the trade-offs between goals, targets, and indicators, asking not only about the relationship between richer and poorer countries, and considering future human generations, but also thinking about the rights of living non-human beings. Sterba (2014), as quoted by Stamm et al. (2023), argues that a reconciliation between anthropocentric and non-anthropocentric ethics is possible. He acknowledges the intrinsic value of all species, but he argues that in certain circumstances the well-being of humans can be prioritised, for example in the case of *human defence* and *human preservation*. However, the *principle of disproportionality* must also be considered: actions that meet non-basic or luxury needs of humans are prohibited when they aggress against the basic needs of animals and plants (Stamm et al., 2023, p. 183).

Although the SDGs are intended to include the creativity, know-how, technology, and financial resources from all of society in working together towards achieving the goals (compare SDG 17) it is difficult for most persons to remember seventeen goals. A simpler model is needed to make it possible for important stakeholders such as children in their early childhood to participate and take ownership of the vision towards a qualitatively better future. The seven Planetary Well-being Goals (PWGs) proposed in the illustration below include, but are not limited to, the seventeen SDGs.

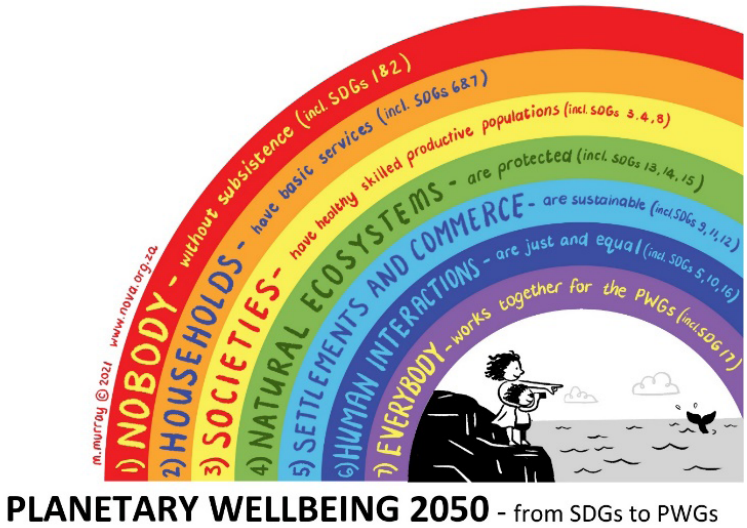


Figure 1: Planetary well-being – designed by the author

Thus, the PWGs that this chapter proposes are:

1. NOBODY without subsistence
2. HOUSEHOLDS have basic services
3. SOCIETIES have healthy, skilled, productive populations
4. NATURAL ECOSYSTEMS are protected, restored, and endorsed
5. SETTLEMENTS AND COMMERCE are sustainable
6. HUMAN INTERACTIONS are just and equal
7. EVERYBODY works together for the PWGs

6. Navigating complexity - some ideas for the way forward

What is new in the Anthropocene paradigm is not complexity per se but the urgency to better understand the impact of humans on the Earth system, and to act timeously and on scale to lessen the negative impacts that humans are causing. Navigating complexity means finding a mid-way between the extremes of fatalism and optimism in human attempts to transition to a qualitatively better state. The knowledge that we only have a partial, or even limited, understanding of the workings of the Earth system does not mean that we should not invest our efforts in attaining a better understanding of how various natural and social subsystems relate to each other and how the constitutive parts of the system contribute to the system as a whole. According to Sachs (1999, p. 120), "the biosphere is conceived as a system of interactive components where no single part – oceans, atmosphere, rock, vegetation, animal world, human beings - can be adequately understood in isolation from the others; the sciences - and particularly the bio-sciences on one side and the geo-sciences on the other – are challenged to undertake greater integration". Planetary well-being as a development goal will need the insights which the human sciences render on the *relations of meaning*, and the insights which the natural sciences render on the *relations of cause and effect, and probabilities* (compare Sachs, 1999, p. 181).

It is unavoidable that there will be certain hierarchies and conflicts in terms of how we value the individual and collective lives of individuals and the lineages of species. There will also be a hierarchy in terms of our understanding of phenomena and systems, as well as our ability to intervene responsibly with the intention to positively impact planetary well-being.

What this chapter has presented is not a solution to the complex challenges that face humanity in the Anthropocene. It asserts that planetary well-being is a qualitatively better all-inclusive development goal for the Anthropocene than sustainable development, especially if sustainable development means that growth must be sustained as the key to a better life

for all. Instead, it has been proposed that human development means transitioning to a qualitatively better state. To strive for planetary well-being, means to include humans and living non-humans as part of the Earth system in the reflection when strategies are drafted aimed at qualitative improvement by various stakeholders, locally, nationally, and internationally. Through interconnectedness, made possible by technology, more and more people are local and global citizens simultaneously. Through the World Wide Web and social media many are aware of happenings far from where they find themselves. This participation is not only as consumers of information, but there is also the real possibility to contribute by participating in conversations with others on multiple platforms. The question arises: If I am a local and a global citizen in terms of my participation in conversation, am I not, and how can I also be a global citizen in terms of my responsibilities? The universal and local are interconnected in ways that have never been possible before. The *Internet of Things* (IoT) and *artificial intelligence* (AI) will further increase the number of connections. It is not possible to turn the wheel backwards again and pretend that we have not seen the satellite images of Earth from space, showing the delicate Earth, our home, bursting with life. Earth is observed in this satellite image as one system in space, with no prominent boundaries observable, such as the divide between rich and poor, developed and underdeveloped, and Global North and Global South. The distinction between the Global North and the Global South is a boundary that stands in the paradigm of Harry Truman's distinction between developed and underdeveloped people of the world. It is a boundary that can be abolished in the Anthropocene.

Sachs (1999, p. 172) refers to the interesting concept of 'environmental space'. He argues that it captures the two central concerns of sustainability; namely, the concern for ecology and the concern for equity and he asks: "Are the rich countries capable of living without the surplus of environmental space they appropriate?" Environmental space is a broader concept than, for example, a carbon footprint. Most interesting would be if environmental space is calculated backwards and forwards

in time. Rich countries have consumed much environmental space in the past century, but likewise, poor countries will take up more and more environmental space if they follow the same developmental trajectory as richer countries. If the average life expectancy of an individual is 75 years, and if the average age at which a person has their first child is 25 years, then it means that this individual will be alive together with their offspring into the third and in some instances, the fourth generation. We cannot pretend that it does not make a difference how many children people have when calculating the carbon footprint or environmental space of an individual and their offspring. A new paradigm would be to regard all persons and countries as world citizens and to calculate environmental space looking backwards and forwards in time.

To move forward in the Anthropocene, we should move beyond the type of discourses that portray the Global North as the sole sinner and the Global South as the beggar, who hopes to benefit materially from the guilt which the North accumulated since colonial times to the detriment of justice and the ecology (compare Murray, 2003). We are all human beings in need of human development; namely, to transition to something qualitatively better. With satellite and other technologies, we continue to learn how small and fragile we are and how precious life on Earth is. Our salvation does not principally depend on economic growth: we need to rediscover what it means to be human. Humans are the only species that we know of at this stage that contemplates the meaning of planetary well-being and prays that we succeed in transitioning to something better. May our prayers be answered.

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Chapter 2

The battle of faith and technology in the Anthropocene: climate alarmism versus eco-modernism – between rupture and next step

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Abstract

Many people today are seriously concerned with global warming because of human actions and, consequently, the liveability of our planet for future generations. In the societal debate, two directly opposing camps face one another in a contest around faith and technology in the Anthropocene. This chapter offers a critical analysis of both by discussing the ideas of two of its prominent exponents, namely Clive Hamilton (for the climate alarmists) and Braden Allenby (for the eco-modernists). The key point of the analysis is that these parties are inescapably caught in a conflict which cannot hope for a resolution. This is because they are rooted in modernity, which disconnects Earth from its relationship with Heaven and the Creator of Heaven and Earth.

Keywords: Anthropocene, climate alarmism, ecomodernism, faith, heaven and earth, modernity, technology

1. Introduction

Let me start with a personal anecdote from my student days in Delft. As a young student in Applied Physics, I took an optional course offered by a Philosophy professor. During one of his first lectures, the latter remarked rather casually about

what he considered as his central task in his teaching. He said something like: 'You are studying here to become engineers. I would like to contribute to your broader academic education. I am a Christian myself, and for me, that means that I do not see *faith* and *technology* as two separate worlds that are completely unconnected. No, technology is not a neutral matter but is supported by a vision of faith'.

Having grown up in the Christian faith tradition, these words obviously must have touched me at the time because they have stuck with me and spontaneously resurfaced in my memory while I was writing this essay. While trying to find my way through the contemporary debate on the Anthropocene, while I was ploughing through an ever-growing pile of literature on the subject, it dawned on me that for many there is something like a shock experience with unmistakably religious traits, a shock experience of power and powerlessness with technology. The foundations of our technological world and human self-understanding have been shaken according to French historians Christophe Bonneuil and Jean-Baptiste Fressoz in their book *The Shock of the Anthropocene* (2016, p. 25): "It is our own model of development, our own industrial modernity, which, having claimed to free itself from the limits of the planet, is striking Earth like a boomerang."

At least this much is clear from this quote: the Anthropocene raises fundamental questions. And these do not just concern specific practices or sub-areas of society. No, if we continue along the lines of the authors quoted, the central question is what we should understand under *development* in the age of the Anthropocene that confronts us with the limits of earthly reality. What else can we do but adapt to this? But how then does what we call 'development' in such a world differ from the hopeless existence of the prisoner in his cell, from which there is no escape? And further, if this reasoning is correct, is this then not essentially the death blow of the Baconian project of modernity which, after all, rests on his notion that "Nature is conquered only by obedience"?[1] Ergo, in

1 This much-quoted phrase was written around 1600 by the philosopher and politician Francis Bacon in his *Novum Organum*

the Anthropocene, we have gained one more illusion: victory over nature and the pursuit of greater well-being in a better world must fail, it seems, assuming that we find ourselves in a planetary situation that is fundamentally unchangeable and that we must therefore make the best of it in our earthly misery. Yes, worse still, we have meanwhile even increased our misery; it seems as if in the pursuit of our dream of a better world, we have disregarded the limits of our existence on the planet Earth that we depend on.

As might be expected, other, less alarming noises can also be heard. Globally, two factions are opposed to each other and threaten to divide the whole of society to the bone, in science, politics, and the relationship between rich and poor countries, etc. In this chapter, I want to explore the ideas of the opposing factions, commonly referred to as climate alarmists versus eco-modernists[2]. At its core, it is a struggle over faith and technology in society and how we should relate to the disappointing project of modernity. Or, to quote a climate alarmist, "So the battlelines have been drawn. On one side are those who plan to force Gaia into total submission; on the other are those who believe attempting to do so is the ultimate folly" (Hamilton, 2017, p. 42)

From this philosopher's perspective, the front of the struggle in the Anthropocene lies in the difference in

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I, 3, marking the beginning of what is called 'the new age' or also 'modernity'. The title of this pioneering book is 'a new instrument' for a good reason, it aims to replace an old tool, the organum in Aristotle's writings in which there was little room for an experimental approach to nature. What is characteristic is the turn from science to a practice that wants to take nature seriously, instead of obeying or blindly assuming preconceived, authoritative, and speculative ideas about it.

2 I do not want to get involved here in a discussion amongst climate scientists about climate change as a political-social problem. In his publications, social geographer Mike Hulme (2009; 2023) warns against climatism as a political ideology and misleading alarmist language use. He wants to point out that some scientists are not concerned with understanding nature better, but are mainly focused on 'climate action'. In doing so, they subordinate science to political policy, he rightly notes, and contribute to climate stress in society, especially amongst young people.

attitude towards the pursuit of using technology to make the Earth subservient to human existence. While one side, the eco-modernists, wants to continue this deployment of modernity, the other side, the climate alarmists, seeks a radical reorientation of man and technology. Before we explore the ideas of both parties in more detail, I would like to elaborate on the anecdote that I started with, to bring the spiritual dimensions of the Anthropocene into sharper focus against this background.

2. Faith and technology - between tradition and modernity

I can well imagine that a reader who holds this book in their hands (I will call them Reader 1) was repulsed when I mentioned, of all people, a philosophy professor who presented his students with the idea that technology is not obtainable in isolation but is always supported by an underlying vision of faith. "How so?" Reader 1 mumbles, "I don't see any connection. Faith is what you do in church, and technology is technology. Full stop. It may be true that a believing peasant asks God for a blessing in personal prayer, but that still does not make his farming technique in ploughing, sowing, and harvesting fundamentally different from that of a non-believing peasant. Conclusion: the philosophy professor was telling his students a fable about a world that does not exist: technology is technology and thus has nothing to do with what people believe." Another reader (Reader 2) with whom Reader 1 shares his dissatisfaction, thinks differently about it, and responds by saying: "I get your point, but how hard is the conclusion you draw really? Perhaps you can maintain it for the modern world with which you and I are familiar, but for that reason alone it is still not necessarily applicable to technology in other societies and cultures".

Having arrived at this point in the fictitious controversy, I would like to interject briefly. I think that Reader 2 has an interesting and relevant point. Is modern technology indeed not totally different from technology in traditional or pre-modern societies? To illustrate this, I refer to a compelling

example coming from the North American philosopher, William Barrett (1913–1992). In a study less known outside America, *The Illusion of Technique* (1978), he compares the fishing technique of the Yurok Indians, the original inhabitants of northwestern California in the United States, with modern technology.

> The Yurok Indians are a tribe living on our Pacific Coast who subsist very largely on the salmon that swim out of the ocean into their rivers. Before the season the salmon begin running, the Yurok build a dam to trap the fish in order to ensure a good catch for the winter. The building of this dam is preceded and accompanied by much ceremony and ritual. There are mass enactments of the tribal myths, purification baths, fasting from certain foods, sexual abstinence, and a taboo against certain kinds of incontinent talk. (…)
>
> The dam itself is a fairly complex technological achievement; but for the Yurok the rituals that accompany it are as much part of the whole technique of hunting the salmon as the act of building or the preparing of nets and other gear. (…) Thus he comes to think of the fish that are caught as a gift of nature, and even the skill of the fisherman as another such gift. Consequently, the whole hunt is not a sheer self-assertion of the human will against nature (Barrett, 1978, pp. 17–18).

It is possible that Reader 1 was impressed by the culture of the Yurok Indians but has not yet changed their point of view accordingly. They will possibly say something like: 'So what? This example illustrates my point very clearly: the believing Christian peasant who I mentioned remains stuck in an outdated frame of mind and associated rituals of bygone days, such as the days of prayer and thanksgiving for crop and labour, which still recur every year in the list of Christian holidays. These days have no substantive meaning for the agrarian system and are nothing more than an external ritual in our modern society.' Let us assume that this hard stance by Reader 1 stirs up the contradiction in Reader 2 and again stimulates critical rebuttals such as: 'How do we actually determine that a culture

and religion are outdated? What standards apply to it? Anyway, assuming that there are good arguments to be made for it in a particular case, for example, for the Yurok tradition, this does not mean that religion is an outdated phenomenon anyway, including that of the believing peasant'.

Let us end this discussion here. In any case, it is clear that there are serious points of difference that call for continued reflection on the relationship between "faith" and "technology". While Reader 1 defends the prevailing view of modernity that technology in modern society has nothing to do with faith, Reader 2 believes that on this very point, ancient traditions and modernity differ less than Reader 1 believes, indeed that technology is pre-eminently the religion of modernity. In this, he follows David Noble who, in his fascinating book *The Religion of Technology* (1998), has convincingly shown that from the Middle Ages onwards, the development of technology in the Western world is closely linked to its Christian roots. The central stance that Noble defends is that "the emergence of Western technology as a historical force and the emergence of the religion of technology were two sides of the same phenomenon." (Noble, 1998, p. 9). This religion of technology has now spread throughout world society, manifesting itself differently within diverse cultural spheres of influence.

Certainly, Readers 1 and 2 have a serious dispute, but we can also note that they both argue in terms of tradition and modernity. I have deliberately chosen the example of the peasant because it is precisely in that sector of society that tradition or remnants of it have coexisted in various forms with modernity for a very long time. In the past 80 years, i.e. the post-Second World War period, the traditional peasantry has virtually disappeared in the West. British social historian Patrick Joyce, who has impressively described this quiet death in his recent book *Remembering Peasants: A Personal History of a Vanished World* (2024), even calls this one of the most profound transformations of our time. The socio-political developments of recent years in my own country, the Netherlands, and also elsewhere in Europe, show that the agri-industry, in particular, forms the backdrop for enormous tensions and great uncertainty

in the search for a way forward[3]. As is well known, the broader problem behind this is the global climate crisis that has led to the very agricultural sector of society experiencing the shock experience of the Anthropocene which I mentioned above. In the prologue of his book, Joyce rightly remarks in this context that it is precisely the peasant who is the victim of the disappointing progress of modernity: "Many in our time take great interest in the destruction of the planet. While we may all in the end pay a common price for this destruction, peasants have already paid theirs. Not just with environmental destruction and agribusiness in recent decades but over centuries, for the great victims of modernity and progress have been peasants" (Joyce, 2024, p. 5).

3. Faith and technology in the Anthropocene - between rupture (Hamilton) and next step (Allenby)

If my diagnosis is correct, that in the shock experience of the Anthropocene, deeper religious dimensions of our existence are being brought to consciousness, then the question arises as to how this is reflected in the debate currently underway. In it, as mentioned, two schools of thought are opposed to each other, and an important question then is how each of these clashing visions relates to the project of modernity. A shocking experience puts a question mark behind the prevailing views according to which we live, throws all our thinking and actions upside down, and calls for a real search for a new orientation. It should be noted, however, that such a search process takes time and is not completed overnight. It is much more than a mere theoretical exercise, although an indispensable part of it is undoubtedly a critical review of all kinds of ideas and thinking to which the following also seeks to contribute in the outline discussion of two leading spokesmen, Clive Hamilton as representative of climate- or eco-alarmism and Braden Allenby as exponent of eco-modernism.

3 For a more detailed analysis of the transformations in agricultural modernisation, I refer to Chapter VI, 'Farmers between Disappearance and Resistance', in the excellent study by Dutch cultural anthropologist and philosopher Lemaire (2010).

3.1 An initial sounding

To find out exactly what we are dealing with these two, it may help to first return for a moment to the controversy between Readers 1 and 2 about their bone of contention on faith and technology. Suppose we were to ask Clive Hamilton: 'Clive, in whom do you most recognise yourself in your view of the Anthropocene as a philosopher, Reader 1 or Reader 2?' I think he would say without hesitation: 'Definitely not in Reader 1. In his attitude, I detect the spirit of modernity that fails to interest me. At first glance, I think Reader 2 and I would understand each other quite well if we could continue our discussion about the relationship between faith and technology. Setting aside exactly what each of us believes, and potentially important points of difference therein, there is no doubt for me that the world of technology is not separate from people's faith. In the discussion on the Anthropocene, the connection between the two is precisely the crux of the matter for me. My entire reflection is aimed at freeing us from the dominant techno-religion of our culture, even though I certainly do not want to be seen as a techno-hater. In my diagnosis of the Anthropocene, although we have now progressed too far with technology, there is no way back. And now that we have passed the critical point, it is important to differentiate between technology that can be applied on a local scale, such as painting roofs white to reflect sunlight or planting forests, and methods with a planetary scope, such as spraying sulfur particles into the stratosphere.'

So much for this staged mini-interview with Clive Hamilton; let us now explore a few questions for Braden Allenby. 'Braden, I did a little snooping in your Curriculum Vitae and understood that as a professor of *Civil and Environmental Engineering*, you follow an environmental approach to the development of technology and society. From that background, how do you view the controversy between Readers 1 and 2? Incidentally, I have also seen that in your career as an adjunct professor, you have been associated with Princeton Theological Seminary for some time, and I therefore suspect that in your view too, as appeared to be the case with Clive, faith and technology are not separate worlds.' Judging from what I have

read about Braden Allenby, he will not need much time for a spontaneous response. He will presumably say something like: 'You are absolutely right. What people believe is a relevant and also important fact in my approach to sustainable development of technology and society. Industrial Ecology is sometimes described by peers as a "toolbox for sustainable development" and the "science of sustainability". I agree with this description, which is not to say that faith weighs equally in my view in all cases. It depends entirely on what I will call the level of complexity of the technical constellation in question. And for me, as an industrial ecologist, that is precisely a core issue in a scientific and ethical approach to technology in the Anthropocene. Incidentally, we should be well aware that even in earlier times, before the current discussion on the Anthropocene, humans have always used technology to shape planet Earth, albeit unconsciously and on a smaller scale.'

Allenby has written: "The Earth is increasingly a product of human engineering. Up until very recently, however, this engineering process has occurred without conscious recognition; it consists of the sum of human activities, grown to scales unprecedented in the history of the globe" (Allenby, 2007, p. 1)

From this first introduction to Clive Hamilton and Braden Allenby, it can be deduced that the main heading above this section, "Faith and Technology in the Anthropocene", applies to them both, even if it is perhaps already apparent from the foregoing that at least one difference sets them apart in the pitch with which they express themselves. For Hamilton, the Anthropocene is to a much greater extent an existential issue touching his deepest convictions than seems to be the case for Allenby. I have expressed this with the words in the subtitle: "Between rupture and next step". In that respect there is a "rupture" in Hamilton's view of the Anthropocene and also what I mean by the "next step" in Allenby's case, I will try to make clear in the following. The word "between" in this context does not mean that I am concerned with seeking some kind of middle position, a bit of one and a bit of the other. To overcome the conflicting tensions between both positions, it is necessary

to probe deeper into their common spiritual background in Enlightenment thinking, as will become clear later.

3.2 Clive Hamilton - the Anthropocene as a rupture

The debate on the Anthropocene has developed from recently acquired insights in the geosciences. The story goes that Paul Crutzen, a researcher in atmospheric chemistry who was awarded the Nobel Prize in 1995 for his study on the hole in the ozone layer, launched the term "Anthropocene" for the first time at an international conference in 2000 in a discussion amongst geologists on the human-dominated state of planet Earth. Often quoted are the words spoken unexpectedly by Crutzen on that occasion: "No! We're no longer in the Holocene but in the Anthropocene!" (Bonneuil & Fressoz, 2016, p. 15). In retrospect, here lies the start of a much broader discussion than the one amongst geologists on the precise historical periodisation of successive geological eras of the Earth.[4] Indeed, with the introduction of the idea of the Anthropocene, the sharp dividing line between, on the one hand, the evolutionary development of planet Earth and the natural processes involved in it and, on the other hand, the history of man and culture as it evolves on that Earth, falls away.

Precisely this is the cardinal point on which Australian climate philosopher Clive Hamilton has focused his thinking in his book *Defiant Earth* (2017), elaborating on his *Requiem for a Species* (2011) and *Earthmasters* (2013), two earlier studies focusing more specifically on the role of human action in the climate crisis. As a philosopher, he believes that the idea of the Anthropocene in its implications goes far beyond a purely natural science discussion in Geology of the transition from one phase of Earth's history to the next, as so many others have preceded it. This transition also marks a radical break in our thinking about man-and-world, whose scope we hardly fathom yet, Hamilton says, and in his view marks the end of modernity

4 See Bonneuil and Fressoz, (2016) and Lewis and Maslin (2015) for an overview of the geological debate on defining the Anthropocene as a new geological epoch. See the previous chapter of this book as well.

and the beginning of a new era, that of a tormented Earth and of man-and-earth in mutual dependence. Our history is linked to the fate of Earth being in the hands of man and the ongoing development of modern technology. This implies "a break in Earth history of the greatest profundity; it divides the life span of Earth into two halves ontologically. In other words, the being-nature of the object itself has changed" (Hamilton, 2017, p. 7).

Thus, for Hamilton, the idea of the Anthropocene as a new era in the history of man-and-earth is not just an interesting idea of an inspired climate philosopher but, he argues, rests on a hard scientific foundation from which one simply cannot escape. Under the heading "Earth System science", he writes, amongst others, the following about this in the first chapter of *Defiant Earth* (Hamilton, 2017):

> The idea of the Anthropocene was conceived by Earth System scientists to capture the very recent rupture in Earth history arising from the impact of human activity on the Earth System as a whole.

I ask the reader to stop and read the above sentence again, taking special note of the phrases "*very recent rupture*" and "*the Earth System as a whole*." (…) It is of the utmost importance to understand that the "Anthropocene" is not a term coined merely to describe the continued spread of human impacts on the landscape or further modification to ecosystems; it is instead a term describing a *rupture* in the functioning of the Earth system as a whole, so much so that the Earth has now entered a new geological epoch. Whatever conclusions that one might draw as to the ultimate causes and the solutions to the Anthropocene, an understanding of the basic science of it must come first (Hamilton, 2017, p. 10).

Further on in the text, Hamilton continues:

> It became possible to conceive the idea of a *human-induced rupture in the functioning of the Earth System* only after the development of the new scientific paradigm

> of Earth System Science, the roots of which lie in new strands of scientific thinking dating from the 1970s and 1980s that coalesced in the 1990s (Hamilton, 2017, p. 10, italics added by me).

In the above quote, I want to zoom in specifically on the italicised words *"very recent rupture"* and *"the Earth System"*, which, also by Hamilton's own admission, form the cornerstone of the idea of the Anthropocene, to which he then returns again and again in his reflections. The phrase "*Earth System as a whole"* refers to a *new object* of scientific enquiry uncovered at the turn of the century with the emergence of Earth System science.[5] Of course, one might say that in ecology as a biological discipline, the scientific study of all kinds of local or regional ecological systems has been going on much longer anyway. This is true, Hamilton admits, but Earth System science is not the same as the total of locally focused ecological studies, some aggregate approach in the ecology of the Earth. Earth System science studies Earth as a total system, i.e. the Earth system as a whole.

Fundamental to the system-theoretical framework of thought that Hamilton uses as base is the distinction between system and environment.[6] Assuming that I have correctly interpreted Hamilton in the foregoing, I conclude that for him the "Earth system" is the most comprehensive system outside which nothing exists as Earth's environment that must be considered in our thinking and actions. And if this conclusion is correct, the question remains for Hamilton: How sure one can be of having, and in principle one can have, a good view of the boundaries of the "Earth system" of which, after all, man himself is part? It is an important question, also for Hamilton himself, in my opinion.[7] For it is precisely with this that the

5 See Lenton (2016) and Barton (2022) on the emergence and development of Earth System science, launched as NASA's interdisciplinary space engineering research programme.

6 See Chapter 3.4 in Strijbos (1988) for a critical discussion of the reversal from Cartesian subject-object to thinking in terms of system environment.

7 This issue of boundary demarcation is the central problem in C. West Churchman's systems thinking, of which I have given a brief discussion in Strijbos (n.d.). For a broader discussion, see Ulrich,

claim of an all-embracing *"very recent rupture"* and the idea of the Anthropocene stands or falls.

There should be no doubt that Earth's natural environment has been severely degraded by human activity in many places. This has been known and denounced by many since about the middle of the last century. More and more in our time, there is a growing realisation that environmental problems have global dimensions, such as greenhouse gas emissions and their dreaded effects on lasting climate change. There is no doubt that from a geological point of view, in the consequences of the collective actions of humans, a "rupture" in the development of Earth's environment is becoming visible, which started the discussion on the Anthropocene. It is a different matter whether it can also be said that this *rupture-1* of a natural science type encompasses at the same time a *rupture-2* concerning man's place in reality. However, the answer to this question cannot be given with the help of natural science. It is therefore necessary to go to the field of humanities, Philosophy and Theology.

The salient point now is that with Hamilton and others, a distinction falls away: "(…) the arrival of the Anthropocene means that human history and geological history have converged (…)" (Hamilton, 2017, pp. 7-8). And this convergence shows that despite all man's attempts to use technology to free himself from the realm of nature, exactly the opposite has happened. The future of our technological world is linked more strongly than ever to the fate of Earth. The "rupture" of the Anthropocene, according to Hamilton, has painfully revealed that the project of modernity, propelled by faith in technology, has placed the existence of man-and-Earth on a path of self-destruction. It is, therefore, the task of Anthropocene thinking to radically break with the climate of thought of the Enlightenment of the 18th century. It must thus break with the ideal of freedom through control in order to discover, from a

W. (2002). "An appreciation of C. West Churchman". (A revised. version of 'C. West Churchman – 75 years,' *Systems Practice*, 1(4), 341-350, in: 'A Tribute to C.W. Churchman,' Werner Ulrich's Home Page, http://wulrich.com/cwc_appreciation.html and http://wulrich.com/downloads/ulrich_2002f.pdf)

new anthropocentrism, that man's claimed freedom is not in opposition to nature but is interwoven into the realm of nature:

> The new anthropocentrism might be misunderstood as close to ecomodernism and its all-powerful Kantian subject. In fact, it is radically different. It is true that both understand humans as occupying the central place with a unique transformative role on Earth; yet ecomodernism remains entrenched in the humanist tradition in which human "spontaneity" and creativity make the future. The new understanding is anti-humanist because it recognizes the hard constraints on world-making imposed by a finite and untameable Earth (Hamilton, 2017, p. 66).

To sum up, we can conclude that, according to Hamilton, the Anthropocene calls for a radical reorientation at the spiritual level, that is, in the vision of being human and the relationship of man-and-Earth. While I agree with Hamilton that the spiritual-intellectual roots of modernity are at stake, I believe that he has failed to break free from them. I will get back to that later. But first, it is necessary to pay attention to Braden Allenby as a representative of eco-modernism, sharply criticised by Hamilton.

3.3 Braden Allenby – the Anthropocene as the next step

I routinely read the newspaper in the morning after breakfast, before tackling my work for the day. On the day of writing this section, I had just read an interview on climate change and water management with the Dutch government's recently appointed Delta Commissioner, Co Verdaas, a part-time professor of area development at Technical University Delft. What immediately caught my attention were the words of the government commissioner, which the interviewers had placed as the headline above the article: "From *just protecting* against water, we are moving towards *living with water*"[8]. In my opinion, this aptly summarises current discussions in the Netherlands on how to deal with Anthropocene issues because of climate

8 Daily newspaper *Trouw*, 23 February 2024:10-11

change. All things considered, we are dealing with an age-old problem in the Dutch delta, the hard and continuous battle against water. Who does not know the saying, both in the Netherlands and abroad: "God created the Earth, but the Dutch made their own land"? Interestingly enough, this saying did not come from a Dutchman, as one might think, but its origins must be attributed to a foreign observer, the 17th-century Scottish theologian James Fraser of Kirkhill (1634-1705), but this only as a marginal note.[9]

What concerns me now is that in the words of Fraser and Verdaas, an image emerges of humankind who, in the misery of their existence, strives to use technology to build a safe and liveable environment. Although one usually thinks of technology first and foremost as material artefacts that humans can use for one purpose or another, the stature of technology in contemporary society is much more complex than a sum of isolated things and processes. Of this complex and layered phenomenon, the book *The Techno-Human Condition* by Braden Allenby and Daniel Sarewitz (2011a) provides an interesting analysis based on a systems model with three successive levels, I, II and III of increasing complexity. At level I, technology concerns the design and construction of material things and processes, such as a car. To be used, however, a car requires a complex system of roads, traffic rules, and other facilities: level II of technology. The ongoing development of technology at levels I and II finally results in level III, the anthropogenic world of Systems Earth. The core of their vision is summed up superbly by the authors the same year in *New Scientist* magazine under the self-explanatory title "We've made a world we cannot control". The 'big idea' of this article is that the problems of the Anthropocene cannot be tackled with the level I and II technology known to us. And this means, the authors conclude, that "(t)he world we are creating thus demands a transition from our almost paranoid societal obsession with Level I certainty and coherence to acceptance that Level III

9 See the article by Frits Niemeijer, published on the website of the professional journal *Vitruvius* (www.vitruvius.nl)

uncertainties and contradictions are the essence of the world we have already made" (Allenby & Sarewitz, 2011b, p. 29).

I agree with Allenby that the classical scientific method – "the favoured child of the Enlightenment", as he calls it – applies to the traditional field of engineers, level I of technology, but not to levels II and III. This understanding of different levels of technology is in line with an interdisciplinary-oriented movement, emerging after the Second World War, aiming to put an integrated scientific approach on the map, crystallising into different types of systems thinking (see Strijbos, 2017). If in its footsteps, some 60 years later, Earth System thinking appeared on the scene, Braden Allenby positioned himself in it with a research agenda in ESEM (Earth Systems Engineering and Management), of which I have provided a broader critical review elsewhere (Strijbos, 2021). In the context of this chapter, I refer briefly to the controversy between Readers 1 and 2 as I outlined in Section 2.

In this controversy, Allenby will, I assume, be particularly drawn to Reader 2. He would say, I presume: 'Certainly, at level I of the three-layer model of technology that concerns the transformation of physicochemical substances, faith plays no role in the design activity. So, to that extent, I share the view of Reader 1. However, it is different at levels II and III, where it concerns design problems of technology in a socio-cultural context. Then people's beliefs in that context, as the example of Yurok culture illustrates, start to play a proper role. The designer is then faced with the question of handling differences in culture and religion as part of the problem. The problems of technology on a planetary scale in the Anthropocene represent a new design space of greater complexity, which therefore calls for expansion of the scientific method.' Allenby might go on, 'My take isn't engineering reductionism; it's that all the things we think are fixed – human nature, ethical and religious systems, natural systems at all scales, language, fundamental values – are increasingly contingent in the Anthropocene, and we don't know how to think about, or manage, a terraformed planet. Recognising that technological evolution has overthrown the status quo is not to segue into technological reductionism; it

is to perceive the outlines of an entirely new environment that we're not close to grasping.'[10]

My issue concerning this argument by Allenby is exactly what I must imagine concerning his idea of extending the scientific method in the Enlightenment tradition. Unfortunately, I have not gained clarity from his publications as to what the 'next step' means substantively and methodologically. It seems logical to make a comparison with the systems thinking on which ESEM builds. In ESEM, I believe, there is a parallel problem. To overcome the technological reductionism of Hard Systems Thinking, alternatives have been launched such as Soft Systems Thinking and Critical Systems Thinking (see Jackson, 1991). Similar to these earlier discussions within the systems movement, Allenby wants to avoid technological reductionism in his approach to ESEM. However, it escapes him that this is only possible by breaking with the Enlightenment's dogma of autonomous reason (see Strijbos & Basden, 2006, Chapter 14). I believe that this then becomes visible in the programmatic elaboration of ESEM at a methodological level, of which, to my knowledge so far, Allenby has given a first interesting impetus in the formulation of several guiding normative principles that I summarise somewhat below:

1. Know from the beginning what the desired (and reasonably anticipated) outcomes of any intervention are, and establish quantitative metrics by which progress may be tracked.
2. Rather than being exogenous to a system, the Earth systems engineer will have to see themself as an integral component of the system, closely coupled with its evolution and subject to many of its dynamics.
3. Whenever possible, engineered changes should be incremental and reversible, rather than fundamental and irreversible.

> An important goal in Earth systems engineering projects should be to support the evolution of resiliency, not just redundancy, in the system (Allenby, 2001, p. 23).

10 Personal communication, 30 October 2023.

What is striking is that these principles relate exclusively to the role of the 'Earth system engineer' in the transformation process, leaving out of the picture the normative determinacy of the 'Earth system' itself and also the role and own freedom and responsibility of other 'Earth system' participants involved in the process. One must therefore fear that the reductionism rightly criticised by Allenby has not yet been overcome with these four principles.

4. A critical stance

In summary, what I have set out so far in this chapter boils down to the fact that the two opposing sides in the Anthropocene are, in fact, embroiled in a high-stakes conflict between two quarrelling siblings both raised in the house of the Enlightenment. While one sibling, the climate alarmist, wants to break radically with her background and seeks salvation elsewhere in a new relationship to the Earth, or rather a new alliance of humankind and Earth as partners, the other sibling clings to modernity's faith in progress in science and technology. To assume a critical stance in this conflict, I would like to recall that the Enlightenment climate of thought is indebted to the tradition of Christianity from which it emerged. It is not feasible here to indicate in a single word how, in the history of the West, in the transition from the Middle Ages to the new era, a dramatic turn in the climate of thought took place. Characteristically, the major themes of the Christian doctrine (creation, fall of man, redemption, faith, and hope) were transformed into a strongly optimistic, anthropocentric view of life in which the focus is no longer on God but on humankind, a view that is cosmocentrically oriented towards the world with humankind at its centre.

This does not immediately mean irreligion or atheism. On the contrary, the aforementioned Francis Bacon, one of the founding fathers of modernity, stood emphatically in the tradition of English Protestantism of his time and aimed not only for innovation in the field of science and technology but also for the role of the church in society. As I have discussed more broadly elsewhere, with Bacon, these two, science and

technology on the one hand, and church and religion on the other, are independent avenues for redemption from the misery of human existence after the Fall (see Strijbos, n.d.). Science and technology serve humans as instruments of self-redemption in their earthly existence, while church and religion focus on man's eternal salvation and reconciliation with God through the work of Christ. In this spirit, the conclusion of Book II, aphorism LII of *The New Organon* (Novum Organum) ends with the words:

> For by the Fall, man declined from the state of innocence and from his kingdom over the creatures. Both things can be repaired even in this life to some extent, the former by religion and faith, the latter by the arts and sciences. For the Curse did not make the creation an utter and irrevocable outlaw. In virtue of the sentence 'In the sweat of thy face shalt thou eat bread' (Genesis 3:19) man, by manifold labours (and not by disputations, certainly, or by useless magical ceremonies), compels the creation, in time and in part, to provide him with bread, that is to serve the purposes of human life.

From the picture sketched here, I think it is possible to draw lines to the controversy between eco-modernism and climate alarmism.

We saw that climate alarmism, as per Hamilton, revolves around a plea for a new anthropocentrism, a reconsideration of our place in our relationship with the Earth. For him, it is certain that in the Anthropocene, humankind exceeded the Earth's limits with modern technology and that a way back to the Holocene era is not possible. His message is that we must break away from utopian visions as per Bacon, "in which humans mimic the God of Genesis by aspiring to a 'second creation' on Earth" (Hamilton, 2017, p. 73). Above all, it comes down to finding a new relationship with Earth, and recognising that we are part of it. With this attitude to life, searching for a liberating spiritual perspective for our times, Hamilton strikes a chord with me. However, what escapes Hamilton, or at least does not explicitly come up for discussion with him, is that the

Genesis story he refers to draws humankind's place in a God-created, indissoluble connection of Heaven and Earth. "In the beginning, God created the heavens and the earth" we read in Genesis 1:1, where in this context 'the heavens' does not refer to the firmament, the starry sky that dominates our existence on Earth, but to heaven as the dwelling place of God and the angelic world created by Him. Thus, in the light of the biblical creation story, the Earth assigned to man as his dwelling place is not a self-contained system, a demarcated 'Earth system' under man's control. Being human on Earth takes place under an open heaven. Hamilton's criticism of the old anthropocentrism of modernity is not radical enough, and his search for a new anthropocentrism remains sadly entangled in modernity's fundamental error of detaching Earth in our thinking and action from its connection with heaven, with God as the origin, being the foundation and meaning of all that is created. As the Bible says: 'For from Him and through Him and for Him are all things. To Him be the glory forever. Amen.' (Romans 11:36).

While Hamilton's stance in the Anthropocene focuses on the spiritual basis of modernity, Allenby, as an eco-modernist, concentrates his attention on the phenomenon of technology, and specifically the stature of technology in the Anthropocene, which he refers to as level III technology. However, he overlooks the fact that the Enlightenment scientific method is not a neutral given but assumes the autonomous subject, detached from the normative relationship with everything else created and with God. Thus, the fundamental fallacy of modernity that I touched on with Hamilton is, so it turns out, also hidden beneath Allenby's reflections on technology (see Strijbos, 2021). The two opposing sides keep each other locked in a hopeless and fruitless conflict. Only when the fallacy of modernity is seen through, a new perspective can open up for a shared vision of the future of the Anthropocene.

5. Conclusion

The search for such a shared vision in the confrontation with Western Enlightenment thinking and its claims of universality cannot bypass Christianity, the church, and theology. The

struggle for faith and technology in the Anthropocene requires no less than a renewed listening to the biblical message and thinking through the relationship of Christian faith and human power with technology. This is what I have sought to contribute to in this chapter.

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Part Two

Interventions

Chapter 3

An approach to identifying reasonable health-oriented air quality interventions in a data-constrained context

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Abstract

Decreasing industrial emissions receives significant attention and funding. Non-industrial sources from within residential areas are relatively neglected, despite potentially having a higher impact on human health. Implementing evidence-based air quality interventions to improve health in low-income households is a complex endeavour. This is especially true when targeting local, non-industrial sources. Complexity is apparent

in (i) measuring air quality, (ii) quantifying source-specific exposure, (iii) establishing exposure-response, (iv) identifying and prioritising key micro-environments and meso-airsheds that are amenable to intervention, (v) developing and selecting interventions within the reality of low-income households and settlements, and (vi) measuring intervention success in a dynamic context. Some sources have not been researched in depth from the perspectives of air quality and health. This includes sources that are prevalent in low-income settings but not in high-income countries. A lack of high confidence results from air quality and health research about such sources hampers decision-making regarding some intra-community interventions in low-income settings. To make progress with improving health through air quality interventions, we propose (i) considerations regarding the selection of pollutants to target, (ii) considerations regarding exposure reduction, (iii) proceeding with sufficiently positive interventions where sufficient knowledge is available, (iv) an evidence-based[1] method for intervention development and selection in particular communities or subgroups of households, (v) an appropriate approach to air quality impact evaluation in dynamic environments, (vi) actively avoiding zero-impact interventions, (vii) targeted research regarding specific topics, (viii) respecting the intended beneficiary, (ix) considering the impact of green policies that potentially increase pollutant exposure suffered by members of low-income households by increasing energy cost, and (x) clarifying *ambient air*.

Keywords: air quality interventions, decision-making under uncertainty, environmental pragmatism, exposure assessment, exposure-response relationships

1 Editors' note: The policy background is extensively discussed in Chapter 10, which includes a discussion of *evidence-based*.

1. Background

The Atmospheric Pollution Prevention Act (APPA) (Act 45 of 1965)[2] (RSA, 1965)[3] represented an early effort to address air pollution control in South Africa. Its primary focus was on industrial sources of pollution. However, the Act's scope did not extend to noise, dust, or vehicle emissions. As a result, the APPA's effectiveness in comprehensively mitigating air quality problems was limited. The emergence of the idea of localised areas with concerning levels of pollutants, often termed "hotspots", necessitated a modernised approach to air pollution control in South Africa. The National Environmental Management: Air Quality Act (NEM: AQA) (Act 39 of 2004)[4] (RSA, 2004) was enacted in 2005 to address this issue. This Act introduced air quality management as the core control strategy. The NEM: AQA incorporated various legislative measures, including establishing ambient air quality standards, minimum emission standards, and decentralising air quality management responsibilities. The Act required the identification, quantification, and mitigation of all significant pollution sources. It recognised source-based controls alongside alternative measures such as market incentives, voluntary programmes, as well as public education and awareness initiatives. The NEM: AQA promoted cost-effective mitigation and management practices and mandated air quality management planning by authorities and emissions reduction planning by polluters. Public access to air quality information and participation in consultation processes were also emphasised by the Act (RSA, 2004).

The National Environmental Management: Air Quality Act (NEM: AQA) of 2004 provided for South Africa's Minimum

2 APPA No. 45 OF 1965 assented to 17 April 1965, commenced by 21 April 1965 as amended by APPA No. 17 of 1973, as amended by APPA No. 21 OF 1981, as amended by APPA No. 15 of 1985.

3 'RSA' refers bibliographically to South African government publications since 1961.

4 NEM: AQA (No. 39 of 2004) was first published in the Notice 163 in the government Gazette 27318 of 24 February 2005, and amended by NEM: AQA No. 20 of 2014 in the Notice 390 in Gazette 37666 of 19 May 2014.

Emissions Standards (MES)[5]. The MES applies to various listed activities, including combustion installations, petroleum refineries, and facilities involved in carbonisation, metallurgical processes, and waste treatment. The NEM: AQA adopted a phased implementation approach. Existing sources were initially required to meet less stringent emissions limits by 2015. This provided a grace period for industries to adapt and implement air pollution control measures. By 2020, existing facilities had to comply with the stricter emissions standards that had already been applied to new facilities from 2015. A key aspect of the 2020 MES update was the mandatory installation of controls for criteria pertaining to air pollutants from coal-fired facilities. These controls included flue gas desulfurisation for sulfur dioxide (SO_2), filters for particulate matter, and low NOx burners to reduce nitrogen oxides (NOx).

Retrofitting existing coal-fired power stations with pollution control equipment to reduce emissions of particulate matter, NOx, and SO_2 presents challenges. The original design of some older plants may not be easily modified to accommodate new equipment. Additionally, the cost of retrofits can be substantial. Eskom (2019) estimated the cost to be R187 billion for South Africa's coal-fired power stations. Eskom applied for a postponement to comply with the MES until 2025 and a suspension for power stations due for decommissioning by 2030. Eskom has invested in pollution control technologies to comply with stricter air quality regulations. These advancements target various air pollutants:

- Flue gas desulfurisation (FGD) technology can reduce SO_2 emissions by over 90%. Medupi was built ready for FGD installation and Kusile already has the technology.
- Pulse-jet fabric filters are being employed to capture approximately 99% of particulate matter, significantly improving air quality.

5 The MES was first published in Notice 893 in Government Gazette 37054 of 22 November 2013 and amended by Notice 551 in Gazette 38863 of 12 June 2015 and Notice 1207 in Gazette 42013 of 31 October 2018. As we write, the last update was in Gazette 42472 of 22 May 2019.

- Low-NOx burners are being installed to reduce NOx emissions and to ensure compliance with minimum emissions standards (Eskom, 2019).

Sasol, South Africa's energy and chemical giant, has embarked on a significant air quality improvement programme since 2015. Between 2015 and 2023, Sasol invested more than R7 billion in emissions reduction initiatives, achieving MES compliance for 98% of its emissions sources at Secunda, Sasolburg, and Natref facilities (Sasol, 2023b). Sasol reported plans to invest an additional R4 billion by April 2025 to ensure all that remaining emissions sources (excluding a solution for a specific SO_2 issue) comply with even stricter new plant standards (Sasol, 2023a). A common challenge for both Sasol and Eskom was the difficulty in implementing technology to achieve full compliance with MES for SO_2. They both applied for the postponement of or alternative compliance arrangements.

Despite targeted emission reduction efforts by some industries, achieving the desired air quality improvements remains technically and financially difficult. Additional tools, such as offsets, are required to assist in attaining the overall objectives envisioned by the standards. An offset is an intervention, specifically implemented to counterbalance the adverse and residual environmental impact of atmospheric emissions to deliver a net ambient air quality benefit within, but not limited to, the affected airshed where ambient air quality standards are being or have the potential to be exceeded and whereby opportunities and need for offsetting exist. The Minister published the Air Quality Offsets Guideline under section 24 J (a) of the National Environmental Management Act, 1998 (Act 107 of 1998) (RSA, 1998; 2016). Several industries were required to submit air quality offset plans. These included Sasol and Eskom. The Department of Environmental Affairs (DEA) (and subsequently the successor Department of Forestry, Fisheries and the Environment (DFFE)) did not keep a public registry of air quality offset requirements, plans, or reports. This severely limits the public's and experts' understanding, participation and analysis.

While industrial sources are doubtlessly important, local air quality is often more strongly determined by ground-level sources within or near residential areas. Studies have shown that although power stations affect nearby communities, a high proportion of particulate matter in low-income settlements near power stations is from within these low-income settlements (Chidhindi et al., 2019). The introduction of new small-scale industries and the ongoing challenges of domestic burning, waste burning, biomass burning, and vehicle emissions all impede air quality improvements (Tshehla & Wright, 2019). These diverse sources of pollution require a comprehensive approach that combines industry-specific regulations with clean energy solutions, effective household waste management strategies, local dust control, and stricter controls on open burning practices to meet the desired air quality in low-income settlements.

The importance of these local air pollution sources in terms of health outcomes is demonstrated by several studies. A cross-sectional study carried out by the Nova Institute, the CSIR (Council for Scientific and Industrial Research) and the University of Cape Town for the Department of Environmental Affairs and Development Planning of the Western Cape, Olaniyan et al. (2019) investigated the association between asthma and common indoor exposures amongst school children from four informal settlements located in two municipalities in the Western Cape province (Masiphumelele, Khayelitsha, Marconi Beam, and Oudtshoorn). The study provided circumstantial evidence that the use of paraffin for cooking and heating was associated with an increased risk of rhinitis and airway inflammation (Olaniyan et al., 2019). A study by Buthelezi et al. (2019) in an informal settlement in Umlazi, KwaZulu-Natal province, found that upper respiratory tract infections were prevalent in respondents who used non-electric sources compared to electric sources for heating and cooking. A reasonable health-oriented air quality intervention needs to account for local sources and not only industrial sources.

Unsurprisingly, more than one economic analysis identifies interventions addressing local, ground-level, or

indoor sources as cost-effective targets for intervention. The so-called FRIDGE study is a well-known example (Airshed Planning Professionals and Bentley West Management Consultants, 2004). Another South African economic analysis of air quality initiatives identified that technological interventions within homes represent the most efficient strategy for reducing healthcare costs linked to air pollution (Leiman et al., 2007). This suggests that prioritising advancements in household appliances or technologies for cleaner fuel use could yield significant health benefits while remaining cost-effective.

Air pollution has both human health and environmental impacts, and the regulation of ambient standards focuses on concentrations that directly impact human health. The chapter will emphasise this aspect and not discuss other environmental effects. The chapter is divided into six sections. Section one is the introduction; Section two addresses the complexity of designing evidence-based air quality interventions, focusing on epistemic and practical difficulties; Section three presents the state of knowledge regarding air pollution sources within low-income residential areas; Section four discusses the state of action; Section five explores the relationship between the knowledge and action; and lastly, Section six answers the question of how to identify reasonable health-oriented air quality interventions in a data-constrained context.

2. The complexity of designing evidence-based air quality interventions

There is a need for intervention to decrease people's exposure to harmful airborne pollutants. However, designing and implementing evidence-based air quality interventions to improve health in low-income households is a complex endeavour. This is especially true when targeting intra-community sources. Developing, implementing, and measuring air quality interventions present both epistemic and practical difficulties.

The epistemic difficulties are apparent in at least the following:

- Measuring air quality is difficult.
- Estimating the contribution of sources to the total air pollutant load is difficult.
- Estimating an individual's or population's exposure to air pollution from a particular source is difficult.
- Quantifying the effects of exposure is difficult.

Bearing in mind these complexities, there are also practical questions to resolve:

- How should one identify where an intervention should be conducted?
- How should one go about identifying and prioritising intervention options?
- How should interventions be developed and implemented?
- How should the outcomes be measured and reported?

The epistemic difficulties are elaborated under subsection 1, and the practical questions under subsection 2.

2.1 Epistemic difficulties

2.1.1 Measuring air quality

The measurement of air pollutants represents one of the first steps towards the development of evidence-based air quality interventions designed to reduce air pollution-related health impacts. Air quality monitoring can provide prima facie evidence that an air quality problem exists and can provide clues as to the sources of the problem.

Monitoring air quality in ambient or indoor environments in low-income settings is riddled with challenges. These challenges are related to:

- high temporal and spatial variability of pollution concentrations
- the presence of a wide range of pollutants
- the presence of multiple pollution sources

- the cost and maintenance requirements of air quality monitoring equipment
- logistical challenges such as unreliable access to electricity or limited Internet connection.

It is somewhat naïve to expect that ambient air quality measurements before an intervention is implemented and then again after the intervention has been implemented will provide a firm indication of whether an intervention has contributed to a reduction of the targeted pollutants. Although this may be the case in an environment that is dominated by a single pollution source on which the intervention has a dramatic effect, most low-income households are exposed to a mixture of local and regional pollution sources that are somewhat stochastic and show large spatial and temporal variances.[6]

Although complex from an environmental health[7] perspective, the measurement of air quality in low-income settings is important. Resource constraints, however, prevent this from occurring at the required scales. In data- and resource-constrained environments, traditional methods of air quality measurement, which often rely on expensive and sophisticated equipment, may not be present or feasible. Alternative possibilities include, either on their own or in combination, satellite data, dispersion modelling, low-cost sensors, pollutant-specific exposure proxies (including fuel-use patterns or the use of indicator plants) or citizen science approaches, where community members are trained to collect air quality data using simple tools. All these approaches have their limitations. Combinations of monitoring approaches that complement one another can at least provide an estimation of the level of pollution that people are exposed to.

6 Editors' note: These themes are also discussed in Chapter 12 of this book.

7 Environmental Health is a discipline that examines human health effects from exposures to harmful agents in the environment. The 'environment' may include the outdoors, home, workplace, or public buildings.

2.1.2 *Quantifying source-specific contributions*

Measuring air pollution and identifying concentration hotspots to inform interventions for reduced health impacts is the logical first step, but this alone is insufficient. Greater understanding and quantification of the various sources of air pollution are crucial for developing and enforcing efficient strategies to mitigate and control air pollution (Mathuthu et al., 2019). Identifying the sources of an air pollutant of interest in low-income areas can be a challenge. Often, a combination of indoor sources (such as cooking and heating) and outdoor sources (such as traffic, waste burning, and industrial emissions) together with industrial and regional backgrounds creates a complex mixture of air pollutants, to which people are exposed and which ultimately, either in isolation but also in combination, cause negative health impacts.

Source apportionment has been used for the identification of air pollution sources as well as the quantification of their contribution to air pollution levels (Engelbrecht et al., 2002; Tshehla & Djolov, 2018; Walton et al., 2021; Alfeus et al., 2024; Van Der Westhuizen et al., 2024). Source-oriented models and receptor models are the two main types of models used to identify sources of pollution (Cogho, 2019). Source-oriented models are typically preceded by emissions inventory exercises. They require knowledge of all emissions from the contributing sources (Pant & Harrison, 2012). As a result, the use of source-oriented models is limited in South Africa because the required detailed emissions inventories for input into the models are not always readily available (Alfeus et al., 2024). Detailed emissions inventories in low-income settlements are expensive and difficult to create because the source landscape often contains a myriad of small, sometimes intermittent or sporadic, pollution sources of different kinds.

Receptor models use receptor concentrations as input to calculate the source's contributions (Van den Berg, 2015). The receptor models include the analysis of pollution data collected on the receptor sites and the subsequent identification of the chemical composition of the measured pollutant. Inductively

coupled plasma–mass spectrometry (ICP-MS) or Wavelength Dispersive X-ray Fluorescence (WD-XRF) has been used to identify elemental composition and ionic elements using ion chromatography. The study by Van Loggenberg (2020) compared elemental composition readings from XRF and ICP-MS and reported that lower trace metal concentrations determined with WD-XRF compared to ICP-MS are caused by fine-size particles penetrating deeper into the substrate medium, which can increase X-ray scattering and background noise, whereas higher concentrations of trace metal species associated with crustal sources determined with WD-XRF were attributed to the nitric acid digestion underestimating silicate minerals in the dust. The choice of instrument in practice depends on the availability and the cost of analysis and not the limitation or underestimation of certain elements which might result in the underestimation of contributions of certain sources.

The most common unsupervised analysis technique for elemental or chemical composition data obtained in this way includes principal component analysis (PCA) and positive matrix factorisation (PMF) (which is sometimes, more correctly, referred to as non-negative matrix factorisation, NNMF). These techniques require minimal prior knowledge of emissions profiles. Other techniques, such as the US EPA (United States Environmental Protection Agency)'s chemical mass balance (CMB) model, require more detailed information about the emissions sources (Van den Berg, 2015; Walton, 2021) but have distinct advantages. The CMB model does not require large datasets for input into the model as well as further source interpretation (Walton, 2021). However, it is not widely used in South Africa because local source profiles are still lacking (Muyemeki et al., 2021); and readily available source profiles are not always indicative of the properties of a specific source at different airsheds (Walton, 2021). Although PCA has been used for source apportionment, Van den Berg (2015) noted that PCA is a good method for ascertaining which typical chemicals originate from which source, but it cannot be used for source apportionment analyses and for quantifying source contributions in the way that CMB can. PMF is also not

without limitations. Some limitations stem from assumptions that the model is based on, such as that the composition of the emissions sources is constant over the sampling period at the receptors (Walton, 2021). The PMF is commonly used because, compared to the CMB model, it does not require source profile data; compared to PCA it uses a point-by-point minimisation scheme which allows the profiles to be directly compared to the input matrix without any transformation (Van den Berg, 2015).

Source apportionment approaches can also take on more qualitative approaches such as the direction-based receptor models (Carslaw & Beevers, 2013) or identification of main pollution sources based on time-specific activities (e.g., in domestic settings, cooking takes place at specific times); if specific pollutant concentrations continuously peak at times during which meals are prepared, it is safe to assume that domestic cooking could represent an important source of the pollution. In addition, a combination of trajectory models and satellite data can help to assign pollutant concentrations in given areas to specific source categories (e.g., residential or traffic-related sources). Similarly, questionnaire data and information received from community members may indicate which pollution sources are most critical to consider in exposure work.

2.1.3 Quantifying source-specific exposures

In air pollution studies, *exposure* is commonly understood as the pollutant concentration that a person "comes into contact with", which is typically measured by air quality instrumentation. It can, however, more comprehensively refer to the amount or the dose of a pollutant that enters the human body (e.g., in the case of air pollution, mostly through inhalation) and then continues to react within the body, causing specific health impacts (US-EPA, 2023). Quantifying source-specific exposure is considered important in exposure research because it tells us more about the potential toxicity of a pollutant as well as the associated physiological implications. This is a way in which one can identify high health risk air pollution sources in low-income settings for intervention prioritisation. Exposure should

also be defined when assessing the impact of an intervention so that the impact of the intervention can be correctly isolated. It is important to distinguish whether the exposure is being quantified on the basis of a community, a targeted group, or on individuals.

While quantifying source-specific exposure is key, understanding and identifying the duration and the physical location in which the exposure is taking place is a crucial step that cannot be omitted, especially for individual exposure studies.

When designing an intervention, the complexities of exposure must be considered. A study by Wernecke et al. (2021) in a low-income community in the Mpumalanga Highveld identified five main locations where people spend time: inside their homes, directly outside their homes, on dirt roads, on tar roads, and in open fields. They then measured the concentration of pollutants in each of these micro-environments. Based on the time spent in each environment and the corresponding pollution levels, the researchers estimated how much particulate matter the participants may have inhaled. The most concerning finding was that the highest concentrations of pollutants were measured inside and directly outside the participants' dwellings.

Some interventions do not modify pollution sources but only introduce behaviours or technologies that reduce people's exposure to pollutants (Ballard-Tremeer & Mathee, 2000). For such interventions, it is especially important to adequately quantify the behaviours associated with exposure. Many interventions, however, aim to reduce emissions from a specific pollution source. For example, the installation of flue gas desulfurisation by Eskom (Eskom, 2024) and Sasol (Sasol, 2023b). During the design of such interventions, an exposure assessment functions to demarcate the group of people most impacted by the source and help to quantify the expected benefits of reducing emissions from that source.

Over and above "simply" measuring the concentration of a given pollutant in the air, the source from which the pollution stems tells of the composition of the pollutant

(Fisher et al., 2021). In a low-income community context for instance, the air pollution developed by burning domestic waste in the ambient environment could represent a mix of volatile organic compounds (VOCs), particulate matter (PM) (including heavy metals such as lead and mercury), polycyclic aromatic hydrocarbons, various gaseous pollutants (e.g., SO_x, NO_x, CO), highly toxic chemical compounds and also greenhouse gases (Wang et al., 2023). Similarly, the practice of domestic wood burning could create a different amalgamation of pollutants.

2.1.4 Establishing exposure-response relationships

The related concepts of *concentration-response*, *exposure-response* or *dose-response* function within environmental health studies and are used to understand the impact of air pollutants on human health. *Exposure-response* refers to the correlation between external intensity, duration, and nature of the exposure to a specific pollutant and the realisation of specific health outcomes (Cox, 2023). For example, average ambient $PM_{2.5}$ concentrations derived by either stationary measurements and/or remote sensing can be related to the incidence of specific respiratory diseases in a given population.

The concept *dose-response* involves a more nuanced assessment. It includes identifying how much of a given pollutant enters the body and how it incrementally interacts with the physiology of the individual, ultimately causing specific health impacts. For this, it is not only important to define the pollutant of interest, but in the case of PM, for example, it is important to understand the relevant chemical composition and physical attributes of the pollutant (as identified through source-apportionment work) and to understand how the pollutant (or in this case toxicant) is absorbed and metabolised by the body, causing a specific biological effect (US-EPA, 2023). The dose-response approach is fundamental in toxicology and is essential for setting exposure limits and safety standards.

The heterogeneous nature of air pollution, in terms of pollutants and sources, necessitates a careful definition of an intervention study's scope. Understanding the health effects associated with varying levels of specific pollutants is crucial

for prioritising interventions. A key decision is the selection of the target population: Will the intervention aim to improve community-wide health outcomes, or will it focus on improving the well-being of a specific exposed group of individuals?

From a health point of view, the most studied pollutants are $PM_{2.5}$, O_3 and NO_2 (Yazdi et al., 2021). These pollutants have historically been associated with morbidity and mortality incidences related to respiratory and cardiovascular disease, and a range of other negative health impacts (Lancet Planetary Health, 2022). Acute exposure to $PM_{2.5}$, which represents particulates smaller than 2.5 microns in diameter that can be inhaled deeply into the lungs, has been linked to the prevalence, morbidity and exacerbation of, as well as mortality related to, respiratory ill health problems. This includes asthma and chronic obstructive pulmonary disorder (COPD) (Wang & Liu, 2023; Wen & Gao, 2018; Guo et al., 2018).

For a long time, response functions were derived to model relationships between chronic exposures and specific health outcomes at a population scale in developed countries. More recently, exposure-response functions have been derived using data from studies conducted around the world, including in low- and middle-income countries (LMICs) (Xue et al., 2023). For example, a non-linear exposure-response function showed that chronic exposure to ground-level ozone levels contributes substantially to the mortality of children under five years of age in LMICs (Xue et al., 2023). Another LMIC study showed that incremental increases in $PM_{2.5}$ levels are associated with a significant increase in deaths from all causes amongst the population studied (Li et al., 2018). Importantly, more research is being conducted at a physiological level. For example, research into the dose-response relationship between air pollutants and reactive oxygen species in the human respiratory tract shows that breathing in air pollution directly causes oxidative stress and triggers the body's immune response, exacerbating health effects (Lakey et al., 2016). Chemical exposure-response relations provide a quantitative basis for assessing the relative importance of specific air pollutants in different environments (Lakey et al., 2016).

Deriving these functions for specific air pollutants and health outcomes involves epidemiological studies, toxicological research, and exposure assessments, all of which require the necessary resources, which are sparse in low-income settings. Given that ambitious research may not always be possible in data-constrained contexts, utilising existing epidemiological studies and adapting their findings to the local contexts might be necessary.

The lack of local and area-specific exposure-response or dose-response functions represents a critical gap in air pollution and health studies. This complicates the assessment of the possible effects of air quality interventions in lower-income settings and thus makes the selection of appropriate interventions more difficult. Ideally, more should be invested in the derivation of more context-specific and localised exposure-response and even dose-response functions. The dilemma remains that the resources required to do this are not available in resource-constrained environments. Careful consideration of the benefits of exposure-response or dose-response studies is needed.

2.2 Practical questions

2.2.1 Identifying and prioritising key micro-environments and meso-airsheds that are amenable to intervention.

Pollutant concentrations show substantial spatial variation. Though ambient air pollution levels in low-income settings often exceed safe-to-breathe levels over large spatial areas, measurements taken around households burning dirty fuels or around waste dumps may demonstrate exceptionally high concentrations. The indoor environments can see especially high pollutant concentrations in low-income settings because of high reliance on the use of dirty fuels for cooking or heating activities (Language et al., 2016; Segakweng et al., 2022; Adesina et al., 2020).

The key to impactful air quality interventions is finding the environments with the highest concentrations and where

people spend most of their time which thus have the largest health impacts. That means determining the exposure hotspots within micro- or meso-airsheds (i.e., localised areas within a community setting or communities within a larger region that share similar air pollution characteristics and sources).

In a resource-constrained environment, a lack of prioritisation can lead to inefficient use of limited resources. This is often why stationary air quality monitoring stations, though considered an acceptable proxy for air quality exposure, should not be used in isolation when designing interventions targeting human health. The cost-efficiency of interventions will be increased when key micro- and meso-airsheds in which interventions can be implemented are identified and prioritised.

2.2.2 *Developing and selecting interventions within the reality of low-income households and settlements*

Intervention strategies need to be effective and feasible within the economic constraints of low-income settings. Commonly, interventions in such settings include promoting affordable clean cooking technologies, enhancing natural ventilation in homes, or community-based tree planting initiatives and other nature-based solution approaches to improve air quality through affordable purification methods. Engaging with the community to understand their needs and capacities is vital for the success of the interventions[8] reported in this book. Thus, developing and selecting air quality interventions require a nuanced understanding of the socioeconomic and cultural context of a given location to cater for specific needs and constraints so that interventions are not only good on paper but also in practice (Burns et al., 2019).

Building on the concept of micro-environments identifying micro-airsheds / micro-environments with high pollutant concentrations in which "vulnerable" people who are most susceptible to air pollution exposure impacts (for example the elderly, children, women and those with pre-

8 Editors' note: This is illustrated by the case studies discussed in Chapters 5 and 6. Chapter 9 discusses theory in this regard.

existing health conditions known to be exacerbated by or sensitive to air pollution exposure) spend most of their time, and then targeting those environments for improved air quality, represents an effective way to ensure those most at risk receive the greatest protection.

It is important to understand that in many resource-constrained environments, survival is "more important" than clean air. In such settings, efforts are geared towards putting food on the table and a roof over one's head, rather than breathing air that is not detrimental to one's health. Interventions need to take this into account. As poor air quality is a fundamentally systemic issue related to energy poverty, the best interventions would ideally target not only the source of the pollution but also the source of the problem, i.e., the socioeconomic disparities and circumstances forcing the reliance on polluting fuels and practices. This means implementing comprehensive strategies that include access to clean and affordable energy, economic development programmes, education, and affordable healthcare services (Burns et al., 2019). By addressing these root causes, interventions can contribute to sustainable improvements in air quality while also enhancing overall community resilience and well-being, and additionally improving the health of the environment.

The thought that the implementation of a single intervention may lead to evidence-based improvements in health is challenged by the fact that sustainable and long-term impacts are more likely achieved through multi-pronged intervention approaches over time (Burns et al., 2019; Avis & Bartington, 2020).

2.2.3 Measuring intervention success in a dynamic context

The complexities mentioned above suggest that the success of air quality interventions to improve health in dynamic low-income settings is challenging to measure. The complexity of the situation necessitates a flexible and robust monitoring and evaluation framework. This framework should incorporate quantitative and qualitative indicators to assess changes in air quality and health outcomes over time.

This requires the definition of the baseline scenario that would exist if the intervention were not implemented. It furthermore requires a decision on the parameters to be monitored and metrics and indicators used to track those parameters. This includes the determination of what it means to have a 'successful intervention'. A suite of measures is needed to assess the immediate, medium-term, and long-term impacts of air quality interventions. The exact configuration of measurements will be determined by the nature of the intervention.

The effects of air pollution interventions occur over different time scales and (potentially) across the whole impact pathway. The Driving-Force-Pressure-State-Exposure-Effect-Action (DPSEEA) Framework is used to depict the impact pathway. Air quality *drivers* (the first position on the impact pathway) are long-term phenomena and can be assessed using long-term or periodic monitoring. Emissions (an environmental *pressure* – position two on the impact pathway) result from activities and events. It is often easier to measure indicators of activities and events than the emissions themselves. Ambient air quality is the relevant environmental *state* (position three on the impact pathway) for the sake of this discussion. This is measured using intermittent or continuous air quality monitoring and relevant monitoring locations. Monitoring *exposures* (position four on the impact pathway) means monitoring the time and location of people in relation to varying ambient states. In sophisticated cases, a differential intake rate (i.e., breathing rate in the case of air) can be quantified to estimate dose and not just exposure. Health *effects* constitute the fifth position on the impact pathway. The period over which health effects can be monitored is determined by the nature of the dose-response relationship itself. Some effects occur shortly after exposure (e.g., an asthmatic response to high SO_2 concentrations), while some develop over the long term (e.g., COPD from long-term PM exposure).

Figure 2 presents the WHO (World Health Organization)'s DPSEEA framework with examples of the impact pathway of

domestic fuel burning for space heating, adapted by the authors from Friedl and co-authors (Friedl et al., 2008).

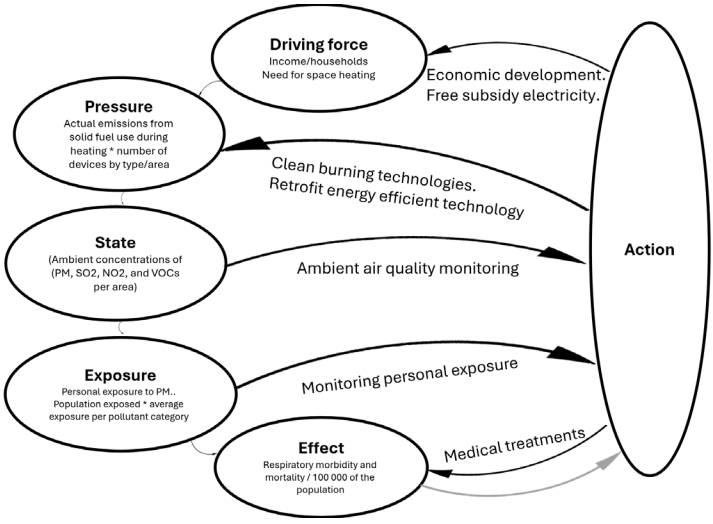


Figure 2: The WHO's DPSEEA framework with an example of biomass burning for space heating.

Success could also be measured by the capacity to scale and adapt interventions across different contexts, ensuring that strategies remain relevant and effective in improving public health amid evolving challenges. Targeting the reduction of short-term higher air pollution concentrations below pollutant levels established in exposure-response functions as important health thresholds may be easier to accomplish than the reduction of long-term pollutant exposure, which is typically lower. Similarly, targeting a micro-airshed such as an old-age home or single homes in which elderly people live and are exposed to high pollution concentrations may be ways in which the health impacts of interventions could more easily be isolated from confounding factors. This same rationale could apply to a micro-airshed in which vulnerable groups spend most of their time and/or are exposed to the highest pollution concentration or the most toxic pollutants.

Evaluating the impact of interventions is challenging, especially in dynamic environments where multiple factors influence air quality. A combination of continued air quality monitoring, health outcome tracking, and community feedback can provide insights into the effectiveness of the interventions.

3. State of knowledge regarding air pollution sources within low-income residential areas

3.1 Solid fuel burning

A great deal of research has been done regarding solid-fuel burning in low-income residential settings. This is because of reliance on burning solid fuels for cooking and heating in low-income settlements. Even though 89.3% of South African homes had electricity in 2021 (StatsSA, 2022), many low-income families cannot use electricity for all their energy needs because of the cost and, in recent years, load shedding. Instead, families use a mix of energy carriers, called fuel stacking, for activities such as cooking and heating that require a lot of energy (Langerman & Pauw, 2018). The type of solid fuels used varies based on availability, cost and the utility required (e.g., how much space heating is needed). Friedl et al. gave a systematic overview of solid fuel use in dense, low-income settlements in South Africa before 2008 (Friedl et al., 2008). More recently, Pauw et al. (2022) reviewed solid fuel use on the Highveld and described types and formats of fuels used, the fuel-burning devices used, the utilities for which solid fuels are used, as well as their spatial distribution. They also describe the historic actions undertaken to combat the inappropriate use of domestic solid fuel.

A study conducted at KwaZamokuhle, the Nova Institute and North-West University on behalf of Eskom (Adesina et al., 2020) has shown that most households in that settlement used coal or wood to meet their energy demands. In Umlazi, a coastal low-income settlement in KwaZulu-Natal, South Africa, households use electric- and non-electric (coal, wood, gas, paraffin) energy sources for cooking and heating (Buthelezi et

al., 2019). Naidoo et al.(2015) conducted a study in Zenzele, a settlement near Johannesburg without access to electricity. It was found that households in un-electrified areas typically rely on paraffin and liquid petroleum gas for cooking and lighting during warmer months, while solid fuels such as wood and coal are preferred during winter by those with limited means (Naidoo et al., 2015). Nationally, solid fuels are used as a primary energy carrier for heating rather than for cooking (Friedl et al., 2008; StatsSA, 2022).

The combustion of these fuels releases pollutants such as carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2) and volatile organic compounds (VOCs) into the air, contributing to local air pollution. Residential ambient air concentrations are highly variable in time and space. Adesina et al. (2020) carried out continuous monitoring of particulate matter (PM_4) in two houses in KwaZamokuhle: a solid fuel-burning house (coal) and a non-solid fuel-burning house. The solid fuel-burning house had higher concentrations than the non-solid fuel-burning house (Adesina et al., 2020). Similar findings were observed by Moletsane et al. (2021). The study measured ambient fine particulate matter ($PM_{2.5}$) in distinct microenvironments (at four sites) of KwaZamokuhle between March and June 2018. It was further found that the highest concentrations of hourly averaged ambient $PM_{2.5}$ were recorded at a site with wide concentrations of informal dwellings and solid fuel-reliant houses (Moletsane et al., 2021). Hersey et al. (2015) conducted a study on the five major metropolitan areas in South Africa: Cape Town, Bloemfontein, Gauteng province, Industrial Highveld Air Quality Priority Area, and Durban. The study categorised each metropolitan area into four categories: township areas with proximity to domestic burning, urban / suburban residential areas, industrial areas, and traffic sites directly adjacent to major on-road sources. Low-income township sites in Gauteng experience by far the worst particulate air quality in South Africa, with monthly averaged PM_{10} concentrations as much as 78% higher in townships than in industrial areas (Hersey et al., 2015).

In addition, extreme $PM_{2.5}$ concentrations that exceeded the 24-hour $PM_{2.5}$ National ambient air quality standard (NAAQS) of 40 $\mu g.m^{-3}$ were seen during the cold period (May and June); meanwhile, the warm period (March and April) recorded relatively lower $PM_{2.5}$ episodes across different sections of KwaZamokuhle (Moletsane et al., 2021). A study conducted by Matandirotya et al. (2022) at the low-income urban settlement of Jabavu, located within the City of Johannesburg, South Africa, during 2018 observed similar trends of high concentrations during winter. This is because there is an increase in the use of solid fuels by households in the settlement to keep warm during winter (Matandirotya et al., 2022). Several studies (Adesina et al., 2020; Nkosi et al., 2017; Wernecke et al., 2015) have reported two burning events per day that have been observed with an increase in particulate matter, a morning burning event between 06:00 and 12:30, and an evening burning event from 16:00 to 22:00. It is worth noting that the burning event and seasonal pattern occur during the period of poor atmospheric dispersion potential (Lindeque et al., 2021), hence the high concentration.

Furthermore, in addition to being an outdoor source of air pollution, solid fuel combustion increases indoor air pollution. High indoor concentrations are observed even in households that do not burn solid fuels themselves. Adesina et al. (2020) observed that indoor concentrations were higher than outdoor during morning and evening; these periods coincide with the fuel-burning pattern at KwaZamokuhle. Similar results were observed by Language et al. (2016) at KwaDela. Concentrations of respirable particulate matter within indoor environments were significantly higher than those of PM_{10} and $PM_{2.5}$ found in the ambient environment (Piketh, et al., 2016). A study by Segakweng et al. (2022) collected outdoor (ambient) and indoor aerosols in different size fractions during summer and winter in four low-income urban settlements located in the north-eastern interior of the South African Highveld, i.e. KwaDela, KwaZamokuhle, Zamdela, and Jouberton. The highest concentrations of particulates were measured indoors, with the highest mass concentration determined in the indoor $PM_{2.5-10}$ (coarse) size fraction (Segakweng et al., 2022).

3.2 Waste burning[9]

Some sources of air pollution, such as waste disposal and burning, industrial activities, traffic emissions, and transboundary pollutants in low-income settlements, have not been researched in-depth from the perspectives of air quality and health. In South Africa, low-income residential areas are mainly rural areas, informal settlements, and government-subsidised formal settlements. Waste service delivery in rural areas and informal settlements ranges from no service at all (Rodseth et al., 2020) to minimum service. In rural areas, 86,4% of households discard their refuse themselves (StatsSA, 2022). Haywood et al. (2021) found that the waste bins supplied by the municipality are insufficient to handle the amount of waste generated in dense, low-income formal settlements with additional backyard dwellings. The unequal distribution of waste collection services can be partly explained by the challenging and currently unsolvable conditions in informal settlements. These settlements often lack proper road access, often have a high population density, poor spatial planning and layout, and illegal land ownership. These factors make it difficult or impossible to provide waste collection services in these areas. Solid wastes are produced at a faster rate than any other environmental pollutant (Yadav et al., 2019) and in larger quantities than local municipalities can handle. The residents resort to unregulated waste 'management' practices such as illegal dumping and uncontrolled burning (Rodseth et al., 2020), which release harmful pollutants into the air, including PM, heavy metals, and toxins from burning plastics and other materials. According to the results obtained by Rodseth et al. (2020), 29% (3.67 million tonnes per annum) of domestic waste generated in South Africa is not collected or treated through formal management options. It is estimated that the proportion of household waste disposed of illegally ranges from 5% for unserviced rural households to 27% in metropolitan areas (Rodseth et al., 2020).

9 Editors' note: See chapter 5.

The study by Haywood et al. (2021) conducted in four provinces in South Africa, Limpopo, Gauteng, Mpumalanga, and North West, reported that households who used non-electric sources of energy for heating or cooking, those who lacked proper sanitation, and those who did not have access to piped water inside the dwelling were more likely to dispose of waste by dumping it in the street or yard, or by burying it. The burning of waste within the yard was reportedly less common in families who reported living in a shack and were more likely to dump waste in the street, possibly because of a lack of yard space.

3.3 Adjacent industries

Some low-income residential areas are located near areas where industrial facilities emit pollutants into the air (DEA, 2009). These pollutants can include sulfur dioxide (SO_2), nitrogen oxides (NOx), PM, and other harmful substances, depending on the type of industrial processes taking place. Proximity to stationary sources of pollution deteriorates air quality in low-income settlements. The study by Belelie et al. (2019) evaluated the dispersion of $PM_{2.5}$, $SO_{2,}$ and NO_X emissions from Eskom power plants (Arnot, Hendrina, and Komati) located close to KwaZamokuhle Township. The simulations show that KwaZamokuhle Township receives SO_2 and NOx from the power plants' emissions (Chidhindi et al., 2019). Emissions from industrial point sources have a different temporal pattern than that of domestic sources. Several studies, for example, the one conducted by Matandirotya et al. (2022) at KwaZamokuhle, show elevated SO_2 concentrations during the middle of the day. This is the time of the day when dispersion conditions permit tall stack emissions to be mixed down into the surface. Even though this is a detectable phenomenon, it is worth noting that the SO_2 did not exceed the National Ambient Air Quality Standards.

3.4 Traffic

Particular low-income residential areas also experience high levels of air pollution caused by traffic emissions. These emissions come from gasoline or diesel vehicles and include pollutants such as NOx, CO, PM, and VOCs. Unpaved roads

in low-income settlements have been linked to an increase in coarse particulate matter (Matandirotya et al., 2022). Bokamoso, a low-income residential area within the Rustenburg Municipality, has a paved road network of 19%, and 81% unpaved roads (Nkosi et al., 2023). This study has shown that an increase in vehicle speed and vehicle weight increases the amount of non-exhaust traffic PM_{10} emitted (Nkosi et al., 2023). The majority of the houses in low-income settlements are poorly ventilated. Pollutants infiltrate into households from the outdoor air, leading to elevated concentrations of pollutants indoors (Mutahi et al., 2021).

3.5 Commercial cooking

Commercial cooking in low-income settlements refers to street vendors making fires using "dirty fuels" on roadsides either to cook meals or roast meat for selling. The Department of Environmental Affairs (DEA) identified commercial cooking as a source of air pollution in low-income settlements (DEA, 2019). Sepadi and Nkosi (2023) conducted a health risk assessment of informal food vendors in Johannesburg. The study recorded higher concentrations of air pollutants at the outdoor markets compared to indoor markets. In addition, they reported that outdoor cooking vendors have a higher risk of developing respiratory diseases. The use of 'dirty fuels' by street vendors has not been addressed. This could be a lack of comprehensive research into intervention strategies or a lack of funding to implement the interventions.

3.6 Regional sources

In addition to local sources, transboundary pollution further contributes to the problem of air quality in low-income settlements. The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model has been used to trace the sources and paths of transboundary pollutants by running backward trajectories. The HYSPLIT makes assessments of air parcel trajectories based on Lagrangian models to identify sources, pathways of pollutants, and transportation within the atmosphere over time. A study by Muyemeki et al. (2021)

reported that air mass originating from Mozambique and passing through mining and industrial areas in the Mpumalanga region contributes to high concentrations of $PM_{2.5}$ observed during the summer and autumn in low-income settlements at the Vaal Triangle Highveld priority area (Kliprivier, Sebokeng, Sharpeville, and Zamdela). The study further reported that air mass originating in northern South Africa and passing through Botswana and the mining areas of the North West province were reported to contribute to high concentrations of $PM_{2.5}$ observed during the winter at the Vaal Triangle Highveld priority area (Kliprivier, Sebokeng, Sharpeville, and Zamdela) (Muyemeki et al., 2021). The Indian Ocean air mass passing through Mozambique and Limpopo, as well as the Atlantic Ocean air mass passing through Northern Cape and Gauteng, has been observed by Matandirotya et al. (2022) as contributing to air pollution in low-income settlements at an Mpumalanga highveld priority area (KwaZamokuhle).

4. State of action

4.1 Interventions to address solid fuel burning

Over the years, numerous attempts have been made to eliminate or decrease the health impact of air pollution in South Africa. These actions were directed at air pollution from different sources and were undertaken at different positions along the impact pathway (IER, 2012; IAEA, 1995). Some actions attempt to reduce the *drivers* of air pollution, some limit emissions (i.e., *pressures*), some attempt to modify atmospheric *states*, some modify *exposure*, and some treat the *effects*.

Solid fuel use has historically received a lot of attention (see Pauw et al., 2022, and Friedl et al., 2008, for additional sources). To address solid fuel use, one can either replace the functionality of the solid fuel burning device with another usage pattern or modify the device or the fuel or the operational technique. The first way of replacing a functionality is to make it unnecessary (i.e., remove the *driver*, to use the DPSEEA terminology).

Formalisation of houses and electrification are two government interventions that have reduced solid fuel use significantly. The primary objective of these was not, in the first place, air quality, but to raise the general standard of living. Improved air quality is a benefit of an improved standard of living. Electricity is an economical source of energy for lighting and cooking and therefore readily replaces the liquid and solid fuels used for these utilities when the opportunity arises. Although the thermal properties of most subsidy houses in South Africa are inefficient in colder areas, these houses still provide better protection than a corrugated iron shack. The formalisation of housing (which includes electrification) on the whole was therefore associated with a reduction in solid fuel use.

Smokeless stoves that use bituminous coal made for South African conditions were developed and tested as far back as the 1960s (Sorgnit, 1968a; 1968b; Van Doornum, 1965). In the 1980s, an attempt was made to enforce the use of smokeless stoves. This largely failed (Pauw et al., 2022). The attention moved to fuel in the 1990s with the low-smoke coal programme of the then Department of Minerals and Energy (see for example, Asamoah et al., 1998, and Dickson et al., 1995). Experiments with different low-smoke fuels never lead to a solution that could be implemented *en masse*.

The improved top-down ignition technique (*Basa Magogo!* or *Basa njengo Magogo*)[10] was implemented widely and had mixed success, depending on the quality of implementation. In areas with high implementation quality, high adoption rates and reasonable attrition rates were achieved. Still, the initial implementation by the Nova Institute on behalf of Sasol had positive results (Wagner et al., 2005). Nova's implementation of the technique, using climate finance, scaled in impact drastically. The government's Clean Fires Campaign was a damp squib. All things considered, the implementation of the top-down ignition technique offered a cost-effective but temporary

10 Editors' note: See, amongst others, Section 6 of Chapter 9.

solution because the proportion of people who use the technique wanes with time after implementation.

The subsidy houses built under the RDP (Reconstruction and Development Programme) after 1994 were thermally inefficient (Nel, 2023). The adoption of thermal performance standards for these houses was an important step towards avoiding this problem in future. For existing structures, different retrofit solutions have been tried. The most thoroughly tested and most widely implemented solution involves applying spray polyurethane foam (SPF) combined with a fire-retardant paint to the inside of roofs and fitting a standard gypsum ceiling below that. This is combined with a coal for liquid petroleum gas (LPG) stove swap. The development of this solution was started by the Nova Institute and TIASA in 2004 and developed in partnership with Sasol and Eskom through at least five rounds of in-use testing until the first large-scale implementation was undertaken by Sasol in eMbalenhle and Lebohang (Murray et al., 2023). Murray et al. (2023) reported on a follow-up study that determined that the implementation by Sasol was extremely successful.

Eskom's pilot project involving this technology took place in KwaZamokuhle between 2015 and 2017. Several alternatives were evaluated. The interventions tested included: installing insulated ceilings and insulation on three walls, replacing the coal stoves with low-emission coal stoves, replacing the coal stoves with LPG heaters and stoves, and an electricity subsidy in the winter months. Each household was given an insulation retrofit and either a low-emission coal stove, an LPG heater and stove, or an electricity subsidy (Eskom, 2024). The intervention finally selected was the installation of thermal insulation and swapping the coal stove for an electric / LPG hybrid stove and an LPG heater (Langerman et al., 2018).

Recently, the idea to build a smokeless coal stove suited to the needs of low-income households has gained momentum with the development of a low-emission semi-continuous coal stove at the North-West University (NWU, 2024)[11]. An evaluation

11 Editors' note: See chapter 9 below.

of end user satisfaction following an in-use evaluation by households was conducted in Zamdela, South Africa, in 2022 by the Nova Institute. Overall, the evaluation of households was very positive.

4.2 Miscellaneous interventions in the context of air quality offsets

Air quality offsets lead to a proliferation of interventions aimed at reducing harmful emissions in communities. A project by Sasol's Sasolburg Operations and Natref, aimed at removing grass and waste material, resulted in significant reductions in air pollution estimates. Sasol claims that cutting and removing 4.4 million square metres of grass and 1,040 tonnes of biomass avoided an estimated 6.6 tonnes of PM_{10}, 5.2 tonnes of $PM_{2.5}$, and 0.62 tonnes of SO_2 emissions. The methodology on which this calculation is based is not publicly available. Similarly, Sasol claimed that removing 3,080 tonnes of waste prevented an estimated 21.27 tonnes of PM_{10}, 22.5 tonnes of $PM_{2.5}$ (this is reported as such but appears to be wrong because the $PM_{2.5}$ to PM_{10} ratio exceeds 1), and 2.95 tonnes of SO_2 emissions. These findings highlight the potential air quality benefits of managing biomass and waste effectively.

Additionally, to curb dust pollution, Sasol's Sasolburg Operations embarked on a road construction project within the Zamdela area. This initiative specifically targeted particulate matter emissions caused by vehicle traffic. To achieve this, they have paved approximately 1.6 kilometres of the access road. The impact of the reduction of particulate concentrations over the residential area resulting from this intervention is unclear.

In recent years, the proliferation of interventions, caused by the inception of air quality offset policies, included interventions with no clear impact on air pollution, nevertheless being implemented as part of air quality offset programmes. Sasol also implemented a comprehensive education and awareness campaign with two key components. One is a general public campaign where field officers engage directly with residents in eMbalenhle and Lebohang through door-

to-door interactions. Local newspapers publish these topics in three languages to broaden outreach. There was also a school awareness campaign that involved 26 primary schools in Govan Mbeki Local Municipality in 2022. Around 27,060 learners participated in engaging activities such as puzzle-building, colouring books, dramas, debates, and quizzes. A post-assessment confirmed a positive impact, with learners gaining a deeper understanding of air quality concepts (Sasol, 2023b). It is unclear if or how this awareness translates to air quality outcomes.

4.3 Emission control technology

Experimentation with new technological interventions is continuing. Researchers are actively exploring various technologies to curb air pollution from household fuel combustion. These technologies include the use of a catalyst inserted into the flue of the stove. However, implementing these solutions has proven challenging. For example, although wood boiler catalysts reduce air pollutants, they struggle to function at low flue gas temperatures during startup and shutdown (Ozil et al., 2009), and some residential heaters may not have sufficiently high flue gas temperatures to activate the catalyst (Hukkanen et al., 2012). The study by Steyn et al. (2023) used a manganese active catalyst and was successful in the laboratory; however, in a real-life setting, particulate matter increased when the catalyst was used.

5. Relationship between knowledge and action[12]

The most impactful changes in people's exposure to harmful air pollution resulted from improvements in the material standard of living[13]. This emphasises that general economic development is the long-term solution that must be pursued, and that approaches that detract from this should be viewed with the

12 Editors' note: It will be instructive to compare this section with chapter 6, where caution is advised against a certain kind of knowledge in specific contexts.

13 Editors' note: This may underlie some of the sentiments expressed in Chapter 14.

strongest suspicion. Langerman et al. (2018) demonstrated the marked contrast between air quality in a low-income (KwaZamokuhle, an apartheid-era township) and an adjacent middle-income town (Hendrina). While both share the same background sources of the industrialised Mpumalanga Highveld, KwaZamokuhle has markedly higher PM concentrations and noticeably articulated peaks that apparently derive from the internal sources inside the township – mainly domestic coal burning and dust sources (Qhekwana, 2019).

The most successful intervention implemented specifically to curb air pollution was triggered by an air quality offset requirement and resulted from research, development, and testing over longer than a decade. A key factor was the combination of rigorous technical evaluation, combined with qualitative and quantitative research into end user requirements, behaviours, and perceptions.

This thermal insulation retrofit and stove swap intervention that was implemented by Sasol at scale and performed exceedingly well (see Murray et al., 2023). It succeeded because it addressed the correct driver. It also worked on a technical level. It was implementable and improved the quality of life of end users. The reduction in PM_{10} and $PM_{2.5}$ emissions from this project has been quantified, but the final impact on human exposure has not been quantified through dispersion modelling.

At the same time, interventions have been implemented where the relationship between the intervention and even the reduction of emissions is not clear at all. The air pollution awareness campaign implemented by Sasol is an example of this.

There are no cases in South Africa where the health effects of an air quality intervention in a low-income settlement have been directly measured. At best, some interventions calculated the reduction in pollutant emissions, but none of those projects made their assumptions, calculation methods, or data collection and quality procedures public. As far as we could ascertain, none of this is open to public scrutiny.

5.1 How to identify reasonable health-oriented air quality interventions in a data-constrained context

5.1.1 Requirements for high-quality, evidence-based interventions

A high-quality, evidence-based intervention requires that an air quality monitoring network that is spatially representative of the settlement be operated for a sufficient time to understand the temporal variation in pollutant concentrations. This network could consist of either conventional compliance-grade monitoring equipment or a combination of alternative instruments and methods, such as low-cost sensors and remote sensing.

After understanding pollutant concentrations, the sources contributing to these concentrations need to be understood. This implies the need for an emission inventory of background and foreground sources.

After understanding the spatial and temporal variability in pollutant concentrations and the sources involved, and the sources contributing to these, the contributions from the identified sources need to be more accurately quantified. Different source apportionment models can be used to estimate the contributions of each identified source. Typically, methods that can accurately identify individual sources, such as CMB, should be used; but these should be cross-checked with other receptor models so that unexpected and unknown sources can also be detected. The spatial and temporal resolution of the sampling campaign needs to be adequate to resolve the number of sources.

With an understanding of pollutant concentrations and source contributions in hand, an assessment of how the population is exposed to these pollutants must follow. This assessment should consider the frequency and the magnitude of exposure over the population.

Ideally, one would have already established the exposure-response relationships for the most important pollutants and health outcomes derived from comparable populations. This can then be used to calculate the source-specific impact of exposure

on the population. This knowledge can be used to prioritise the sources to address for each airshed in which exposure takes place (be that micro-, mini- or meso-airsheds) and identify sources to address, and possibly the required emissions reduction from each.

With a source and an emissions reduction target, the development or selection of interventions that meet the needs and fit the constraints of low-income households can commence. This presupposes a detailed understanding of the usage patterns, requirements, and constraints of households that will participate in the intervention.

Part of the development of an intervention is the development of the quantification methods for baseline emissions, exposures, and effects (emissions, exposures, and effects in the absence of the project activity) and project emissions, exposures, and effects (emissions, exposures, and effects when the project activity is implemented).

5.2 Proposal for a pragmatic approach to intervention development

We conclude this chapter by proposing a broad approach towards air quality intervention programmes. As industrial sources are managed via the MES, we limit this section to interventions in residential areas.

The phased approach that we describe below is predicated on the supposition that (i) interventions must meet three key criteria: sufficient impact on experienced air quality, positive or neutral impact on quality of life, and feasibility; (ii) activities and measurement should be informed by relevant and sound science; (iii) interventions that are supported by stronger knowledge should be given preference, all things being equal; and (iv) a staged approach to intervention development and implementation should be followed. A full description of the staged approach to intervention development is not attempted here: however, we signal the stages to include evaluation and scoping, pre-feasibility, feasibility testing, pilot, launch, scaling, and exit or maintenance.

We propose a four-phased approach to air quality intervention programme execution. The phases include (i) preparation, (ii) baseline establishment, intervention development and selection, (iii) implementation, and (iv) monitoring and evaluation.

Preparation could include a rapid in situ assessment by a multi-disciplinary team of experts and a formal assessment of readily available documented area intelligence. The preparation should be designed to inform the requirements of subsequent activities, such as baseline establishment and intervention development.

Baseline establishment, intervention development and selection are put together as a phase. In this context, baselines would include information regarding demographics[14], intra-community emissions activity, air quality, household practices and quality of life. Intervention development includes the identification of the airshed of concern, the pollutant of concern and addressable sources, followed by an assessment of source impact on the pollutant of concern within the airshed(s) of concern. The addressable sources are then evaluated in combination with potential avenues of intervention to estimate the potential efficacy of various interventions, ultimately to arrive at an estimate of the potential impact of intervention(s) on the human-experienced pollutant of concern. This is followed by a detailed design of candidate interventions, in-community feasibility testing at a scale likely to produce statistically significant results, extensive feasibility performance monitoring, and evaluation of the intervention in terms of emissions reduction achieved, air quality benefit expected, impact on quality of life, and implementability in terms of the funding and resource context. For interventions that pass the three key hurdles - sufficient air quality benefit, positive or neutral impact on quality of life, and implementability, one can

14 In countries or locations where national statistics are of poor quality, it may be key to conduct an enumeration survey early in the process to establish key demographic variables such as population, number of households, and number of stands.

proceed to propose roll-out design and costing, followed by the selection of intervention(s) for implementation.

Implementation should be aligned closely to the intervention and local interaction that was successfully tested – one should not assume that minor variations would not have a meaningful and potentially detrimental impact on intervention uptake, intervention use, emissions impact, intervention longevity, and the like. Also note that in low-income settings, implementations that optimise the employment of local unemployed individuals, while judiciously using expert service providers, national suppliers, and local suppliers, are likely to enjoy greater support and greater success.

During monitoring and evaluation, data is collected again regarding the use of the intervention, the emissions impact, the quality-of-life impact[15] (including cost and utility impacts experienced by households), whether intervention use is sustained, and whether the intervention artefacts have suitable durability and are maintained by users. Air quality modelling or highly targeted air quality monitoring (such as indoors) can be conducted to describe the impact. Ultimately, the data is analysed, and the intervention is evaluated with a view to describing real-world costs and the benefits of implementation at scale.

5.3 Dealing with knowledge constraints

From sections one to four of this chapter, we can conclude that the ideal high-quality, evidence-based intervention development described in the preceding subsection cannot be developed in South Africa at present. We have shown that specific and comprehensive data relevant to South Africa is hard or impossible to obtain for every step. We outlined a pragmatic framework for decision-making that takes a realistic view of the quality and quantity of data available to the decision-maker.

The limitations will mean that one will not always be able to provide direct or full evidence for a specific decision taken at

15 Editors' note: See Chapter 12 on measuring impact.

a particular step in the process. For example, it is difficult to obtain a full year's air quality data to make a definite conclusion about compliance with the NAAQS. The conclusion of whether an area is compliant with the NAAQS or not is necessary for one to decide whether to include or exclude the area in the target areas for an intervention. Even if this can be undertaken at one point, it will remain unclear how air quality varies over the rest of the target area. Regardless, a decision must be made. That decision must necessarily be taken based on a balance of probabilities and not beyond reasonable doubt.

Viewing a phenomenon from different positions along the impact pathway is, in our view, a reasonable way to make decisions amid the inevitable limitations in knowledge. When one observes the *drivers* for certain behaviours through household surveys, quantifies the emissions (*pressures*) or at least the activity rates leading to those emissions through household measurements or direct observation and observes the temporal, spatial and compositional signature of that source through some form of ambient air quality monitoring (*states*), one can formulate a reasonable hypothesis of the impact of a source in a particular environment, even though each one of the measurements is subject to uncertainty. Dispersion modelling is useful in this undertaking as it elucidates the relationship between pressures and states in a particular environment, but the results should be viewed in context. It is important to incorporate the fact that there are different types of airsheds where people are exposed to particular sources into the decision-making process.

Given the limitations, the metrics used to evaluate the success of an intervention cannot be the health effects that constitute its ultimate aim. As one moves right on the impact pathway towards exposures and effects, complexity and uncertainty accumulate and the time scales over which causes and effects are linked increase. This is especially true for the effects of chronic exposure. The best that can be undertaken in most circumstances is to formulate the target of an intervention as an emissions reduction (and possibly a modelled concentration reduction). Monitoring an intervention

then means collecting data on the activities causing the emissions and estimating the reduction based on the difference between a counterfactual baseline scenario and an actual project scenario. Dispersion modelling can provide an estimate of the implication of this estimated emissions reduction on ambient pollutant concentrations.

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Chapter 4

Sustainable energy interventions in low-income households in the Anthropocene: Case studies of the uptake of cleaner energy

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Abstract

As global efforts to transition to renewable energy intensify, there is a real risk that households in the Global South, particularly sub-Saharan Africa, will be left behind. The use of dirty fuels can be time-consuming, especially for households that collect wood, and has negative implications for the health and safety of household members. Programmes promoting clean energy use in households typically substitute a dirty fuel or appliance with a cleaner alternative, such as a clean-burning stove. Sustainable energy use can also be approached considering the trade-offs that need to be made between energy security, affordability, and environmental sustainability. However, projects designed using these approaches, such as clean cooking stove roll-outs, have typically achieved poor rates of adoption and sustained use. In this chapter, we argue that sustainable household energy interventions are those based on user requirements, designed to meet energy service needs and impact favourably on a household's ability to meet its fundamental needs. We analyse the approach that the Nova Institute has used to design clean household fuel interventions that have achieved remarkably high success rates in several towns in South Africa. Methods employed in developing interventions for communities in the Platinum Belt in the North West and Limpopo provinces of South Africa are examined. We find that essential elements informing the design of successful interventions are increasing the scale of implementation as knowledge and control increase through a rational project life cycle, a comprehensive understanding of household fuel stacking practices to provide energy applications, and an assessment of the impacts of interventions on the overall quality of life.

Keywords: energy transition, household energy use, in-community testing, rational project life cycle, satisfaction ratings, sustainability

1. Introduction

Energy services are deemed essential to human development and life satisfaction (Brand-Correa & Steinberger, 2017; Max-Neef et al., 1991). A sizeable proportion of the world's population still experiences energy poverty. In sub-Saharan Africa in 2021, almost 600 million people lived without access to electricity and around 900 million without clean cooking fuels (IEA, IRENA, UNSD, World Bank, WHO, 2021). The implications of using inadequate or dirty energy at the household level are vast: indoor air pollution from solid and liquid fuels was responsible for 2.3 million premature deaths globally in 2019 (Murray et al., 2020). More profoundly, energy poverty results in the inability to fulfil essential states and activities required for human dignity, well-being and a flourishing life (Day et al., 2016; Nussbaum, 2000).

Many interventions have been implemented to promote access to sufficient, sustainable energy at the household level. These interventions take many forms and typically aim to change the technology or energy source used by a household; for example by providing a clean cooking stove (Dagnachew et al., 2020; Pailman et al., 2018) or an electricity subsidy (Makonese et al., 2012; Ruiters, 2009), or to influence a change in behaviour such as by teaching household cooks low-emission techniques for making fires (Le Roux et al., 2009; Surridge et al., 2005) or increasing awareness of excessive energy use (Löfström & Palm, 2008).

Despite the good intentions of many of these programmes, they are plagued by low adoption rates and households abandoning them after a short period of use (Gill-Wiehl et al., 2024; Khandelwal et al., 2017; Pope et al., 2017; Quansah et al., 2017). Reasons cited for the poor success of the programmes include inadequate design of the disseminated technologies, lack of training, and cultural and social factors.

In this chapter, we review conceptions of sustainability that are typically assumed in household energy interventions and argue that sustainable household energy practices must be understood as providing household members with essential services that enable them to meet fundamental human needs or capabilities. We report on an approach used by the Nova Institute in South Africa to develop sustainable energy interventions in a phased manner tailored to address the specific household energy service needs in a community. Drawing on case studies in the Platinum Belt region in the North West and Limpopo provinces, we demonstrate the value of in-community testing of proposed interventions[1] and employing a quality-of-life assessment to ensure that interventions are aligned with household requirements and will be permanently adopted.

2. Sustainability in household energy use interventions

The development of household energy interventions is strongly influenced by the understanding of the notion of sustainable energy and the dynamics underlying household energy use, whether explicit or assumed. An overview of the different conceptions of sustainability as applied to household energy use and the processes by which households make energy choices and adopt sustainable interventions is provided here.

Often, interventions to promote sustainable energy at the household level in the Global North focus simply on reducing the carbon footprint of household energy use by improving energy efficiency and energy conservation, and sometimes increasing renewable energy use (Borg & Kelly, 2011; Löfström & Palm, 2008; Naus et al., 2015). In the Global South, where a significant proportion of households still use solid and liquid fuels such as wood, coal or paraffin (IEA, IRENA, UNSD, World Bank, WHO, 2021), sustainable energy is assumed to be fuels or technologies that emit less air pollution, especially particulate matter and its precursor gases (Pope et al., 2017).

1 Editors' note: The reader may wish to compare this chapter with Chapter 9.

Attention has also been drawn to the safety risks of using solid fuels and paraffin, including fires (which may spread between dwellings), burns, and poisonings from inadvertently drinking paraffin (Kimemia et al., 2014). These are one-dimensional notions of sustainability, only considering a single aspect of the environmental impact of energy use.

The Brundtland Report (Federal Office for Spatial Development, 1987, p. 41) inextricably linked sustainability with the provision of social services when it defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Elkington (1997) acknowledges the inevitable financial trade-offs that need to be made when deploying resources to meet human needs in an environmentally benign way by introducing the triple bottom line – profit, people and the planet – to measure the economic, social and environmental performance of a business or organisation (Alhaddi, 2015). The triple bottom line forms the basis of the *2030 Agenda for Sustainable Development*, "a plan of action for people, planet and prosperity" (UN, 2015, p. 3). The *2030 Agenda* focuses on sustainable development and poverty eradication through the 17 Sustainable Development Goals (SDGs)[2]. SDG 7 is to "ensure access to affordable, reliable, sustainable and modern energy for all" and targets universal access, increased renewable energy, energy efficiency, and the development of associated infrastructure and technology.

However, the relationship between energy and human flourishing and well-being goes deeper than access to adequate energy and the services that energy provides. Max-Neef et al. (1991) reflect on the nature of human needs and identifies nine fundamental needs: subsistence, protection, affection, understanding, participation, idleness, creation, identity, and freedom. He defines 'satisfiers' as the means to fulfil the needs. While human needs are unchanging across time and culture, the satisfiers are culturally, socially, and temporally flexible.

2 Editors' note: As discussed in Chapter 1.

Brand-Correa and Steinberger (2017) argue that energy services satisfy some human needs.

In a similar vein, Day et al. (2016) draw on the work of Amartya Sen and Martha Nussbaum (Nussbaum, 2000; 2011; Nussbaum & Sen, 1993; Sen, 1992; 1999) and conceptualise energy use within a capabilities framework. Capabilities are the opportunities to be able to 'be and do' and include states such as being in good health or activities such as being able to earn a living. Sen and Nussbaum argue that development programmes should aim to increase people's capabilities. Day et al. (2016) argue that a distinction should be made between primary capabilities, such as good health and having social respect, and secondary capabilities, which are precursors to the basic capabilities. Energy services are required to achieve some secondary capabilities. For example, good health (the primary capability) requires space heating or air conditioning and cooking nutritious food (the secondary capabilities), all of which require energy. Basic capabilities (the ultimate objective of development programmes) thus require secondary capabilities, some of which require energy services. Energy services require an energy source (such as biomass or electricity) and a conversion technology (such as a stove). An understanding of the energy services that a household requires, and the energy applications used to fulfil secondary and primary capabilities is needed to inform the development of sustainable household energy interventions.

This understanding of the role of energy services in human development and well-being is a far cry from the notion of sustainable energy as that which minimises the emissions of carbon dioxide or air pollutants. Sustainable energy use, therefore, should be considered to be much more than practices that do not harm the climate, the environment, or the health of the energy users, but rather practices that support the attainment of fundamental human needs and basic capabilities[3].

Our understanding of the dynamics and motives underlying household energy use practices is similarly wide-

3 Editors' note: Chapter 1 again.

ranging. The energy ladder model postulates that households naturally embrace cleaner, more modern and more convenient energy sources as household income increases (Hosier & Dowd, 1987; Leach, 1992). The energy stacking model recognises that the move to clean energy is not linear but that households use multiple fuels concurrently, even for the same utility, to ensure energy security. Multiple fuel use is also driven by the household's diverse energy service needs (Foley, 1995). For example, solid fuels are effective for providing heat but cannot power electronic equipment or household appliances such as refrigerators. Van der Kroon et al. (2014) further propose that household energy choices are affected by factors external to the household in addition to features of the household. He categorises the external factors into the socio-cultural and natural environment (factors such as climate, ecology, and history) and the political, institutional and market environment (such as government policies and consumer markets).

These frameworks assume that households make rational decisions to optimise their resources to meet their requirements for energy services as fully as possible. However, it is well established that there is often a gap between households' knowledge and values, and their behaviour. Frederiks et al. (2015) explain the discrepancy using behavioural economics and psychology. Irrational decisions are made because of cognitive biases, such as the sunk cost effect, when people persist with a course of action even when it is no longer reasonable. Other biases include weighing potential losses more than potential gains and the tendency to be swayed by social norms and the influence of people deemed to be trustworthy. Kowsari and Zerriffi (2011) explain seemingly irrational energy use behaviour by adding habits and experience (for example, cooking method) and attitudes as factors that affect energy choices, in addition to household characteristics and the external environment.

More recently, households have been considered in the literature on transitions to more sustainable socio-technical systems (Raven et al., 2021; Skjølsvold et al., 2018; Yadav et al., 2019). In this context, particularly in the Global North, households are considered sources of environmental pollution

and lock-in to high-consumption and high-carbon lifestyles, and they are increasingly becoming generators of renewable energy and drivers of sustainable practices from the consumer side. Raven et al. (2021) identify two broad approaches to households in the sustainability transitions literature. Much more commonly, households are considered to be a fixed unit of analysis with specific attributes, such as income level, that determine how they interact with their external environment (closed-box approach). These interactions determine technology adoption and energy source selection, for example. Occasionally, households are assigned agency and internal dynamics are recognised, such as productive systems, the social and material context, and relations between household members and with other households (open-box approach).

The energy ladder and energy stacking models, Van der Kroon et al.'s (2014) external environments framework, and even the psychological explanations for decision-making biases align with the closed-box approach. Spurling et al. (2013) point out that this thinking leads to three types of policy interventions: innovating technology, shifting consumer choices, and changing behaviour. Two examples of these types of policy interventions, clean cooking stove programmes and awareness programmes, have been widely implemented in the household energy context. These programmes have achieved surprisingly poor results (Gill-Wiehl et al., 2024).

On the other hand, the open-box approach lends itself to a greater understanding of household energy use by considering it to be a manifestation of social practice. Social Practice Theory (Hargreaves, 2011; Shove et al., 2012) identifies the three elements of practices as *materials* such as technologies, *competencies*, which are skills and techniques, and *meanings*, which are the shared meanings, social norms and aspirations of a group of people. Social practice is the manifestation of interdependencies between these elements. Persistent use of coal, for example, is then understood to arise in part because a household has inherited a robust coal stove (material), is skilled in making traditional porridge on a coal fire (competence) and bonds over family meals where the porridge is eaten (meaning).

From this perspective, policy interventions should instead aim to recraft practices by changing the elements that make up the practices, substituting practices with more sustainable alternatives, and changing how practices interlock (Spurling et al., 2013). A successful intervention depends on practitioners being willing to purchase new material, learn new skills and create new meanings for their new practice (Frost et al., 2020).

In summary, the development of sustainable energy interventions needs to understand the full range of energy services required by a household and how fuels and technologies are used to achieve these services and perhaps more importantly, the fundamental human needs and capabilities that these energy services enable. Interventions should not simply focus on changing fuel, technology, or behaviour, but also more holistically on the competencies and meanings of practices.

3. An alternative model for developing sustainable household energy interventions

The Nova Institute has been developing and implementing household interventions for several decades and has incorporated several elements into its approach that have enabled it to achieve remarkable success in permanently shifting household practices to embrace the interventions. The elements are:

1. Following a *rational project life cycle* to increase the scale of implementation as knowledge and control increases, ensuring that community-specific information is available for intervention selection and design, and deliberately planning for the longevity of an intervention after implementation
2. Developing customised interventions that are *community-specific*[4] and based on *user (household) requirements*
3. Evaluating the feasibility of proposed interventions based on the *impact on quality of life*, determined during *in-community testing* in real-life conditions

4 Editors' note: As was said in the Overview of the book, the context can be as important as the intervention.

These features incorporate the critical aspects of sustainability into selecting, designing, and implementing household clean energy interventions. A project's longevity, whether through maintenance plans, ensuring financial viability or partnering with local government authorities, is explicitly planned for. Moreover, the user-centred approach emphasising quality of life (incorporating environmental, economic, and social aspects of development) puts fulfilling fundamental human needs at the core of the development of interventions.

Two notable examples of initiatives of the Nova Institute that have been rolled out using this approach are the improved top-down ignition methods for coal fires[5] (called *Basa Magogo!* or *Basa njengo Magogo*) that were implemented in approximately 80,000 households on the South African Highveld over a number of years (Van Niekerk et al., 2021), and the swopping of a coal stove for an insulated ceiling and liquid petroleum gas (LPG) heater and stove that Sasol implemented in approximately 5,500 households on the Mpumalanga Highveld (Murray et al., 2023; see also Phogole et al., 2022). We outline here the overall programmatic context and the approach to developing sustainable household interventions followed by the Nova Institute, focusing on the particular elements of the strategy that reflect their understanding of sustainability. The approach prioritises achieving fundamental human needs.

The rational life cycle approach is typically executed through three phases:

- Phase 1a: establishing a baseline[6]
- Phase 1b: developing and selecting appropriate interventions[7]
- Phase 2: implementing selected interventions[8]

5 Editors' note: Featuring in various chapters of this book.
6 This phase can overlap with the scoping stage – Stage 1 of intervention development. (These stages are set out below.)
7 This phase usually includes Stages 2–4 of intervention development – pre-feasibility, feasibility, and pilot.
8 This phase typically overlaps with Stages 5 and 6 – launch and scale.

- Phase 3: monitoring and evaluating the impact of programme interventions[9]

A baseline study for a large programme typically includes gathering technical measurements and social indicators through quantitative and qualitative methods. The baseline not only provides pre-intervention indicators essential for impact measurement; it informs the development and selection of appropriate interventions. The baseline information helps to identify the drivers for behaviours or technologies that are currently in use but are sub-optimal.

Intervention development usually aims to provide alternative usage patterns or technologies that are more beneficial to end users and the environment. Households use dirty fuels such as coal, wood, or paraffin for various reasons. On the South African Highveld during the cold winters, people living in thermally inefficient houses, such as those without ceilings or shacks built from corrugated iron, choose coal as the cheapest energy carrier for space heating (Graham & Dutkiewicz, 1999). In addition to the availability and affordability of coal in regions near coal mines, the drivers for coal use are climatic conditions and energy poverty. Nova designed a solution with households[10] and other stakeholders to address both these drivers - the demand for space heating on winter nights was reduced by insulating houses, and stoves and heaters using the cleaner and more convenient LPG were provided. The intervention was remarkably successful, as 97% of dwellings where the intervention was implemented remained coal-free for at least three to five years after installation (Murray et al., 2023). The case study discussed in this chapter is located in the warmer areas of South Africa in the North West and Limpopo provinces. Here, winters are mild and thermal comfort is not the primary driver of solid fuel (wood) use. Households often have access to electricity and prefer electricity for cooking. However, they do not have warm water for bathing, and several

9 This phase typically overlaps with Stages 5 and 6 – launch and scale.

10 Editors' note: Compare chapter 9 where the requirements for co-creation are discussed.

households make an open fire outside to heat bath water. In such a context, an improved wood stove is not as effective as, for example, solar water heating, since the energy service required is water heating and not cooking or space heating.

When developing and selecting interventions (Phase 1b), Nova follows a staged approach based on the principle that understanding should precede action, and the scale of implementation can only be increased as it is matched by increased knowledge and control. The intervention development life cycle contains seven stages: 1. Scoping, 2. Pre-feasibility, 3. Feasibility, 4. Pilot, 5. Launch, 6. Scale and 7. Maintenance or Exit. We briefly discuss each stage below:

Stage 1: Scoping

The chances that an intervention will be sustainable increase as the objectives of the critical stakeholders overlap. Investors or sponsors typically have a specific purpose when they invest in development work. This is contained in their mandate or vision statement for a government department or public benefits organisation. Corporate sponsors may have a specific objective related to their corporate responsibility programme or to their environmental and social licence to operate. Examples of the latter include air quality and greenhouse gas offsets (Langerman et al., 2018; Pauw et al., 2022). In the case of air quality offsets, the overall objective may be to reduce ambient air pollution in a particular area by a specific quantum. This, in turn, may lead to identifying specific sources of air pollution as the target of the intervention. An immediate objective for the sponsor of an air quality intervention in the context of air quality offsets will thus typically be to reduce emissions from a specific source by a certain proportion. For the projects implemented by the Nova Institute in the Platinum Belt, for example, the sponsor aimed to reduce ambient fine particulate matter concentrations from domestic wood burning to offset emissions from their own facilities.

The objectives of households in retaining or changing energy-use practices relate to their quality of life. The

motivation, for example, to change domestic energy usage patterns may be to fulfil an aspiration or to avoid side effects or trade-offs related to a specific energy usage pattern. Solid fuel use has numerous trade-offs, including ambient and indoor air pollution, odours, the need for extensive storage, handling and preparations, general cost inefficiency as far as cooking is concerned and the danger of burns and fires. Aspirations for a specific material standard of living, such as living in a well-built formal house, are generally present in low-income communities in South Africa. Still, residents often lack the means to achieve those aspirations (Møller & Roberts, 2014).

It is equally important to understand the services that are provided by existing energy usage patterns even though they have inevitable trade-offs. An established energy usage pattern offers users a combination of services where they find the best choice between their current alternatives, given their situation and available information. Typically, multiple energy carriers are used in low-income households, which indicates that households carry out the balancing act between the utilities and pay-offs of their energy choices. During the scoping phase, it is critical to understand how the existing usage pattern targeted for replacement meets the user requirements because any alternative must perform equally in terms of those requirements with fewer trade-offs.

An intervention is possible where there is a specific desire for change, either to avoid something experienced as detracting from the quality of life or to fulfil an aspiration. Intervention development can start once there is a shared definition of the problem and its potential solution, or the ideal and its realisation, between the initiator of the intervention and a sufficiently representative group of intended users.

Baseline information gathered in the programme's first phase is typically used to inform the intervention development and selection scoping. Methods used to obtain baseline information include structured household questionnaires to gather data about the prevalence of specific usage patterns in an area. The services associated with energy carrier-equipment

combinations and their relative prevalence can be established in this way.

To accurately quantify domestic energy use, it is advisable to also conduct well-structured in-use measurements of energy or fuel use in a sample of households. When performing in-use evaluations, care should be taken to make the measurement as unintrusive as possible so that household members will act as naturally as possible. Nova uses structured and open-ended interviews to understand users' subjective evaluation of their energy service needs and experiences.

Stage 2: Pre-feasibility

During the pre-feasibility stage, intervention alternatives are formulated and evaluated based on the user requirements for the activities for which the intervention is developed. For complex evaluations where multiple criteria have to be applied, Nova uses a formal approach such as the analytical hierarchy process (Saaty, 1980). Favourably evaluated alternatives proceed to further development and testing during the feasibility and pilot stages.

Stage 3: Feasibility

During the feasibility stage, the intervention concept is elaborated into a detailed design for a prototype. It is highly preferable to involve end users at this stage so that end user preferences and requirements guide the design process from the start. During feasibility, a small number of prototypes are constructed (see prototype examples in Figure 4, developed to address domestic wood burning in Limpopo and the North West provinces) and evaluated by representatives of the end user population. At this stage, implementation remains limited, but intense monitoring occurs since the feasibility stage aims to assess and improve the intervention design. Several iterations may be needed to achieve a design that performs technically and meets end user requirements.

The requirement for passing the feasibility phase is that one or more of the intervention candidates should be free from

fatal flaws and test significantly positively on the objectives that it aims to achieve. These objectives can be tested in the form of criteria that an intervention has to comply with. The criteria need to be established to ensure that an intervention is sustainable, in the sense of addressing fundamental human needs in a way that enhances the environment and the social and economic well-being of the household and also in the sense of permanently altering the energy-use practices of the household.

In air quality offsets, for example, an intervention is deemed feasible if it reduces emissions of air pollutants (particulate matter and its precursors), has a positive (or at least neutral) quality-of-life impact on the end users, and is practically implementable. Nova researchers have developed the Nova Particular Impact on Quality-Of-Life Assessment (Piqola) tool to assess the effects of a particular intervention on the quality of life of an individual in the context of household life (see Chapter 12: Case studies in the quality-of-life assessment of cleaner energy interventions through 'narratives of impact'). The Piqola tool is used in feasibility assessments and is based on Max-Neef et al.'s (1991) assertion mentioned above that quality of life depends on the possibilities people have to satisfy their fundamental human needs adequately. What differs between people is not their fundamental human needs but how they are satisfied or actualised (Max-Neef et al., 1991; Murray & Pauw, 2022). This is measured by the Piqola tool.

Stage 4: Pilot

A pilot implementation can be undertaken once a successful design emerges from the feasibility stage. The pilot implementation aims to test the final design's implementation at its intended scale. During this stage, the logistics and management aspects of the full-scale implementation are refined. A successful pilot establishes a replicable implementation method that will enable large-scale implementation at multiple sites.

Stage 5: Launch and Stage 6: Scale

In more extensive programmes, a launch implementation phase may be necessary to evaluate further and refine large-scale implementation processes. In other instances, implementation may proceed after the pilot phase. Most programme resources will typically be invested in implementation. It is ideal to source contractors and human resources from local communities where possible.

Stage 7: Maintenance or exit

The viability of an intervention can be seen as the inverse of the external support needed for it to continue to function. Intervention designs that households can maintain without support (or with minimal support) pose a low risk of social disruption at the end of the intervention cycle, and bridge a medium-term challenge while the long-term solution that is already in process is preferred.

Depending on its objectives, resources and mandate, the entity driving an intervention's development and initial implementation may not be willing or able to sustain it indefinitely. The intervention maintenance exit and handover stage must be planned up front. Where the intervention relates to a service, the handover stage involves integration into the municipal services regime. This may require additional resources and capacity from the local government.

4. Case studies on the development of sustainable household energy interventions in North West and Limpopo provinces

The application of Nova's phased approach to intervention development is illustrated here by drawing on a case study where it was applied in the Platinum Belt in the North West and the western Limpopo provinces in South Africa. The project sponsor's main objective was to reduce air pollutant emissions from household burning for an air quality offset project. This case study demonstrates how energy service needs differed

even between communities near one another and with similar household income levels, how the interventions were designed around the user requirements, and how information crucial for a proposed intervention's success (or failure) was gleaned from the quality-of-life assessments conducted during in-community feasibility testing.

Scoping activities encompassed eight low-income communities in the vicinity of two smelting operations (Figure 5). Based on the frequency of and services derived from solid fuel (wood) use in households, three communities were selected for the development of interventions to reduce wood burning in the pre-feasibility phase. The nuanced insights gained during the feasibility testing are explored in detail.

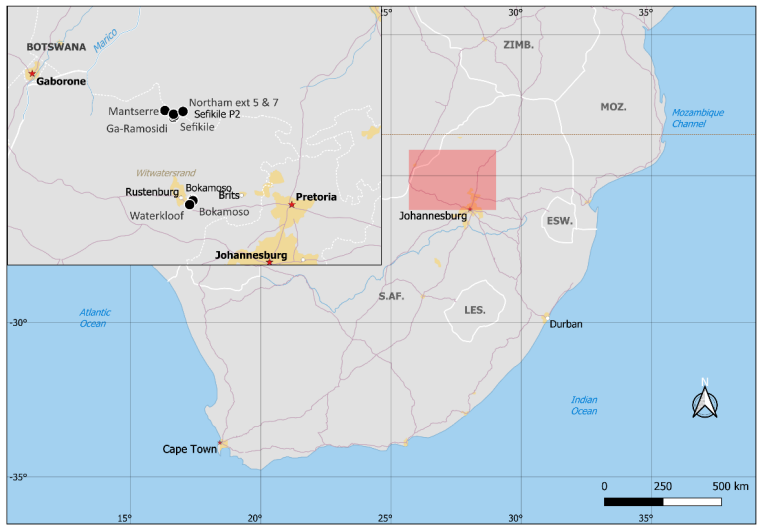


Figure 3: Location of the eight communities in the North West and Limpopo provinces (shown with black dots) where the potential for sustainable household energy interventions was assessed

4.1 Scoping stage

The scoping phase included conducting 1,392 comprehensive household surveys (CHSs) in the eight towns. The frequency of wood burning in households and the services provided by wood burning in summer and winter were determined, and the socio-demographic baseline of the households was established. Although all the communities were designated as low-income, varying government service provision and employment status meant that wood was only regularly used as an energy source in four communities: Mfidikwe, Mantserre, Ga-Ramosidi-Sefikile, and the informal part of Sefikile (labelled here as Sefikile P2) (Figure 3). The communities of Mantserre, Sefikile P2 and Mfidikwe were selected to test the feasibility of interventions targeting wood use reduction.

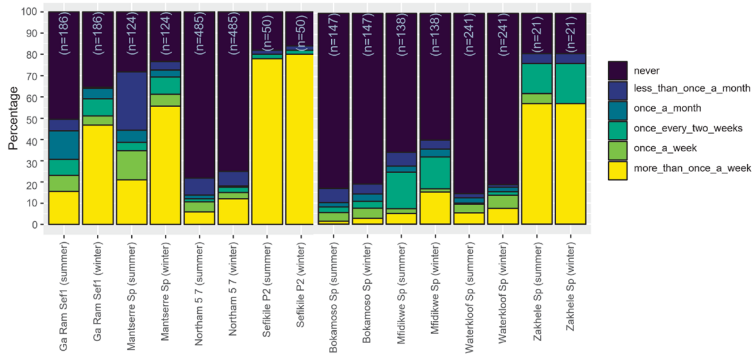


Figure 4: Frequency of wood use at selected households in eight communities in the Platinum Belt in the North West and western Limpopo provinces

Mantserre (Figure 5) is a low-density, formal Tswana settlement with access to electricity, unreliable water supply piped to stands (not into structures) and effective waste services. Key roads are paved; unpaved roads have low traffic. Energy stacking is prevalent: ubiquitous electrification has crowded out paraffin use, but most households practice regular wood burning. Wood burning is used typically for water heating but

often also for cooking. Wood is usually purchased, and relatively large volumes are used.

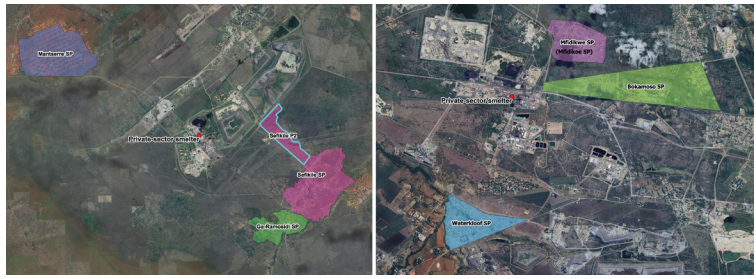


Figure 5: The locations of Mantserre and Sefikile P2 (left) and Mfidikwe (right), where sustainable household energy interventions were developed (credit: Google Earth)

Sefikile P2 is the section of Sefikile northwest of the Sefikile hillock that extends towards the mines. It is treated as a settlement on its own since it has unique characteristics. It is a medium-density, informal Xhosa settlement with no electricity, unpaved roads only (with low traffic), water on most stands, and no waste services. Paraffin and wood are the key energy sources. It has a high proportion of primary and regular wood users (in winter and summer). Almost all wood users do not purchase their wood but gather it in the surrounding area.

Mfidikwe (also spelt Mfidikoe) is a formal rural area in the Rustenburg Local Municipality. It is a dense, formal, multilingual settlement (half Tswana, with isiXhosa the largest of the remaining languages) situated in an area with many industrial pollution sources. Half of the structures are informal. Half of the households are tenants. The settlement has access to electricity, a reasonably reliable water supply piped to stands (typically not into structures) and relatively effective waste removal services. Key roads are paved; unpaved roads have low traffic. Energy stacking is prevalent: ubiquitous electrification has reduced regular paraffin use to only a fifth of households, but almost two-thirds of households still sometimes use paraffin. Wood burning is prevalent amongst about 40% of

households, although a relatively low proportion of households are regular wood users. Wood burning is mainly used for cooking, but also for water heating. Wood is typically collected for free, and smaller volumes are used.

4.2 Pre-feasibility stage

Since the primary services provided by wood-burning in the four communities were bath water heating and cooking, four technologies were identified for evaluation in the pre-feasibility stage: solar water heaters, rocket stoves, Wonderbags, and LPG stoves (Figure 6). The solar water heater system comprises vacuum glass tubes in which the water is heated directly by the sun and an insulated storage tank. The hot water is fed out by gravity. The solar water heater systems were installed on specially designed wooden pedestals, avoiding the risks associated with roof mounting on unstable low-income housing. A rocket stove is a wood-burning stove that burns extremely hot and efficiently. The rocket stove model used was the Burn-manufactured *Kuniokoa*. *Wonderbags* are heavily insulated bags that provide for slow cooking and heat retention. The LPG option featured a four-burner stove-oven with a 7 kg gas cylinder.

4.3 Feasibility stage

Intervention combinations were designed for each community based on the energy services that the households required (Table 1). In Mantserre, two of the three intervention combinations included a solar water heater because wood is mainly used for water heating. In Sefikile P2 and Mfidikwe, LPG stoves and rocket stoves were tested because wood (and paraffin in Sefikile P2) is used primarily for cooking. A *Wonderbag* was included in all the intervention combinations because it is of low cost. A control group was included in each community.



Figure 6: The four technologies identified for evaluation in the wood-using households, from left to right: solar water heater on a wooden stand, rocket stove, Wonderbag and LPG stove

Table 1: Wood-burning intervention combinations tested in households in Mantserre, Sefikile P2 and Mfidikwe

Mantserre	Sefikile P2	Mfidikwe
i) Solar water heater and Wonderbag (20 households) ii) Rocket stove and Wonderbag (20 households) iii) Solar water heater, rocket stove and Wonderbag (20 households) iv) Control (20 households)	i) LPG stove, rocket stove and Wonderbag (20 households) ii) Control (20 households)	i) Rocket stove and Wonderbag (20 households) ii) LPG stove and Wonderbag (20 households)

Three criteria were used to evaluate the success of an intervention combination in the feasibility stage:

1. Emission reduction: The amount of wood used by a household was considered to be a direct indicator of total emissions from the burning of the wood. Wood weighing surveys and temperature measurements of the stoves or fires using an iButton were employed to determine if interventions significantly lowered wood use against a baseline. iButtons, which are temperature loggers, were

attached to rocket stoves, inside *Wonderbags*, and on LPG stoves to track adoption rates.
2. Quality of life impact: The Piqola survey[11] was applied to evaluate the effects of the intervention combinations on quality of life. Designed by Nova, the Piqola assesses the quality-of-life shifts when household technological changes occur. The survey encompasses narrative interviews, satisfaction ratings, and Likert scale statements to compare pre- and post-intervention scenarios. Piqola's strength lies in its user-centric approach, ensuring that researchers treat participants as individuals with fundamental human needs rather than mere data points for external objectives.
3. Practicality of implementation: The practicality of the intervention in the specific community was assessed by drawing from the experiences of the household members and installers during the in-community tests.

4.3.1 Mantserre

In Mantserre, where wood is mainly used for bath water heating, the wood weighing survey results indicate that the solar water heater plus *Wonderbag* intervention led to the most significant reduction in wood use. While the control group's average monthly wood use was 125.53 kg, the switch to the rocket stove and *Wonderbag* resulted in a slight increase in wood use by 9.89 kg, which was not significant (p=0.61). Combining the solar water heater, rocket stove and *Wonderbag* resulted in a modest reduction in monthly wood use of 8.26 kg, which was not significant (p=0.39). By far the most significant decrease in monthly wood use occurred in the solar water heater and *Wonderbag* group, with a reduction of 51.41 kg, proving statistically significant (p=0.03).

The iButton data showed varied usage of the Rocket Stoves. Of the households where iButtons were installed in the rocket stove and *Wonderbag* group, five households used the rocket stove regularly, four occasionally, and two not at all. In the solar water heater, rocket stove and *Wonderbag* group,

11 Editors' note: Reminder! Dealt with intensively in Chapter 12.

the rocket stove was routinely used in three households, used occasionally in three, and not used in two.

From a quality-of-life perspective, participants were asked to rate their satisfaction with their households' energy use before and after the intervention on a scale from zero to ten, where zero is not satisfied and ten is completely satisfied (Figure 7). All groups in Mantserre were more satisfied with their ability to cook and heat bath water after the interventions. The most significant increases in satisfaction with water heating, clothes washing, and dishwashing occurred in the groups that received solar water heaters.

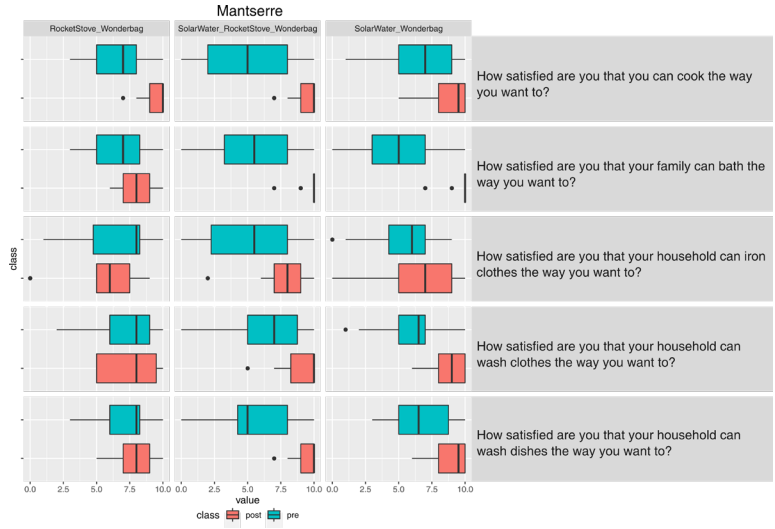


Figure 7: The pre- and post-intervention satisfaction ratings of households for several household energy services – cooking, bathing, ironing, clothes washing and dishwashing – in Mantserre. The pre-intervention responses are in blue; post-intervention responses are in orange. The boxplots depict the minimum, first quartile, median, third quartile, and maximum responses.

Considering the practicalities of implementation, the solar water heater is user-friendly and durable, with a structure that is easy

to assemble and plumbing fixtures that are widely accessible. However, the need for a pedestal because of poor roof conditions presented challenges, mainly caused by the complex engineering of the wooden pedestal, which was more difficult and costly to construct than anticipated.

When the results of the in-community testing were assessed relative to the feasibility criteria (emission reduction, quality of life improvement and practicality), a solar water heater intervention was selected for full-scale implementation in Mantserre. The solar water heater intervention was also deemed likely to succeed in the neighbouring communities of Ga-Ramosidi and Sefikile because of their similarities with Mantserre (identified during the scoping phase).

4.3.2 Sefikile P2

The iButton data in Sefikile P2 revealed that most households adopted the LPG stove as their primary energy carrier, while enthusiasm for rocket stove and *Wonderbag* adoption was not convincing. The wood-weighing survey showed that the control group had an average monthly wood use of 147.27 kg. In comparison, the intervention group that received the LPG stove, rocket stove and *Wonderbag* used significantly less wood, averaging 102.11 kg per month, which is a substantial decrease of 31%. This reduction is statistically significant, with a p-value of 0.04.

The quality-of-life assessment showed that there were substantial improvements in household energy service satisfaction following the intervention (Figure 8). Across all services - cooking, bathing, ironing, clothes washing and dishwashing - there is a marked improvement in user satisfaction. Cooking satisfaction particularly stands out: respondents rated their pre-intervention satisfaction at a mediocre 5 out of 10, which soared to 10 out of 10 post-intervention. This remarkable improvement highlights the intervention's success in meeting the cooking needs of the households, which likely translates into better overall daily living experiences. This significant uptick in satisfaction

suggests that the intervention effectively addressed the primary cooking challenges faced by the community.

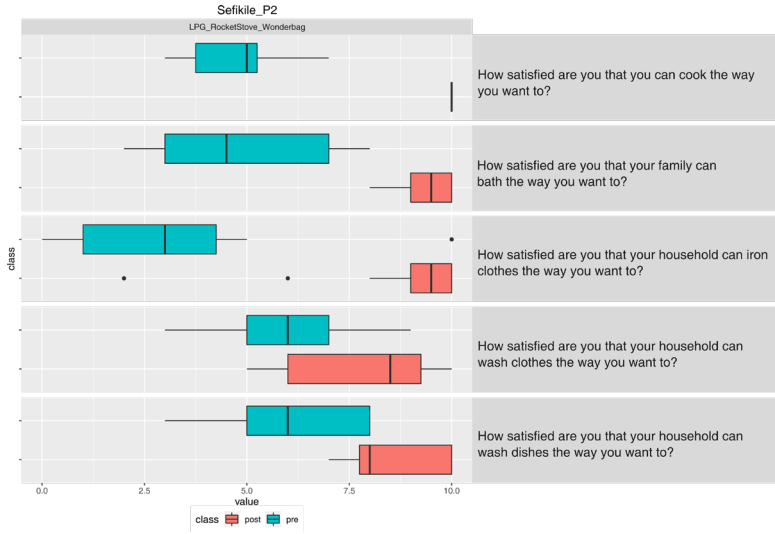


Figure 8: The pre- and post-intervention satisfaction ratings of households for several household energy services – cooking, bathing, ironing, clothes washing and dishwashing – in Sefikile P2. The pre-intervention responses are in blue; post-intervention responses are in orange. The boxplots depict the minimum, first quartile, median, third quartile, and maximum responses.

From a practical perspective, the rocket stove and *Wonderbag* were both straightforward to distribute and operate. Necessary safety protocols need to be followed for the LPG stove implementation, but they do not introduce significant technical hurdles. Opting for a 7 kg LPG cylinder and a suitable regulator proved to be practical for dissemination and for post-implementation transport and refilling by community members. It is essential for project implementers to involve experienced LPG safety trainers for household training and to coordinate with suppliers early on to accommodate procurement lag times.

Considering the results of the feasibility testing, it was decided that an LPG stove implementation is likely to meet all three feasibility criteria at Sefikile P2.

4.3.3 Mfidikwe

In Mfidikwe, when compared to the control group that had an average monthly wood use of 78.67 kg, the group that received the LPG stove and *Wonderbag* showed a slight decrease in wood use with a monthly average of 65.66 kg; however, this was not statistically significant with a *p*-value of 0.28. The rocket stove and *Wonderbag* group exhibited the largest decline in wood use, with an average monthly use of 50.36 kg, 36% lower than the control group. This reduction nearly reached statistical significance with a *p*-value of 0.07.

The iButton data from Mfidikwe households showed LPG entering the household energy stack alongside electricity. This contrasts with the unelectrified community of Sefikile P2, where LPG was adopted as the primary energy carrier.

The quality-of-life assessment suggests modest changes in satisfaction with household utilities following the interventions (Figure 9). There is a slight improvement in cooking satisfaction for LPG and rocket stove interventions, more so for the LPG stove. In contrast to Sefikile P2, which lacks electricity, and Mantserre, where water heating drives wood use, Mfidikwe's results are not as pronounced. The data implies that while LPG offers more efficient cooking and the rocket stove potentially lowers electricity costs, the impact on satisfaction levels is not as significant as observed in the other communities.

It was concluded that wood interventions are unlikely to succeed in Mfidikwe, since unconvincing feasibility results were achieved for both the emission reduction and quality-of-life impact measures.

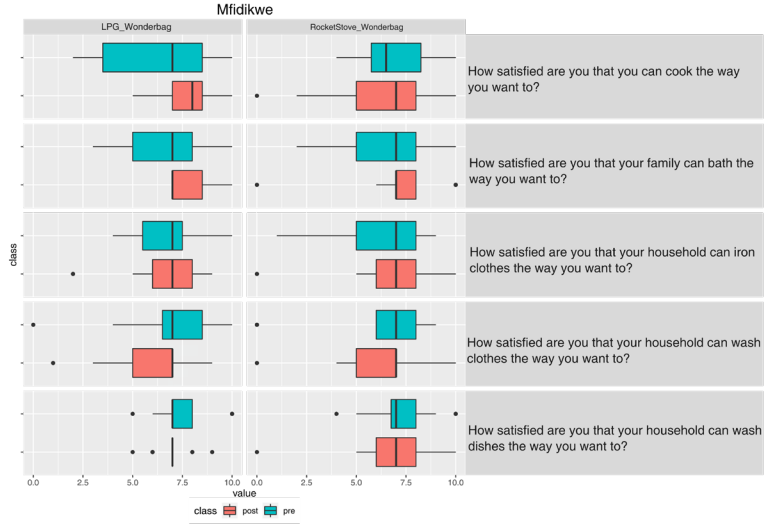


Figure 9: The pre- and post-intervention satisfaction ratings of households for several household energy services – cooking, bathing, ironing, clothes washing and dishwashing – in Mfidikwe. The pre-intervention responses are in blue; post-intervention responses are in orange. The boxplots depict the minimum, first quartile, median, third quartile, and maximum responses.

5. Conclusion

In household energy interventions, sustainability needs to be understood from the recipients' perspective, as improving a household's ability to sustainably actualise their domestic energy needs. Such an understanding implicitly incorporates an intervention's economic, social, and environmental benefits to a household. Household energy interventions should be designed based on user requirements and deliberately plan for maintenance and handover after a roll-out. Such an approach inevitably needs to be customised per community.

The Nova Institute's phased approach to the development of household interventions incorporates these aspects and

employs several tools and strategies to design for sustainability. Nova adopts a rational life cycle approach, basing intervention selection and design decisions on detailed socioeconomic and fuel or technology stacking information gathered from households, and scaling up implementation as knowledge and control increase. A quality-of-life assessment is performed during the in-community testing of interventions to gauge the impact of interventions on satisfaction with energy services and overall quality of life.

A case study from the Platinum Belt in the North West and Limpopo provinces in South Africa illustrates that household energy interventions need to be informed by the need for a specific intervention – of the eight communities assessed initially, only four passed the feasibility testing. A thorough understanding of how households use fuels and technologies to provide energy services informed the selection of interventions for feasibility testing. Even though the communities were all low-income and situated within close proximity to one another, the energy services provided by wood (the solid fuel of choice) differed between communities. In Mantserre, wood was mainly used to heat bath water, while in the informal and unelectrified Sefikile P2 and the formal and serviced Mfidikwe, wood was used primarily for cooking. Measurements of the change in the amount of wood burnt and quality-of-life assessments informed the final decision on intervention selection. A solar water heater significantly reduced wood use and increased user satisfaction in Mantserre (where wood was used to heat water). The other two communities (where wood was mainly used for cooking) responded differently to the alternative stoves provided. In unelectrified Sefikile P2, the households readily adopted an LPG stove, while in Mfidikwe, households did not willingly embrace either the rocket stove or the LPG stove.

The positive adoption and retention rates of the coal-burning interventions designed using Nova's approach on the Mpumalanga Highveld (Murray et al., 2023; Phogole et al., 2023) and the promising reception of these wood-burning interventions in the North West and Limpopo provinces discussed here provide an optimistic outlook for facilitating the

energy transition in low-income households internationally, particularly in sub-Saharan Africa. Moreover, the concurrent achievement of the aims of the sponsors of these interventions bodes well for securing funding for similar clean energy household initiatives in future.

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Chapter 5

No time to waste: Lessons learned from waste management in the absence of public services

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Abstract

Development[1] within the Anthropocene can be described as a cradle-to-grave system. The linear economy uses non-renewable resources, built up over millennia to produce goods and services, many of which are used only once and then discarded. In this, waste becomes the anomaly of modernity's expectations of absolute efficiency, and therefore the generation of solid waste stands in contradiction to an efficient linear economy, threatening biodiversity, polluting, destroying habitats and contributing to global warming, when waste is burnt and when it is dormant on waste heaps, leaking greenhouse gases and heavy metals into the environment. Waste is especially

1 Editors' note: *Development* in the old meaning of the term, before sustainability was integrated into the concept.

problematic in low-income and informal communities that lack reliable waste management services. Although some residents collect recyclables for resale, the burning and public dumping of solid waste is common practice. These communal and personal dumping spaces are also regularly burned as a way of dealing with material accumulation, health risks and inconvenient smells. While some waste entrepreneurs collect recyclables for resale, the profit margins are extremely small, and they have limited access to the necessary transport and storage to recycle on a larger scale.

In this chapter, by using a collective case study approach, we consider the problem of waste in ten informal communities in the North West, Limpopo, and Mpumalanga provinces of South Africa by mapping illegal dumping sites throughout the communities. We also observe changes in these dump sites over time to determine how dynamic they are. We further investigate the characteristics of waste from 105 low-income households from five different low-income communities and how they relate to the waste that eventually ends up in informal dumping sites in these communities. Focus group discussions assist in understanding community members' perceptions of these waste management practices.

Lastly, the chapter describes Nova Institute's pilot alternative waste management interventions in two communities from the study. These pilot studies comprised three components: household waste separation at source; waste picker integration; and waste sorting facility establishment. Combined, these three components aimed to optimise material recovery for reuse, optimise recycling and composting, and reduce waste to landfill transfer or waste burning.

Keywords: burning, dumping, low-income communities, recycling, separation at source, waste, waste picker integration

1. Introduction: Waste in the Anthropocene

The modern linear economy is one of the most powerful factors that gave rise to the Anthropocene – the geological epoch in which human behaviour is the main driver of change

in the environment, including climate change, land use transformation, biodiversity loss and pollution (Eickhoff, 2024). One of the human activities with the largest impact on Earth is the production of waste (Riebeling, 2022; Vaverkova & Koda, 2023), to such a degree that the Anthropocene has been described as the "apotheosis of waste" (Hecht, 2018, p. 111) or the "age of waste" (Corvellec, 2018).

The modern economy is considered predominantly a linear economy or a cradle-to-grave system. Primary resources are extracted, processed, and made into products. These products, many of which are designed for single use, are eventually discarded and end up back in the natural environment as waste.

The accumulation of waste material in the natural environment is one of the most significant system failures of the modern economy, threatening biodiversity, destroying ecosystems, and contributing to climate change when heaps of waste not reacting to oxygen emit greenhouse gases or when waste is burnt (Rodseth et al., 2020). In addition, the modern economy will eventually face resource depletion and insecurity, and public health risks. This makes the movement to a more circular economy economically and environmentally imperative. Waste products can be mined for secondary resources that not only have economic value but also reduce environmental costs. This in itself has economic value (Van der Merwe et al., 2023).

Some examples exist of circular economy, such as designing products that can be easily repaired or refurbished and disassembled for reuse, or recycled, and using recycled materials in production (Kirchherr et al., 2017). However, these processes are still considered niche and not employed on a large scale.

For most domestic households in countries like South Africa, products are bought, used, discarded, and collected by municipal waste services and disposed of at landfills (Godfrey et al., 2017). Along the way, informal recyclers collect material for resale, but this is not a formalised process (Samson, 2020a).

In the 2023 StatsSA household survey report (StatsSA, 2023), only 60% of South African households receive waste

management services. Waste management services in townships and informal settlements in particular are not managed effectively (Haywood et al., 2021). Problems regarding waste are exacerbated when waste is infrequently or never collected. Low-income households, with limited resources, then need to manage their domestic waste on their own, which is not effective, since effective waste management can only be achieved with collaboration and cooperation amongst residents, companies, and authorities (Rodić & Wilson, 2017; Schenck et al., 2022; Kalina, 2020; 2021).

In the absence of public waste management, a household could pay for a private company to collect their domestic waste, but if other residents do not invest in private waste collection services and discard their waste in public, then the household that pays for private collection carries the cost of waste collection but does not have the benefits of a clean community. This leaves residents despondent about addressing waste, further exacerbating the situation, meaning that voluntary cooperation in waste management schemes is not feasible, since the negative effects of waste are not only felt by those who do not responsibly manage their personal waste but also by those who collaborate in voluntary waste management.

Furthermore, poor waste management not only affects the local communities but also ecosystems, waterways, and public health beyond the affected community. Poor waste management affects most of the Sustainable Development Goals (SDGs) set out by the United Nations (UN, 2015)[2]. Effective waste management needs to be centrally organised and preferably funded through channels such as taxes, government infrastructure support grants, urban development grants and public-private partnerships (Mokgabodi, 2013). This should also be conducted in low-income areas, with a lower contribution to taxes, since the benefits of efficiently managed waste would extend far beyond immediate community boundaries.

2 Editors' note: As well as the Planetary Well-being goals articulated in Chapter 1.

In this chapter, we consider waste management in the absence of frequent, reliable public waste collection services. We study eight low-income communities within Limpopo, Mpumalanga, and North West. Our main research question was: How do households manage their domestic waste in the absence of reliable waste collection and management services? We describe three possible strategies that households follow: burning, dumping, and recycling. We used a survey to document households' reported behaviour for burning waste on their private property, as well as dumping waste. We also recorded the location of all public waste heaps, which is an indication of dumping waste. We monitored a sample of the recorded waste heaps over time to determine if a typical waste heap grows, if it is ever cleared or burnt, or if it remains relatively unchanged over time, all of which can indicate public burning and dumping behaviour. In one community, we compared the composition of waste from households with the composition of waste from public waste heaps; this gives a preliminary indication of the type of waste that is more likely to accumulate on public waste heaps and is not collected for recycling. Lastly, we describe how the Nova team piloted the implementation of community-based strategies to manage waste in more responsible ways.

2. Low-income households' informal waste management practices

2.1 Context

The studies on informal waste management practices were conducted in four different municipalities in the provinces of Limpopo, North West, and Mpumalanga, each forming part of private sector air quality offset programmes. The studies were conducted to establish a baseline scenario on various socioeconomic and environmental aspects related to ambient air quality and 'quality of life' within these low-income contexts situated near private industry operations. Table 2 shows economic and geographical information for each of the communities, with data from StatsSA and the comprehensive household survey conducted by the Nova Institute. The

differences between the various contexts investigated here emphasise the message that waste technology must always be contextualised.

In the Govan Mbeki Local Municipality in Mpumalanga, we included the settlements of eMbalenhle and Lebohang. These two settlements are near the town of Secunda, which hosts one of the largest coal-to-oil refineries in the world. The two communities are about 30 km apart. The settlements of eMbalenhle and Lebohang have grown as the industry has given more economic opportunities. These two communities, especially eMbalenhle, are the largest of the communities considered in this study. eMbalenhle, which is closer to the refinery than Lebohang, has about five times as many people as Lebohang and is about 1.5 times more densely populated. However, the mean per capita income and monthly household income of the two communities are similar. Their access to services is also very similar; for example, in both communities, about three-quarters of people have access to electricity.

The two communities situated in Limpopo, Smashblock and Northam, are about 25 km apart and in the vicinity of a private-sector smelter. The communities have similar demographic characteristics in terms of population size and density. The community of Smashblock has a higher average per capita income, about 40% higher than the mean per capita income in Northam. However, Northam is a more established community, with most (88.7%) of the people using electricity, compared to Smashblock, which has no access to electricity. Similarly, a higher proportion of people in Northam live in structures made of concrete or brick (56.5%) compared to Smashblock (33.6%). There is, therefore, a high variation between the two selected communities in the Thabazimbi Local Municipality.

The three communities in the Rustenburg Local Municipality are at most 7 km apart. They are located in a semi-urban context similar to that of Northam. While the population density is like other communities in our study, a higher percentage of the space in the community is occupied.

While all three communities have high levels of electricity use, household structures are mostly informal, except for Bokamoso, where about 90% of participants said they live in a concrete or brick structure.

The communities of Sefikile and Mantserre are more rural and about 13 km apart, close to a private-sector smelter that forms part of the local mining industry. The communities are similar in size and population density, with electricity use ranging from 78% to 100%. However, a higher percentage of residents in Sefikile live in corrugated zinc structures (63.1%) compared to Mantserre (37.1%).

2.2 Methodology

Using a collective case study research design (Crowe et al., 2011; Yin, 2009) we used multiple methods to collect the necessary data, including focus group discussions, a comprehensive household survey, recording the location of illegal dumpsites, monitoring the dumpsites' changes over time, and analysing the composition of waste from households and dumpsites. Data collection occurred between 2020 and 2023. Each of the methods is described in this methodology section:

A **comprehensive household survey** was conducted on a randomly selected sample in each of the communities. Using secondary data and satellite imagery, the communities were divided into grids or polygons with approximately the same number of residents. Enumerators then systematically approached households to take part in the survey until the required sample size was reached.

Illegal dumping mapping: All waste heaps, exceeding 1 m^2 (Malinowski et al., 2015; Niyobuhungiro & Schenck, 2021) were regarded as illegal dumpsites and recorded. The National Waste Management Strategy for South Africa (RSA, 2011; 2020) uses the term 'illegal dumping' as dumping in public in South Africa is unlawful (RSA, 2011). Illegal dumpsites are often burnt by members of the community to reduce material build-up. Enumerators were given a specific route that covered the entire area multiple times, on which all dumpsites and other pollution

Table 2: Economic and geographical information on communities

Area	Total population	Area (km2)	Population density (per km2)	Mean household income (ZAR)	Households with electricity	Household structure made of 1) concrete or brick or 2) corrugated zinc or wood
Govan Mbeki Local Municipality (Mpumalanga)						
eMbalenhle	122,265	18.3	6,645	1,080	74.6%	No data
Lebohang	32,449	5.7	5,733	1,113	79.8%	No data
Thabazimbi Local Municipality (Limpopo)						
Smashblock	11,008	3.1	3,551	2,457	0%	1) 33.6% 2) 59.2%
Northam	12,006	2.1	1,921	1,775	88.7%	1) 56.5% 2) 42.7%
Rustenburg Local Municipality (North West)						
Ikemeleng	6,454	1.3	4,853	484	91.7%	1) 31.1% 2) 68.1%
Mfidikwe	4,992	1.0	5,094	-	100%	1) 18.1% 2) 80.4%
Bokamosso	2,983	1.3	2,386	-	100%	1) 89.1% 2) 10.9%
Moses Kotane Local Municipality (North West)						
Sefikile	5,050	4.3	1,172	-	78.0%	1) 36.9% 2) 63.1%
Mantserre	4,360	3.8	1,121	-	100%	1) 62.1% 2) 37.1%

Data on population size was taken from census data in 2011 (StatsSA, 2011) that listed populations per town and projected the average population growth rates of each municipality from 2011 to 2021. To estimate area size, the area was manually drawn on satellite images around each community. Mean household income, data on electricity, and house type from the Nova Institute Comprehensive Household Survey, conducted on a randomly selected representative sample in each community.

sources were logged. Although burning waste in private spaces was at times recorded when visible, this was not the primary focus of the enumerator and therefore all incidents were not recorded. Each community was mapped multiple times, from 20 days in the largest community to 10 days in the smallest community. We used the average number of heaps across all days and considered the average number of dumpsites recorded across all days.

After the illegal dumpsites were recorded, the communities were divided into blocks. A random sample of illegal dumpsites was selected for each block. According to the sizes of the communities, different numbers of dumpsites were selected; in Govan Mbeki Municipality, 30 dumpsites were selected; in eMbalenhle and 20 in Lebohang, during the summer and the winter and each site was visited at least 10 times. In Thabazimbi Local Municipality, 56 dumpsites were visited in Smashblock in winter. In Northam, 38 dumpsites were observed. Communities in Rustenburg Local Municipality and Moses Kotane Local Municipality were only visited in the winter. In Ikemeleng, 36 selected dumpsites were monitored, 14 in Mfidikwe, 36 in Bokamoso, 16 in Sefikile, and three in Mantserre. Every heap was visited every weekday for two weeks. Some selected sites were not monitored for the entire time frame because they were dumpsites that the fieldworkers were not able to identify again; this included 4 of the 16 selected dumpsites in Sefikile and 2 of the 14 selected dumpsites in Mfidikwe. With every visit, fieldworkers recorded what they observed by choosing whether (1) the site looks exactly the same; (2) there is new rubbish on the site; (3) the site burned since the last visit; (4) there is an active fire on the site; and (5) the site looks smaller (burned or some of the rubbish has been removed).

An analysis of the composition of the illegal dumpsites was conducted in one of the communities, Ikemeleng in Rustenburg Local Municipality. Enumerators recorded the mass and volume of waste samples from illegal dumpsites over two weeks, dating to the end of October 2020. Two to four samples were drawn from each identified dumpsite by using 70 l plastic waste bins filled with materials from the dumpsites. Each

Table 3: Overview of available data

Municipality, province	Communities	Household Survey, sample size	Waste mapping	Waste heap monitoring	Public and household waste survey
Govan Mbeki Municipality, Mpumalanga	eMbalenhle	1,263	Jan– Feb 2023 and Jul 2023	S:-30 (March 2023) W:30 (July 2023)	No
Govan Mbeki Municipality, Mpumalanga	Lebohang	836	Jan– Feb 2023 and Jul 2023	S:20 (Feb–Mar 2023) W:20 (July 2023)	No
Thabazimbi Municipality, Limpopo	Smashblock	388	July–Aug 2021	S: N/A W: 56 (Aug 2021)	No
Thabazimbi Municipality, Limpopo	Northam	485	June 2021	S: N/A W: 38 (July 2021)	No
Moses Kotane Municipality, North West	Sefikile	236	June 2021	S: N/A W: 20 (July 2021)	No
Moses Kotane Municipality, North West	Mantserre	124	June 2021	S: N/A W: 3 (July 2021)	No

Municipality, province	Communities	Household Survey, sample size	Waste mapping	Waste heap monitoring	Public and household waste survey
Rustenburg Municipality, North West	Waterkloof	241	Jun–Jul 2021	S: N/A W: 36 (July 2021)	Yes
Rustenburg Municipality, North West	Mfidikwe	138	Jun–Jul 2021	S: N/A W: 14 (July 2021)	No
Rustenburg Municipality, North West	Bokamoso	147	Jun–Jul 2021	S: N/A W: 36 (July 2021)	No

An overview of the available data for each community is given. The sample size of the household survey refers to the number of people who were randomly approached to take part in the survey and gave their consent; participants were from randomly selected blocks in each community. The waste mapping dates show the months in which fieldworkers walked on preset routes to map each waste heap in the community. Waste monitoring heaps refers to the number of heaps that were selected to be further monitored for changes, the months in which this was performed are shown in brackets for the summer (S) and winter (W). The last column indicates in which community an analysis of the content of public waste heaps and household waste was performed. See Section 2.2 for more information.

sample was drawn at a separate point within the dumpsite to ensure that the samples were representative of the heap's contents. The samples were weighed and their content was sorted according to 13 waste categories, including plastic, paper, cardboard, glass, metal, e-waste, organic, sanitation, hazardous waste, construction waste and textiles, ash and dust, and other types.

A **waste composition analysis** was also conducted in Ikemeleng, which included the analysis of the composition of waste from 20 households. The household waste was sorted into the same 13 categories used in the public waste survey. Waste was collected once every week in each of the participating households. All the waste was then sorted into large collection bags and then sorted and weighed into each category.

Lastly, **focus group discussions** were held in each community forming part of the study. Here, members of households who participated in the household waste study were invited, as well as locally active waste pickers, to discuss their current waste practices and to conceive of possible solutions to the challenges that they faced related to their waste management.

3. Describing domestic waste behaviour

3.1 Waste collection services

The level of service delivery differs in each community. During a focus group discussion in Ikemeleng, one resident said: "(I) think service delivery will help in many things. If the municipality or government were rendering service here, the majority of problems would be minimised. Therefore, service delivery would be of great assistance."

Table 4 shows reported details of waste removal services, ranging from 80.3% waste removal services in the communities in Moses Kotane Local Municipality to only 29.5% of households with collection in Thabazimbi Local Municipality, which ranges from no collection in Smashblock to 55.9% of households with waste collection in Northam. Households with waste removal

Table 4: Household and domestic waste information

Region	Thabazimbi Municipality	Rustenburg Municipality	Govan Mbeki Municipality	Moses Kotane Municipality
Waste collection frequency:				
Once a week or more	29.5%	45.1%	66.9%	80.0%
Once every two weeks	0.1%	0.4%	1.1%	0.3%
Once a month	1.6%	0.8%	2.9%	0%
Less than once a month	0.1%	0%	0.3%	0%
Never/no services	68.7%	53.8%	28.9%	19.7%
Waste collection failure (only those with services)				
More than once per month	61.5%	28.8%	38.3%	2.8%
Once per month or less	1.5%	70.4%	12.2%	51.2%
Never or very rarely	26.4%	0.8%	49.7%	33.3%
How waste is disposed of (multiple answers possible)				
Dispose at a dump site	14.6%	10.5%	Data not available	0.6%
Dispose anywhere in public	3.0%	3.4%		0%
Recycle	0%	1.1%		3.9%
Burn waste	42.3%	55.0%		66.7%
Buried waste	1.3%	20.7%		0.3%
Composted or animal feed	0%	3.6%		0.3%
How often do you burn waste?				
Once a week or more	27.5%	38.5%	5.2%	28.6%
Once to twice per month	6.9%	13.1%	5.1%	28.6%
Less than once a month	7.9%	3.4%	1.5%	9.4%
Never	57.7%	45.0%	88.2%	33.3%

The data shown is from various household surveys done in the communities. See the methodology section for more information. The communities in Thabazimbi Local Municipality are Northam and Smashblock; the three communities in Rustenburg Local Municipality are Bokamoso, Mfidikwe, and Ikemeleng; the two communities in Govan Mbeki Local Municipality are eMbalenhle and Lebohang; and the two communities in the Moses Kotane Local Municipality are Sefikile (including the extension Ga Ramosidi) and Mantserre.

services do report some collection failures, ranging from 2.5% to 61.5% of participants who said that in the last three months, there have been more than one collection failure every month in the communities in the Moses Kotane and Thabazimbi Local Municipalities, respectively.

Given the low coverage of domestic waste collection, as well as the higher failure rate, most households do not have regular waste collection. For example, on average, about a quarter of the households in the Northam and Smashblock (the two communities in the Thabazimbi Local Municipality) have waste collection services – but all of these households are located in the community of Northam, and none of the households in the community of Smashblock have waste collection services. In addition, 61.5% of households said that there was a failure in the weekly waste collection at least once per month in the last three months, which means that in these two communities, only 12% of people report weekly waste collection. The collection rates are better in Moses Kotane Local Municipality, with about 25% of households reporting regular weekly waste collection.

In the absence of public waste collection services or high failure of collection, households manage their own domestic waste. In the following section, we discuss three strategies that households commonly employ, namely, dumping, burning, and recycling waste.

3.2 Dumping and burning waste

The strategy most used to manage domestic waste is for households to dump or burn their domestic waste at public waste heaps within the community. We discuss these two strategies together in this section.

In the household survey conducted in the communities, most people said that they burn their waste or dispose of it at public waste heaps in the community. In the Thabazimbi and Rustenburg communities, 14.6% and 10.5% of participants said that they discard their domestic waste at public waste heaps in the community; in both communities, a further 3%

of participants said that they dump domestic waste anywhere in public.

During a focus group in eMbalenhle, a resident said: "(We burn) papers and old clothes that you do not need anymore, we throw them outside, light fire and burn them". Reportedly, the incidence of burning waste is very high, ranging from 42.3% in Thabazimbi to 66.7% of participants in Moses Kotane Local Municipality who said that they burn their domestic waste, either regularly or occasionally (see Table 4).

To understand the prevalence of illegal dumpsites and public burning in the community, fieldworkers walked routes covering the entire community and logged any instances of dumpsites, burning waste, and previously burnt waste. We found high levels of illegal dumping in the communities.

Figure 10 shows the number of dumpsites, burning waste, and previously burnt waste in each of the communities in our sample per square kilometre, differentiating, when data is available, between the winter and the summer. While Thabazimbi and Govan Mbeki local municipalities have the lowest density of dumpsites, consistent across the winter and summer, Rustenburg Local Municipality has the highest density of dumpsites, also with relative consistency between the seasons.

If we consider Figure 11, we see a more consistent trend across communities and seasons. Illegal dumpsites are the most common type of waste recorded in all communities and seasons, followed by previously burnt waste. All communities have more waste heaps, ranging from more than 80% in Moses Kotane in the summer to about 55% in Secunda in winter. All communities have a small percentage of actively burning waste, which is expected, since it is dependent on the exact time that the survey is conducted. In the cases where we have data for both seasons in a community, we see slightly more burnt waste in the winter than in the summer.

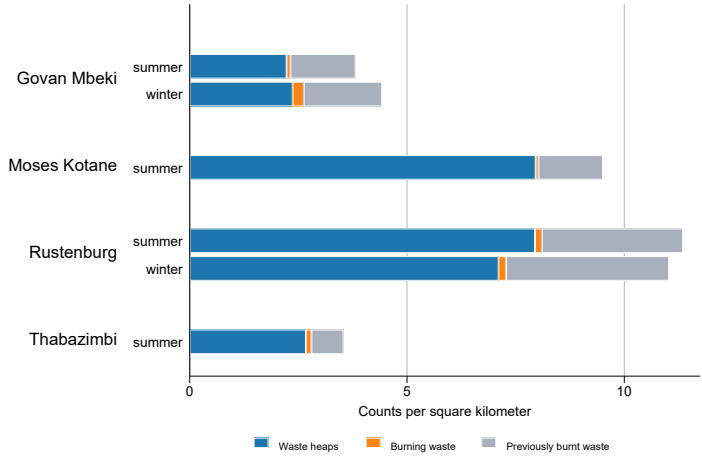


Figure 10: Illegal dumpsites, burning waste, and burnt waste in the communities in Northam (Mantserre, Sefikile), Rustenburg (Ikemeleng, Bokamoso, Mfidikwe), Secunda (eMbalenhle, Lebohang) and Thabazimbi (Smashblock, Northam) per square kilometre in the communities. Winter data was not collected in Thabazimbi, and summer data was not collected in Moses Kotane. See Section 2.2 for more information on the methodology.

Observing these recorded dumpsites over time also gives us an indication of how dynamic or static these dumpsites are. Meaning, are the dumpsites relatively stable over time, in that they do not become significantly larger or smaller over time, or do they change significantly over time? This could include frequent new deposits, frequent burning or removal of waste. To understand how dynamic or static the dumpsites are, enumerators visited a subsample of dumpsites in various seasons. They had to mark whether a dumpsite either looked the same, the site looked smaller (burned and some of the rubbish had been removed), or whether the site was burning or burned since the last visit or had new rubbish on the site. These dumpsites were observed over two weeks.

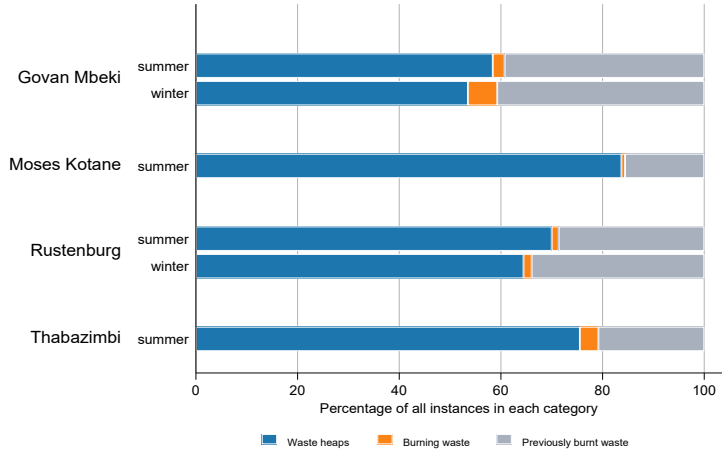


Figure 11: Waste heaps, burning waste, and burnt waste in the communities in Northam (Mantserre, Sefikile), Rustenburg (Waterkloof, Bokamoso, Mfidikwe), Secunda (eMbalenhle, Lebohang) and Thabazimbi (Smashblock) per square kilometre in the communities. Winter data was not collected in Northam. See Section 2.2 for more information on the methodology.

The observed changes in the dumped waste are shown in Figure 12 are place-dependent, with Rustenburg Local Municipality in the winter showing many new deposits and Moses Kotane and Thabazimbi local municipalities in the winter showing more dumpsites with no change. If we consider Goven Mbeki Local Municipality, with data for summer and winter, we can see that communities have similar dynamics across the seasons.

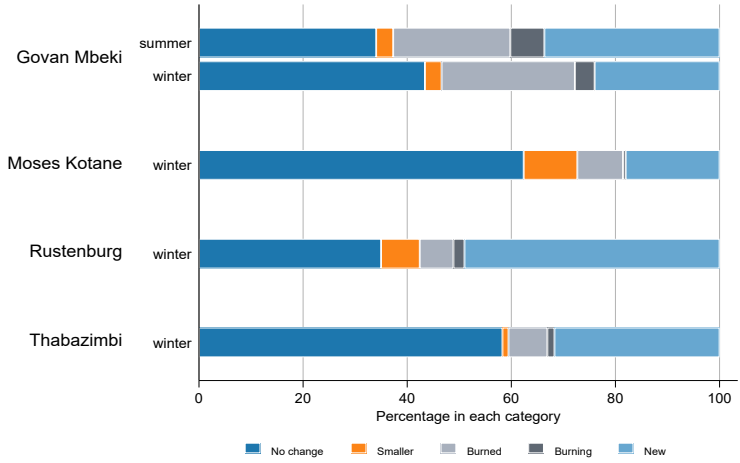


Figure 12: Changes in waste heaps over time. Blue shows waste heaps with no changes over time, orange shows heaps that decreased in size, light and dark grey show waste that was burned or is burning, respectively, and light blue shows heaps that grew with new waste deposits. No summer survey was conducted in Northam and Rustenburg.

3.3 Recycling waste

During a focus group in eMbalenhle, one resident mentioned the value of recycling: "You can see that the municipality is no longer interested in collecting our waste. So, we just must see what we do with the waste. What is helping us most is that we sell most waste, such as bottles, tins and even the papers too are weighed." In some cases, entrepreneurs or volunteers from the community also collect neighbours' waste, either to collect recyclable waste for resale or to merely help, usually by dumping the waste at informal dump sites in the community. During a focus group at eMbalenhle, one participant said that he and four other residents use a trolley to collect their neighbours' waste for free: "(G)oing around to other people and asking them if we can collect their waste and they give us the waste… Yes,

for free. We have sympathy for other people. It does not mean that we all want money."

In Ikemeleng, one of the communities in the Rustenburg Local Municipality, a household waste survey was conducted where the waste of a group of households was collected and analysed into different waste types. A public waste survey, where waste samples from public waste heaps were collected and analysed into the same waste categories, was also conducted in the same community. Comparing the composition of waste from households to the composition of waste from public waste heaps in the same communities could give an estimation of the type of waste that households discard and the type of waste that is more likely to be dormant on waste heaps, meaning not recycled or burnt.

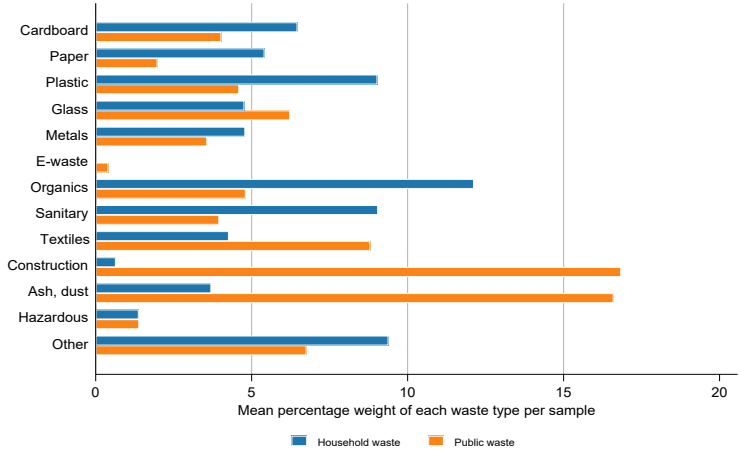


Figure 13: Household waste composition compared to composition of waste on public dump sites. Domestic waste from 20 households was categorised into 13 waste types (blue, household waste survey). Samples from multiple public waste heaps in the community were also drawn and divided into the same 13 categories (orange, public waste survey).

Figure 13 shows the weight of each waste type analysed from household waste (blue bar) and public waste (orange bar). We calculated the total weight of each sample and calculated the percentage of weight that each waste type contributed to the total. Figure 13 shows the mean of the percentage weight of each waste type per sample. Figure 13 should be used to compare the differences in the compositions from households and public waste heaps, i.e. comparing the length of the blue and orange lines for each waste type. Since we use the weight of the waste and not the volume, we could underestimate the presence of lightweight waste types, and the graph should not be used to compare the composition of waste across waste types.

From Figure 13, it is clear that certain waste types are more likely to stay dormant on public waste sites compared to others. This could be caused by multiple reasons, for example, certain waste types have a higher likelihood of being diverted from dump sites because of their recyclability, biodegradability, or can easily be burned. On the other hand, there could be a high accumulation of other waste types, because of the difficulty of disposing otherwise.

We do see that recyclable waste, specifically cardboard, paper, plastic, and metals, has a higher mean percentage per sample in household waste samples than in public waste heap samples, which could indicate that these items are intercepted for recycling after being discarded by the household. However, despite the important work performed by waste pickers to intercept recyclable waste for resale, there are still significant levels of recyclable waste on public waste heaps. Supporting informal waste pickers could increase the efficiency of their services.

We observe higher levels of biodegradable waste from household waste than from public waste heaps, which could be an indication that animals eat biodegradable waste on public waste heaps, or it follows the usual process of biodegradation. During a focus group in the same community, Ikemeleng, many participants mentioned animal activity related to public heaps; one participant said: "We do have a big problem with the pigs

… searching for food through the wastage, leaving the place upside down."

Even sanitary waste is eaten by animals, as one participant described: "The pigs, or even dogs, would bring the wasted diapers in the house. When you go outside the house in the morning, you see all these diapers brought by these animals all over the yard." This could be why we see a larger mean of sanitary waste from households' waste samples compared to public waste heap samples.

We also observed a remarkable amount of clothes on public waste heaps. This is significant, as one might expect low-income contexts to pass down or re-sell clothing, rather than dumping it on public heaps. This might be related to cultural values related to clothes, where owners would rather burn textiles than pass them on to others - an aspect to be further researched.

We see a much higher percentage of construction waste compared to household waste on public waste heaps, which could be attributable to various reasons. Construction waste cannot be burned and is difficult to dispose of; this means that over time, there will be a build-up of construction waste on public waste heaps. The same is true for ash, since ash builds up on the waste heaps every time public waste heaps are burnt to dispose of built-up material. In addition, people do not regularly dispose of construction waste, meaning that depending on the timing of when the waste of households is collected for analysis, there might not be any construction waste recorded from the household waste. It should be noted that construction waste is much heavier than other waste types, such as plastics, and since we consider the percentage weight of each waste type, this would overestimate the amount of construction waste on public waste heaps.

4. Possible solutions and interventions

Given the challenges faced by low-income households and the complexities related to their waste management practices, as illustrated in the case studies, the following section comprises

a consideration of possible solutions to these challenges by offering an account of two pilot projects that Nova implemented in Ikemeleng and Smashblock to address their waste management problems.

Improved waste management has the potential to increase jobs, reduce the impact on the environment, regain resources, and increase income through various income streams. The alternative waste management model designed by Nova, aimed at reducing waste burning and public dumping, does not comprise a distinct technology alternative, but rather a combination of technologies, materials, arrangements, and procedures. The configuration opted for in these projects is locally operated and relationship-driven, which is done by integrating waste pickers, employing local labour, and closely cooperating with residents. In addition, the project optimises recycling through separation at source (S@S) and establishing waste sorting facilities.

Project developers drew from three sources, namely:

1. The *Waste Picker Integration Guideline for South Africa*[3]
2. Waste Picker integration website; and
3. outcomes of Nova-waste picker interaction or co-creation during the baseline study.

The first two sources provided detailed procedures on waste picker integration into formal waste management structures, as well as offering background to the principles on which the national integration process is based. These principles include:

- **Separation at source (S@S):** separation at source is the separation of different types of consumer waste materials; firstly, at the point of generation and secondly, at a sorting facility once it has been discarded. S@S typically focuses on the separation of recyclables (and often further disaggregation into different types of recyclables), organic waste and solid waste. Selective collection of separated

3 DEFF/DSI 2020 Waste picker integration guideline for South Africa https://wasteroadmap.co.za/wp-content/uploads/2021/02/Waste-Picker-Integration-Guidelines.pdf.

materials ensures that they do not contaminate each other and that waste-to-landfill transfer is minimised.

- **Separation outside source:** the informal system created by waste pickers working in streets, open spaces and landfills to salvage recyclable and reusable materials mixed into the waste stream, and to separate, clean and transport them to either sell, use themselves, or make new products (Samson, 2020b).
- **Integrated separation at source:** separation at source that integrates waste pickers and their informal separation outside the source recycling system.
- **Waste picker integration:** the creation of a formally planned recycling system that values and improves the present role of waste pickers, builds on the strengths of their existing system for collecting and revaluing materials, and includes waste pickers – people who collect reusable and recyclable materials from residential and commercial waste bins, landfill sites and open spaces to revalue them and generate an income – as key partners in its design, implementation, evaluation, and revision. Waste picker integration requires changes in several spheres and includes the integration of waste pickers' work, as well as the political, economic, social, legal and environmental integration of waste pickers.
- **Recycling:** processing and manufacturing activities to convert previously used materials into new products or inputs.

4.1 Separation at Source at the household level

S@S encourages the recovery of recyclable resources and could generate an (albeit small) income in the reselling of recyclable waste. However, the implementation of S@S programmes without the integration of informal actors, such as waste pickers, risks them being cut off from their source of income and livelihood (Sekhwela & Samson, 2020; Wilson et al., 2006). It is therefore essential to align S@S initiatives with waste picker integration. Re-making products from recycled materials reduces the pressure on primary resources and reduces waste transference to landfills. Further, giving people the resources

to assist with separation at source could increase the recovery of nutrients from biodegradable waste and reduce the leaking of methane gases when biodegradable waste does not properly break down in anaerobic conditions. Additionally, it could increase the diversion of waste to the landfills.

S@S in these pilot projects consisted of sorting household waste into three waste streams consisting of recyclable, non-recyclable, and organic material, and for each of these categories, a waste bin was provided to households. The project included training households on how to separate their waste at home, provision of waste containers for each main waste stream and a weekly waste collection service performed by waste pickers. In addition, households received training and continuous evaluation to correctly execute waste separation. This aspect is of great importance and determines the level of successful household S@S, as also noted by other scholars (Babei et al., 2015; Matter et al., 2013). Household waste is collected weekly by waste pickers and sorted at a local sorting facility for recycling and local composting purposes before the remaining non-recyclable materials are transferred to a municipal landfill.

During the feasibility studies that Nova conducted, different sets of waste containers or bins were tested with households. The aim was to provide sets of bins to have storage options and capacity for recyclable, non-recyclable, and organic waste. For residential stands with three or fewer households, one set of three 70 l plastic bins with colour-coded lids was provided, and for residential stands with more than three households, two 120 l wheelie bins for recyclable and non-recyclable waste, and one 70 l bin for organic waste were issued.

The project personnel provided S@S training and support by recruiting local personnel to train households in the fundamentals of recycling and separating their waste into the correct bins. Instructive labels were placed on the bins to remind project participants of the correct bin in which to place each waste type. A stand evaluation officer was recruited and trained to visit each stand on at least a monthly basis to assess the stand compliance and offer follow-up training where

necessary. Lastly, a public information desk was created close to one of the waste sorting facilities, where queries could be received and resolved.

During the first month of waste collection from participating households, the stand evaluator had to conduct frequent follow-up visits to households, and conducted retraining, as the concept of waste separation took a few iterations before it was fully adopted. However, after this initial month, the follow-up frequency gradually decreased, and waste separation became a common household practice. The main challenge in this regard was experienced with stands which had multiple tenants or 'backyarders' renting from a landlord. These stands received one set of large bins that, therefore, were shared by all. For these stands, the evaluator had to arrange a day and time where all could be present to receive training together. This proved to be a successful method that allowed for convenient and effective material recovery from the collected household waste.

4.2 Waste collections and waste picker integration

Because of the lack of public waste management services, local entrepreneurs, or waste pickers, have seen the problem as an opportunity to secure a livelihood and improve the community. Supporting and integrating these informal waste pickers into an improved waste management system will keep income in the community and contribute to developing localised solutions for each community. It is therefore important to integrate the waste pickers and informal collectors into the new waste management project. However, it is important to note that integration should not be conceptualised in the absence of waste pickers but rather formed in consultation with them to ensure a shared understanding of this concept co-created and implemented (Sekhwela & Samson, 2020). During a focus group discussion at Waterval, one resident said: "There ought to be people hired from within the community to work specifically on the collection of waste. These people should be the ones looking around the community for full bins and call for collection according to sections". Utilising the informal

waste management systems rewards those entrepreneurs who have been contributing to waste management before, creates jobs in the community and increases the likelihood of creating location-specific solutions.

According to the waste picker integration guideline, the identification of waste pickers in itself serves multiple purposes, including leading to improved working conditions, ensuring access to social security benefits, integration into formal waste management systems, and promoting sustainable waste management practices.

For the pilot of this alternative waste management model, Nova engaged stakeholders who were actively involved with local waste processes. To assist in the identification and recruitment process, these stakeholders included waste picker representatives, local government authorities (ward councillors), waste management companies and NGOs. Such collaborations helped to ensure a comprehensive and inclusive approach to waste picker identification. Thus, a comprehensive list of waste pickers active within the community was drawn up as extensively as possible, and from this list, specific waste pickers who resided and operated in the pilot service block were recruited to participate.

Candidate waste pickers were required to produce official identification documentation. For South African citizens, this entailed their official identification document (ID), and Nova captured their ID number and filed a copy of this document as proof. For foreign nationals, a legitimate passport from their country of residence was required. Capturing this information will further enable participating waste pickers to take part in the national waste picker registration programme, which is a current national process forming part of the waste picker integration guideline. Furthermore, each waste picker was given a unique QR (quick response) code to assign them to a specific service block.

Waste pickers were required to provide their current residential address to indicate under which demarcated project service block they fell. This was performed to ensure that

recruited waste pickers service the same block where they are residing. Recruiting local waste pickers ensures a baseline familiarity with the working area and households living there.

To ensure the success of this project, it was necessary to establish that participating waste pickers already have experience in the practice of waste picking. This mainly entailed the collection, sorting and selling of recyclable waste materials, at least on a S@S basis. A survey was conducted in the recruitment phase to establish, firstly, that the individual was an established waste picker with collection, sorting and selling experience. Secondly, to estimate the current volume of materials that they collect. The latter is important to judge whether a waste picker has the physical ability and/or drive to collect waste on a full-time basis.

To perform the household waste collection, each waste picker was issued with a uniform, the necessary personal protective equipment and a trolley cart (see Figure 14), which mainly consists of a large plastic mould to limit the trolley weight and ensure ease of movement for the waste picker. The integration actions followed in these pilot projects worked effectively, as waste pickers typically spent half a day collecting and therefore had ample time to continue with their own waste practices as before. Waste pickers were remunerated for their collection by being paid R1,00 per kilogram. Scholars have noted the existing or potential tension between parallel running formal and informal waste management processes, specifically the competition to collect high-value recyclable materials (Godfrey et al., 2016; Sekhwela & Samson, 2020). In this sense, the pilot project integrates waste pickers to perform collection of all materials from households and thus eliminates the potential for competition with other formal actors.



Figure 14: Waste picker trolley

4.3 Waste sorting facility

The third component of the alternative waste management model comprised the establishment of a waste sorting facility, or a material recovery facility, as it is more commonly referred to within the waste sector. The main function of this facility is to further sort, weigh and process the waste material collected from the households, especially recovering materials for recycling and reuse. Locally processing waste, by sorting each waste type individually into different recycling waste streams, such as composting biodegradables and semi-processing waste, could reduce the transportation cost of waste, which comprises a significant cost in waste management. This does not, however, mean that a waste sorting facility drastically reduces the cost of transportation of materials; it only reduces the amount of waste transferred to landfills, and where materials can be sold or directly reused locally, the cost is eliminated, but the proximity of recovery facilities to large recycling companies

greatly determines the prices paid for it, therefore impacting the income of the waste pickers.



Figure 15: Local waste sorting facility

To perform these tasks, four individuals were trained and assigned to the roles of site officer (1) and waste sorters (3) for each waste sorting facility. These facilities consisted of three main infrastructural areas, namely a sorting area where recyclables are further categorised and weighed; three or four large 12 m shipping containers for material storage; and a composting area where organic waste is processed by applying the *bokashi* composting method . To achieve the goal of optimal waste-to-landfill diversion, recycling and composting processes had to be developed. For the recycling materials, which mostly consist of paper and packaging materials, categories were identified that are currently absorbed back into the local recycling economy, thus even though some waste types are potentially recyclable, the fact that a local economy has not been established for the waste type might render it non-recyclable.

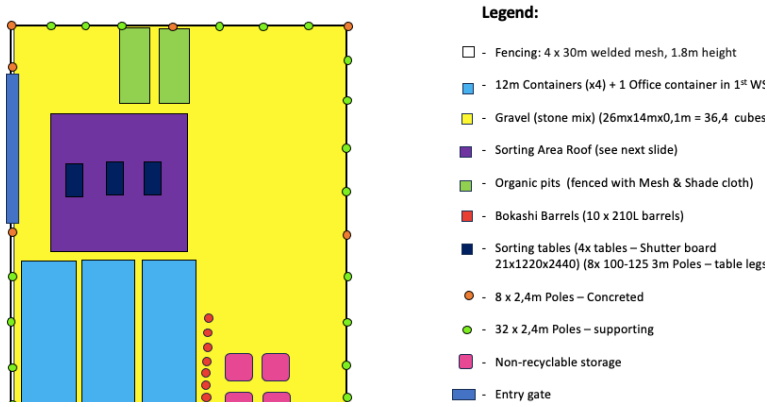


Figure 16: Plan of waste sorting facility

The recyclable materials are stored in 12 m shipping containers, and once maximum capacity is reached, these are sold to a local recycling buy-back centre. The income generated through this sale was paid out to waste pickers in addition to the R1,00/kg collection payment. We noted a significant difference in prices paid for materials between the project located in a rural context compared to the project situated in a semi-urban setting.

Organic waste was the only waste type for which Nova developed its own recovery or reuse process. By utilising the *bokashi* composting method, organic waste is mixed with *bokashi* bran, placed in 210 l plastic barrels, and sealed off from oxygen to ensure anaerobic fermentation. The organic materials remain in these barrels for two weeks to allow the anaerobic decomposition process. Hereafter, it is buried in soil for further breakdown and to be turned into valuable compost. This process has added significant value to the waste management model, since the analysis of the composition of the household waste showed that a significant portion of household waste is organic (see Figure 13).

The two pilot projects established by Nova indicated that by adding infrastructural devices such as a waste sorting facility, a significant amount of waste materials can be recovered for reuse and recycling that would, in the absence of

the project, be burned or landfilled. In summary, each of the three components forming the alternative waste management model was implemented with relative success. The introduction of household S@S to the pilot project's participants was adopted with less effort from Nova staff than was initially anticipated. Training and equipping households to practice S@S is one aspect of the process, but there are no guarantees that participants would be willing to change their behaviour. However, as mentioned above, S@S was successfully adopted by the majority of participants. Secondly, the form of waste picker integration applied by these pilot projects allowed for effective household waste collection. On average, waste pickers collected from 15 households per day, which required about two hours of their time. This number could be doubled, at least, which would then also increase their income. Lastly, the sorting, weighing, storage and composting activities related to the waste sorting facility were conducted with relative ease. The high-value recyclable materials were easy to sell; however, materials such as glass proved to be a challenge in the rural pilot project. Nova has yet to establish whether a need exists within these communities for garden compost. The processing of organic waste into compost was effective, but the uptake of this material into the communities still needs to be tested.

5. Conclusion

The linear economy is unsustainable, using limited primary resources to produce goods and services, which are only used once and discarded. The build-up of waste is a limitation of the modern economy (Kirchherr et al., 2017). This is most evident in informal communities that do not have reliable public waste services. Residents then resort to managing their own waste (dumping, burning, and burying), forming local recycling and waste collection practices. However, it is difficult to develop effective private service or a voluntary community approach to waste collection, since the benefits of effective waste management, including a clean community and reduced public health risks, are enjoyed by everyone in the society, irrespective of whether they contributed to these successes. This makes it

very difficult to address waste concerns without public policy, regulations, and collective efforts (Haywood et al., 2021; Viljoen et al., 2021)

We see some significant variation in the communities which we studied in this chapter; some communities have no public waste collection services, and others have up to 80% coverage of the community. For those communities with waste collection services, we do see varying levels of service failure. In the absence of waste collection or with high service failure, people need to manage their own domestic waste, which is mostly conducted through dumping in informal dumping sites in the community or burning, in private and public spaces: such as what was found by Haywood et al. (2021), Viljoen et al. (2021), Niyobuhungiro and Schenck (2021) and Schenck et al. (2022). This results in high levels of unmanaged waste throughout the community, as was also recorded in the study when illegal dumping sites were mapped and monitored. We do see some consistency across seasons for the two communities where we have data on illegal dumpsites for the winter and summer seasons. However, observing these dumpsites over time shows variations across communities; while communities in Thabazimbi and Moses Kotane local municipalities have relatively static dumpsites (with little growth or reduction), communities in Govan Mbeki and Rustenburg local municipalities have more dynamic heaps, with more deposits and more burning.

We also find more waste that is difficult to dispose of (such as construction waste, textiles, dust and ash) compared to household waste, on dumpsites. In addition, we find less waste that is easily recycled, such as plastics and paper, which indicates interception by informal recyclers. However, some recycling materials such as glass are not collected by the same ratio, and are more prevalent on dumpsites. Glass constitutes a heavy recyclable material and the value thereof is quite low (typically around R0.50c/kg) compared to other recyclables. This might explain its prominence on illegal dumpsites. Similar trends were found in the studies by Schenck et al. (2022).

Supporting the practices of informal waste pickers could increase the efficiency of their services and increase recycling rates even further. For example, while many entrepreneurs collect recyclables for resale, the profit margin is small and on a small scale. They face high fixed costs. Informal recyclers do not have access to the necessary transportation and storage to scale up their operations and increase their income. A possible solution is to integrate the informal solutions, including recycling and waste picking, into a centralised system. Giving households the necessary resources to separate at source will increase nutrient recovery from biodegradable waste, increase collection of recyclables, reduce waste to landfill, and reduce pollution from burning domestic waste. Building on established informal waste practices will ensure that the solutions are fit for each community and increase income and job creation in that community.

Given the limitations of informal community initiatives, it is therefore important to assist communities with centralised waste management interventions. Improved waste management increases well-being in the communities by reducing unsanitary conditions and toxic smoke from waste burning, which constitutes a public health concern (Kalina, 2020; 2021). Improved waste management also increases general life satisfaction and could also have secondary advantages, such as increased investments in the communities (Haywood et al., 2021; Fadhullah et al., 2022; Perkumienė et al., 2023).

We studied a pilot waste intervention that integrated local waste pickers to collect waste from households that was separated at the source into organic waste, recyclable waste, and non-recyclable waste. Here, waste pickers transfer all collected household waste to a local waste sorting and processing facility, that discarded non-recyclable waste to a municipal landfill, recyclable waste to buy-back centres and composted organic waste on-site. The outcomes from the two pilot projects discussed strongly indicated the potential for an alternative waste management model consisting of three components (household S@S; waste picker integration; local waste sorting facility) to maximise recovery of recyclable and reusable

materials, and to optimise waste to landfill diversion. From these findings, we conclude that the operational design of this intervention shows the potential to effectively address public waste dumping and burning in the absence of formal waste management processes. However, these pilot studies discussed form part of a private-sector air-quality offset programme and are funded in this way. This programme does not necessarily offer a sustainable financial model for the suggested waste management process, and perhaps a private–public partnership could be considered to financially sustain such a waste model once the offset compliance is completed.

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Chapter 6

Knowledge is power: the danger of knowledge in the search for sanitation solutions with African communities

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Abstract

People in low-income communities in South Africa generally suffer from inadequate sanitation. This causes numerous health and safety risks, especially to women and children who are most vulnerable. In this chapter, the authors reflect on the way that we are preparing ourselves for a process to develop decentralised, non-sewered sanitation practices together with residents in rural and peri-urban communities, who often have different cultural and religious thought patterns than the experts who present technical solutions to them. In our experience, when people from a modern Western context implement solutions in the African context, the solutions are often incompatible with the new context. We used the concepts of *lifeworld*, *sense of place* and *consciousness* to better understand the relationship

between people, their environment, and the technologies that they use. We present two case studies to illustrate how such philosophical theories can be applied. We keep in mind that knowledge is power. A better understanding of knowledge transfer and how it can undermine the co-creation process is considered an important step in preparing for co-designing solutions with end users.

Keywords**:** co-design, consciousness, lifeworld, sanitation, sense of place, transdisciplinary research

1. Introduction

Life in the Anthropocene is characterised by globalisation, fragmentation, and dysfunctional relationships. An important problem arising from globalisation is the disconnect between the solutions that are developed in one context and then transposed to another context where they do not fit, leading to poor adoption of technologies by the end users or the creation of new problems. In this chapter, we reflect on ways in which citizens' daily practices can be brought into the process of improving sanitation systems in some low-income communities in South Africa.

What Enda Hayes (2017) wrote about air pollution applies to many projects that aim to solve some or other problem where people are involved, not least in Africa:

> …around the world… 'people' are absent in the models and scenarios used to estimate and predict air pollution concentrations. The modelling of emissions sources, not the human activities that result in them, leads to a bias in policy that focuses on mitigating emissions through technological change rather than through changing individual and societal behaviour. In turn, this leads to a consequent reliance on technological innovation, not social innovation. We need to bring citizen's daily practices, activities and behaviours into this debate.

This call has also been made strongly by proponents of contextual engineering; for example, Witmer (2022) provides a clear argument why "technical design must be interwoven with sociocultural identity if it is to achieve the objective of addressing a user population's physical needs effectively and sustainably".

A common practice is that information is obtained about the target group's "user requirements" and this is then considered when the solution is designed by the experts. We argue that such information is insufficient for the goal of designing a solution.

The crucial question is which debate Hayes refers to when he talks of "this debate". Is it a debate where technical experts call in the help of social scientists, who bring their knowledge of the people into the debate so that it becomes an inter-disciplinary or multi-disciplinary debate, or are the "people" and practitioners also included in the debate, making it a trans-disciplinary debate?

The authors of this chapter believe that it must be the latter and describe in this chapter the way in which they are preparing for a process to co-design, with two groups of smallholder farmers, non-sewered sanitation systems that are integrated with their farming practices.

A thorough knowledge of the particular context is required for a solution to become sustainably embedded within the complex system in which it is applied. The question is, what does this knowledge look like, and how can one obtain it? And can developers from outside a community solve a problem, such as poor sanitation, for a target community by gathering all the relevant contextual information?

The aim of this chapter is not to reach general, empirically supported or certain knowledge. It is rather to explain how we have tried to open our minds to be able to enter into an inter-subjective relationship and exchange with the smallholder farmers during the co-designing process.

One of the threats to such a process is the unconscious assumption in the minds of the experts that they have more knowledge than the people whom they work with. It is not an unfounded assumption; they are, after all, experts in their field. The people for whom these technical solutions are meant, often share this assumption. The problem with such an assumption is that these technical solutions may cause more harm than good within the particular context where it is implemented, as Witmer (2022) clearly shows with various case studies. This happens when the knowledge of the experts influences the eventual result to such an extent that the residents' knowledge of their context does not play a sufficiently strong role in the design process.

The warning of the Swiss Alliance for Global Research Partnerships (GRP-Alliance) - previously the Swiss Commission for Research Partnerships with Developing Countries [June 2025] - (SCNAT, 2012, p. 7) is therefore very relevant: "Transparency and unrestricted flow of information are the bread and butter of research in partnership aiming at outcomes relevant to society. This is true for interactions at the personal as well as institutional levels. But information is power, and sharing information or opening information channels might very well lead to tangible losses."

Rather than looking for certain knowledge, our aim at this stage is to have a sufficient understanding of the complexity of the context in which we plan to work, to open our eyes to the different factors that may interact and combine in that context, the tensions and synergies, the flowing nature of an unfinished process. An informed and considered uncertainty, combined with a rational and intuitive understanding of what is happening, is necessary to not be too certain on the one hand, and not be ignorant on the other.

The eventual aim is one or more technical solutions that have become part of the daily practices of life and that work well in the daily patterns of low-income communities, in (this case) the South African Lowveld, which can mostly be described as rural and peri-urban. We want to achieve this by building

relationships with a small but representative group of residents, by constructing solutions together with them, testing the solutions in practice, redesigning them, and testing them again until all agree that the solution complies with their criteria. Both parties are present as people, with our thoughts, feelings, values, prejudices, etc. There is never "certain knowledge", and the design can always be improved upon.

2. Theoretical framework

As part of our preparation, we look at three theories that may help to guide us: the concepts *lifeworld* in the work of Hannah Arendt (Vanneste, 2023) and Jurgen Habermas (Cherem, n.d.), *sense of place*, and *consciousness* as used by Peter L Berger (Berger et al., 1974). The concepts are further used to discuss case studies of the development of non-sewered sanitation in low-income communities in South Africa.

Low-income communities in South Africa, mostly with an African background (81,4% of South Africans are black African, (RSA, 2025), struggle with problems of hunger, malnutrition, poor sanitation, water scarcity, etc. Their current practices have ecological impacts, which become a problem for them. Assistance from outside is needed, but the problem is, how can this assistance be given by a person from outside the community?

3. The philosophical debate

3.1 Lifeworld

The concept *lifeworld* originated in the late 19th century, with the German-Austrian philosopher Edmund Husserl (1859-1938) as the leading figure. It was a central concept in the philosophical school of phenomenology that he founded. Phenomenology has become a strong movement, with philosophers and other scholars mostly from Europe.

3.1.1 Hannah Arendt

According to Vanneste (2023), the Jewish philosopher Hannah Arendt struggled with the two types of knowledge: scientific knowledge and the experience of everyday life. Classical philosophical tradition keeps truth, *aletheia*, and the lifeworld apart. In this tradition, truth has its own terrain: you have to make an effort to gain it, and above all you have to make an abstraction of it – you deal with ideas rather than with events. You can capture facts once and for all in logical or mathematical reasoning. This approach has its roots in ancient Greek philosophy, especially the philosophy of Plato (Vanneste, 2023). Arendt, on the other hand, considered life experience as a different kind of knowledge in which truth relates to meaning, a result of talking, listening, and discussing (Vanneste, 2023, p. 39). She thus ties in with the Jewish *emeth*, which associates truth with faithfulness and reliability. It has to do with relationships, of working together in trust. It is something on which you can trust in your daily life. The classical truth, *aletheia*, can be grasped by an individual; for *emeth,* you need a relationship with others. The power of a reliable promise is a means to accommodate the unpredictability of action (Vanneste, 2023). This approach does not deny the facts of scientific knowledge but situates these facts in the context of life.

3.1.2 Jürgen Habermas

The German philosopher and social theorist Jürgen Habermas argues in a similar fashion to Arendt in several ways. Cherem (n.d.) grounded his social theory in spontaneous communication:

> For Habermas the lifeworld is a reservoir of taken-for-granted practices, roles, social meanings, and norms that constitutes a shared horizon of understanding and possible interactions. The lifeworld is a largely implicit "know-how" that is holistically structured and unavailable (in its entirety) to conscious reflective control. We pick it up by being socialized into the shared meaning patterns and personality structures made

> available by the social institutions of our culture: kinship, education, religion, civil society, and so on. The lifeworld sets out norms that structure our daily interactions. We don't usually talk about the norms we use to regulate our behavior. We simply assume they stand on good reasons and deploy them intuitively.

Systems that function in a given lifeworld can be revised and changed, but that requires careful communication that roots these changes in mutual understandings of the lifeworld. There is a dialectical relation between knowledge (theory) and world (practice):

> Without being rooted in the mutual understandings of the lifeworld, we would get untrammeled systems… disconnected from the intersubjectively vouchsafed practical reason that Habermas thinks underpins all meaning. The organizing principles of systems themselves would stop being coherent (Cherem, n.d.).

In this view, lifeworld is more than the subjective appropriation of the world based on external conditions, more than a person's subjective construction of reality (Kraus, 2015) – it is intersubjective, based on the interactions between the taken-for-granted practices, roles, social meanings, and norms of the culture in which people grow up, and the external conditions that they experience.

3.1.3 How can a lifeworld be understood?

If (aspects of) the lifeworld are unavailable to conscious, reflective control, if we pick them up and deploy them intuitively, the question arises: how can we understand the lifeworld of a community other than our own? If Arendt, as interpreted by Vanneste, is correct that classical philosophical tradition keeps truth, *aletheia*, and the lifeworld apart, what happens when such an approach is used to study the lifeworld of a specific community? The scientific approach followed by social scientists finds it easier to study some aspects of everyday life than other aspects. It can study the observable "daily

practices, activities and behaviours" of the citizens that Hayes (see above) talks about, and interpret them according to the meaning patterns of the social scientists rather than according to the meaning patterns of that lifeworld. However, social innovation based on this approach would most probably not work in a given context (it will be "untrammelled, disconnected from practice, not coherent"). To be meaningful and effective, social innovation must involve the "implicit 'know-how' that is holistically structured and unavailable (in its entirety) to conscious, reflective control" that Habermas, according to Cherem, talks about. It includes the shared meaning patterns and personality structures of the social institutions of that culture: kinship, education, religion, civil society, and so on.

The methods of the natural sciences are used by social scientists to study social observable phenomena such as the employment situation, availability of material resources, housing conditions, social environment (friends, foes, acquaintances, relatives, etc.), as well as the persons' physical conditions (fat/thin, tall/small, female/male, healthy/sick, etc.), what Björn Kraus (2015) calls "life conditions". *Life conditions* can be measured and quantified to produce data. These things can be directly observed, especially if they are seen separately from the shared meaning patterns and personality structures of their culture. The lifeworld is more evasive; it is intangible, it is often tacit. You cannot simply ask a person what their lifeworld is and expect a simple and direct answer, in the same way that you can ask them about their life conditions. The social sciences do not, however, give much attention to the intangible aspects of lifeworld. This is conducted in the Humanities, which are the *Geisteswissenschaften*, that deal with meaning from the start. If 'people' must be present in the models and scenarios used to estimate and predict things (Hayes, see above), it will be important, but not enough, to have quantitative information from social scientists' part of the discourse. A qualitative understanding is also needed, but that is still not enough if people from the relevant community, who understand the tacit and implicit character of that lifeworld, are not involved in a meaningful way.

The lifeworld(s) of a given community can only be comprehended through personal encounters, through entering into the world of the other, through intuitive awareness of meaning, a result of talking, listening and discussing, in relationships with others, by working together in trust (cf. the type of truth that Arendt spoke about). Also, through observing expressions of feelings, through listening to views that people share, and through attending to what they do. It takes time to develop some understanding of another lifeworld. Experts from outside a community cannot know that lifeworld adequately, but they do need some level of understanding to be able to engage people from that community in a meaningful way. That includes an understanding of the limits to their understanding.

Both ways of knowing, what we can call the more objective and quantitative way of the natural sciences and the more intuitive, relational and inter-subjective or qualitative way of efforts to understand the "experience of everyday life" (Vanneste, 2023), that one may find in the Humanities, the *Geisteswissenschaften*, are relevant and important, but inadequate if the debate is limited to outsiders.

Researchers who want to understand the lifeworld of a group other than their own face certain limitations: they cannot leave those aspects of their own lifeworld that are unavailable to conscious reflective control behind. These things influence what they see and how they understand it. However, an awareness of such limitations increases the chance of a successful orientation towards the lifeworld of addressees. "This can happen when two very important criteria are fulfilled: First of all, when social work professionals critically reflect on their own part in recognition and comprehension processes. And secondly, when the addressee's subjective view of the world becomes the major focus of professional interest" (Kraus, 2015, p. 7).

It is difficult to translate the one type of knowledge, the knowledge of everyday experience and the tacit aspects of a group's lifeworld, into the other type of knowledge, into scientific knowledge that is separated from the lifeworld, which makes an abstraction of the knowledge of everyday

experience. Everyday experience is about events, about relationships, about unconscious thought patterns that cannot be translated sufficiently into objective scientific knowledge. But the opposite must be done. To find a meaningful solution for a given problem, the scientific knowledge must be made functional within the everyday patterns of life in that context. The scientist must make an effort to enter into that world, to understand it. When specific problems of everyday life must be solved, everyday experience is paramount, the relevant scientific knowledge must be translated into the knowledge of everyday experience so that it can function constructively within that specific context. In Arendt's terminology, scientific truth must help to develop something that is reliable in practice, something that fits into the given pattern of relationships, something on which people can trust in their daily lives.

If the researcher, designer, development officer or social worker cannot understand all the tacit aspects of a given community and then make a decision for that community, it means that the members of that community must make the decision for themselves, e.g. about the way in which a certain technical solution that is presented for a perceived problem will be used. The reason is simple: a solution that does not fit into the lifeworld of a certain group of people, that does not make sense to them, and that they do not see as a possibility for themselves, will not be used by them. There may be, in the eyes of people who are not part of that specific group, better options available, but in this case, too, beauty or usefulness is in the eye of the beholder.

The ability to find a meaningful solution for a given context requires the combination of the insights of various role players. No single role player has the complete insight to do so on their own. The development agent is needed to introduce new technical possibilities or other potential solutions to communities that may not be aware of them. However, being aware of one's own limitations will help the development agent who presents a potential solution to do it in such a way that the persons in the given context can understand it, compare it to other possibilities, and decide if it is a possibility for themselves

or not, and if so, how it must be adjusted and redesigned to fit into their lifeworld and life conditions. The development officer and researcher can and should take part in this process in a constructive way, knowing when to take part and when to stand back.

The tacit aspects of a community's lifeworld are not expressed adequately in rational language, but it does come into full operation when the community decides to use, or not to use, a solution that is presented to them.

Tony Waters (1992) provides an interesting case study of the reasons why grain mills that were introduced to villages in Tanzania worked well, while water systems, which were technically very comparable to the grain mills, did not work. He explained it with reference to Habermas' model of lifeworld and systems. Habermas' model also helped him to understand why villagers offered 'purposive-rational accounts' of their activities even though they may have been embedded in 'traditional-rational systems of reasoning'. The communication between these two worlds of knowledge is complicated and often skewed and distorted.

3.2 Sense of place

A similar concept to lifeworld, *sense of place,* has developed in the United States, in Geography and other social sciences. Like lifeworld, sense of place refers to how people in a given context experience things, what meaning they give to things, to those characteristics, in particular the less tangible ones, that make a place special or unique, and those that foster a sense of authentic human attachment, identity, and belonging (Pritchard, 2023). The reason why this concept is so similar to the concept *lifeworld* is that human geography, especially Anglo-American geography, has since the 1970s been heavily influenced by phenomenological philosophy and has become interested in studying the meanings that places have for people within it. Sense of place refers to the way that people experience the location in which they are. It is described as follows: "(S)ense of place is the lens through which people experience and

make meaning of their experiences in and with place" (Adams et al., 2016). Sense of place is built upon the direct and full engagement of all senses.

In Geography, ecosystems in general are a central pillar of 'sense of place' (Pritchard, 2023). Sense of place can explore the positive bonds of comfort, safety, and well-being engendered by place, home, and dwelling, but also the negative bonds, e.g., the term 'placelessness' characterises the weakened bonds of attachment to community and home produced by the forces of modernism and postmodernism, while some places and situations induce senses of fear and dysphoria. Attention to sense of place has highlighted the importance of the perceptual and cognitive dimensions of human decision-making - such awareness can lead to action, to placemaking (Foote & Azaryahu, 2009).

3.2.1 The problem of placelessness in the Africa context

The concept of "placelessness" that cropped up in the discussion of the concept *sense of place* is in agreement with the concept *exile and homecoming* that have been central themes in the political struggles against colonialism and apartheid. The longing for home is expressed in many ways. In his book *Homecoming*, Ngũgĩ wa Thiong'o (1981) of Kenya sees building a home for all Africans as the main task of the post-colonial era:

> We need to see Africa's cultural history in three broad phases: Africa before white conquest, Africa under colonial domination, and today's Africa striving to find its true self-image [...] we are all involved in a common problem: how best to build a communal home for all Africans. Then all the black people, all the African masses can truthfully say: we have come home. (xix, 4)

Today, the search for homecoming is still at the heart of prominent streams in the decolonisation movement, even though the concept has become entangled in the conflicting interests of various stakeholders in various contexts: historical,

spiritual, cultural, political, and economic (Schramm, 2010, p. 247; see also Van Niekerk, 2024).

In their book, *The Homeless Mind: Modernization and Consciousness* (1974), Peter L Berger and others describe the particular impact of modernisation (see next section). Foote and Azaryahu (2009, p. 98) add some more features of placelessness:

> … placelessness is the result of the erosion or fracturing of the coherence of place since the mid-nineteenth century as the result of homogenization and standardization, consumption and commodification, and last but not least: the influence of international patterns of planning and architectural styles which gradually effaced regional and local differences in style. Placelessness means the loss of individuality, distinctiveness, and authenticity. Moreover, the erosion of sense of place also entails a decline of a sense of community, since place-based communal attachments become geographically fragmented to the effect that the basic association of place and community is severed. (p. 98)

Placelessness seemed very much tied to the rise of mediated environmental experiences, such as those mediated through literature, film, television, music, photography and, mostly recently, the Internet, and other network technologies.

3.2.2 Consciousness and the formation of packages

In 1974 Berger et al. attributed the experience of homelessness, which is similar to placelessness, to the impact of modernisation. Modernisation leads to a feeling of homelessness all over the world. In order to understand the processes of modernisation, one should recognise the reciprocal relationship and interdependence between institutions that are carriers of modernity (such as technological production and mass education) and the consciousness of the community (Berger et al., 1974).

Consciousness refers to our everyday knowledge, perceptions, attitudes and affects, our thought processes, our

emotions and will, our beliefs, our dreams, our subconscious and memories, our paradigms and our theories. Consciousness is organised in patterns that can be described systematically to some degree, but not always in clear formulas. Art is one way to express consciousness. Consciousness must always be understood in a specific context.

Interaction takes place between the carriers of modernity and the consciousness of the community: there is give and take. Technological production is a primary carrier of modernity (there is also education, bureaucracy, the media, etc.), and consciousness is the determining factor in the process of modernisation. Processes in modernity and processes in consciousness that have an affinity to each other seek each other out and form 'packages' (Berger et al., 1974). A package is a new thing, a new combination of things and thoughts from different sources. It has a new dynamic and meaning. Within this new context, the function of each individual element is different from the function it had in its original context (see also Van Niekerk, 2024).

3.2.3 Practices

Practices are similar to packages. The German philosopher Martin Heidegger argues in *Being and Time* (German: *Sein und Zeit*, published in 1927) (Heidegger, 1967) that a practice is a complex phenomenon that is constituted by the unity of the resources and tools used to perform the practice (e.g. a stove), the labour of performing the practice, the 'product' of the practice (a meal) and the 'for-the-sake-of' of the practice (a family meal, healthy family relationships). The 'for-the-sake-of' determines the meaning of the practice as a whole. In a practice, the aspects of resource, tool, labour, and human being belong together in such a way that none can be without the others (Ingram, 2009).

A domestic practice combines diverse elements in a set but more or less flexible pattern in which different household members play different roles, usually making use of resources and tools, for whatever purpose that they have, such as to satisfy a fundamental need or needs. (see also Van Niekerk, 2024).

4. The lifeworld of township residents, as observed in some of Nova's surveys

Over the last twelve years, Nova has done extensive surveys of townships in the Mpumalanga, Free State, North West and Limpopo provinces. This included questionnaires and focus group sessions, as well as the co-creation of solutions and the successful implementation of some of the results. In most cases, the residents report that their general satisfaction with life is much higher than one would expect, given the high levels of poverty and the strong negative opinions on living conditions: poor service delivery, deteriorating infrastructure, high levels of joblessness and growing populations. In discussions and focus group sessions, the picture is not always that positive. We provide a general overview of what was found regarding sanitation, which is still in a preparatory phase.

Problems with sanitation must be seen against the general feeling that the place is dirty: the air is polluted by industries or mines, by traffic, by dust from the roads, by waste that is burned because it is not removed, and by the use of dirty fuels such as coal and wood. Waste, including diapers, is scattered everywhere. In some places, it seems that diapers are the most prominently dumped waste type. Pigs and dogs eat from the diapers and bring the wasted diapers into the yard or even into the house. When it rains, the diapers mix with water on the road, or the pit latrines fill up, and the content is washed into the neighbour's yard or into the street. Focus group members complain about residents' lack of respect for each other as a major cause of waste being dumped everywhere.

Sanitation is a problem on its own. Some places are not connected to a sewerage system, and people resort to non-sewered sanitation such as pit latrines. Full pit latrines are often not emptied by municipalities, and are too expensive for many residents to empty. Some residents, who do not have sanitation, use buckets to relieve themselves and then throw the waste in the veld or in informal dumping areas, which creates problems for waste pickers. Flush toilets do not necessarily solve the problems. Sewerage systems become overloaded or deteriorate

as they age. One resident from the town of Northam in the North West province summarised it as follows:

> So, what is happening is that there are T-shirts and clothes and children's disposable diapers that are thrown into the drain. Whenever the municipal workers come, they come to unblock the sewer every two days. This happens in my full view. In that way they work, I don't want to lie. They always find these diapers and clothes inside. After they have unblocked the drain, people throw stuff in, and it blocks again in about two days. The pipes are too small. When the water comes again, it gushes out of the mainlines through the pipes and then up. It was difficult for me to even go around the back of my house. Municipal workers come to check it, but they say there is nothing they can do. The problem is underneath my neighbour's house foundation. They said they can only from time to time drain the sewer. When they unblock today, tomorrow the drain leaks again. When my neighbours flush their toilets, the whole dirt comes to my drain. I ended up buying a new pipe to close the leakage. Since then, it has been better but I am not sure if it will leak again. When the dirty water flows into the street, the kids go and play there. The kids like to play with water and they contract different ailments which make them sick. Children play there and come home wet and full of mud, as they enjoy playing with wet and dirty things.

4.1 Reflection

These communities are in the process of transition from an old traditional social order that was able to construct an integrated world of life on a small scale, to a large-scale order formed by large, and seemingly irreconcilable powers.

The general impression is that waste is a function of, or at least part of, the general dysfunctional condition of these communities. Some residents call it chaos. The dysfunctionality can exist on different levels and is described in different ways:

- Tensions between residents and corrupt or absent local leaders, leading to group-forming and tension between residents. Sometimes ethnic groups form, but it can also be other formations.
- Poor service delivery by local government.
- High levels of unemployment cause poverty and idle youth, which manifest in drunkenness and refusal to listen to parents.
- Social cohesion is not strong; the feeling is that people do what they want and claim that they have human rights.
- Two opposing themes are common in these surveys: a feeling of powerlessness ("There is nothing we can do" is a general comment) as well as a general willingness or even eagerness to think about solutions and actively participate in their implementation (for example, recycling). With this willingness to do something, residents request help: they want to do so in cooperation with entities from outside their own community, such as an industry or even Nova itself. One group emphasised that residents need to be educated, while others thought of projects that could make jobs available.

5. Two case studies

In this section, we report on the results of a scoping study that Nova conducted for the Water Research Commission in two communities in the Mopani District of the Limpopo province in the Lowveld of South Africa in 2022 to 2023.

5.1 Ga-Sekororo, Limpopo

The first study was in Ga-Sekororo (Van Niekerk et al., 2023). The project aimed to determine the potential of integrating non-sewered sanitation with agriculture. The study demonstrated the difference in perspectives between project team members living outside the context of the target community (who are also the authors of this chapter) compared to the perspective of the farmers living within the context. Focus group meetings with smallholder farmers in the Ga-Sekororo village were undertaken

in September 2022 and March 2023. The main aim of the discussions was to prepare for a project about how to integrate sanitation into agriculture in a way that could work.

Based on this conversation with the farmers, a "deep systems analysis" (Van Rooyen et al., 2017) was developed on how their problems are interlinked. This systems analysis was mostly conducted by the team members living outside the context of the village, using the information that was shared with them by the farmers.

The second focus group meeting followed a different approach, aiming to develop the deep systems analysis from the smallholder farmers' perspectives. The Nova researchers visited several farmers, explained the aim of the study, asked about their living conditions and invited them to attend the exploratory meeting, where it was agreed to work together in pursuit of improved sanitation. In a follow-up meeting, the researchers said that they wanted to better understand the sanitation and agriculture problems in the villages. The farmers were then given approximately two hours to talk about these problems. The researchers asked questions, and the farmers responded, but also volunteered opinions.

Figure 17 shows the systems analysis that was conducted according to the understanding of the team members living outside the context of the Ga-Sekororo village, using the information that the farmers presented to them. A lack of water and services, poverty and the meeting of different cultures were identified as primary drivers. Poor sanitation, crop failures and the striving for progress were identified as secondary drivers. Problematic outcomes included groundwater pollution, hunger, the safety of children and females, poor health, crime, etc. This framework is not wrong in the sense that these are not fundamental problems that people deal with. It was after all the issues that the farmers communicated during the first focus group meeting.

This was followed some months later by a second systems analysis. In this meeting, apart from making notes (in the form of flow diagrams) on a flip chart that was displayed and visible

to all who attended the meeting, the team members who lived outside the village did not participate in the conversation; for example, by asking questions or by making suggestions.

The two analyses that were developed during the two focus group meetings differed in many fundamental ways. As shown in Figure 18, a very different picture emerged from the second meeting. The first important difference was that the farmers spent more than two-and-a-half hours discussing the problems related to agriculture and water pollution. Only in the last few minutes were some comments made about sanitation, and then they continued their discussion on agriculture. Their livelihood is a much greater concern compared to sanitation.

During the second focus group meeting, the farmers also showed concern for environmental impacts through their complaints about other people dumping waste in the river. They initially mentioned that a dam would solve their irrigation problems, but this idea was rejected when they started thinking about the impact of such a dam on the environment and the environmental authorisation that they would need.

A fundamental difference between the first and the second systems analyses was that the first provided a very neat and somewhat abstracted view of the community. The second analysis shows the details of the messy reality in which the farmers live.

To conclude, the following five key sanitation issues were identified in Ga-Sekororo:

- **A lack of options to manage waste when the pits are full**: farmers are, in general, much more concerned about managing the waste in the pit and relatively less concerned about the front end of the toilet (user interface). Most farmers who attended the focus group meetings aspire to have good service delivery in the form of cartage to empty their pit latrines; they do not aspire to have on-site flush toilets because of the reality that there is not enough water for that.

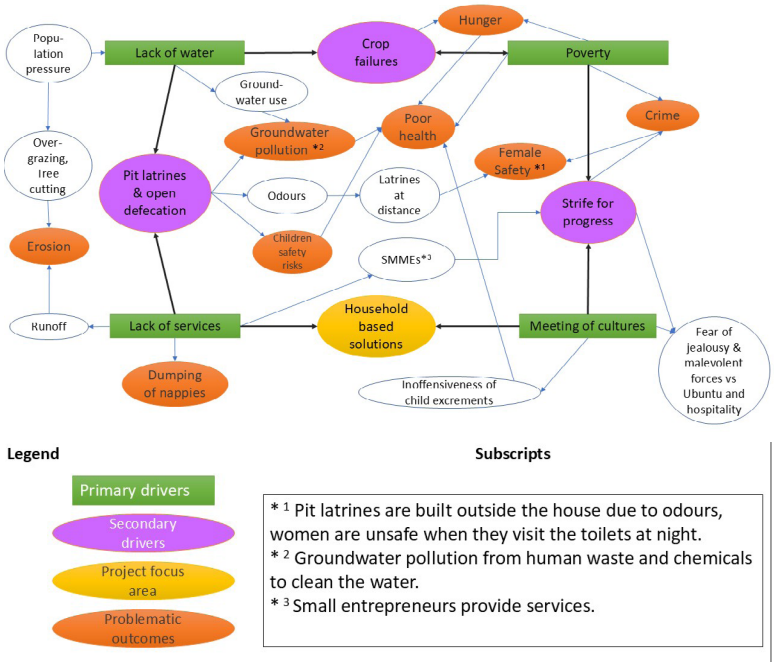


Figure 17: A systems analysis of the smallholder farmers in Ga-Sekororo. (Compiled by the researchers after consultation with the smallholder farmers).

- **Safety risks**: Toddlers are not allowed to use pit latrines because of the risk of falling into the pit. They are taught to practice open defecation. Crime in some areas is a risk for women when they have to use a pit latrine at night.
- **Difficulty in cleaning:** Most people do not have a problem with cleaning the toilets, but it is not easy to clean out or empty the pit itself. All participating farmers use cleaning materials such as *Domestos*, *Jeyes Fluid* and *Jik* to clean their pit latrines regularly (one to three times per week). A few farmers mentioned using decomposing granules in their pit latrines to increase the processing of the waste and to reduce odours. They mentioned that these chemicals require a lot of water, and one is not allowed to use the toilet when the chemical is poured inside the toilet. They normally use the chemicals at night. They do not discard foreign objects

into the toilets that are still in use; old and unused pits are used for general waste disposal.

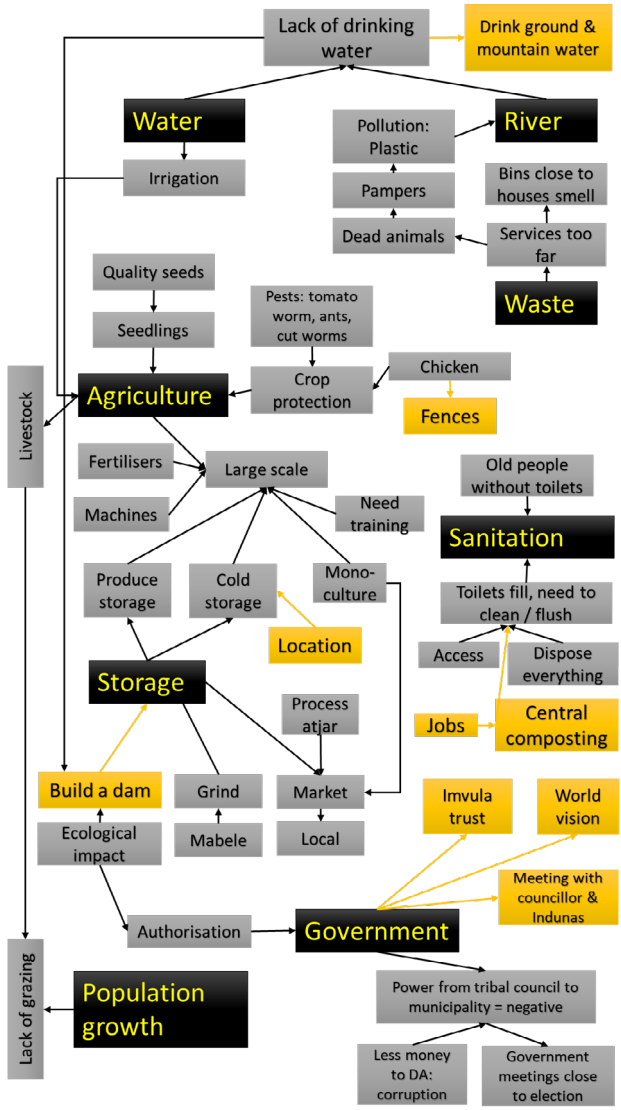


Figure 18: A systems analysis of smallholder farmers' perspectives at Ga-Sekororo

- **Insects:** People mentioned insect pests that are a problem in the pit latrines. The toilets can become very hot, and there are many flies inside. When you enter the toilet, the flies sit all over you, and the people fear that this could cause diseases. A farmer said that insects bite her legs when she cleans the toilet. Sometimes, there are so many ants in the toilets that people are unable to sit on the toilets, and there are also huge cockroaches.
- **Odours:** Some of the farmers said that the ventilation-improved pit latrine has an unpleasant odour that sticks to one's skin and clothes after using the toilet, and they have to change their clothes after visiting the pit latrine.
- **Lack of privacy**: A sixth aspect, the importance of privacy, was not apparent in Ga-Sekororo. However, Nova found it to be the case in other projects. The phenomenon was illustrated by a Central Ablution Block (CAB) facility in KwaZulu-Natal. This facility included wash basins and showers, and not just the toilets. The doors of the toilets are not visible from the outside. That is in contrast with a public toilet, where everyone can see you entering and leaving. According to an official from the eThekwini Municipality, the CAB brings the small community together: it is something that belongs to all of them, children play there, and people put up shops around it, like a town square.

These aspects were taken up in the questionnaire that was used in Ikemeleng.

5.2 Ikemeleng, North West

Another case study aimed to learn some lessons about the reasons why some people are not using the toilets that were provided for them, while others do. This was performed by exploring the emotional bonds and attachments that people develop towards certain spaces and places using *sense of place* as a framework, and to determine how those attachments influence the sanitation practices that develop and how sanitation shapes the sense of place of rural or peri-urban communities.

The study area is a peri-urban area in Ikemeleng, Rustenburg, where mines have given people prefabricated pit latrines in one area after displacing the people about five years previously. During a scoping of the area, it appeared that these toilets were used with varying degrees of success. Ikemeleng provides a good study area for determining the influence of sense of place on sanitation practices.

Other problems at Ikemeleng included poor waste management services (a problem with which the Nova Institute, with funding from Anglo American, has made much progress), air pollution, no streetlights, no secondary school, drugs, and high crime rates. The community has only one primary school, which does not have enough capacity for all the children in the community. Children must travel far for schooling, and they have to leave their houses before sunrise, walk in the dark on streets covered with sewage and with a high risk of crime.

5.2.1 Methodology at Ikemeleng

Qualitative research, such as individual interviews and focus groups, is useful for exploring the emotional bonds and attachments that people develop towards certain spaces and places. The planning of this project at Ikemeleng included a scoping of the study area. The authors of this chapter visited a few households that had received the said state-of-the-art ventilated improved pit latrines. We had in-person discussions with a few households about the new ventilated, improved pit latrines and what the people liked and disliked. Some households used the ventilated improved pit latrines for toilets, and others did not. Also, in preparation of the survey, a focus group meeting and training of the fieldworkers were conducted. The survey was adapted after the focus group meeting, based on inputs from the fieldworkers, all of whom reside in Ikemeleng. This was followed by the survey, which was conducted in April 2024 by six fieldworkers who interviewed 175 households in total. The participants were selected by sampling every third house with an improvised toilet and every second house without. If someone was not home, the neighbour on the left was approached and then the neighbour on the right was

approached. This process was followed to ensure a random selection of households. We followed up the survey with two focus group meetings, one with the fieldworkers and the other with selected residents, in May 2024.

The six key sanitation issues, namely (1) the lack of waste management options, (2) safety, (3) cleaning, (4) insects, (5) odours, and (6) privacy, as discussed in Section 4.1, were used to set up a quantitative survey that we filled in with households in Ikemeleng that received the ventilated improved pit latrines and other non-recipient households. Based on the site visit and focus groups, the survey also included questions about all used and dysfunctional toilets on their property, the details about the toilets, what the people like and dislike about the toilets, and why they do not use the dysfunctional toilets anymore.

The survey also included questions to households about other factors related to well-being, namely education, income, and wealth. Participants were asked about their subjective levels of general life satisfaction and satisfaction with their access to sanitation. We compare the improvement in access to sanitation, in terms of privacy, security and health risks, between recipients of the improved pit latrine and non-recipients five years after receiving the ventilated improved pit latrines. Lastly, we also consider participants' level of satisfaction regarding sanitation and sanitation characteristics, such as the number of people using the toilet, cleanliness, safety, and others.

5.2.2 Comparing results from the quantitative versus qualitative research

There were differences between results from the quantitative versus qualitative research, as well as between results within the questionnaires. The survey results were unexpectedly positive; 56% of interviewees reported their life satisfaction as seven or more out of ten. On average, people had a life satisfaction of 6.7 out of 10. People were also positive about their communities, with 54.6% saying that they liked their community or neighbourhood somewhat or a lot and 59.2% saying that they liked their houses somewhat or a lot. However, during focus group meetings that followed the survey, many people seemed

less satisfied and called Ikemeleng a community with many problems.

5.3 Feedback on current sanitation

Of all survey participants, 44% had an improved pit latrine that was originally installed by the mine. About 13% of households with improved pit latrines actually disassembled the structure to use the toilet on a new pit which they dug themselves. Approximately 50% of the households that have received the lined pit latrines were still using them. The others said that it is not functional any more.

Satisfaction with their toilet scored lower than general life satisfaction, with an average of 4.1 out of 10, with no significant difference between those who have an improved toilet and those who do not. However, when asked how well their toilets work, 84.7% said that they worked well or very well. When we asked fieldworkers and residents in focus groups about the contradictions, in reportedly low satisfaction with toilets and high reported functionality, focus group members said that residents do not have any other reference point. Even with dysfunctionalities, they report high satisfaction because it is their own toilet, and it is all that they know or are familiar with.

House visits that were performed in preparation for the survey have revealed that some people were not using the pit latrine that was given to them by the mines. The reason was mostly that the pits filled up too quickly, and it was too expensive for the people to empty the pits regularly. The reason for this is that the pits are too shallow and do not drain because they are lined with panels to prevent groundwater pollution. Some of the toilets had cracks where rainwater could enter and fill up the pits, but because of the lining below, the water did not drain out of the pits again. Full toilets can overflow when it rains, and the waste can then flow towards the street or to a neighbour's yard. It costs between R800 and R1,200 to empty a pit, which is up to twice as much as the mean income per capita per month of households in the poorest decile, according to data from the Luxembourg Income Study 2024 (Our World in Data,

2024). The cost of emptying the pit latrines could, therefore, be more than a third of the monthly income of poor households in South Africa, making it unaffordable for most low-income households.

However, in the survey, the households that received an improved pit latrine said what they liked most about these pit latrines was various aspects of the structure, such as the toilet, the door, or the cubicle structure. What participants liked the least was the shallow pit. This was also confirmed with follow-up focus groups and emphasises our observation during visits to other similar projects that researchers often focus more on the actual toilet structure (front end) than on the management of the waste (Van Niekerk et al., 2023). If a few end users who have the everyday knowledge of the context in which they live were included in the design of the toilet, it would have been clear that better management of the human waste, especially given the shallow and lined pit, would have improved usage. This could have allowed the intervention to be changed to resolve that problem.

The safety of the toilet was another concern. Children are often not allowed to use a pit latrine. For the unimproved pit latrine, there is a high risk of children falling into the pit and drowning. However, during the follow-up focus groups, participants said that children are also not allowed to use the improved pit latrine, with a seat that is similar to a flush toilet, since the pit latrine is still dirty and small children are always at risk where there is a hazard such as deep pits, even if the hole in the seat is small. Other household members said that they do not use the pit latrine at night because it is not safe to use it in the dark or to walk outside at night. Another concern was that traditional healers could access their excreta and use it for casting spells on them; almost 30% of interviewees indicated that they believe that, and are very concerned about it. This was confirmed during the focus group meeting. We first encountered this aspect in the literature about water, sanitation and hygiene in sub-Saharan Africa, (see Akpabio & Takara, 2014). During the focus group meeting, it was said that emptying the pits is more difficult because of people disposing undergarments into

the pits, which blocks the "honeysuckers" (a honeysucker is a term used in South Africa for a cesspool emptier that is used to empty cesspits, septic tanks and latrines) during emptying. This is a general practice because people also believe that people who mean you harm can burn your undergarments and so put spells on you.

In terms of the cleanliness of the toilets, 68.0% indicated that their toilets were somewhat or very clean. However, during the follow-up focus group with fieldworkers, they said that the toilets were not as clean as residents had said, which could show their sense of ownership of their own toilet. That means that participants would probably rate a public toilet or a neighbour's toilet with the same level of cleanliness as much dirtier. There was no significant difference between the reported cleanliness of improved toilets and others.

In the survey, 65.0% of participants said that bugs never or only occasionally bothered them in the toilets, but during the focus group discussions, people said that flies in the toilets were a particular concern. Similarly, most people (50.9%) said that they are never or very rarely bothered by the odour in their toilets. This was not significantly different between households that received an improved toilet and others. However, in the follow-up focus group, when asked about the biggest problems regarding sanitation and the community in general, bad odours was one of the prominent complaints, and that odours from the toilets are in the streets and in the houses, especially on really hot days.

In the survey, a large majority of participants (86.1%) said that they were satisfied with the level of privacy that their toilet gives them. During the focus groups, it was mentioned that there are various cultures within the community; some households do not have a problem with privacy and even just have a small curtain in front of their toilet. Other households prefer a solid structure with a lock. Households living in more public walkways or areas, especially those around shebeens (informal bars), complained that people enter their property without consent to use their toilets.

5.4 Disposal of greywater

During the focus group meetings, another significant problem was mentioned: the disposal of grey water, which is often discarded in the street or in your own yard and it then flows to a neighbour's yard. This is the cause of much frustration and conflict between neighbours. The municipality even went so far as to cut off the water supply during the day so that people could not throw dirty water onto the roads. However, residents complained that they did not have any other choice and that cutting the water supply did not solve the problem.

5.5 Ikemeleng's lifeworld and sense of place

The impact of sanitation on the sense of place of the community in Ikemeleng is negative. Most of their biggest problems are connected to or exacerbated by poor sanitation. While a foul-smelling environment, insects in your toilet and the lack of safe sanitation for children will have a direct impact on the sense of place in the community, issues such as outside toilets exposing people to crime, overflowing toilets causing conflict with the neighbours, and school children walking over human waste in the dark on their way to school are ways in which poor sanitation combines with other issues to increase their feeling of placelessness. Our focus group meeting with the residents was unpleasant. People felt hopeless and powerless against the problems that they faced and showed very little agency or intention to work their way out of these problems.

6. Discussion

The philosophies and case studies discussed highlight how tough it is to develop solutions in rural and peri-urban communities, where the development agent comes from outside the community.

A common practice is that solutions are given to such communities without sufficiently engaging with the dynamics and living patterns of such communities, and the result is poor adoption of the solution by the recipients. For example, many non-sewered sanitation development projects in South Africa

focus on developing toilet seats and pedestals (front-end) while the problem of managing waste (back-end) has received far less attention (Van Niekerk et al., 2023) - but the residents in our focus group emphasised the management of the waste as being far more important.

If research is undertaken to gather information to make better-informed decisions, it is often not sufficient. The difference between the system analysis prepared by the researchers based on information obtained by farmers in Ga-Sekororo, compared to the analysis that the farmers themselves have conducted in a focus group afterwards, clearly illustrates the differences in how people from inside a certain context (with living experience) and outside the context (with information only) perceive the system. Both may provide a certain insight into the situation (the view from the outside and the view from the inside may both have value).

Some of the results of the focus groups and the survey are consistent with each other, while others show discrepancies. We asked the fieldworkers why there was such a discrepancy between the survey results and what was said in the focus groups. They gave the following possible explanations:

- The current conditions are what people are familiar with. They do not feel unhappy with something if they have no other frame of reference.
- People are shy to discuss sanitation, and when they are asked direct questions in a survey, they hold back more uncomfortable information.
- During the interview, in some houses, residents said that their toilets were clean, but when the fieldworkers saw the toilets, they did not think that they were clean. This may be because the residents clean the toilets themselves, and they believe them to be as clean as they could get them. The fieldworkers also mentioned that residents do not think of their own waste as dirty.

At this stage, we can merely highlight the complexity of the system and how insufficient any one research instrument is on its own. Even more, the picture that emerges, with the

discrepancies and yet obscured aspects of the lifeworld, does not provide us with certain knowledge of the situation.

The discrepancies between the results from the various projects confirm, to some extent, the concept of lifeworld as described by Hannah Arendt and Jürgen Habermas. Lifeworld is not grasped through scientific understanding or analysis but through relationships and trust. Lifeworld is not available to conscious, reflective control, and one can only gain access to the lifeworld through personal interactions. It is not possible to analyse another person's lifeworld by directly asking them about it or through a survey. Open-ended conversations are more effective in understanding a person's lifeworld than direct questions, but the open discussions during the focus groups do not give full insight into the lifeworld of the residents.

We hope that the inconclusive results of the research so far, the various loose pieces of information and insight, will help us to achieve the transparency and unrestricted flow of information that the Swiss Alliance for Global Research Partnerships (GRP-Alliance) (SCNAT, 2012) regards as the bread and butter of research in partnerships aiming for outcomes relevant to society. It can help us in two ways: it has opened our eyes to the wide variety of factors that interact and combine to produce the patterns of sanitation use that we have observed and which form the context in which the eventual solution must work; and it undermines any tendency that we may have to think that we know better than the residents themselves. If knowledge is power, and if there is a risk that experts from outside the community may be regarded as more knowledgeable than the residents of the community, this lack of certainty helps to even the playing field.

The most reliable information regarding the use of an intervention in a community is how they receive and use it, and the impact it has on them.

Another debate than "this debate", which Enda Hayes seems to refer to (the technical debate, even if it includes social scientists), is necessary. A debate where the citizens of the given context can explain the dynamics of their situation

is needed. Or, actually, it is not a *debate* that is needed. The citizens in the given context cannot explain their lifeworld adequately because "much of it is largely implicit 'know-how' that is holistically structured and unavailable (in its entirety) to conscious reflective control" (Habermas, see Section 2.1.2). But it does play a huge role in the choices that they make, in their decisions and actions. A *co-design process* is needed, where they can make decisions about the solutions that will, or will not work for them.

A second way in which the residents are empowered to give their opinions is to provide them with several available potential technical solutions that they can use and evaluate. This prevents the possible assumption that the experts from outside want to promote a certain option. They can compare the different options, discuss the merits and demerits of each, and decide what would work best in their situation and how they can be adjusted and approved. The experts from outside provide information and opinions as needed.

7. Conclusion

From various focus group meetings and conversations with residents in different communities in South Africa, we have obtained surprising information about the way in which people use their toilets. Solving the problem of sanitation in low-income communities is indeed a tough task. The problem cannot be considered without some understanding of the full context of the community.

A complex situation requires an approach that can engage with complexity. Development agents from outside typically have flush toilets at their homes; therefore, the front end of a toilet is the only part of sanitation that they routinely encounter. It means that these people do not have personal and practical experience of the problems of dealing with the waste in the toilets, and they tend to focus on the front end rather than on the problems regarding the way in which the waste is disposed of or reused, because it is not within their frame of reference. Another example: development agents would not

have knowledge of situations where people from the street can use your outdoor toilet, e.g. if the owner lives close to a shebeen or where your toilet overflows when it rains and the contents are washed into your neighbour's property.

People who throw all kinds of garments into pit latrines out of fear of curses complicate the process of emptying the pits. Fieldworkers at Ikemeleng encountered a situation where a pit could not be emptied because, for some unknown reason, the people had thrown a pillow into the pit.

These are a few of many important insights that may impact the success of a sanitation solution. Therefore, although development agents from outside are needed, they lack the knowledge of the context to develop a suitable solution on their own.

One of the ways in which efforts are made to bring scientific knowledge and sense of place / lifeworld together is in the search for practical solutions through transdisciplinary research, which includes the end users as active members of the development team.

A process is needed to integrate multiple perspectives and different types of knowledge. The scientific and technological experts have valuable inputs to make, and so do social scientists and the humanities, *as well as* the people who live within the relevant context, because they know what the experts do not know: the dynamics of events within that context in everyday life. To be able to do that, we need to understand the nature of the everyday type of knowledge better. We have looked at three ways in which it has been described, namely according to concepts of the lifeworld, sense of place and consciousness.

All these philosophies highlight the importance of relationships between development agents, end users, and the lifeworld in which the development occurs. In a modern world where social media has reduced the concept of 'relationships' to the sharing of information without a physical presence or knowledge of each other, the challenge is to encourage development agents to understand the importance of building relationships with end users when solutions are developed.

The residents must decide whether the solution will fit into their lifeworld. The researchers from outside that context must determine whether that solution fits into the wider context (ecological, social, economic, political, etc).

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Chapter 7

Flourishing Early Childhood Development through empowering families: The contribution of the CHICS Programme to parental agency and family–ECD dynamics

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Abstract

Early infancy is vital for development and growth, with long-term effects. Many children struggle in the early years and may not receive sufficient support to engage in developmental activities throughout these crucial years. Families must be equipped and reinforced to enhance the development of their children. Significant advantages may come from family-centred programmes enhancing parental agency and family dynamics for early childhood development (ECD). This qualitative study explored the growth and contribution of the Community Household Interface Care and Support (CHICS) programme of

the Nova Institute. This qualitative study was implemented through a document review and analysis by examining documents covering 2010 to 2023. Important findings illustrate how CHICS developed from a community-based franchise model to an ECD centre-based model, thereby enhancing economics and sustainability. The programme curriculum's core strengths - parental agency, family-ECD centre collaboration, and whole child development - turned out to be its essence. CHICS provided better interactions between parents and ECD professionals, increased parental engagement in children's schooling, and supported parent networks. Furthermore, the CHICS programme encourages family-ECD centre cooperation so that parents may participate in the development of their children. By changing family dynamics and parent agency at the micro level, community-based interventions such as the CHICS programme may help ECD systemically. This emphasises the importance of policy and financial tools to increase empowerment-based family interventions to foster early childhood flourishing, particularly amongst disadvantaged groups.

Keywords: early childhood development, ECD centres, family, Nova, nurturing care framework, South Africa

1. Introduction

South African children face numerous challenges in their early childhood development, including a lack of food, poor public services, and abuse. These issues significantly impact their health and development, with up to 6% of children at risk of malnutrition. Poverty also affects two-thirds of these children, potentially having lasting negative effects on their future (Giese et al., 2022; Bridgman & Von Fintel, 2022; Ward et al., 2018; Meinck et al., 2016). Early childhood development (hereafter ECD) centres play a crucial role, but many children are not physically or cognitively prepared by the time they start primary school (Giese et al., 2022). In South Africa, 41% of ECD centres operate without registration, often caused by their inability to meet essential government standards. Many of these centres face infrastructural limitations that undermine their capacity to care effectively (Atmore et al., 2012; South Africa, 2022). It

is of concern that many children are not well prepared, either physically or cognitively, by the time they have to join schools. What is more, many of these centres operate without being formally recognised because of their inability to meet minimum standards set by the government concerning the state of facilities and safety.

To address these pressing issues, the Nova Institute pioneered the CHICS programme, which fosters close collaboration with communities and views them as active participants rather than as mere beneficiaries. The programme involves training CHICS officers, implementing a child-focused curriculum on life skills, and holding monthly meetings to address parental concerns and mobilise community action for child development. These gatherings highlight the importance of caregiver agency and cooperation amongst community members, building a supportive environment for children.

Enhancing parental involvement is key to the success and sustainability of initiatives aimed at early childhood development. Studies show that programmes targeting parents directly, such as home visitations, are particularly effective in improving early childhood outcomes (Heckman & Mosso, 2014; Kim et al., 2018; García & Heckman, 2022; Bierman et al., 2017; Brentani et al., 2021). However, the high costs associated with these programmes can limit their feasibility and scalability, especially in low-income settings. The CHICS programme presents innovative methods for engaging parents through ECD centres, offering a more cost-effective and sustainable approach to enhancing early childhood development.

Emphasising the difficulties that South African children experience in early childhood development, this chapter seeks to emphasise the vital role that ECD centres play in strengthening families and communities. The chapter introduces the CHICS programme as a creative, community-based solution to help improve the lives of children in early childhood development. The emphasis of this chapter is the value of parental participation and exploring affordable approaches to help children to flourish through families in environments

with limited resources. Following the introduction, this chapter locates a document analysis within a nurturing care framework. Emanating from this framework is a discussion of the application of the nurturing care framework to different environments of the child. Following these perspectives, the methodological approach of the review is presented, and the chapter ends with a discussion and conclusion.

2. The Nurturing Care Framework

The Nurturing Care Framework (NCF) is a crucial tool for identifying what children need to thrive. According to the World Health Organization et al. (2018), the NCF is all about ensuring that children receive a desirable start in life through health, nutrition, safety, responsive care, and early learning opportunities. These elements are crucial because they establish a foundation for a child's future development. But it is not just about listing these needs; the NCF goes further by recognising that the support systems in place might not always be up to par, especially in underprivileged areas. To address this, the NCF makes four key recommendations:

1. **Strengthening Families:** This approach equips parents and caregivers with tools to create a supportive home environment, including responsive caregiving programmes, financial services such as subsidised childcare and healthcare, and community support groups and workshops. These resources help parents to meet their children's emotional needs, invest more time in nurturing, and guide their children's growth.
2. **Providing Essential Services:** Access to essential services such as immunisations, nutritional supplements, and health checks is crucial for every child's healthy growth. Tailored education ensures relevance and engagement. Eliminating obstacles such as cost, transportation, and lack of information can ensure that these services reach every child, providing equal opportunities for success regardless of their family's economic situation.
3. **Supportive Policy Advocacy:** To ensure early childhood development, policies should focus on universal pre-primary

education, robust child protection measures, and adequate parental leave. These holistic policies should incorporate health, education, and social welfare, and collaboration amongst governments, non-profit organisations, and community groups is crucial for ensuring children's rights and well-being.

4. **Consistency in National Initiatives:** Children's needs evolve with societal changes, necessitating adaptable approaches across health, education, nutrition, and child protection. Harmony between sectors is crucial, preventing overlap and optimising resource use. Global best practices and regular updates ensure relevance and effectiveness, embracing innovative solutions and new challenges.

What really sets the NCF apart is its focus on the environments, including physical environments, that shape a child's early years, mainly their homes and communities. It emphasises the vital role that caregivers play in providing love and care, and highlights how crucial it is for communities to advocate for and protect their youngest members. As noted by Black and Trude (2019), the family and community setting are not just a backdrop for development; it is where the magic of growth happens. Within the NCF, various environments can assist the flourishing of children in their early years.

2. The importance of nurturing environments

ECD, covering physical, social, emotional, cognitive, and linguistic development from birth to eight years old, is essential for human capital development and poverty reduction. It promotes learning, educational success, and professional opportunities by ensuring their health, welfare, and accomplishments (Bekir, 2020). Stressors, poverty, and malnutrition in early childhood increase children's risk of developmental challenges. Timing is crucial for appropriate evaluation and intervention to reduce developmental issues in children (Dong et al., 2023). Investing in ECD fosters equitable, comprehensive and sustainable development, progress, and integration. It promotes knowledge acquisition, school success, and future employment, which may boost family well-being,

economic productivity, and growth (Cui et al., 2020). Nurturing children and investing in the early years are beneficial (Daelmans et al., 2021). The first environment of nurturing is within the family.

Families are crucial to child-rearing. Children need a solid foundation from their parents (Hasanova, 2022). Families operate in ways that benefit children (and future adults). For example, cooperation between family members in completing tasks fosters reciprocity and strengthens the family unit, leading to happiness and fulfilment; distributing responsibilities between family members promotes cohesion and mutually beneficial relationships; strong family relationships based on love, confidence, and admiration are crucial for child development; and creating strong emotional bonds between parents and children. Poor families struggle to provide a supportive atmosphere because of limited resources and unexpected conditions (Gao, 2020). Parents invest in their children based on socioeconomic position, income, education, assets, employment, and social capital (Wati & Sahid, 2022; Zhang, 2021). Parents' conduct affects their parenting. Recognising the varied obstacles and conditions that families confront is crucial (Wati & Sahid, 2022; Zhang, 2021). Children's growth and well-being may benefit from support systems and resources that enhance family relationships and bonds, parental skills, and socioeconomic challenges. While the family initiates child development, the ECD centre enhances it.

Children's future successes depend on ECD availability, help, and processes. It prepares the learner or student for achievement in reading, science, languages, leisure, and creativity (Shavkatovna, 2023). ECD centres not only offer controlled instruction and care but also lay a firm foundation which may reduce the likelihood of retaking courses and dropping out of school (Bai et al., 2020). Furthermore, ECD centres provide advantages beyond cognitive skill development. Young children learn respect, affection, care, security, imagination stimulation, attention to body and emotional needs, development of good habits, economic and social independence, support of children's rights, access to profitable

job opportunities, basic life skills, and an environment that fosters educational and fundamental abilities (Jeong et al., 2021; Milbrath et al., 2020). ECD centres are located within communities that support families and these centres.

A nurturing and supportive community enables healing and development by listening and responding to its members. Community support is a crucial factor for the survival of early childhood development centres. ECD Centres often connect families, educators, and community resources because they are ingrained in the social fabric of their communities. Community support for ECD development and centres can often be seen in volunteering, offering resources, sponsoring events, fostering social connections and so on. This support, as community engagement, may assist in overcoming resource limits (Devenish et al., 2020).

Clearly, a vision for flourishing children requires nurturing environments, but in South Africa, ECD presents several issues. These include a lack of (1) access to high-quality ECD programmes and facilities, particularly in poor rural communities; (2) funding, especially in underdeveloped areas and reduced government assistance for ECD facilities; (3) quality caused by variations in ECD initiatives across many locations and institutions; (4) proper infrastructure and amenities; and (5) uniformity in the curriculum and programmes. Furthermore, ECD practitioners may lack the appropriate training and credentials. Particularly in informal areas, ECD centres may not be registered, and parental involvement and participation may be limited (Ally et al., 2022; Baloyi & Makhubele, 2018).

The Community Household Interface Care and Support (CHICS) programme of the Nova Institute is an example of flourishing early childhood development through the family. The aim of the CHICS programme is for every child in Southern Africa to be raised in a nurturing and wholesome environment. This is the place where children have the chance to fully meet their basic human needs within the settings of their own homes, and to have an improved quality of life. The purpose is to enhance the quality of life for children by connecting

and empowering parents. The CHICS initiative operates on the belief that increased parental involvement in the home environment and the ECD centres leads to improved quality of life and better educational results for children, hence increasing their chances of success. Providing mentoring and assistance to ECD principals facilitates increased parental involvement in their children's development. This is achieved by supporting and fostering parental engagement and empowerment via the dissemination of trustworthy information on early children's development and quality of life, and by offering them venues for effective implementation. An optimal household environment is crucial for promoting the well-being of children and the broader community. It is well recognised that early childhood development, which significantly impacts quality of life, starts inside the family. This nurturing environment is essential for children to flourish.

To understand the contribution of the CHICS programme to ECD centres, parents, and the development of children in the early years, a qualitative study was conducted by implementing a document review and analysis.

3. Method

A qualitative document analysis was conducted to explore the available records and programme reports of CHICS. The records were studied using thematic analysis to understand programme history, challenges, accomplishments, and decision-making. The study used three document categories: 1) user manuals for CHICS officers, teachers, principals, participating congregations, and supporting staff; 2) annual reports to funders on the programme's progress, lessons learned, and successes; and 3) feedback reports from participating early childhood development centres, which may include interviews or focus groups. After the initial screening of all the available CHICS programme reports, survey methodology and curriculum instructions were excluded since they were irrelevant to the study. Afterwards, a thematic analysis was conducted on the pertinent reports, as shown in Table 5. Rereading the reports helped to identify tendencies that might explain the programme's evolution and

the increase in parental engagement and agency throughout its implementation. The programme development text, improvement choices, and participant input on their favourite parts were emphasised and combined. After that, the material was categorised chronologically and thematically to show the CHICS programme's progress and success in encouraging parental participation and agency.

Table 5: The documents accessed for the analysis

Phase	Name	Years	Reports used
1	Franchise Model	2010 – 2017	Manual for the establishment of a CHICS project team (Nova, 2011) CHICS Officer Manual (Nova, 2010) CHICS Operational Social Franchise Manual (Nova, 2017) Manual for Parental Empowerment Group Meetings (Nova, 2015) Report on CHICS Parents Focus Group Sessions (Nova, 2021) Project Implementation: Narrative Report (Nova, 2017) Project Implementation: Narrative Report (Nova, 2018)
2	Principal Model	2019 – current	Project/Programmatic Cooperation: Narrative Report (Nova, 2019) Narrative Report for NOVA – Brickstar and CHICS 2019-2020 Project number: 110114/341 (Nova, 2020) Narrative report. CHICS Programme and Strengthening the Brickstar Network 2020-2022 Project number: 100000/097 (Nova, 2021) Narrative Report for CHICS Programme and Strengthening the Brickstar Network 2020-2022 Project number: 100000/097 (Nova, 2022) Narrative report NOVA 2022-2024. Project number: 100000/186 (Nova, 2023)

Phase	Name	Years	Reports used
3	Green CHICS	2021 – current	Strengthening the Brickstar network 2020–2022 Project number: 100000/097 (Nova, 2022) Narrative report NOVA 2022–2023. Project number: 100000/186 (Nova, 2023) Feasibility testing report of the Green CHICS Programme in four ECD Centres. Narrative Report 2022

Over the last 15 years, the CHICS programme has had three distinct phases: 1) the Franchise Model was the original CHICS model, which employed an external fieldworker known as the CHICS Officer to manage and facilitate the day-to-day programme at the ECD centres; 2) the Principal Model, when the principal was trained to act as the CHICS officer at their own ECD centre; 3) the Green CHICS model, that had a similar structure as the principal model but focuses more on the children's immediate natural environment than on quality of life in general.[1]

4. Results

4.1 Social Franchise Model

The CHICS programme was initially structured on a model called the Social Franchise Model. A franchise is one of the methods to duplicate a programme, service, or business through a contractual relationship between independent entities. The franchisor, in this case, Nova Institute, developed and packaged a product or service, the CHICS programme, and made it available through licensing to other third parties (the franchisees) that met the criteria to locally own and implement it in a clearly defined manner, at a specified location and for a given period. The signing of the license agreement illustrated that Nova (franchisor) granted the rights to the franchisee to use and apply the CHICS programme brand name and its intellectual

1 Editors' note: Quality of life is an enduring theme throughout the book. See, for example, Chapter 12.

property. In return for the franchisees' rights to use Nova's CHICS concept, Nova obtained the rights to monitor all the local operations and to take any action to ensure system compliance and quality.

4.1.1 The role of the church

In the early parts of CHICS, close collaboration with the local churches was an important partner in ensuring access to communities and implementing the programme at daycare centres. The CHICS Project Team Manual (Nova, 2011) states: "Many crèches [ECD Centres] are connected to a church or church group in some or other way. Church facilities are often used as a daycare or aftercare centre. This is a cost-effective use of space that would otherwise be wasted. Staff are often volunteers from the community who have minimal training. They look after the children in return for a small wage."

The Nova Institute saw the connection between the church and the crèche and advocated for the church to actively and significantly contribute to the growth and well-being of the children in their congregation and community. This is also evident in the initial acronym of CHICS, "Church Household Interface Care and Support" (CHICS Officer's Manual 2010, Project Team Manual, 2011). The Project Team Manual (Nova, 2011) stated: "The CHICS programme is built on the belief that the church could play a positive role in encouraging a healthy household culture. The programme offers an opportunity for congregations to make a hands-on difference in their local community." The manual continues: "There are many suffering children in Southern Africa. Poverty and illnesses like HIV/AIDS affecting them or their parents increase the severity of many children's situations. Congregations have access to important resources. Buildings, networks, funds, spirit-filled church members, etc".

The importance of the church is also evident in the number of times the words "church" (42) or "congregation" (116) were used in the Project Team Manual (2011), as opposed to the words "child" or "children" (51), "crèche" (69), "teacher" (8) or "principal" (0).

Several congregations of the Dutch Reformed Church (DRC) and the Uniting Reformed Church in Southern Africa (URCSA) played a significant role in the development of CHICS through funding and implementation, respectively, especially during the pre-feasibility phase. Nova signed franchise agreements and implemented CHICS as a social franchise with the church at six congregations. One was the DRC Lynwood Ridge Congregation, which implemented it at Mamelodi township of Pretoria in Gauteng. URCSA congregations were: the Kgautswane congregation, located in a rural village of Ohrigstad in Limpopo province; the Polokwane City congregation, which was implemented at its ward congregation, Ga-Mothiba, outside Polokwane in Limpopo province; the Hebron congregation in North West province; the Eendracht Congregation at Lesley township in Mpumalanga province; and the Phahameng congregation at Mamelodi in Gauteng province.

4.1.2 Establishing a network

Under the franchise model, the local congregation assisted in identifying the paid community member who would serve as the CHICS officer. It was their role to establish a solid network of contacts between the parents, the community, the crèche, and the church. A strong social network would enhance a child's upbringing. This is mentioned multiple times in the Project Team Manual (Nova, 2011):

- "The programme aims to bring together and establish a strong network of different role players who have child welfare at heart";
- "The CHICS programme … acts as a tool by which a local congregation, in cooperation with the CHICS office, can establish a relationship-based network that could improve children's quality of life. It is, therefore, not the CHICS programme's aim to take the place of or improve services that are already made available by the government or private institutions. The aim is rather to bring together people and institutions that could benefit children"; and
- "The CHICS officer has an important role to play in creating and maintaining a network of relationships

between congregations, nursery schoolteachers, parents, children, and service providers already established in the community".

Building a network of relationships in which a child can thrive was also mentioned in the CHICS Officer's Manual (Nova, 2015):

- "The general aim of CHICS is to develop and promote ways to improve quality of life of children. (This is done together with households and a wider community network of role players mentioned above of which daycare centres and local congregations play key roles)"; and
- "CHICS is a programme which introduces and facilitates the engagement of households, daycare centres, local congregation community stakeholders and specialists in a participatory process to improve the quality of life of the children, particularly vulnerable children."

The importance of the CHICS officer building a network for the development of children in the community was also mentioned in other manuals:

- "We aim to bring together and establish a strong network of people who believe that children should have a proper quality of life and ultimately work towards reaching that goal" (Manual for Parental Empowerment Group Meetings, 2015); and
- in the CHICS Operational Social Franchise Manual (Nova, 2017), an entire chapter is dedicated to the guidelines on how to create a CHICS network

4.1.3 Role of the Community

Therefore, given the focus on the network of church, community, households, crèche and supporting organisations, the focus of the CHICS programme in the franchise model was not on the daycare or the child specifically but on the community or a network of actors who can work together. This is evident by the fact that the words "community" (103 and 25) were used more often than the words "crèche" (69 and 0) or "nursery" (23 and

0) or "teacher" (8 and 18) in, respectively, the Project Team Manual (Nova, 2011) and CHICS Officer's Manual (Nova, 2010).

Initially, the crèche was seen as a meeting place for parents and community members to meet to improve their surroundings. For example, the focus of the programme was initially on assisting the households, as also indicated by the slogan of CHICS at the time: "Empowering households through children." The Project Team Manual (Nova, 2011) states: "The way in which the CHICS programme starts off in a local community largely influences the eventual success thereof. Access to the community should not be taken for granted, and it is advisable to work with people or institutions that already have good trusting relationships in place." In the CHICS Officer's Manual (Nova, 2010), the CHICS Officer is advised to familiarise themselves with the community because that is where children and their households are based.

The local church could also help to give the CHICS Officer access to the community. The Project Team Manual (Nova, 2011) states: "From the start the local congregation is one of the most important role players in a CHICS programme. The local congregation already has established relationships in the local community. No meaningful work can be done without a good relationship with the local community and therefore close cooperation with the local congregation is very important."

Further evidence of the importance of the church and community during the CHICS franchise model was the story of Reverend Mokoena. Reported in an internal document dated October 2016, Rev Mokoena orally told his story:

> *Kgautšwane is a deep rural area. It is a dry area, work is very scarce and most people are very poor. It is my first congregation, and I hope it will be my last. People here need hope, and where else will they get it if the church is not there for them?*
>
> *CHICS is an empowering tool for my congregation. When I came here, I did not know the dynamics of the community. As time went on I became aware of the huge needs of the people but I did not know how to address them. This congregation has*

many posts, some even miles away, and on Sundays I have to visit them. We have the Sunday school, but you find a child of 9–11 years old walking around in the street during the church services and school time.

You have to ask yourself why this happens. The child has parents, but some are ignorant. Ignorance is not intentional, it is part of their life, with hopelessness.

You have to ask yourself what we can do. So we started Amogelang (programme that gives children a meal, meaning "Be grateful"). CHICS came in with Amogelang. CHICS helped us to talk to the parents about needs. There are short-term needs, such as food and clothes, but there are long-term needs, such as education. Through CHICS, we network with parents and we can talk about needs in concrete ways. CHICS has helped us with that; we could not do it without CHICS. Parents dump their children at the Sunday school; they feel it is not their responsibility, but CHICS has helped us to involve the parents again.

Even the CHICS volunteers have developed a lot by being involved. Even myself, I was not aware of the concrete needs as set out by CHICS. You can preach a very good sermon, but people have needs, concrete needs, and how do you address that?[2] *That is a challenge, and CHICS gives an answer to that question.*

Our church was once accused of trying to kill other churches by being better than they are through these programmes. … Even the schools felt we were a threat to them, and the social workers and the nurses were surprised that we attend to the needs of the children and we were not well received. I used the opportunity to talk to them, and they now see that we can help them and that we can work together. If you go to the social worker in her office, she cannot breathe. There are too many stacks of files, but they can see now that we can help them. We are also working with others; like HIV – the testing is now done here.

2 Editors' note: This is echoed in Chapter 13.

> *CHICS helps to empower the ministry; it does a lot. When I came here, I did not think I will find child-headed households, the high rate of unemployment, and so on, and I did not know what to do. CHICS helped me to address these things…, but the hopelessness is going down, the level of knowledge of HIV is improving. I cannot do it through the preaching, …, but the programmes address it weekly. I do not have time to educate the people about water, but CHICS has time to do it in the week.*

Although advocating for the child is at the heart of the CHICS programme – the CHICS Officer's Manual (Nova, 2010) states that the basic CHICS value is to always act in the child's interest – the community served as a means of reaching the child rather than a crèche because CHICS feels that the home environment is the most crucial setting for early development. The Project Team Manual (Nova, 2011) states: "All children should have the opportunity to develop a good character, learn life skills, have sufficient food and water at their disposal and live and move in a healthy environment. First and foremost, the household is the place where children should be given these opportunities". The idea was that through the relationship with the CHICS officer and other parents during parental empowerment meetings, parents could be empowered to improve their home environment, the Project Team Manual (Nova, 2011) states: "… bad decisions aggravate the (difficult home situations in low-income environments), for example where alcohol abuse and/or domestic violence occur. It is the goal of the CHICS programme to find ways to improve parents' ability to offer their children a higher quality of life".

4.1.4 The role of the parents

The monthly CHICS meetings for parents and community members provide the CHICS officer with their primary chance to meet and engage with parents. Parents may mingle and have a light dinner together at these gatherings. They also invite knowledgeable community guests to provide educational lectures on children and provide parents with the opportunity to contribute creatively by sharing their experiences with the group and the programme. The meetings are very important,

the Project Team Manual (Nova, 2011) states: "The parent empowerment group is a very important aspect of the CHICS programme because it is the medium whereby parents are encouraged to have better relationships with their children, where relationships between parents can be strengthened and where parents could be introduced to resources available in the community."

4.1.5 Results of the Franchise Model

During a study with the ETH Zürich in 2021, researchers from Nova conducted a focus group at three daycare centres that have implemented the CHICS Franchise Model for several years. The focus groups highlighted the key role of the CHICS officer, particularly in fostering unity and empowerment amongst parents. One parent said, "We can thank (the CHICS officer), who leads us in a manner that makes us one. Yes, we are united."

Through CHICS meetings, parents gained confidence, emotional support, and valuable knowledge and skills, enabling them to tackle poverty-related challenges. One parent said: "When CHICS came here, it found us empty, very empty and it gave us knowledge… We were empty in our minds, but it opened them and filled them with information that would help us tomorrow."

These gatherings allowed parents to debate and act on crèche, community services and infrastructural concerns impacting their children. CHICS helped isolated parents to collaborate and communicate, building community and shared responsibility. One parent mentioned, as recorded internally in Nova: "CHICS found us separated and living our own lives and minding our own business as people, and it brought us together as parents and showed us that we could not live alone, but we need each other, so it made us one… we always knew that we have a water problem, but we just did not talk about it, why? I do not know, but in the CHICS meeting, we started to talk about water".

4.2 The Principal Model

The Principal Model started to develop in 2019 because of the difficulties of working with local congregations. This was the second phase of the CHICS programme. In this model, the head teacher or principal is trained and empowered to implement the activities of CHICS in their own ECD centre instead of appointing a remunerated CHICS officer as the fieldworker like the social franchise model. At the time of writing, the CHICS Principal Model has been implemented in 15 ECD centres around Pretoria.

The first mention of what would become the Principal Model is in the Narrative Report (Nova, 2019): "The (resources), which we are currently developing, is designed with the early childhood development (ECD) practitioner as the main target user to facilitate the improvement of quality of life of children and transforming ECD centres as centres that drive quality of life improvement and engagements with communities and households." In the new model, the teacher was trained and equipped with the necessary knowledge and, with guidance, could decide (contextualise) how to implement the training and knowledge at their ECD centres.

4.3 Moving towards ECD as the main partner

A report (Nova, 2019) to the funder states: "When developing CHICS, we have always believed that every local congregation would primarily qualify to become a CHICS franchisee. The experience we had from the CHICS pilot 2016–2018 emphasised that local congregations have their own dynamics depending on their leadership styles, experience and context." In a previous report (Nova, 2017), it was mentioned that: "Social impact as a motivation to establish CHICS did not seem to be a good enough incentive for some local congregations: potential franchisees are also interested in a model with a business opportunity alongside the social impact".

In the following year, the report (Nova, 2018) noted as a "lesson learnt" that the local congregation was too slow to make decisions, and while they reacted enthusiastically, they were slow to implement. The report stated: "There are long chains of

communication, decision-making and slow feedback from the local congregation resulting in instructions and guidelines being distorted and delayed as they proceed through multiple levels"; "local congregations' representatives mostly showed a lot of enthusiasm and optimism about guidelines and ideas without sufficient efforts to act. We found it difficult to mitigate this challenge as CHICS depends on only one remunerated official; the rest of the local people are volunteers."

It was also mentioned that the congregation is not necessarily the best partner for the CHICS programme in other reports (Nova, 2021): "However, it emerged from our engagements with the local congregations that we worked with… that the church is not the ideal partner to successfully scale the CHICS programme. This is mainly for the following reasons:

- It makes implementation unaffordable and unsustainable: It takes a lot of time to source the funds needed to remunerate a CHICS fieldworker from local businesses and/or the partner congregation, and it has often not been successful.
- The sustainability of the programme is uncertain because it is always linked to specific people in the congregation. The practical leadership style, approach and the activities of local congregations largely rely on the involvement of the members of the church who are appointed as office bearers. When they are replaced by others, the whole situation often changes. Continuity under the succeeding office bearers (often under the new leadership of the church) for the following years is never guaranteed.
- Lack of capacity for the potential driver of the programme implementation: In our experience, the minister of the church who initially expressed interest in establishing CHICS in their congregation does not always have enough capacity to implement or drive its implementation. Lack of their involvement does not always imply failure; however, it has a significant impact.
- The ECD centre is not a key concern in many local churches: The church is involved in many activities, some that are essential for their survival and some that they are dedicated

to. Most churches we had contact with have an ECD centre on their premises or in their buildings during the week, but that is often managed by the ECD staff, who are trained for their work.

4.4. The Emergence of Green CHICS

During the same period, the Green CHICS (GC) model was introduced, which is essentially the same as the principal model but with a larger focus on the environment. One of the reasons for the development of GC was to explore scalable models for CHICS. The idea was to combine environmental education and ECD outcomes to diversify funding streams and attract potential funders who would be interested in supporting the programme if environmental and ECD outcomes were realised. In the Narrative Report (Nova, 2023), GC is described as follows: "In pursuit of improving our marketing and expanding the impact of CHICS, we developed and launched a new focused sub-programme of CHICS, Green CHICS (GC) programme… GC is for parents and children to develop resilience against the effects of climate change. GC is a focused version of the full CHICS package that focuses on the environment. By embedding the brain-building environmental education programme supplement into ECD services, GC supports parents to create a home environment characterised by environmentally conscious interactions to adopt healthier and greener practices related to daily living." (Nova, 2023)

Thus, the church was initially seen as a good partner in supporting children in low-income communities, but it later became clear that, while there is a lot of overlap between the mission of the church and the CHICS programme, early childhood development specifically is not the sole core mission of the church and when congregation members leave or are replaced in the leadership positions, the CHICS programme usually suffers or ends. The church also needs funds for its own operations, which made fundraising for CHICS a lesser concern. The CHICS programme became a supplement to existing ECD

centres, increasing family participation, agency, and teacher–parent interaction.

4.4.1 Shifting the focus to early childhood development

From 2017 to 2023, the use of the words "early childhood development" increased significantly in the investigated records and programme reports and terms referring to merely looking after children, but not necessarily educating them, such as "daycare centre" or "crèche" decreased. This could indicate that the movement from the franchise model to the principal model increased the focus on the education and development of children.

For example, Figure 19 shows the use of various terms in reports to funders, called "Narrative Reports" from 2017 to 2023. The left panel shows instances with the terms "teacher" or "principal", and the right panel, with a different scale, shows instances without, to indicate changes more efficiently in the usage of the other terms. Use of "principal and teacher" increased significantly, "early childhood development" and "parent or caregiver" also increased somewhat, while church or congregation consistently decreased. This could be taken to scale and be sustainable. Several large funders are mostly interested and have a strong emphasis on ECD. Nova started working on proposals for some of these funders and received good attention and funding from Innovation Edge.

The move to partnering with professionals in the ECD sector was evident in the following year's report (Nova, 2020): "The CHICS Programme's first strategic plan for large-scale implementation has been based on the local franchise model. However, our thoughts have evolved during 2019 when we were developing the CHICS mobile application and during interactions with influential role players in the early childhood development (ECD) sector. We then began to see a complementary niche role for CHICS as an additional feature that can add value to existing ECD programmes. Our main finding then was that it would be valuable to further develop a complementary CHICS model in addition to the franchise model that we have been piloting. Since then, our focus and our approach of developing CHICS

has considered the further development of the implementation materials in such a way that they would be easily adaptable to be implemented by existing entities in the ECD sector".

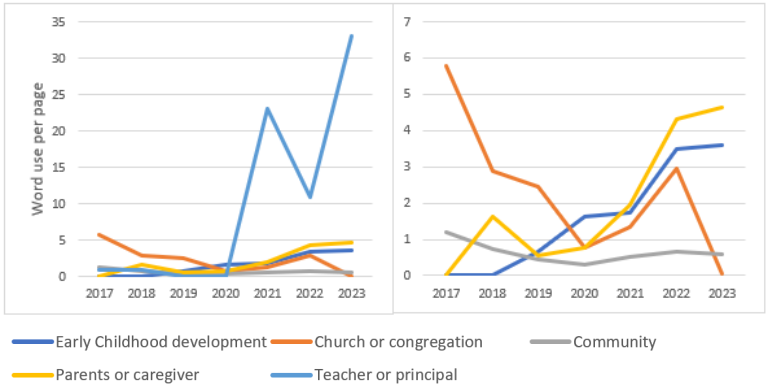


Figure 19: Word use per page in Narrative Reports from 2017 to 2023

4.5 Teachers' and parents' relationship

In the early initiative, the CHICS officer was external to the school and stood between the church-based childcare and the community. As it grew, the CHICS officer became a crucial figure between the ECD centre and parents, rather than being a community worker. This strategy improved parent-teacher connections. As the report (Nova, 2020) stated: "We now focus on the importance of the niche role of CHICS, which is to facilitate parental agency and reignite a sense of aspiration in grassroots or local civil society. The way in which we now present CHICS has led us to change our mission"; and "The initial mission of CHICS was 'to develop and promote ways with households and networks to improve the quality of life of children'. As a result of identifying our niche role (which still requires some fine-tuning) our mission has been modified: 'to contribute towards the building of relationships that improve the quality of life of households with children'. This is still conducted in close cooperation with the ECD centre, where the children's curriculum is presented once a week and parents'

empowerment meetings once a month"; and lastly "Our focus broadened from doing our own thing with CHICS to also finding our place within the broader field of ECD".

The increased cooperation between teachers and parents ensured increased synergy between what the child was exposed to at home and the ECD centre. One principal said: "When I talk to the parents about what we want to do, they say, yes, my child has already told me that… We thought they were too small, but now we tell them to do certain things, for example, to observe how water is used at home. Before you can put your bag down in class in the morning, they will say: 'Teacher, my mother brushed her teeth while the water was running. I told her to close the tap, and she did so'." (Nova, 2023).

The strengthened relationship with parents was very positive for the teachers. The Narrative Report (Nova, 2021) stated: "(the principals) mostly welcomed and applauded the positive relationships they have developed with the parents. Most of them were surprised by the fact that parents responded very well to attending the CHICS monthly meetings although they previously had poor attendance at their school meetings, they had to attend just four times a year (once per quarter). We also gained a good insight into how the parents and the ECD staff can work closer together in the education and care of the children". In a subsequent report (Nova, 2022), it said: "Several principals mentioned that the more they engaged the parents, the more they came to realise that they had always needed some type of initiative such as CHICS to enable them to engage the parents meaningfully. When they have a positive relationship with parents, they can achieve even more things than before, and the platform that CHICS had created for them to meaningfully engage the parents was what they have always needed. Realising how CHICS can make things easier between them and the parents has sparked self-confidence and the need to participate".

For the teacher to know the home environment is also important (Nova, 2023): "One principal mentioned that she was mostly interested in the fact that CHICS offers them an

opportunity to understand the household context of the child. She has always been concerned that, as principals, they do not know what happens at home that can affect the development of the children they work with. Therefore, if the ECD centres can get access to the lives of children at home to develop a working relationship with the primary caregivers of the children, then together, they can embark on a common journey to model the life they desire for the children. CHICS has enabled her to kick-start a working relationship with the parents and to gain access into the home life of a child because it is now easier to discuss the home issues that may influence the development and learning of the child". In the Narrative Report (Nova, 2021) it is mentioned: "The young child's most important relationship is with its parents and most important environment is the household context. From there, the child moves to the ECD centre. We are seeing in practice how both parents and children grow in their sense of agency and hope when they start working together and achieve – rather than receive – small successes".

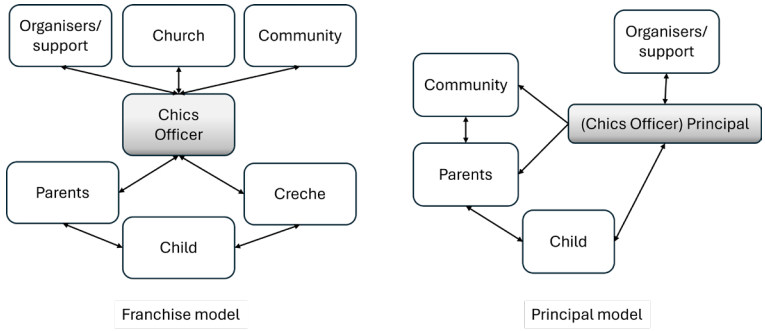


Figure 20: Relationship structure from franchise model to principal model

Figure 20 depicts the switch from franchise to principal model relationships between the CHICS officer and other role participants. The franchise concept centres on the CHICS officer, who connects various community actors or stakeholders to the parents and crèche. The principal model emphasises parent-ECD centre interactions. The CHICS officer works more closely with the children while they are in the ECD centre.

4.6 Parents' and children's relationships

Increased cooperation between parents and teachers also resulted in increased interaction between parents and children. One parent of Green CHICS said (Nova, 2023): "Before Green CHICS, I have never cooked with my children or played games with them. Now, they even ask me, 'Mama when are we going to cook?' One day, I peeled my potatoes, and I called her, I put two bowls on the table and asked her to pick up the chips one by one using her fingers only to put them into another bowl and back while she was reading (counting) one, two, three, four, … she can even count up to forty. I could see that she enjoys herself, and I enjoy it, too. Now, I have downloaded many games and other educational things on my phone, and we play and read with my children a lot nowadays."

Parents get advice and guidance on what their children need to develop and how they can do that at home. Narrative Report (Nova, 2023) states: "This is to say that, when the parents are empowered with reliable information, they can make informed decisions, and when they are provided with opportunities for viable implementation, they can implement those decisions. The result is activities that improve both quality of life and practical ECD learning and development, both at home and at the ECD centre."

4.7 Interparental relationships and support

In the parent empowerment meetings, the parents met with each other, became friends, and supported each other. They shared knowledge about their children and development outcomes. This greatly increased parental agency: "We concluded that our niche role where we can add value in our ability to facilitate parents' agency to improve aspects of the quality of life of children. In 2020, we therefore focused on developing, strengthening, and promoting our niche, namely, to facilitate parents' agency" (Nova, 2021).

4.8 Cost-effectiveness

The principal model had the advantage that it was much more cost-effective: "We found this model more affordable and sustainable compared to the franchise model. Instead of recruiting and paying a CHICS fieldworker, the existing school principal is trained as the CHICS programme facilitator"; and "The success of the principal model in this project indicates that it has high potential for taking CHICS to scale on a relatively low budget. The teacher is a natural role player as a key between the ECD and the household, which is a strategic combination for improving the well-being of people and the environment on a local level" (Nova, 2021).

The principal model proved to be effective because the ECD centre is the central focus of the principal, unlike the church. One report (Nova, 2023) stated: "In the principal model we relied on the inner motivation of the principal to improve her ECD centre and to play a constructive role in the households of her children and the community. This has proved to be a good approach. We did not invest such a high level of capacity (both time and funding) as in the franchise model, but allowed the principals to take the lead and let things develop, with our constant support."

5. Discussion

A document review and analysis was conducted to explore how the Community/Church Household Interface Care and Support (CHICS) programme empowered families to be agents in the development of their children. The qualitative analysis of CHICS programme reports reveals several key insights about the evolution and impact of this early childhood development initiative.

Throughout its evolution, CHICS maintained a focus on holistic child development, recognising the importance of home and ECD centre environments. The programme's emphasis on quality-of-life improvements alongside educational outcomes reflects this comprehensive approach. The transition of the CHICS programme from a franchise

model, which heavily involved local congregations and community participation, to the principal model centred on ECD centres represents a strategic shift towards more direct engagement with children's primary learning environments and the professionals responsible for their early education. This evolution, as evidenced by the increased emphasis on terms such as "early childhood development" and "teacher/principal" in later reports, emphasises a more targeted approach aimed at enhancing learning outcomes and holistic development within the ECD centres.

Moving from a community-focused model to an ECD centre model carries several implications. Firstly, it indicates a deeper integration of the programme within the formal education system, emphasising the significance of early childhood education within structured learning environments. This transition enables a more concentrated effort to improve the quality of education and support provided to young children during their crucial formative years. Furthermore, the shift towards an ECD centre model may foster a more specialised and professionalised approach to early childhood development. By collaborating closely with trained educators and ECD professionals within the centres, the programme can utilise their expertise to deliver tailored interventions and support that align with best practices in early childhood education. By focusing on parents, families and ECD centres, the development of the child is enhanced (see Chikwanda et al., 2022; Luoto et al., 2020). This is a key strength of the CHICS programme and offers the following lessons:

1. A major strength of the CHICS programme is its ability to foster stronger connections between parents and ECD teachers or principals. By empowering principals to implement CHICS activities, the programme created natural bridges between homes and ECD centres. Reports indicate that principals welcomed improved relationships with parents, noting increased parental engagement and a better understanding of children's home contexts. In South Africa, where early childhood development is crucial for laying the foundation for children's future success,

stronger connections between parents and educators can ensure consistency in the child's learning experiences across home and educational settings (Blose & Muteweri, 2021; Chikwanda et al., 2022). This approach of connecting education and home is strongly advocated for globally (Arya et al., 2021; Bierman et al., 2017).

2. The CHICS programme consistently aimed to enhance parental agency in child development. The monthly parent empowerment meetings provided a platform for parents to gain knowledge, share experiences, and build supportive networks. Reports suggest that these meetings increased parents' confidence and ability to engage in developmental activities with their children at home. Strengthening the agency of parents and families in developing their children is a major strength of the CHICS programme and provides lessons in the following way: CHICS recognises parents as primary actors in their children's early development, not just passive recipients of services or advice; parents have continuous support and are provided with consistent information about the child and development and why children develop as they do; they are part of networks and peer support which is relatable; and most importantly, the development activities are extended into the home given that children spend the majority of their time there. Therefore, parents are more knowledgeable, informed and confident. This enhances parental agency in child development in the South African context. It not only strengthens family dynamics and community engagement but also empowers parents to play a more active and informed role in their children's early education, ultimately contributing to more inclusive, supportive, and effective early childhood development initiatives. Acknowledging and utilising the active role of parents can lead to more holistic and sustainable improvements in early childhood development (Coleman et al., 2023; Emmers et al., 2021).

As the CHICS programme evolved, there were other unintentional, either overt or covert, lessons which are worth noting:

- The CHICS programme has a holistic approach to child development by working through the ECD centres, strengthening parent capacity and flourishing child development. The programme, therefore, recognises the critical role of the home environment. This approach acknowledges that learning and development occur continuously in all settings of a child's life.
- Subsequently, by empowering parents with knowledge and skills, the long-term effects are sustained because networks are created and shared consistently and over time through the community and across generations. They can share this knowledge with other parents, relatives, or community members, creating a ripple effect. This approach potentially creates lasting change in the community's approach to child development beyond the direct scope of the CHICS programme.
- The CHICS programme embeds culture because it is culturally relevant and adaptable to local contexts. This is another major strength because child-rearing practices are deeply rooted in culture, locally relevant approaches are more likely to be adopted and maintained, and parents' existing knowledge and practices are respected and validated, which then avoids the pitfalls of imposing a one-size-fits-all model that may not agree with local cultures.
- While the CHICS programme embeds culture, it also addresses inequalities, especially in contexts where access to formal early childhood education might be limited. Empowering parents can help to bridge developmental gaps. Parents provide developmental support to their children, potentially reducing the developmental gap between children who attend formal ECD programmes and those who do not, and parents acquire tools to support their children's development regardless of their socioeconomic status.
- The CHICS programme empowers parents to engage in developmental activities at home and thereby makes it a cost-effective way to enhance child development outcomes. It therefore makes this a cost-effective way to reach children both in and out of an ECD centre.

5.1 Implications for scale

The CHICS programme is adaptable, as evidenced by moving from a franchise model to a principal model and later introducing the Green CHICS variant. This willingness to adapt, based on implementation experiences and stakeholder feedback, is a strength that bodes well for the programme's long-term sustainability and impact. There are a few points to consider if taking CHICS to scale:

- As stated previously, the CHICS programme is *cost-effective* because it uses existing infrastructure (buildings and equipment) and personnel (principals and teachers), thereby eliminating the need to build new facilities or hire additional full-time staff specifically for the programme. In terms of training, instead of training many community workers, the focus is on training ECD principals who are already professionals in child development, which makes it a targeted training approach and therefore more cost-effective by reducing training costs. Operational costs are also minimised because the CHICS activities are incorporated into regular operations in the ECD centres. Furthermore, the CHICS programme's reliance on external funding streams is reduced because there are existing funding streams in the ECD centres, which makes it more sustainable. By training principals to run the programme, there is increased local ownership,
- Taking the CHICS programme to *scale* means that CHICS has the potential to reach many children and families quickly because South Africa has an existing network of ECD centres across the country. Accessing and working through the existing network means (a) a more standardised implementation of the programme across different locations and making it easier to scale up while maintaining quality; (b) facilitating rapid scaling if the model is proven effective and adopted by others; (c) reducing the logistical challenges of setting up new programme sites; (d) allowing for some flexibility in implementation making it potentially adaptable to urban, rural and different socioeconomic contexts. The CHICS programme offers an integrated approach that

strengthens connections between ECD centres, families, and communities.

6. Conclusion

The CHICS programme creates the opportunity for the ECD centre-based interventions to effectively serve as hubs for parent engagement and empowerment. By empowering existing ECD professionals to implement holistic development programmes, a more sustainable programme is possible that does not rely on external facilitators. Parents flourish because they have meetings and activities which significantly enhance parental agency and home-based developmental practices. The CHICS programme demonstrates the potential of integrated, adaptable approaches to early childhood development that empower ECD professionals and parents. Its evolution offers valuable lessons for policymakers and practitioners seeking to enhance early childhood outcomes in resource-constrained environments.

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Part Three

Transversals

Chapter 8

The tough task of enhancing the capabilities of low-income households to benefit from the Fourth Industrial Revolution

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Abstract

The introduction of a series of advanced technologies, collectively referred to as the Fourth Industrial Revolution (4IR), has already altered traditional production and consumption patterns and is likely to continue doing so in future. South Africa faces a primary education crisis, as well as high rates of poverty and unemployment. Given the existing limitations and inequalities, it is unclear whether the 4IR will benefit all members of society equally or at all. This chapter aims to investigate the potential of the 4IR to enhance the quality of life of low-income households in South Africa. We will conduct our investigation by considering the relevance of 4IR technologies for the household, using the 25 elements of the household identified in Nova's QOLA[1] instrument. We will investigate whether there are ways in which low-income households can benefit from the transformations brought about by the 4IR or if there are specific barriers that need to be removed for low-income households to benefit. Given that the interface between low-income households and 4IR technologies is an emerging

1 Editors' note: See Chapter 12, where quality-of-life assessment is discussed in detail.

phenomenon and that the data is sourced from case studies, this chapter will identify key questions and themes for further research rather than offer firm recommendations for action.

Keywords: elements of the household, Fourth Industrial Revolution, low-income households, social context of technology

1. Introduction

The term 'Fourth Industrial Revolution' (4IR) was first popularised by Klaus Schwab, founder and executive chairman of the World Economic Forum, to describe the emerging environment in which disruptive technologies and trends such as the Internet of Things (IoT), robotics, virtual reality (VR), and artificial intelligence (AI) are changing the way we live and work (Schwab, 2016).

The term 'Fourth Industrial Revolution' presupposes three previous industrial revolutions. The *first* one began in the late 18th century, characterised by the transition from manual production methods to machines through steam power and factory systems. The *second* revolution, starting in the late 19th century, brought about mass production and technological advances in steel production, telecommunications, and electricity distribution. The *third* revolution, from the mid-20th century onwards, was driven by the development of digital technology and automation of production.

The 4IR distinguishes itself by integrating technologies that converge the physical, digital, and biological realms. The key feature that all 4IR technologies share is that they utilise the pervasive power of digitisation and information technology (Schwab, 2016, p. 19). The 4IR introduces advanced machine learning, widespread sensor deployment, and biotechnology advancements. These technologies share common attributes such as connectivity, the use of enhanced computational power, and sophisticated data analytics capabilities. According to Schwab, there are four main physical manifestations of the technological megatrends that constitute the 4IR: autonomous

vehicles, 3D printing, advanced robotics, and new materials (Schwab, 2016, p. 19).

The 4IR is marked by a rapid synthesis of previously separate domains, allowing for real-time communication and collaboration across global networks (Schwab, 2016, pp. 14,15). The IoT is a good example of this synthesis of previously separate domains. The IoT devices are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the Internet. In short, the IoT represents a network of physical objects that can sense and communicate (Madakam et al., 2015). Recent advances in AI create yet another important layer in IoT systems. By collecting vast amounts of data through sensors, AI systems create predictive models that can command actuators based on real-time indicators. So, for example, AI systems can 'learn' the ideal soil moisture parameters to maximise the yield of a given plant and control irrigation actuators to ensure optimum conditions on an ongoing basis (Sinwar et al., 2020).

Schwab argues that the successive industrial revolutions have occurred at an increasingly faster pace and that they bring changes that are more rapid and widespread compared to previous revolutions. While the First Industrial Revolution took around 120 years for the spindle, a hallmark of that revolution, to spread outside of Europe, the Internet permeated across the globe in less than a decade (Ibid, pp. 12-13). The Second Industrial Revolution was marked by advancements in steel production, electricity, and the development of the assembly line. Schwab notes that in 1990, the three largest companies in Detroit, the heart of American auto manufacturing, had a combined market capitalisation of $36 billion, revenues of $250 billion, and 1.2 million employees, whereas in 2014, the three biggest companies in Silicon Valley, the hub of digital technology and software innovation, had a considerably higher market capitalisation ($1.09 trillion), generated roughly the same revenues ($247 billion), but with about 10 times fewer employees (Schwab, 2016, p. 14).

This comparison demonstrates one of the concerns about the 4IR: it brings changes faster but may potentially exclude large sectors of society.

South Africa has an alarmingly high unemployment rate and a dysfunctional primary education system. The official unemployment rate for the fourth quarter of 2023, based on the Quarterly Labour Force Survey by Statistics South Africa, was 32,1%. The unemployment rate, according to the expanded definition, was 41,1%. The youth unemployment rate for the same period was 43,4% (StatsSA, 2024a). The results of benchmark tests for literacy and numeracy, specifically the *Trends in International Mathematics and Science Study* (TIMSS) and the *Progress in International Reading Literacy Study* (PIRLS), show South Africa consistently in the bottom decile. However, when compared by province, the provinces with higher urbanisation, namely Gauteng and the Western Cape, do much better.

In this chapter, we will consider what needs to be done to ensure that 4IR enhances the capabilities of low-income households in Southern Africa. We emphatically do not subscribe to the view that there is a hierarchy of needs apart from the obvious fact that dead people have no needs. The ideology of a hierarchy of needs lacks an empirical basis. We view the human needs for creation, participation, understanding, identity and freedom as fundamental (see Murray & Pauw, 2022).

2. Situating South Africa within the Fourth Industrial Revolution

South Africa is a unique context because of the contrasts in wealth, skill, and technological advancement within society.

According to the recent World Bank report on inequality in Southern Africa, South Africa has the highest Gini coefficient of consumption per capita in the world, ranking 1st out of 164 countries in the World Bank's global poverty database (World Bank, 2022, p. 9).

In 2015, more than half of the population lived under the upper-bound poverty line (StatsSA, 2017). The latest (2023)

poverty lines are: food poverty: R760; lower-bound poverty: R1,058; upper-bound poverty: R1,558 (see StatsSA, 2024b). Owning autonomous vehicles or making use of advanced robotics is not, in our view, a realistic prospect for this half of households in South Africa, given the current economic trajectory. The prospect that 4IR technologies will replace some jobs is, however, real.

Despite high income inequality and a high proportion of the population living in poverty, South Africa has a relatively high proportion of Internet users, most of whom access the Internet through their mobile phones. Estimates place the number of Internet users in South Africa at the start of 2024 at about 45 million, implying an Internet penetration of approximately 75% (Kemp, 2024). This means that the basic infrastructure utilised by the 4IR is, at least in principle, accessible to the vast majority of households in South Africa.

In principle, there are two ways in which the 4IR can benefit low-income households in South Africa: It could make products and services cheaper, or it could make them better. Making products and services cheaper would be beneficial in cases where low-income households are the consumers of products produced using 4IR technologies. Making products and services better (but not more expensive) is relevant where low-income households are themselves the users of 4IR technologies. Making essential products and services cheaper is, in effect, the same as lowering the poverty line because the poverty lines are calculated from a basket of essential goods and services. This is an example of the income effect.

The other way in which 4IR technologies may benefit low-income households is if they create more new opportunities compared to the opportunities lost caused by the 4IR that are accessible to low-income households.

The question, therefore, is whether there are concrete prospects for 4IR technologies to enable low-income households to have greater freedom, more income, more knowledge, more participation, more creativity and expression and fewer health and safety risks.

Murray and Pauw (2022, p. 7) identified 25 elements or aspects of the household that facilitate the actualisation of fundamental human needs. A selection of our findings is reported below. These are sorted into six broader categories:

- **Basic necessities** water, food, waste removal, clothes
- **Localisation** terrain, air, house, climate, sound
- **Basic activities** care, work, rest
- **Relationships** self, intimate partner, household members, non-household members
- **Consciousness** faith, values, motivation, thought, learning, communication, beauty
- **Body structure** sex, development phase

Basic necessities

Every element in the households can be brought into a relationship with any one of the nine (or ten) values on the axiological axis[2] of Manfred Max-Neef et al.'s (1991) typology of fundamental human needs and any one of the forms of being[3] on the existential axis. The household element *Food* is not only a satisfier for *Subsistence* but also for all the other needs because food is used to show love, strengthen relationships, express oneself, enjoy oneself, and even participate in communion with God.

Understandably, low-income households will tend to show low satisfaction with the elements of the *Basic necessities* group because they objectively lack them. The question is how 4IR technologies relate to households' water, food, waste removal, and clothes.

Water provision infrastructure is strongly associated with technologies from the Second Industrial Revolution since it relies on mass-produced components such as pipes, mechanical energy for construction, and electricity to drive pumps. Possible

2 Subsistence, Protection, Affection, Participation, Understanding, Creation, Idleness, Identity, Freedom, Transcendence

3 Being (personal or collective attributes), Doing (actions and practices), Having (institutions, norms and habits), Interacting (times and spaces)

improvements in water infrastructure management may be achieved by using the IoT. The effect, if any, on low-income households will likely be incremental and indirect.

Food production, processing, and transport are also associated with the advances of the Second Industrial Revolution. In the 20th century, food production was revolutionised through large-scale mechanical power and synthetic fertiliser application.

The bulk of food produced in Southern Africa is produced by commercial farmers and distributed through conventional market mechanisms. As far as food as an energy source is concerned, this is a very efficient mechanism because conventional commercial agriculture is so much more efficient compared to small-scale agriculture. This is not necessarily the case for all nutrients. According to a report by Statistics South Africa that is based on the General Household Survey of 2021, more than half a million (683,221) households with children aged five years or younger reported experiencing hunger in 2021 (StatsSA, 2023). Although absolute deprivation does exist (1.1 million or 6% reported that they experience inadequate access to food), most low-income households do not necessarily lack access to enough energy from their food but lack, especially, fresh vegetables and quality proteins. Labadarios et al. (2011) conducted a cross-sectional study (n=3,287) based on a face-validated 24-hour recall to measure dietary diversity in South Africans aged 16 years and older from all population groups. They concluded that "the majority of South Africans consumed a diet low in dietary variety. The tribal areas and informal urban areas were worst affected, and eggs, legumes and vitamin A-rich fruits and vegetables were the least consumed" (Ibid, p. 11).

The impact of the 4IR on large-scale commercial agriculture will likely lead to a further decline in human labour per unit of production in agriculture. The first such reduction in labour in modern times came through mechanisation. The 4IR introduces autonomous vehicles, robotics and sensors that enable the mechanisation of tasks such as weeding and picking

fruit that could previously only be performed by humans (see Tevel, 2023). The potential impact of the 4IR in agriculture will have to be addressed at the societal level. According to a report by the Food and Agriculture Organization of the United Nations (Davis et al., 2023), approximately 1.23 billion people were employed in the world's agrifood systems in 2019. Agrifood systems are defined as a combination of agriculture, forestry and fishing and the manufacture of products derived thereof. However, almost half the world's population (3.83 billion people worldwide) live in households linked to agrifood systems (Davis et al., 2023, pp. iii, 5).

Not many households in South Africa produce most of their own food. Based on the 2021 General Household Survey, Statistics South Africa (2023) reported that 3.1 million (17,3%) households engaged in agricultural activities. These households were mainly located in non-metro and rural areas. About 12% of those who produce at least some of their own food, i.e. approximately 2% of all households, reported their agricultural activities as the main source of food for the household.

Nova has implemented projects for small-scale household food production in both urban (Soshanguve, Gauteng) and rural settings (Letsitele area, Limpopo) (Reyneke, 2021). In our experience, efforts to increase small-scale household food production in urban and rural areas were substantially more difficult than we anticipated. In urban areas, space is limited, and where space may be available on an urban stand, the shade of nearby buildings may make it unsuitable for a vegetable garden. In rural areas, space to plant is more accessible, but access to water is often more difficult and stray animals such as goats and donkeys damage crops. 4IR technologies may not necessarily directly address issues with water supply and physical crop protection but may help to address problems that small-scale food producers experience with identifying pests and diseases. Understanding when to irrigate or fertilise is also important. A cursory investigation of the Google Play store shows that numerous applications already exist that use computer vision to identify insects and plants and diagnose plant diseases. In their extensive analysis of the application of

the IoT to agriculture, Ayaz et al. (2019) identified irrigation as one of the major application areas for 4IR. They state that "a precise soil and air moisture control system using the wireless sensors not only makes an optimal use of water but also leads to better crop health" (Ayaz et al., 2019, p. 129555)

Waste removal is an important issue for low-income households in South Africa[4]. The 2021 General Household Survey found that household refuse was removed at least once per week for only 60% of all households nationally (StatsSA, 2022, p. 39). Of households in rural areas, 86% disposed of refuse themselves. In urban areas, only 12% of households disposed of refuse themselves (StatsSA, 2022, p. 40). Once again, the advances of large-scale waste services are because of technologies originating in the Second Industrial Revolution, but these advantages have not reached a large proportion of households in South Africa.

It is not clear if there are 4IR technologies that apply to this problem at the household level. We do foresee that 4IR technologies may be used to improve service delivery at a municipal scale. One such improvement in service delivery may be through an improvement in the monitoring of waste collection. Multiple options for geographical tracking of waste collection vehicles are available. These vary from free Android applications to commercial fleet management software. AI-driven waste sorting facilities utilising waste sorting robots are already in use to sort recyclable waste at scale (see, e.g., Ampsortation, 2025). Such technology may make waste recycling more feasible for more municipalities.

The provision of **clothes** is a basic element of the household**.** The First Industrial Revolution already brought advances in the production of textiles, with the Second Industrial Revolution introducing mass production of clothes. The Fourth Industrial Revolution has already impacted clothes manufacturing, but greater impacts are expected in future. Altenburg et al. (2020) note that the manufacture of clothing can already be robotised, but expect that the robotisation of sewing

4 Editors' note: See the case studies discussed in Chapter 5.

will be more expensive than manual labour until approximately 2035 to 2040. The mass production and consumption of clothes means that for the large majority of even low-income households, clothes as a mere means of protection against the environment is not lacking. We observed low satisfaction rates with clothes, compared to other elements of the household (see for example Murray & Pauw, 2022, p. 14 for data from eMbalenhle, South Africa).

Localisation

Low-income residential areas are often dirty, unsafe, noisy, or crowded. Therefore, it is understandable that we observed low satisfaction with the *Localisation* element group. The *Localisation* element group contains four elements: terrain, air, house, climate, and sound.

Terrain

It is difficult to imagine 4IR technologies that would improve the **terrain** where low-income households are located, with perhaps the exception of crime prevention. As part of a broader policing strategy, networks of security cameras have been shown to reduce certain types of crime, while some types of crimes remain unaffected (Donkers, 2016, p. 129). In South Africa, public open street closed-circuit television (CCTV) surveillance systems operate in the central business districts of the main metropolitan areas (Minnaar, 2007). The implementation of these systems led to a reduction of especially street crime and bank robberies in the area under surveillance (Minnaar, 2007, pp. 193, 194). CCTV technology is not a 4IR technology but rather belongs to the group of technologies that constitute the Third Industrial Revolution. The 4IR version of surveillance networks pairs observation with enhanced abilities, e.g., the ability to automatically zoom in on objects of potential interest, as well as with advanced data processing capabilities that incorporate aspects such as facial recognition, motion analysis, number plate recognition and object recognition (typically firearms). These all have obvious applications for enhancing security. At the same time, it is easy to envision a dystopian future in

which a totalitarian state uses such technologies to enforce total control over a population. In fact, such a scenario is currently playing out in Western China (Shakir & Wang, 2021).

Air[5]

Air pollution has been a side-effect of industrialisation since the first industrial revolution. The quality of **air** breathed by households is determined by a combination of natural and anthropogenic sources at the regional, local, and micro scale. Local air quality is impacted in particular in the presence or absence of large- and small-scale fuel conversion technologies, traffic and dust sources.

Electric vehicles will have obvious air quality advantages for households that live in areas where vehicle emissions contribute significantly to air quality problems. The 4IR technologies are also relevant as far as monitoring air quality is concerned. Miniaturisation of certain types of air quality sensors is well advanced, for example: in 2016, *Wired Magazine* reported that "Half a dozen racing pigeons have been released into the capital (i.e., London) with GPS devices and a 35 g sensor to measure levels of nitrogen dioxide being produced in the city" (Wired, 2016).

There are several air quality monitors marketed for household use. The price of these devices means that there is no prospect for adoption by low-income households. Lower-cost air quality monitors have been mooted as an opportunity to extend air quality monitoring networks. The accuracy of these instruments does not currently compare with that of compliance-grade instruments. DeSouza et al. (2017) evaluated several low(er)-cost air quality sensors deployed in Nairobi. They found that these sensors have technical limitations, but that they can still provide indicative measurements of air quality that are valuable to local communities. They found that a low-cost sensor network increases public awareness of air quality issues and, therefore, can complement but not substitute high-

5 Editors' note: Air quality is extensively discussed in Chapters 3, 4 and 10.

quality and reliable air quality monitoring systems. Wernecke et al. (2021, p. 4) expressed the belief that low-cost sensors have the potential to generate epidemiological evidence and have a role to play in gaining a better understanding of exposures as part of a larger undertaking to understand and act upon pollution-related health impacts.

House

Most households that live in formal houses do not build their own **house.** As with other elements already mentioned, houses in South Africa are constructed with the products of the Second Industrial Revolution, such as mass-produced cement, bricks, tiles, steel, and wood products. According to the 2021 General Household Survey (StatsSA, 2022, p. 35), 11.7% of households in South Africa lived in informal dwellings. Assuming that there were 17.9 million households in South Africa in 2021 (StatsSA, 2022, p. 12), this amounts to just over 2 million households.

The Department of Human Settlements reported to the Portfolio Committee on human settlements (PMG, 2022), that the human settlements sector has delivered 3,431,382 housing units made up of stand-alone houses and units in multiple-storey or multi-unit buildings from 1994 to the end of February 2022. Most of these houses were built without appropriate thermal insulation.

One may reasonably expect that the 4IR may contribute to incremental improvements in the production of building materials, but this is unlikely to solve the housing needs of low-income households in Southern Africa, except if new materials or techniques could be found that will radically drive down building costs.

Three-dimensional (3D) construction printing is an example of one such new technique. Mahachi (2021, p. 4) finds that this technique may eventually be much cheaper than the conventional construction when taking into account the full life cycle cost, but that the conventional 'brick and mortar' home building industry remains competitive and that comprehensive, pragmatic research and practical implementation are needed

to ascertain the role of this technology in housing delivery in South Africa.

The last two elements of the environment in which households find themselves (the *Localisation* element group) are **climate** (which incorporates solar radiation, air temperature, humidity, wind speed) and **sound.** We do not foresee that 4IR technologies can reasonably impact the *ambient* climate. In areas where households are exposed to traffic noise, the use of electric vehicles may provide some relief.

Basic activities

The *basic activities* element group contains the elements of *care, work,* and *rest*. Many products are using 4IR technologies on the market aimed at supporting these basic activities – practically all of them are unaffordable to low-income households. The one platform for 4IR technologies to which large numbers of low-income households have access is mobile phones. Most of these are running on the Android operating system. The StatCounter Global Stats website (2024) estimated that Android accounted for 84% of operating systems on mobile phones in South Africa in 2024. The ten top-ranking applications by download on the Google Store in South Africa, as tracked by Similarweb (2024) included two shopping applications (Temu and Shein), three communication-focused applications (WhatsApp, Messenger, WhatsApp Business), three social network applications (Facebook Lite, TikTok, TikTok Lite), one banking application (Capitec Bank) and a PDF reader. Illidge (2023) listed the most popular Android applications for 2023. This list includes many of the same applications as given by Similarweb for 2024 (WhatsApp, Facebook Lite, TikTok, TikTok Lite, Capitec Bank, WhatsApp Business, Shein) but also includes a music application (Spotify). From a survey of 1,931 respondents aged 18 to 64 years who use a smartphone in 2023, Statista (2024) tabulated the most-used smartphone applications by type in South Africa. The top category was social media applications with 83% of devices, followed by email services (79%), Internet browsers (77%), messenger applications (67%) and music services (60%). About half of the respondents used game applications.

In general, the use of smartphone applications by low-income households is limited by the quality of network connection, the cost of data and the cost of the applications themselves.

WhatsApp, the most popular Android application, has an obvious application in the daily lives of households as it gives members a very cost-effective way to communicate with each other. It is important to note that WhatsApp provides a crucial function (general communication through text, files, and voice) and is free to install and use. The user pays only for data. If used correctly, WhatsApp can be extremely data-efficient. Therefore, WhatsApp is an example of the type of application that could serve low-income households: It is free, data-efficient, flexible regarding its utility and addresses a fundamental usage pattern (communications).

The reach of 4IR technologies is limited by external factors, but also by digital literacy. Regarding healthcare, MISTRA (2020, p. 299) notes that healthcare interventions focused exclusively on technology (particularly digital technologies) will likely fall short of addressing broader systemic and social determinants of health.

The impact of the 4IR on household **work** is easier to imagine for high-income households than for low-income households: gradually expanding automation of the home is taking place through smart technologies. The second industrial revolution brought appliances that minimised manual household work, such as washing machines, tumble dryers, vacuum cleaners and dishwashers. The 4IR brings connected digital appliances (such as Internet-enabled fridges) and even automation (such as autonomous vacuum cleaning robots). Low-income households in South Africa, as a rule, use a limited number of appliances, even from the Second Industrial Revolution, to ease domestic work (typically limited to electric plates and microwave ovens).

The question around economic work outside of the household is whether the 4IR will create or destroy jobs for low-income households. In the view of MISTRA (2020), the impact

of 4IR technologies will be determined by how they are used and managed. Although this seems like a sensible position, the term *manage* is unfortunate. Complex phenomena and systems like technological revolutions and economies cannot be managed by any one party.

There are already social media applications helping people to find lower-end jobs (Mehdi, 2020).

Rest

4IR also impacts **rest** and relaxation in the household. Amongst the most-used Android applications are entertainment-oriented social media applications (notably TikTok and TikTok Lite). Android games, many of which are free, as a category, also have a very high adoption rate.

Relationships

The *Relationships* element group encompasses relationships with oneself, one's intimate partner, household members, and non-household members. Relationships are not in the first place about technology or even about circumstances. In our quality-of-life research (Murray & Pauw, 2022), we found a certain independence between this element group and objective living conditions, with respondents in low-income households being relatively satisfied with the relational aspects of their lives as opposed to their physical environment or their objective standard of living.

Self

One's **self** is one's body. There are numerous 4IR technologies that people use to monitor and understand their own bodies. Numerous devices are available to monitor physical activities. These include pedometers, accelerometers, activity trackers, heart rate monitors, and smartphone applications (Åkerberg et al., 2017). There are also numerous devices, such as smartphone applications, e-scales, and wearable devices, that are used for self-monitoring dietary intake and weight management (Carpenter et al., 2022). The price of most of these devices

(see Carpenter et al., 2022, p. 6) means that, apart from free or low-priced Android applications, most of these devices will not be affordable to members of low-income households. The other recent technological breakthrough in self-monitoring technology is continuous blood glucose monitoring using photoplethysmography (PPG), which is a non-invasive optical technique. Very reasonably priced wearable PPG devices are already on the market. South Africa has a very high rate of non-communicable diseases such as diabetes and high blood pressure. These are not only diseases suffered by the wealthy. Significant proportions of members of low-income households also suffer from these conditions. The prevention and treatment for these conditions include lifestyle-related aspects of life, physical activity and diet, in which the 4IR technologies mentioned above have a definitive role to play.

Intimate partner

One's relationship with one's **intimate partner** and fellow **household members** is not primarily mediated by technology. In our research, respondents are generally satisfied with their relationship with their intimate partner and fellow household members, even when their satisfaction with their environment and physical standard of living is low. 4IR technology has facilitated significant cultural shifts in how people go about finding an intimate partner. A variety of services and applications that utilise artificial intelligence, machine learning and location sensing exist for this purpose. These services and applications vary in their focus and user communities, from people looking for functional long-term life partnerships (e.g., e-harmony) to those looking for casual sex. The cultural impact of these services and devices will likely first be seen in higher-income communities, but will inevitably also affect members of low-income households. The potential for using these services and applications for sexual exploitation by individuals or organised criminal groups is obvious.

There is a relevant phenomenon in the context of low-income households in South Africa where social media (a 4IR phenomenon, because communication is mediated by

algorithms) plays an important role: the blesser-blessee phenomenon. This phenomenon involves young women entering sexual relationships with older men who provide material and financial benefits, resembling a modern form of the 'sugar daddy' relationship. The difference is that these relationships are often publicly mediated through social media platforms and Internet sites such as *BlesserInc* and *Blesserfinder* (Basson, 2018, p. 4). The term is fairly recent. Palfreman (2020, p. 3), with reference to Mampane and Kinuthia, noted that "the terms have become prominent in the media only since 2016, with the adoption of the hashtag '#blessed' used on pictures uploaded to social media showing money and gifts women have received from older men". Basson's study, conducted under the Youth Research Unit at Unisa's Bureau of Market Research, found that the reasons why young women engage in such relationships are *varied and intertwined*. For some, it is part of a survival strategy amid poverty, but for others, the attraction of a flamboyant lifestyle and high social status in the eyes of peers is a strong motivation (Basson, 2018, pp. 4, 5, 11). In fact, without denigrating the role of poverty, unemployment and gender inequality in the South African context, Basson goes as far as saying that: "The literature suggests that there is a wider occurrence of transactional sexual relationships for fulfilling desires for status and gifts than for securing basic needs owing to poverty" (Basson, 2018:4, 5). Social media (Facebook, Instagram and Twitter) play a prominent role in the phenomenon. An interesting aspect is the fact that Instagram has become the vehicle through which assertions of status are advertised to peers. In the focus group interviews conducted by Palfreman, the participants identified Instagram as the platform blessees mainly use for self-promotion. Instagram, in addition to various Facebook groups, is also used for attracting blessers, and by blessers for finding blessees. They also noted that social media normalises the phenomenon and presents a positive image of blesser-blessee relationships and that it does not show the potential negative aspects (Palfreman, 2020, p. 30). Social media is clearly not the only factor, but it does add a new dimension to an older phenomenon, and it once again

demonstrates the speed at which new social phenomena can permeate society.

Non-household members

As with the other relationships, the relationship with **non-household members** is traditionally not primarily mediated through technology. A good example is Duolingo. Duolingo is a free Android application for language learning that follows a well-tested approach and incorporates user evaluation and dynamic adjustment to the syllabus. This application is not available for any South African language except isiZulu. It boggles the mind that after 30 years of democracy and with a government department tasked with promoting South African languages (Department of Sport, Arts and Culture), only one such implementation of a local language on an application such as this has seen the light of day.

Consciousness

The ***Consciousness*** element group contains the elements of faith, values, motivation, thought, learning, communication, and beauty. This is the element group about which, only a few years back, one would have thought that the technological developments would not have much of an impact. The public release of ChatGPT (Chat Generative Pre-trained Transformer) and the subsequent proliferation of the use of Large Language Models (LLMs), changed all of that. Faith, values, motivation and thought all have an internal locus (conscious and unconscious) but also an interpersonal aspect mediated through communication and participation. In this way, all technologies that facilitate the transmission of ideas and communal participation will impact the *Consciousness* element group. This has already been seen with the introduction of mass communication media during the Third Industrial Revolution.

In our empirical research on quality of life, we repeatedly found low satisfaction related to the household element of **learning**. This is to be expected, given the poor quality of education that the majority of people in South Africa received

(recall the earlier discussion of South Africa's PIRLS and TIMSS results). Informal and formal learning, however, is one area where 4IR technologies may have a significant impact. The current repository of good-quality information and learning resources available for free over the Internet is already incomprehensibly large (consider Wikipedia, MOOCs, Library of Congress, and the Gutenberg Project).

Khan Academy is an example of a superior educational resource that combines content delivery (lectures and notes) with individual evaluation. Khan Academy (2025) is a not-for-profit educational organisation founded by Salman Khan in 2008. It grew from his tutoring his cousin in 2004 and placing his videos on YouTube in 2006. In contrast to traditional institutional models that share characteristics with the industrial production process (batch processing and minimum quality standards), Khan Academy is based on the concept of mastery. The learning content itself is structured hierarchically, with each element linked to its prerequisite knowledge and skills. Material is not introduced to the learner if the prerequisites are not met. Learners have to consistently achieve at a high level in a certain learning element before they can move on to the next learning element. The fact that the technology enables each individual to master the material at their unique pace places the Khan Academy as part of the 4IR. Tertiary education institutions, notably Unisa, but increasingly since the lockdowns, most other universities, also employ e-learning platforms. These e-learning platforms are more akin to the communication revolution because the purpose of the platform is information exchange. A 4IR learning platform will involve a degree of responsiveness and automation, typically through the application of artificial intelligence.

It can be argued that the Internet has, for all practical purposes, removed the limitation of access to knowledge. For low-income households in South Africa, the remaining barriers are those of language, data cost, time, and motivation.

Members of low-income households' communication capabilities have revolutionised with the advent of mobile

phones and the technology options that make their use affordable, such as SMSs (short message services) and affordable messaging applications such as WhatsApp. Where the Third Industrial Revolution made it easier to communicate (through radio and television), social media connected to the mobile Internet gave people the ability to proverbially talk back.

Body structure

The *Body structure* element group is about one's **sex** and **development phase** (age). These are elements that cannot be fundamentally changed, but that one must accept and make the most of. These elements are the ones that, in our experience, respondents in our quality-of-life interviews are the most satisfied with.

Sex

A recent phenomenon relevant to this element group is the rise of a transgender movement that is mirrored in the emergence of rapid-onset gender dysphoria in teenagers (see Littman, 2018). How recent this phenomenon is can be gauged by the fact that a question related to being transgender was only included in the US CDC's *Youth Risk Behavior Surveillance System* (YRBSS) questionnaire in 2023. This can be seen by comparing question 65 in the YRBSS questionnaire (CDC, 2021) with questions 64 and 65 in the 2023 questionnaire (CDC, 2023). In an article in the *British Medical Journal*, Jennifer Block observes that the number of children and adolescents identifying as transgender and seeking medical treatment, especially in the US, has risen rapidly in the years before 2023 (Block, 2023). An analysis of Google searches for the term *transgender* shows the same, with searches for the term increasing markedly in 2015. The Cass Review (Cass, 2022, p. 32) describes this sudden increase in referrals to the UK's Gender Identity Development Service (GIDS): "From a baseline of approximately 50 referrals per annum in 2009, there was a steep increase from 2014–15 … in October 2020 there were 2,500 children and young people being referred per annum, 4,600 children and young people on the waiting list, and a waiting time of over two years to first review."

Block observes that there is significant professional disagreement over the appropriate approach, with certain US medical groups supporting what they call "gender-affirming care", including surgery, puberty blockers and hormones, while several European countries have issued guidance to limit medical intervention in minors. Block notes that concerns about the lack of strong evidence and the potential risks of early medical transition are coming from across the ideological spectrum, and calls for rigorous scientific review are increasing (Block, 2023). For example, a nationwide study in Finland comparing the cohort of all 2,083 sub-23-year-old gender-referred adolescents between 1996 and 2019 with 16,643 matched controls found no strong evidence to suggest that gender-questioning adolescents are at greater risk of suicide (Ruuska et al., 2024). The Cass Review also pointed to a lack of consensus on the conceptual understanding of gender dysphoria (Cass, 2022, p. 16), gaps in the evidence base (Cass, 2022, p. 15), and inconsistencies in service standards and approaches (referred to as a 'clinician lottery') (Cass, 2022, p. 16).

The recent release of the WPATH (World Professional Association for Transgender Health) files gives insights into the workings of the gender transition industry. In analysing these leaked correspondence and discussions between members of WPATH (Public News, 2025). Hughes (2023) argues that WPATH is advocating for unethical, unscientific, and harmful medical practices based on a consumer-driven, politically motivated agenda that is causing serious harm to patients. She draws parallels between WPATH's actions and past medical scandals, such as the widespread and officially approved administration of lobotomies and ovariotomies (Hughes, 2023).

This phenomenon is important in the context of the 4IR because it is a social change that had an extremely rapid onset (recall that there was not even such a question in the 2021 YRBSS), which is very polarising. The phenomenon is furthermore important because of the role that algorithm-driven social media, in particular YouTube (Littman, 2018, p. 2), TikTok (see Dillon et al., 2023) and Tumblr (Littman, 2018, p. 4) may play in this regard. Grace (2023) provides a case study of the

role of TikTok in this regard. In this context, Dillon et al. point to the fact that social media sites "are driven by algorithms that filter, manage, and direct content from creators in positive and negative ways, which users can resist or at other times cannot". Littman (2018, p. 2) analysed parental discussion groups and found numerous accounts of immersion in social media preceding gender dysphoria. When thinking of the role of social media, transgender influencers immediately come to mind (see for example SociallyPowerful, 2024), but Cass (2022, p. 46) adds an interesting perspective by observing that some see social media as perpetuating unrealistic images of gender and setting unhealthy expectations. Although technology is certainly not the only factor, this example demonstrates the speed at which new ideas can impact society and how institutional, social, and technical factors converge in the time of the 4IR.

Development phase

4IR technologies promise dramatic improvements for older people. Wearable sensors exist that can alert someone if an older person experiences a health emergency, such as a fall or stroke. Autonomous vehicles or e-hailing and mobile phone-activated grocery deliveries mean that older people will be able to retain their freedom for longer. Even for people whose vision is deteriorating, text-to-speech technology offers an alternative to reading. All these developments can keep older people independent for longer. The limitation is, however, that not all of these are affordable in the context of low-income households.

3. A framework for future projects: navigating uncharted territories

We touched on the interface between the elements of the household and established and emerging 4IR technology. It is clear that the 4IR has, and will increasingly, impact the lives of even low-income households.

Generally, products currently on the market for use by households that use 4IR technology are focused on higher-

income consumers. Low-income households in South Africa have practically no chance of ever owning or using the iconic 4IR products, such as autonomous electric vehicles or smart home systems. We did see, however, that there are several ground-breaking free-to-use services (numerous Android applications, general-purpose LLMs such as ChatGPT and Google's Gemini, education services such as Khan Academy and free MOOCs) that are more accessible to low-income households or could be made accessible fairly easily.

3.1 Central or distributed?

The 4IR technologies have the potential to centralise power. We referred in passing to the truly dystopian scenarios that are possible with the advent of the 4IR. The use of extensive AI-enabled public monitoring networks by totalitarian regimes engaging in widespread human rights abuses is already a reality. The United States Holocaust Memorial Museum describes the Chinese government's campaign against the Uyghurs in Xinjiang as multi-faceted and systematic. This campaign includes "identity-based persecution, mass detention, surveillance, enforced sterilizations, forced labor, and forced assimilation" (USHMM, 2024).

Not only totalitarian regimes but also institutions in democratic countries are using information and communication technologies to manipulate public opinion. The so-called *Twitter Files* (Taibbi, 2023) is a collection of internal documents made available to a group of writers and journalists after Elon Musk's takeover of Twitter. It evidences the collaboration between state agencies such as the Department of Homeland Security (DHS) and the Federal Bureau of Investigation (FBI), certain NGOs, and social media companies. The documents reveal how a collaborative group undertook to suppress *disinformation* and *misinformation* by removing, reducing the impact of, or appending warnings to messages. These actions initially targeted malicious actions such as false automated accounts (*bots*) from suspected foreign state actors such as Russia and Iran, but ended up suppressing domestic *malinformation*. *Disinformation* is lies, *misinformation* is errors, but *malinformation*

is the truth that is deemed damaging by the censors. Wardle (2020) defines malinformation as true but with malicious intent (of which the censor is the judge – so this is equivalent to the above definition). One example in the *Twitter Files* is an email from the Virality Project recommending the suppression of stories of true vaccine side effects (Taibbi, 2023, see #32). The *Twitter Files* also evidence the successful suppression of the New York Post's reporting on the content of the Hunter Biden laptop (Shellenberger, 2022). This is another example of the suppression of true information that is damaging to a certain interest group. In his Twitter thread, Shellenberger provides files showing the involvement of the FBI in orchestrating the suppression of this news. He further elaborates on this aspect in his evidence before the US Congress (Shellenberger, 2023, p. 22). In this testimony before the Energy and Commerce Committee of the US Congress on *Preserving Free Speech and Reining in Big Tech Censorship* on 28 March 2023 (United States Government Publishing Office, 2023), Schellenberger referred to the cooperation between the intelligence community, the social media giants, and NGOs as the *censorship industrial complex* (a term also used by Taibbi). He defines the censorship industrial complex as "a network of ideologically aligned governmental, NGO, and academic institutions that discovered over the last few years the power of censorship to protect their own interests against the volatility and risks of the democratic process."

Social media provides a platform for large organisations, such as states, corporations, and media houses, as well as small enterprises and individuals, to express their views; therefore, it is the apex of the communication revolution (i.e., the Third Industrial Revolution). However, the operation of algorithms that propagate or effectively hide messages makes social media a 4IR phenomenon. Social media enables both automated propaganda bots (of which the so-called *Guptabots* - see Fraser, 2017 - is a local example) and algorithm-based censorship. Recent advances in generative AI bring the possibilities for sustained, large, sophisticated, multi-layered propaganda operations into view. How citizens, even in democratic societies, will know the truth and maintain their freedom in

the public discourse to search for and test the truth remains a critical question.

There are 4IR technologies that will lead to greater centralisation in some industries. The mechanisation of agriculture resulting from the Second Industrial Revolution already gave rise to larger farms engaging in more capital-intensive and less labour-dependent production. Robotic precision farming is likely to reduce reliance on labour even more, even for applications where a human eye and a human hand were needed in the past (such as weeding and fruit harvesting).

The question is whether there is also a contrary momentum; namely, that the 4IR will enable the emergence of small- and micro-scale production entities. How YouTube has transformed media is enlightening in this regard. YouTube provided a platform for a new generation of independent content creators that would not have been possible in the absence of the platform. These content creators are, however, not independent from the platform and are exposed to the risk of their accounts being suspended and their videos being removed or demonetised by the platform. Their popularity is also not only a function of their content but also of the suggestion algorithm. It is understandable that a platform will have rules and must implement those rules, but it shows the interaction between the centralising and decentralising tendencies of the Internet as a technology.

The question is whether this decentralising tendency (which is nothing else than the expansion of individual capability) will also manifest in physical production processes. Additive manufacturing technologies certainly provide a fast and cost-effective path from a design stored on a computer to a physical object and are available for a wide range of materials (from plastic to titanium); therefore, it has the potential to be used by small, decentralised, and possibly independent manufacturers for a variety of applications.

D'Aveni (2015) notes that it is also likely that digital platforms for enabling design-to-print activities and design

sharing, and fast downloading are likely to emerge for 3D printing. This is where the true growth is likely to be: He predicts that such platforms "will orchestrate printer operations, quality control, real-time optimization of printer networks, and capacity exchanges, among other needed functions. The most successful platform providers will prosper mightily by establishing standards and providing the settings in which a complex ecosystem can coordinate responses to market demands." Once again, the decentralising and centralising tendencies of technological development co-exist.

3.2 The human touch

More than 30 years ago, Manfred Max-Neef, Antonio Elizalde and Martín Hopenhayn called for a change in the development paradigm to *human-scale development* (Max-Neef et al., 1991). This paradigm wants to shift the attention away from the macro-economy to the scale where the individual matters. A common theme that we found while evaluating 4IR technologies in the context of the low-income household is the interaction between social and technical elements. An ideal future scenario would be a future where 4IR technologies amplify individual creativity, understanding, and freedom and deepen relationships while delivering a higher material standard of living. The opposite, dystopian scenario is a future where totalitarian regimes use 4IR technologies to control their populations through AI-augmented mass surveillance and AI-orchestrated multi-layered, immersive propaganda, and where established political and industrial elites in democracies achieve practically the same result by dominating all institutions from production (mostly performed by robots) to media and the organs of state. To pose the question concisely: Will the technologies of the 4IR make us more human or less human?

Max-Neef et al. (1991) emphasised the importance of micro-macro articulation: how the human scale interacts with the macro-scale. The realisation of the ideal scenario where technology enables the flourishing of the individual will not be determined so much by the technology as by the social relations and institutions that use the technological possibilities

to actualise their values and objectives. The Khan Academy is a useful example: according to its 2022 annual report, it has 140 million registered users (Khan Academy, 2022, p. 17). The fact that it is there and that it fulfils a dire need does not mean it will be used at scale in South Africa. This is not only because of limited Internet access. Even for groups where Internet access is unproblematic, widespread use does not occur. A learning platform such as that provided by the Khan Academy functions within a social and institutional context. Some learners use the platform independently out of interest or curiosity, almost like other children will use YouTube or play video games. Others are encouraged or directed by parents or teachers. There are also examples of institutional integration. Some independent schools, such as Action Academy, formally include the Khan Academy platform as part of their curriculum. The platform can thus be used independently, in support of another curriculum or *as* a formal curriculum. The scale of the impact of a specific technology will be determined by the social context within which it operates. For a platform such as Khan Academy to have a systemic impact on education in South Africa, it should function within an alignment of large-scale societal structures and the immediate social context of learners. The large-scale societal structures are education policies, including admission policies at tertiary institutions. The immediate social contexts are the classrooms, peer groups and households of children. We hypothesise that it is this integration of potentially beneficial technology institutions and people's immediate social contexts that will provide systemic breakthroughs.

The possibilities of embedding several other technologies in social structures come to mind: Language learning applications that combine the application with the facilitation of interaction with a real person speaking that language. Such approaches already exist (See, for example Fisher, 2024)

Small-scale food production is another domain of application where the embedding of technology within a social context could be beneficial. In our experience at Nova, home-scale and small-scale vegetable producers often struggle with management aspects such as knowing when to plant, what plant

spacing and rotation to use, when to water, how much to water, and what to do if plants become diseased or are attacked by pests. The extent to which a combination of AI tools and social support (personally and virtually) can be used to overcome these challenges and scale up domestic food production is worth further investigation.

One also wonders if the combination of social support and technology can be used to address the high prevalence of lifestyle-related diseases such as metabolic syndrome. A social support model for weight control is nothing new (*Weight Watchers* is a well-known example). How continuous blood glucose monitoring using photoplethysmography and AI-empowered food trackers on mobile phones could be integrated into a supportive social context (with personal and virtual aspects) warrants further investigation.

4. Conclusion

It is impossible to predict the impact of the 4IR on low-income households in Southern Africa in the Anthropocene, except that one can confidently predict that things will not remain as they are. The complexity of the situation is apparent from the presence of opposing forces simultaneously favouring centralisation and decentralisation, massification and miniaturisation, amplification of the individual voice and influence of central authorities or hegemonies. The extent to which members of low-income households and low-income communities as a group will be empowered will depend on how these forces balance out and on the constellation of social institutions into which these technologies are embedded.

The affordability of technology is an important determinant that will tip the scales towards either the decentralisation-miniaturisation-individualisation or centralisation-massification-institutionalisation side. The introduction of a pay-as-you-go model for mobile phones is a good example of how changes in affordability changed a whole industry. This change in affordability was not even caused by changes in the underlying production costs. Changes in the

fundamental cost of production will have an even more dramatic impact. The long-term decline in the unit cost of computer processing power is a good example of such a trend. It remains to be seen if high-quality 3D printers and agriculture robots will follow the same trend. If they do, this will tip the scales towards the direction of small-scale production.

Another factor favouring the decentralisation / miniaturisation / individualisation pole is ease of use. The less arcane technical knowledge is required, the more this pole will be favoured. The public launch of free-to-use large language models such as ChatGPT and Gemini made interaction with AI as easy as typing a conversation for many people. Voice recognition is already highly advanced and widely used. It is likely that soon large numbers of people will be conducting conversations with AI entities on their mobile phones as if it were a normal human conversation. Overcoming the need to type and, in some cases, the language barrier will truly mainstream AI use. Since large language models are trained (the P in GPT), the incorporation of LLMs into the daily life of most people will simultaneously give enormous power to the selectors of the training corpora for these LLMs.

The physical backbone on which most 4IR technologies depend is the communication infrastructure that enables the Internet (especially high-speed Internet). The physical extent of the spread of many 4IR technologies will be limited by Internet coverage and reach. Some technologies provide access to the Internet to users outside fixed-line or cell phone networks. Starlink is perhaps the best known of these. Political factors currently inhibit the implementation of Starlink in South Africa (Africanews, 2024).

A comparison of the 25 elements of the household shows that there is hardly any aspect of daily life that is not or will not be impacted by the 4IR. Although the iconic products of the 4IR, such as autonomous electric vehicles, are out of reach for low-income households, other 4IR technologies utilising the mobile Internet present many opportunities for services to low-income households.

The 4IR also brings with it new dangers for entrenching inequality and enabling coercion on both the personal and societal scale.

We propose that there is a need for research, development and testing of social-technical compacts that can benefit low-income households in the Anthropocene. Such a compact will involve a technical component, but also a social component and sometimes an institutional component. The social component will involve physical and virtual interaction with peers that is minimally structured, authentic, and spontaneous, but it will centre around a shared objective and a shared ethos (which may be expressed as a code of conduct if the setting is formal). The technical component may be a practice, technology, or group of technologies that can be used to achieve the shared objective.

Another equally important area of enquiry is the question of how low-income households and communities may be protected from manipulation and exploitation in the time of the 4IR.

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Chapter 9

From consultation to collaboration: a comparative analysis of public participation in low-income communities

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Abstract

Addressing complex societal challenges, or "wicked problems", demands innovative approaches that embrace the messy and complex nature of decision-making processes. There is an increasing emphasis on including all stakeholders' diverse interests, values, and preferences in these problem-solving processes, especially those of the voiceless within Global South low-income communities. This chapter explores the shift in public participation from traditional consultation models to more collaborative approaches in addressing "wicked problems" within low-income communities.[1] The study employs a

1 Editors' note: This chapter shares insights with Chapter 6 above.

comparative analysis of two case studies using a SWOT analysis, intending to compare the strengths, weaknesses, opportunities, and threats posed by varying levels of public participation. The first case primarily involves consultation with the community about an intervention, while the second focuses on collaboration through co-creating the intervention with the community. By illuminating the dynamics between traditional public participation consultation processes and collaborative, community-driven approaches, this research contributes insights to the discourse on effective decision-making strategies and empowering communities through participatory engagement.

Keywords: collaboration, consultation, low-income communities, public participation, South Africa

1. Introduction

The urban realm faces many "wicked problems". The complexity of these quandaries precludes the possibility of finding definitive solutions to their harmful impacts, creating a cyclical problem-solving cycle where resolving one aspect may induce new challenges (Rittel & Webber, 1973). Addressing these problems requires embracing the messy and complex nature of decision-making processes (Stahl & Cimorelli, 2013), including diverse stakeholders, conflicting values and unclear boundaries (Goldsmith, 1969). Unconventional thinking and diverse perspectives must be incorporated in a stakeholder-inclusive environment of continuous re-examination and adaptation (Stahl & Cimorellim 2013; Goldsmith, 1969; Rittel & Webber, 1973).

Stakeholders potentially involved in these problem-solving processes include the state, professionals, NGOs and affected communities (Watson, 2014b; Jacobs, 2022). Pluralism, i.e., diverse sociocultural contexts amongst stakeholders, introduces complexities, often manifesting zero-sum games because of conflicting interests, values and preferences (Culwick Fatti & Patel, 2023; Rittel & Webber, 1973). The perceptions of the state, professionals and NGOs are shaped by polity and

political agendas (Davison et al., 2016), and inter-societal perceptions are influenced by cultural views and local reality (Watson, 2003; Culwick Fatti & Patel, 2023). Furthermore, power dynamics amongst stakeholders play a crucial role in directing the process (Webler et al., 2001) and may affect rationality (Flyvbjerg, 1998).

To understand the divergence amongst stakeholders and to build consensus on appropriate solutions for "wicked problems" within local contexts, public participation is employed globally (Brownill, 2010). The idea is to promote inputs from all segments of society, but *how* to proceed remains controversial (Webler et al., 2001). Questions about the extent of stakeholders' involvement and the distribution of power are central to choosing the procedures for public participation (Constantinescu et al., 2020).

The set-up of a public participation process determines the degree to which the respective stakeholders influence the eventual decision on the appropriate solution. The strategy may be to inform, consult, placate or bestow agency to the stakeholders (Pacione, 2009). These strategies would produce highly divergent outcomes – from primarily reflecting one stakeholder's interests, values and preferences to integrating different perspectives and ultimately producing an outcome with which all may be content (Webler et al., 2001).

For a public participation process to meaningfully address societal needs, it must accommodate diverging local resources and conditions (Watson, 2013). This is especially true in the context of the Global South, where inequality prevails. Within a single urban area, access to resources, methods of information distribution, literacy levels and degrees of formality vary significantly (Jacobs, 2022). Implementing stakeholder-inclusive processes will not only accommodate the challenges of pluralism but may also empower disadvantaged, low-income communities to gain agency over the "wicked problems" that they face (Watson, 2014b; Cornelius et al., 2017).

Many challenges within low-income communities of the Global South stem from broader social, economic and

environmental events shaped by the socioeconomic and socio-political environment (Jacobs, 2022). These communities are often situated on the urban periphery, far removed from economic opportunities, and they live in varied conditions of informality and illegality (De Satgé & Watson, 2018). Therefore, they have limited capability to shape or influence public participation processes.

To understand the efficacy of participation within these low-income communities, this chapter employs a SWOT (strengths, weaknesses, opportunities, and threats) analysis of the public participation processes employed in two case studies addressing the "wicked problems" of poor air quality in low-income communities. One follows the more traditional consultation approach, and the other employs a more collaborative approach. Observe that although both these projects apply interventions to improve air quality, this study focuses solely on comparing the varying levels of public participation and community involvement in developing and implementing solutions. Therefore, this chapter aims not to provide recommendations for air quality improvement or conclusions on the various types of air quality solutions applied in the two case studies. Rather, the focus is on comparing the varying levels of involvement in interventions within two low-income communities in developing and designing solutions for "wicked problems", e.g. poor air quality[2].

Air quality presents a quintessential example of a "wicked problem". While there are norms and standards to regulate air quality, the "wickedness" lies in its complex and multifaceted nature; despite scientific understanding of the problem and efforts to influence policy, resource availability, competing priorities, and political agendas hinder effective solutions (Andres et al., 2023). Poor air quality is one of the major threats to human health, resulting in over 4 million premature deaths per year, cardiovascular diseases and reduced lung capacity (Badach e al., 2023; Sefair et al, 2019).

2 Editors' note: The reader may also want to compare this chapter with Chapters 3 and 4 as to air quality.

Given South Africa's poor air quality (DEA, 2024), its ranking as the most unequal country in the world (World Bank, 2024) and its commitment to fair and inclusive public participation (Spatial Planning and Land Use Management Act No. 16 of 2013 – RSA, 2013), it is an ideal location to explore the efficacy of traditional consultation models and collaborative approaches in addressing "wicked problems" within low-income communities.

2. Public participation: a brief history of the approach

The origins of public participation, also known as citizen participation or citizen involvement (Mize, 1972), may be traced back as far as ancient Greece, where the idea of involving the public in political decision-making established the roots to implement this concept as a democratic ideal (Mumford, 1961). Hereafter, public participation was further promoted throughout history by social movements (Klandermans & Oegema, 1987), where activists advocating for causes including human rights, women's voting rights and other marginalising matters have played a critical role in promoting public participation by challenging ruling power structures and pushing for improved representation and inclusivity. Phifer (1990) explains that a rising focus on community development in the early 20th century, especially in the United States of America (USA) during the 1930s and 1940s, furthered public participation on the grassroots level as a tool to identify local needs and to address socioeconomic inequalities in urban and rural communities.

It was not until the post-Second World War era in the mid-1960s, however, that public participation was institutionalised, with a notable precursor being the establishment of the "Great Society's Programmes" under the leadership of then US president Lyndon Johnson (Zelizer, 2015; Maphazi et al., 2013). Tigan (2005) elucidates that these programmes addressed matters relating to civil rights, education, medical care, urban problems, rural poverty, and transportation through citizen participation. Public

participation subsequently emerged as a response to the failures of traditional governance and conventional planning approaches to address these "wicked problems". To this end, the fields of Sociology and Urban Planning contributed significantly to the evolution of public participation, especially in the post-Second World War era (Taylor, 1998), when rapid urbanisation and modernisation resulted in spatial inequalities and increased social marginalisation. Early pioneers such as Patrick Geddes and Jane Addams (Scott & Bromley, 2013; Geddes, 1915) were succeeded by likeminded activists, including, inter alia, Jane Jacobs and Paul Davidoff (Pacchi, 2018), advocating for citizen involvement in shaping the built environment.

Throughout the 1960s and 1970s, public participation gained increasing prominence in urban planning, specifically to address the failures of top-down planning models characterised by technocratic decision-making and limited community involvement (Pacchi, 2018). Driven by the idea that "planning is political" (Taylor, 1998; Fagence, 2014), public participation developed throughout the 1980s and 1990s as a policy and legislative requirement in multi-disciplinary fields to address the need to involve citizens in decision-making and local governance (Lane, 2005). Although these origins of public participation have laid the foundation for citizen participation, Taylor (1998) contends that public participation was primarily regarded as *consultation* with the public rather than the public actively *participating* in decision-making.

3. The multi-layered nature of participation

The notion that public participation comprised mere "*consultation*" was disputed, perhaps most notably by Sherry Arnstein in 1969. In her seminal work *A Ladder of Citizen Participation* (Arnstein, 1969) Arnstein conceptualised participation on a spectrum ranging from *non-participation* to *citizen control*, with varying degrees of citizen involvement and power distribution in between. Figure 21 illustrates this ladder comprising eight rungs, each representing a different degree of participation and citizen involvement, corresponding with the extent of citizens' power in determining the end product of a

public participation process. The ladder is a simplification of the real-life multilayered nature and complexities of participation, but it succeeds in exemplifying the significant gradations of participation, emphasising that not all participation is empowering.

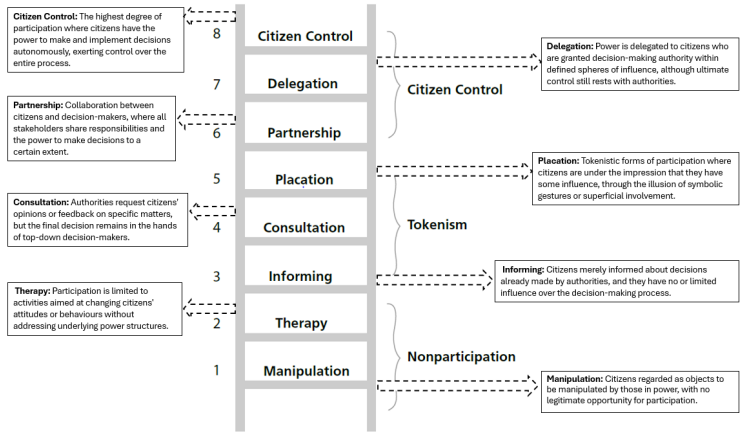


Figure 21: Degrees of citizen participation according to Arnstein's ladder. Source: Adapted from Arnstein (1969)

In essence, Arnstein's ladder illustrated the multilayered nature of public participation and provided a critical perspective on the effectiveness and legitimacy of various public participation processes. It exposed the question of how much or to what degree the public should be involved in decision-making processes (Taylor, 1998), and cautioned against tokenism and spectator politics, where public participation is regarded as a cumbersome ritual and obligatory legal requirement, merely serving to legitimise existing power structures. However, the model has limitations and has been criticised for assuming a linear and hierarchical form, failing to stress the complexities of the process and continuous feedback (Collins & Ison, 2006). Further criticism referred to the seeming elimination of the role of planners and their technical expertise based on the assumption that citizen power will result in good planning decisions (Collins & Ison, 2006; Choguill, 1996). This argument

also applies to other fields of technical expertise addressing developmental challenges and "wicked problems" (e.g. poor air quality) experienced in especially marginalised, low-income communities.

Following Arnstein's ladder of participation, several scholars attempted to develop further and refine the multiple layers of participation. Mensah et al. (2017) explain that Kingston et al. (2000) developed a six-step ladder of participation, while Nobre (1999) designed a community participation ruler with four levels of participation, including to inform, to consult, to discuss, and to share. Davidson's (1998) wheel of participation, on the other hand, conceptualised public participation in a circular spectrum with four main pillars: inform, consult, participate and empower. A myriad of similar attempts to elucidate the multilayered nature of participation followed, with numerous models displaying some commonalities and nuanced adaptations of Arnstein's original eight-step ladder. These include, amongst others, the Ladder of Children's Participation, the Ladder of Empowerment, the Typology of Youth Participation and Empowerment Pyramid, and the Youth Engagement Continuum (IAP2, 2007).

Based on decades of research and practice in the field of public participation, the International Association of Public Participation (IAP2) created a Spectrum of Public Participation, sharing similarities with these preceding models. This Spectrum categorises participation into five modes: inform, consult, involve, collaborate, and empower (IAP2, 2007). It provides a multilayered and structured approach for authorities and practitioners to design and implement public participation processes, emphasising the value of engaging citizens at different stages of decision-making. The IAP2 (2007) does, however, caution that the Spectrum portrays a primarily positive view of public participation at its most constructive, denoting that it does not reflect ineffective or deficient participation practices, e.g. "empty promises" to communities and the resultant consequences. Nabatchi (2012) modified the IAP2 Spectrum in 2012 to incorporate the various modes of communication accompanying each form of participation,

i.e., one-way, two-way, and deliberative. Figure 22 displays this modified Spectrum of Public Participation and serves as the main point of departure for the comparative analysis in this chapter, specifically referring to the differences between the level of shared decision-making in the modes of *consult* and *collaborate.*

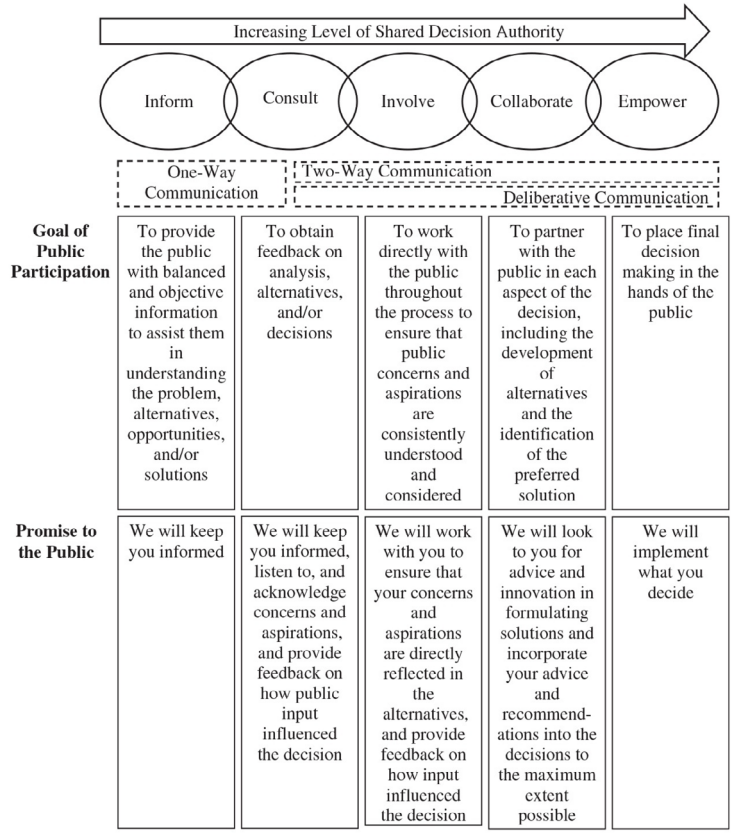


Figure 22: The modified version of the IAP2 Spectrum of Public Participation. Source: Nabatchi (2012)

As illustrated by Figure 22, it is evident that the propensity for deliberative communication increases with augmented citizen involvement, collaboration, and empowerment. This calls for

enhanced participatory engagement and, ultimately, innovative participatory methods to facilitate this process.

4. Contextualising participatory engagement

Given the preceding discussion, it is imperative to note that there is a slight but distinct difference between *public participation* and *participatory planning* or *participatory engagement*. Public participation and participatory planning are related but differ in scope, focus, and purpose, as public participation generally refers to the overall process of consulting individuals, groups, or communities in the decision-making processes that affect them (Barton, 2002). Several scholars contend that, although public participation solicits feedback from the public, it is usually implemented in a more informative or consultative manner (Abas et al., 2023), signalling its association with the lower rungs of Arnstein's ladder or the first two modes (inform and consult) of the IAP2 Spectrum.

Participatory planning, conversely, refers explicitly to a departure from merely informing or consulting communities before implementing preconceived solutions, but rather encompasses the notion that each participant, especially in marginalised communities, becomes a significant contributor to the decision-making process (Mensah et al., 2017). It transcends a multitude of related disciplines, including Urban Planning, Sociology, Political Science, Environmental Sciences, Economics, etc., and involves collaboration between a diverse range of stakeholders, including residents, community organisations, government authorities, and other relevant actors (Clark & Percy-Smith, 2006; Dalal-Clayton & Dent, 1993; Jami & Walsh, 2017). The broader term *"participatory engagement"* exhibits this diverse nature of participatory planning, and will be used in this chapter to accurately reflect the multi-disciplinary disposition of the selected case studies.

Participatory engagement, at its core, aims to foster the co-production of solutions through a collaborative process (Watson, 2014a), signifying its correlation with the upper rungs of Arnstein's ladder and the latter modes (involve, collaborate

and empower) of the IAP2 Spectrum. Participatory engagement is not a linear process but rather dynamic and iterative, continuously evolving to enhance inclusivity and empowerment throughout various stages of the process. It stands as a cornerstone in contemporary approaches to facilitate decision-making in marginalised, low-income communities.

5. Legislative context of public participation in urban planning in South Africa

Urban planning is not the only discipline in which participatory engagement is perceived as necessary, as the involvement of communities in other developmental processes encapsulates a broad range of expertise and a diverse array of facets beyond the ambit of urban planning. However, it is perhaps one of the disciplines where participation, or its absence, substantially influences community quality of life. This raises the question of whether urban planners comprehend the necessity of due participatory engagement, prior to the preparation of their plans and designs, to improve the quality of life. It is nowhere more apparent than when observing the course of legislation, where urban planning is at the forefront. Here, a distinction is made between (i) forward or strategic planning and (ii) statutory planning, which facilitates land development applications. Statutory planning has been known in the past for permutations of Provincial Township Ordinances (most of which are repealed), the Black Communities Development Act (4 of 1984) (repealed) (RSA, 1984), the Less Formal Township Establishment Act (113 of 1991) (repealed) (RSA, 1991), the Removal of Restrictions Act (84 of 1967) (repealed) (RSA, 1967a) and zonings and building controls in Town Planning Schemes (since 2015 replaced with Land Use Schemes) (Viviers et al., 2015). During this time, formal and legal notices, employing various media platforms to "inform" the public of land development applications, occurred as the only means of public participation. These "notifications" occurred (i) *after* the planning and design phase to implement preconceived solutions and (ii) only at a stage when relief was therefore sought. Notices primarily served the purpose of inviting comments (or objections) and involved sound

processes to address objections, if lodged through Township Board hearings. Lacking here, it seems, is the determination to endeavour a participatory engagement process, *prior to* the application phase.

An inclusionary tactic was required to be prudent during strategic planning for the preparation of Structure Plans (in terms of the Physical Planning Act, 88 of 1967 (repealed) (RSA, 1967b) which, because of its complexity and far-reaching impact, necessitated the involvement of several city actors, governmental departments, parastatals and the private sector (Viviers et al., 2015). Once concluded and following its final preparation, exuberant community engagement was often endeavoured *after* the planning phase. While this offered some opportunities to comment on a prepared and finalised Structure Plan (and perhaps influenced its outcomes), our perception is that some urban planners did not perceive this as a means to obtain indigenous knowledge prior to planning, aiming to inform and empower communities to engage with insight. In fact, because of the political dispensation at the time, most communities were excluded from any form of participation. Dismantling this dispensation after 1994 would have required three important and decisive sets of legislation in the urban planning cadre before changes were noticeable. The Development Facilitation Act, 67 of 1995 (repealed) (RSA, 1995), is perceived as the first impetus that required, in its Chapter 1 principles (compulsory to all municipalities). It provided for (i) appropriate levels, measures and methods in which communities should be consulted and, (ii) for the first time, allowing for a Planning Tribunal composed not only of municipal officials but incorporating the community members. The latter tribunal and Act were subsequently found unconstitutional by the Constitutional Court (Berrisford, 2011), resulting in the replacement of the Act by the current ruling Spatial Planning and Land Use Management Act (16 of 2013) (SPLUMA)[3], which commenced on 1 July 2015 (RSA, 2013).

3 Editors' note: The Act is also discussed in Section 4.2 of Chapter 11.

Promulgation of the SPLUMA was, nonetheless, preceded by the ruling Local Government: Municipal Systems Act (32 of 2000) (MSA) (RSA, 2000), discarding Structure Plans and requiring a municipality to prepare an Integrated Development Plan (IDP), which must include (as a compulsory sector plan), a future municipal Spatial Development Framework (SDF). The latter is perceived as a strategic planning instrument to guide future spatial planning and development of a municipality for the next 20 years. Although the MSA is not specific regarding the contents of an SDF (now outlined in the SPLUMA) it stipulated, for the first time in planning legislation in South Africa, the need for "community participation" (in Section 16 of the Act) and affirmed that municipalities "must develop a system of participatory governance" that will "encourage, and create conditions for, the local community to participate in the affairs of the municipality" (RSA, 2000). As a result, most municipalities gave effect to this legislation by inaugurating "IDP Forums" representative of the community, several city actors, governmental departments, parastatals, and the private sector, for participation in strategic planning endeavours of the municipality in formulating its IDP (and thereby also its SDF). Apparent here, it seems, is the determination to endeavour participatory engagement of communities *prior to* and *during* the urban planning and design phase of strategic planning. The principle of "substantial public engagement" was later also duly endorsed in the SPLUMA for when a municipality endeavours strategic planning, i.e. preparation of an SDF (RSA, 2013).

The statutory course had an unfortunate and less desirable outcome. In offering the objectives of the SPLUMA, the development of an effective, uniform, and comprehensive system, promoting social and economic inclusion (Laubscher et al., 2016) was determined. While the ruling SPLUMA (i) pertinently outlined unified land development application procedures for all municipalities, inter alia for participation during the amendment of a Land Use Scheme (LUS), and (ii) affirming that future regulations may well be prepared, delineating the process for "public participation" during the preparation of an LUS, it is neither specific in requiring

participatory engagement prior to the commencement of planning endeavours, nor was any relevant regulations for prior engagement since formulated. It does positively determine that these procedures may later be finalised in national regulations. It seems that the determination to endeavour *participatory engagement* during the urban planning and design phases is evident. The principle of "substantial public engagement" was also later duly endorsed in the SPLUMA when a municipality endeavours strategic planning, i.e. preparation of an SDF. Evidently, this presents an opportunity to foster regulations, when prepared, regarding procedures for public participation, obliging participatory engagement, much earlier and before procedures seeking a relief, or to adopt preconceived solutions prior to appropriate consultation with stakeholders.

Ultimately, promulgating the Development Facilitation Act in 1995 triggered the preparation of municipal bylaws by all newly demarcated municipalities (as determined by the Municipal Demarcation Act, 27 of 1989) (RSA, 1998) relating to land use management and planning, inter alia, laying down procedures for participation when statutory planning is endeavoured. Regrettably, bylaws seem to adopt familiar archaic tactics by starving participation prospects to mere notification (informing the public) *after* the design and planning phase, and was an indisputable opportunity forfeited to improve participatory engagement on higher nuances than mere notification and seeking approval for preconceived solutions. As is apparent from the legislative discourse in urban planning, participation seems, for the most part, to be an effort to "inform" communities of land development applications merely to obtain "buy-in" on predetermined solutions on time. These historic non-participatory engagement processes prior to development projects, in our experience, resulted in communities' non-acceptance of the project, non-utilisation of the outcomes or, in extreme instances, its destruction. The question can be put why municipalities and a limited number of urban planners are increasingly concerning themselves with due participatory engagement from the onset, during planning and attempting reliefs for developments. The answer is embedded

in their own empirical and experiential learning, showing that negating participatory engagement before planning processes may cause severe breakdowns in the development process. Here, conscious decisions by authorities and urban planners seem apparent in engaging communities beyond legislative requirements, giving effect to appropriate and inclusive participatory engagement.

6. Method

To explore the potential efficacy of different public participation approaches, here consultation and collaboration, in addressing "wicked problems" within low-income communities, this study employs a SWOT (strengths, weaknesses, opportunities, threats) analysis of two case studies – *Basa Magogo* and the *Semi-continuous Coal Stove* project. Both these projects intervened in low-income communities to address the "wicked problem" of poor air quality.

The process of participation for both cases was captured in project reports[4] (Nova Institute NPC and NWU, 2022; Van Niekerk, 2017). These reports were inductively analysed on Atlas.ti to explore the potential efficacy of traditional consultation models and collaborative approaches in addressing "wicked problems" within low-income communities. The analysis utilised the SWOT (strengths, weaknesses, opportunities, threats) framework (Figure 23) for coding - a process where "groups of words" elucidating the potential efficacy of the participative approach are labelled and categorised according to the framework (Birks & Mills, 2015; MacCallum et al., 2019). The codes created during the inductive analysis are presented in Figures 24 and 25.

4 It is important to note that *Basa Magogo* is a much longer-running project and has already been implemented at scale, while the Semi-continuous Coal Stove project is a more recent endeavour. The two projects were, however, compared at similar project stages Nova Institute NPC and NWU 2022. NWU: Zamdela Stove Project Pre- and Post-implementation Piqola for the Zamdela Stove Project. [Unpublished report]; Van Niekerk, A. 2017. *The Basa Magogo story*. [Unpublished report]..

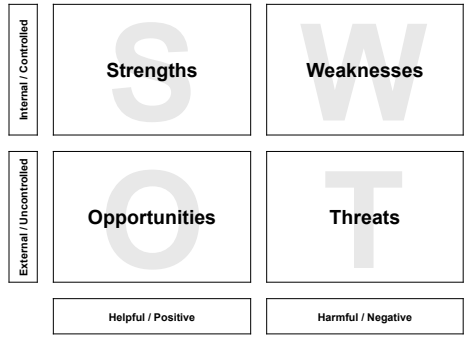


Figure 23: The SWOT framework. Source: Composed from Sarsby (2012)

7. Consultation during the Semi-continuous Coal Stove project

The Semi-continuous Coal Stove project aimed to find a practical and user-friendly solution to reduce harmful emissions from domestic coal use on the South African Highveld. The stove has significantly lower emission factors than current domestic coal stoves. The North-West University (NWU) high-efficiency low-emissions stove testing has been ongoing since 2015. The team consisted of chemical engineers, atmospheric scientists, and social scientists. It yielded positive results in the laboratory but the team wanted to understand how it is used and experienced in a real-world scenario. In 2022, a pilot study was conducted where the stove was installed in six low-income households in Zamdela, Sasolburg.

Consultation with the participants aimed to evaluate the feasibility of the stoves from an end user perspective, focusing on satisfaction and the impact on energy usage and quality of life. A systematic approach was employed, firstly compiling a list of potential impacts of the intervention, and secondly analysing the list to select relevant survey questions. The questions included semi-structured questions for gathering

narrative responses on the community's quality of life, numeric scale (0–10) satisfaction questions, and Likert scale questions about the household perceptions and experience with the stove. This methodological toolbox, Piqola (Particular Impact of Quality of Life Assessment),[5] was developed with a theoretical framework based on research in South America (Murray & Pauw, 2022). It therefore incorporates the context of the Global South. Piqola was furthermore informed by the researchers' previous experience during fieldwork in South African low-income communities and updated as used to ensure continuous improvement.

The households were selected during a community gathering, and their general quality of life and energy usage patterns were assessed via interviews. The stoves were installed, and the indoor and ambient air quality were measured for three months. Thereafter, the households' experience with the stoves was assessed via interviews.



Figure 24: Word clouds indicating the code frequency developed through the SWOT analysis of

5 Editors' note: Intensively discussed in Chapter 12.

consultation during the Semi-continuous Coal Stove project.

7.1 Strengths

The preferences of the end user and real-world implementation are considered on a small scale before a scaled roll-out. The end user was provided with the opportunity to voice their level of satisfaction with the semi-continuous coal stove and how it impacted their broader energy usage and quality of life.

The questions were asked in a probing rather than a leading manner and focused on aspects relevant to understanding the intervention's impact and ensuring alignment with the project's objectives. They were asked from different angles to achieve a more in-depth understanding and to capture information that would otherwise have been missed. The interview entailed semi-structured, satisfaction, and Likert-style questions, contributing to a more holistic understanding of community needs, preferences, and concerns. Furthermore, it provided the opportunity to compare pre- and post-intervention scenarios. Interviews were, furthermore, conducted in the language of choice for the interviewees. Participants speak more freely and elaboratively in a language that they are comfortable in. This may ensure more comprehensive responses.

The project was quick and provided immediate results. The entire project was completed in less than a year. Households were recruited for participation in March and April 2022; surveys were conducted in May 2022; the stoves were installed in August 2022; and the post-intervention surveys were conducted in August 2022.

7.2 Weaknesses

Linguistic nuances may be lost in translation, leading to misinterpretation of responses. Additionally, translators' understanding of context may impact the quality of translations. The results were analysed using a deductive method. Although deductive analysis provides structure and efficiency, there is a risk of overlooking nuances in the data. This also creates

space for the researcher's interpretation of the results without iterative inputs and clarifications from the community.

7.3 Opportunities

The toolbox (Piqola) for consultation with the community, being developed within a Global South context, reflects a deep understanding of the unique Global South context and its continuous development and tailors it to the context of South African low-income settlements, ensuring effectiveness and relevance. Piqola may therefore offer insights into best practices for consultation within low-income South African contexts, ultimately contributing to the all-inclusive project's success and generating meaningful insights into quality-of-life impacts.

7.4 Threats

The satisfaction questions employed a numeric scale. Participants may 1) interpret the scale differently, 2) provide socially desirable responses, or 3) tend to select neutral responses. Different cultures may also interpret the scale's endpoints differently, and researchers may misinterpret responses from participants of various cultural backgrounds. Contextual factors, e.g. recent events, may also influence participant responses.

Previous projects were unsuccessful due to neglecting the end user preference (Nova Institute NPC and NWU, 2022). This suggests a potential disconnect between technical solutions and end users, posing a possible threat to consultation efforts. Therefore, it is imperative to recognise and actively address this challenge.

8. Collaboration during the *Basa Magogo* project

Basa Magogo co-created the intervention with the community. The *Basa Magogo* project started in 1998 as part of Sasol Synthetic Fuels' efforts to find solutions for the high levels of air pollution in eMbalenhle, a township near Secunda in Mpumalanga, South Africa. In the winter of 1998, five possible

technical solutions were evaluated for domestic air pollution in eMbalenhle: 1) new "smokeless" stoves; 2) insulation; 3) low-smoke fuels; 4) liquid petroleum gas (LPG); and 5) repairing the stove and chimney - plus two combinations of some of these, measured against a control group (Van Niekerk, 2024). Thus, eight groups of five households each were monitored, and seven used the installed technology.

The team consisted of a researcher with a background in Theology and Anthropology, a local co-ordinator who had recently completed his theological studies, a community leader and three fieldworkers from the community. During the testing of various technical solutions, a mechanical engineer and an academic researcher in Sociology were also involved.

The results were evaluated together with the residents, and the coal use and levels of pollution were measured (Van Niekerk, 2024). None of them complied with all the criteria. The research team was, however, under pressure to illustrate a concrete positive result within a short space of time. They were aware that several government departments were promoting the so-called Scottish method, or top-down ignition method, over the media and popular television programmes. This method was developed before 1955 by Dr Petrick of the then Fuel Research Council. The team did not find anybody who used it, and the mass marketing campaign seemingly had no impact at all (Van Niekerk, 2024).

The technique was demonstrated to three of the fieldworkers. It is quite simple: instead of starting the fire with paper and wood at the bottom of the *imbaula* (an old 20-litre paint tin with holes in the sides that is used as a stove in many South African low-income communities) and then adding coal on top, the paper and wood are placed on top of the coal, and the fire burns from the top downwards (Van Niekerk, 2024).

The three fieldworkers illustrated the technique to nine families in their homes. They all used it but were not impressed by it. The main complaint was that the coal did not ignite properly; they did not have enough paper and wood to enable the coal to ignite. One fieldworker, however, remarked that a

particular grandmother said that it worked for her. Investigating further, the team found that she added a few handfuls of coal on top of the wood. After she had demonstrated it to the team, the fieldworkers were convinced that it could work. The *Basa Magogo* method was named after this lady, Granny Nebelungu Mashinini. *Basa Magogo* means "light up, grandmother!" (Van Niekerk, 2017).



Figure 25: Word clouds indicating the code frequency developed during the SWOT analysis of collaboration during the Basa Magogo project.

8.1 Strengths

The goal to engage the end user in the search for a suitable solution signals a more collaborative approach, as the community, along with "experts", was involved in the process of finding solutions for the challenge of poor air quality. Engaging the end users and obtaining their input in finding solutions to complex challenges ultimately resulted in promoting a culture of responsibility and ownership amongst these households that may support the long-term effectiveness of the project.

The project followed a more open approach without preconceived ideas of what and how solutions should be provided. Nevertheless, the goal was to implement a balanced approach, where openness for alternative possibilities is retained but where the focus is still on finding a solution, thereby accommodating traditional and modern views. It is essential that cultural nuances are identified and recognised as part of the collaborative process, with the research team communicating well and being sensitive towards the "intensity of feelings" regarding specific issues. One such cultural nuance was that many residents emphasised that they wanted to use fire and not only electricity because they said that fire brings the family together. Another sentiment was that fire brought them in contact with the spirits of their ancestors. More recently, there has been a tendency for watching television to replace activities related to fire, and seemingly, fire is not so crucial anymore for keeping in contact with the ancestors.

Lastly, the project displayed cost-effectiveness and innovation as internal strengths.

8.2 Weaknesses

The *Basa Magogo* project and its current status quo were the result of years of close interaction, feedback and collaboration between researchers and residents of the communities involved, signalling the time-consuming nature of the collaborative approach, which may be perceived as a weakness of the process.

To maximise the constructivist nature of the collaborative approach, it is not only essential that the researchers involved have the necessary communication skills to transfer potential technical knowledge to the community, but also to interpret and capture input from the community thoroughly and comprehensively. Poor communication skills may therefore be a weakness in the collaborative approach.

8.3 Opportunities

An opportunity for collaborative community engagement approaches exists in Africa, as this signals a contextualised and

alternative way of finding solutions in a participative manner, as opposed to the traditional "Western" methods of providing solutions without first seeking community collaboration. The sense of ownership may be increased by "branding" or naming the project in a manner that the community will associate with and that they will recognise as "their input". This enhances the collaborative effort and is a strength of the Basa Magogo project. Moreover, engaging external stakeholders, e.g. Sasol, may result in the added opportunity of obtaining financial support or funding that will sustain the long-term nature of collaborative projects.

A long history of involvement by the research team in these types of projects resulted in an improved understanding of the communities' needs and perspectives on the proposed solutions. These historical lessons learnt from previous mistakes or misinterpretations of community needs provide an opportunity for current and future projects to be more collaborative and ultimately be more successful.

8.4 Threats

Implementing the *Basa Magogo* technique incorrectly may lull the community into a false security in the sense that they think their DIY (do-it-yourself) solutions are working and that they are consequently not open to be found for new ideas or negotiations on possibly safer options. These DIY solutions implemented by communities may therefore pose a threat to proper collaboration.

External stress factors, e.g. financial pressure on municipalities, may result in situations where municipalities (or other entities) expect faster results and where the time-consuming nature of the collaborative process may be perceived as a threat.

As part of a collaborative community engagement, the notion of deviating from the focus on finding a solution may result in enormous delays as the project may be continuously "side-tracked" on exploring alternative solutions to retain "openness for alternative possibilities".

9. Conclusion

The SWOT analyses of the two projects reveal valuable insights into the complexities of community engagement in addressing "wicked problems". Both projects demonstrate strengths in engaging with end users, considering cultural nuances, and implementing cost-effective solutions. The Semi-continuous Coal Stove project emphasises quick results and a comprehensive understanding of community needs through structured interviews. In contrast, the *Basa Magogo* project focuses on a collaborative and open approach. While the Semi-continuous Coal Stove project faced challenges related to co-creation and time constraints, *Basa Magogo* encountered weaknesses associated with the time-consuming nature of the collaborative approach, and both projects were confronted with communication challenges. Both projects demonstrate opportunities for continuous improvement and innovation in addressing complex challenges. The Semi-continuous Coal Stove project benefits from a laboratory-proven solution, while *Basa Magogo* capitalises on contextualised solutions to drive collaboration. Both projects face threats related to contextual nuances.

9.1 A significant threat to participatory engagement is the tension between money and time

- Some institutions require quick results and are willing to pay, resulting in the team being pushed to implement technical solutions in a short period.
- Some funders become impatient if the process of finding a solution collaboratively with communities is too time-consuming. This poses an inherent contradiction since more solutions would have been ready for implementation if there had been enough financing to generate these solutions on scale.
- Some institutions are purely profit-driven and subsequently implement any solution at hand merely to generate a report or deliverable, regardless of the impact.
- The period within which a researcher, e.g., a student, has to complete their study is sometimes too short to complete the

entire participatory process, and cracks may arise during the implementation process.

The tension between money and time poses significant challenges to participatory engagement efforts. It is therefore essential to recognise the importance of finding a balance between time and financial constraints, as well as the time required for meaningful community collaboration. In future, exploring alternative funding models such as "impact funding" could offer a promising solution to alleviate some of these challenges.

9.2 The long-term impact of an intervention is threatened by the challenges of maintaining continuous participatory engagement

- Many of the weaknesses and challenges of a solution may only surface over extended periods of continuous use, necessitating ongoing interaction and feedback.
- Because of financial, time and other resource constraints, which might not always be possible for a project team.

The challenges of maintaining continuous engagement hinder a proper understanding of the impact of solutions and may limit their long-term effectiveness.

9.3 Communication may be a considerable weakness in participatory engagement projects

- Clear communication between stakeholders is imperative because of the number and diversity of stakeholders involved.
- Effective communication may be impeded by, for example, language barriers, worldviews, varying socioeconomic contexts and education levels, and discipline-specific terminology and thinking.

Addressing these barriers and fostering clear, inclusive communication channels is vital for ensuring the meaningful participation of all stakeholders.

9.4 The approach to participatory engagement depends on the dynamics of the solution and the community involved

- A highly technical solution, such as a semi-continuous coal stove, would be exceedingly complex to develop in collaboration with a community that may not possess the technical expertise.
- Instead, a practical approach involving baseline solutions for households to test and provide feedback may be more feasible.

By adapting engagement methods to suit the specific requirements of the solution and the community's preferences, projects may foster more meaningful participation and achieve improved success in addressing community needs.

9.5 Misinterpretation and confusion regarding public participation and participatory engagement terminology may result in limited or incorrect implementation of directives

- Public participation and participatory engagement are related but differ in scope, focus, and purpose, as participatory engagement generally refers to a process of more collaborative community involvement and co-production of solutions.
- Many directives, including policy and legislation, merely refer to public participation, failing to provide direction to a more nuanced implementation of participatory engagement, especially in marginalised, low-income communities.

The use of terminology in directives, distinguishing between public participation and its more nuanced implementation through participatory engagement, specifically in low-income communities, is imperative and may result in innovative and more collaborative solutions.

9.6 The legal road to participatory engagement currently seems superficial, arduous, and distant

- Contemporary legislation places accountability on authorities and the urban planning fraternity to warrant the participation of communities and stakeholders when attempting either strategic planning or statutory planning. Although the former has developed into legislation where participatory engagement is advocated and required, statutory planning seemingly relies on archaic approaches, limiting the involvement and empowerment opportunities of end users.
- With the advent of due participatory engagement, resulting in successful project implementation and the improvement of the quality of life of communities, authorities and planners often do so at their own initiative.

It is recommended that stakeholders (including urban planners and authorities) should, notwithstanding the legislative limitations, be continuously inclined towards the significance of due consultation, either during academic programmes or continuous professional development and when executing either strategic or statutory work.

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Chapter 10

The role of scientific evidence in public policymaking for the bio-physical environment where South Africans live

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Abstract

We explore the role of evidence in policymaking in ambient air, waste, and water against the background of the main pieces of legislation covering these areas. Evidence is defined narrowly as corroborated results of properly conducted scientific research and data sourced from scientific technology, as well as science-based advice by experts. Policy in the areas that we investigated is articulated on several levels, subject to Section 24 of the Constitution: white papers (white papers on the environment and sector-specific white papers), Acts, strategies

and frameworks, regulations, and finally norms and standards. This set of policies embodies a conceptual hierarchy but also a historical sequence. We found that the role of evidence as defined grew with time, but also as attention moved from concepts to the physical environment. Interesting aspects that surfaced were the role of consultants and the degree to which policy was based on imported or local research.

Keywords: ambient air policy, policymaking, science-based, science-informed, waste policy, water policy

Prelude

Here is the philosophical argument for evidence-informed policymaking in a nutshell: reality is not always obvious and known, it is not necessarily what we imagine or wish, it does not per se conform to our ideological preconceptions, and our plans will not automatically work out. Therefore, rigorous empirical research is necessary to inform responsible decisions.

We assume that science can contribute to a better bio-physical environment via government policy. Past research has established that polluted air and water, and toxic waste cause illness with all its consequences. Pioneer researchers who found incontrovertible evidence for pollution as a cause of diseases were the British John Snow (1813-1858), and the Americans Alice Hamilton (1869-1970) and Harriet Hardy (1906-1993). Thus, the very existence of extensive environmental policy-based interventions in South Africa is a manifestation of evidence-informed policymaking.

1. Introduction

This articulated case study investigates the intersection between Policy Studies, scientific research, and the world where South Africans live daily. We ask empirical questions about the role of evidence in policy formation since democracy. The National Policy Development Framework (RSA, 2020a, p. 4) states that "policy-making challenges prevail in the country, as the government does not have a standardised or systematic

approach on how to develop evidence-based policies in South Africa". According to Godfrey and her co-authors (Godfrey et al., 2010) scientific knowledge and evidence played a key role in developing environmental policy and legislation in South Africa. The authors highlight, amongst others, the importance of bridging the "science-policy gap". Were they right in 2010? And is scientific knowledge still "key" in 2025?

In this chapter, we explore answers to questions of how scientific knowledge contributed to policy in the fields of ambient air, water, and waste. We describe how evidence (defined below) plays or does not play a role over time in environmental policymaking in various contexts and cases and on various policy levels. This is a first exploration in the hope that more detailed studies will follow.

2. Conceptual aspects

Xuan Yu and his colleagues conclude that "Although the definition of 'evidence' has attracted the attention of many scholars in different disciplines, there is no widely recognised and accepted definition of this term in scientific research" (Yu et al., 2024, p. 41). For us, evidence means corroborated results of properly conducted scientific research, including data sourced from scientific technology, as well as science-based advice by experts. This is a strong definition that is not necessarily adhered to in the policy literature. For example, "evidence as represented in outcomes of deliberations" (Cairney, 2016, p. 102); and according to Kathryn Oliver and her colleagues, "Much of the research in this area is theoretically naive, focusing primarily on the uptake of research evidence as opposed to evidence defined more broadly" (Oliver et al., 2014, p. 1). We do not agree and prefer the narrow definition.

Officials and politicians regularly regard the inputs of stakeholders as 'evidence' even though these inputs are not related to any scientific research. In government deliberations, the fact that a proposed policy is highly unpopular will be regarded as 'evidence' against it. That is not how we intend the concept. However, our concept is still wide: we include scientific

models and data or information gathered by employing scientific methods as evidence.

Next, a definition of policy. *Policy* is a decision and assessment rule (or set of rules) to arrange possible action in a specific domain on a scale between obligatory (it must be done) and forbidden (it must not be done) (Sadiki & Pauw, 2017). Public policy is policy made by a public authority. In the literature, it is often assumed (as discussed, for example, by Patrik Marier (Marier & Van Pevenage, 2017)) that policy is about solving problems. Here, the concept *policy* has a larger scope in the sense that it would bring order or structure to aspects of public reality, for instance, in a white paper. Not all issues in the public sphere are the objects of policymaking at one point because neither the authorities nor the public have unlimited attention spans and resources. Therefore, the issues that receive attention at a specific time are referred to as being on the policy agenda. How something lands on the policy agenda is one of the things that is researched in policy studies. A wide array of items regarding the biophysical environment falls under the above definition of policy. It covers Section 24 of the South African Constitution (RSA, 1996c), but also norms and standards for regarding certain waste materials as toxic or not. It covers laws and white papers, regulations, frameworks, official guidelines, and departmental strategies.

Evidence can thus drive policy in at least three ways: a) by indicating what is the case, b) by providing guidelines on what should be the case, and c) by showing the relative strengths or weaknesses of real or imagined interventions. Take residential air as an example: evidence has shown that a) polluted air in dwellings causes illness, b) what standards of purity should be striven for, and c) whether the *basa njengo magogo* intervention developed by Nova[1] (Le Roux et al., 2009) is more or less efficient and effective than other interventions.

There is a supply and a demand side to the evidence–policy nexus. Strydom and her colleagues write about pull and

1 Editors' note: Discussed in the previous chapter under a slightly different name.

push factors (Strydom et al., 2010). Much of the evidence-based policymaking literature stems from a kind of entitlement from the scientists' side, where researchers expect their supply of knowledge to be taken seriously without duly understanding that policymaking is a political process. On the other hand, politicians and officials might be loath to ask scientists for the needed evidence to support policy and rather rely on the inputs of other stakeholders with vested interests. There is also the disingenuous use of evidence where one receives policy-based evidence instead of evidence-based policy: "The tendency of policymakers to decide what they want to do, then seek enough evidence, or distort that evidence, to support their decision" (Cairney, 2016, p. 121).

Lastly, although the term "evidence-based policymaking" has wide currency, "evidence-informed policymaking" is often a better choice of words. This is exemplified by the title of a report by the Department of Environmental Affairs: *Evidence-informed policymaking in practice: an overview from South Africa's Department of Environmental Affairs* (Shaxson et al., 2015).

3. First description of the statutory and policy background

In this section, we indicate and discuss the main elements of the statutory and policy background as the loci in our case study. An overview of the statutory and policy background is broadly set out in Figure 26. The environmental policy field is articulated along three dimensions: the conceptual (broad policy and strategy), the statutory (what is compulsory) and the ontological (sectoral). Along the conceptual dimension, we find broad government policy set out in the form of green and white papers (and also certain aspects of strategies[2]) that indicate what specific government approaches and actions are in the offing. Along the statutory dimension, we mainly look at five Acts in this chapter: the framework Act (National Environmental Management Act, 107 of 1998 (NEMA)) and four sectoral acts

2 It will be clear below what formal strategies (which may be akin to regulations) entail.

for air quality, water, and waste, respectively. The regulations promulgated in terms of these Acts, legal frameworks, aspects of strategies, and norms and standards contain provisions that must be legally complied with.

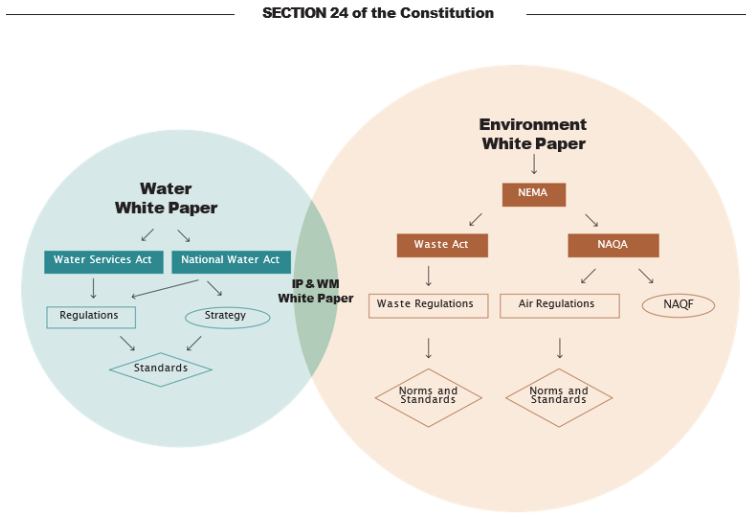


Figure 26: Environmental policy map in South Africa. Source: Authors' conceptualisation

The democratic transition in South Africa led to the development of its Constitution of 1996. In Section 24, the Constitution provides for environmental rights for everyone. It further delineates the legislative and executive powers of each sphere of government within a framework of cooperative governance, which resulted in allocating key responsibilities for environmental management amongst national, provincial, and local authorities (Scott, 2010).

According to Scott (2010), the Department of Environmental Affairs and Tourism (DEAT) (Department of Forestry, Fisheries and the Environment (DFFE) as we write this) has, since 1992, realised the inadequacy of pollution and waste management governance in addressing South Africa's evolving social and industrial landscape. To address this, the

DEAT launched the Integrated Pollution Control (IPC) process aimed at policy development. However, this initiative faced numerous criticisms from civil society and was eventually discontinued. Subsequently, in 1995, a new process named the Consultative National Environmental Policy Process (CONNEPP) was introduced. CONNEPP was charged with crafting a comprehensive environmental policy for South Africa (Scott, 2010). The CONNEPP management team appointed the following people to draft the Green Paper Environmental Management Policy; *Mark Butler – Community Agency for Social Enquiry (CASE) (environmental NGO sector); Dick Cloete – Umanyano Media Service (editor); Ingrid Coetzee – Department of Environmental Affairs and Tourism (central government); Mike Cohen – CEN Integrated Environmental Management Unit (provincial government); Jenny Hall – CRM International (community-based organisations); Arend Hoogervorst – Eagle Environmental (business and industry); Shirley Miller – COSATU (organised labour); Dan Walmsley – Steffan, Robertson and Kirsten (drafting manager)* (RSA, 1996a). It must be noted that not one of the drafting team was signalled as a scientist, for example, as representing a science council or a scientific discipline.

In 1997, CONNEPP reached its conclusion with the release of the White Paper on Environmental Management Policy in 1998 (RSA, 1997a). (It was officially gazetted on 15 May 1998.) This publication outlined the government's national stance on environmental management, delineating its vision, principles, strategic goals, and objectives. The word 'evidence' does not occur. There are references to knowledge and scientific knowledge without giving the latter precedence over informal, everyday or indigenous knowledge.

The National Environmental Management Act (NEMA) 107 of 1998 was enacted to operationalise the National Environmental Policy (RSA, 1998c). The NEMA was regarded as the foundational legislation providing a comprehensive framework for all subsequent environmental laws. It was built on the White Paper that sets out the principles that the government would utilise to guide, develop, and evaluate

policies and subsequent actions, encompassing decision-making, legislation, regulation, and enforcement.

A second white paper followed. Scott (2010) wrote that the release of the DEAT's White Paper on Integrated Pollution and Waste Management (IP&WM) in 2000 represented a significant milestone for pollution and waste governance in South Africa. It is a subsidiary policy of the all-inclusive environmental management policy, as set out in the White Paper on Environmental Management Policy for South Africa (RSA, 2000, p. 12). This policy aimed to proactively address pollution by emphasising prevention, waste minimisation, and the regulation of impacts. The DEAT developed this policy in collaboration with the then the Department of Water Affairs and Forestry (DWAF), followed by a rigorous public participation process across provinces with various stakeholders, including labour, non-governmental organisations, community-based organisations, business and industry, mining, and individual members of civil society (RSA, 2000). At the time, the following drafting team, partially dominated by consultants, was appointed by the project committee to develop the Integrated Pollution and Waste Management (IP&WM) discussion document: *Dr Herman Wiechers – Lead consultant from Stewart Scott Incorporated Bohlweki Environmental; Mr Errol Cerff – Environmental Risk Services (Pty) Ltd; Mr Michael Goldblatt – University of the Witwatersrand; Mr Jan Glazewski – University of Cape Town*. Several specialists assisted the drafting team: *Mr Newton Adams – Catts; Mr Jarred Ball – Jarred Ball and Associates; Mr Llewellyn Botha – Environmental Law Consultancy; Dr Mike Cohen – CEN Integrated Environmental Management Unit; Ms Terry Winstanley – Private Consultant; Mr Thabani Masuku – University of Cape Town* (RSA, 2000).

In this White Paper, scientific knowledge and expertise receive more recognition than in the previous one, but not by much. For example, "developing ambient quality standards, emission or discharge limits in a consultative manner that is based on sound scientific and management principles, as well as local knowledge" (RSA, 2000, p. 51); and "The government will assist people to act in an informed manner by promoting sound scientific research and monitoring and recognising local

knowledge and information" (RSA, 2000, p. 54). "Government will apply a risk-averse and cautious approach that recognises the limits of current knowledge about the environmental consequences of decisions or actions" (RSA, 2000, p. 71).

At the time of the development of the IP&WM, there were 26 international agreements about IP&WM that South Africa had acceded to or ratified. Some of the agreements that influenced the IP&WM policy process were specific requirements imposed on South Africa by international agreements such as the Framework Convention on Climate Change (UN, 1992), which focuses on greenhouse gases, and the Basel Convention (UN, 1989), which deals with transboundary movements of hazardous waste (RSA, 2000).

NEMA was followed by several sector-specific Acts, as depicted in the diagram, that are specifically relevant to this chapter. We subsequently discuss air quality, waste, and water.

4. The development of the air quality[3] legal framework in the democratic South Africa

4.1 Introduction to National Environmental Management: Air Quality Act (NEM: AQA)

The IP&WM policy encapsulated in the White Paper identified several critical issues regarding air pollution that needed attention in policy implementation, such as particulate emissions from coal and fuel burning, vehicle exhaust, industrial emissions, mining and industrial dust, various greenhouse gas sources, waste disposal sites, incinerator emissions, acid rain, and noise pollution (Scott, 2010). Acknowledging the fragmented and uncoordinated approach to air quality management, the policy highlighted the inadequacy of resources for implementing, monitoring, and enforcing existing legislation. From an air quality standpoint, the policy advocated for a comprehensive overhaul of air quality legislation to align with the paradigm shift away from the previous APPA

3 Editors' note: Extensively discussed in Chapters 3 and 4, but from an intervention point of view.

(Atmospheric Pollution Prevention Act (Act No. 45 of 1965)) approach to a more robust air quality management strategy.

The IP&WM policy became the foundation for the development of the National Air Quality Management Programme (NAQMP) strategy, which outlined the government's plan to develop the new National Environment Management: Air Quality Act (NEM: AQA) (RSA, 2004a); amongst others, by offering a comprehensive breakdown of objectives, outputs, activities, and inputs for the programme's key components (RSA, 2002). It became law in 2004. Before the promulgation of the Act, the National Environmental Management: Air Quality Amendment Bill was distributed for public comment on 1 April 2003. The DEAT received numerous submissions from various stakeholders, of which a total of 240 comments were received from 23 distinct organisations (Scott, 2010). Following public hearings, presentations and comments from various entities, including industry, non-governmental organisations (NGOs) and community-based organisations (CBOs), the amended Bill was debated in the National Assembly on 25 August 2004 and passed (Scott, 2010). Scott makes no mention of the input of scientists.

After a long and tedious process, NEM: AQA was finally promulgated in 2005 to supersede the previous APPA. The development and implementation of NEM: AQA primarily aimed to synchronise with the broader regime change, such as the advent of democratic governance in South Africa in 1994 (Naiker, 2012). During this period, there were extensive policy and legislative revisions (the IP&WM and the NAQMP) that integrated best practices and international norms. Additionally, there was a modernisation of the approach to environmental management (Naiker, 2012).

The long process leading to the ultimate development of NEM: AQA (from the White Paper on Environmental Management Policy to IP&WM to NAQMP to the Bill) was mainly through engagements with various stakeholders, including specialists in the air quality field. The NEM: AQA makes clear provision for establishing science-based instruments such as the

National Ambient Air Quality Standards (NAAQS) adopted from the World Health Organization (WHO) (This is discussed below).

The development process of NEM: AQA was complex. It can be difficult to establish the extent to which this process was based on scientific evidence. However, if one considers the definitions in the Act of, for example, *greenhouse gas* and *ozone-depleting substance*, it is clear that some science lies underneath it. We find an obvious marker of science in Schedule 2 of the Act, providing standards for the values of various potential pollutants.

The Act does make provision to implement the use of instruments which by design should be scientifically based, such as the AQMP (in Chapter 3), NAAQS (in Chapter 2) and environmental impact assessment (EIA) and atmospheric emission licences (AEL) (in Chapter 5). However, some of these tools, such as the AQMP and NAAQS, were not in existence at the time of the promulgation of the Act in 2004. These scientifically informed policy instruments were only implemented into law years after the Act was promulgated. For example, NAAQS were gazetted on December 24, 2009, taking into account health impacts, ambient levels at the time, and South Africa's developing economy (Garland et al., 2021; Okello et al., 2020). Engelbrecht and Van der Walt (2007) highlight that when the Act was promulgated, there was a specific requirement for municipalities to develop and implement AQMPs; however, there was no guidance on the content of such plans.

5. Examples of where scientific evidence has influenced the development of air quality-related interventions

5.1 Air Quality Management Plans (AQMPs)

Air Quality Management Plans (AQMPs) serve to assist governmental entities in strategising the execution of NEM: AQA, encompassing mitigation strategies and financial provisions to deal with air quality matters (Naiker et al., 2012). Additionally, per section 15 of the NEM: AQA, every national department,

province, and municipality must develop an AQMP outlining the actions necessary to fulfil the mandates of NEM: AQA and comply with NAAQS (Naiker et al., 2012). Section 17 goes on to provide that the state organs responsible for drafting the AQMP must also submit reports on the plan's implementation.

Furthermore, the Minister is required in terms of section 7 of NEM: AQA to promulgate the Framework for Air Quality Management in the Republic of South Africa (NFAQM). The National Framework aims to fulfil the goals of the Act (RSA, 2007a). Also referred to as the national AQMP, the National Framework provides a medium- to long-term plan for the practical implementation of the NEM: AQA. It also provides mechanisms, systems, and procedures to promote holistic and integrated air quality management through pollution prevention and minimisation at source and impact management and, hence, provides norms and standards for all technical aspects of air quality management. The first framework was established in 2007 and revised in 2012. According to the DEAT (RSA, 2007a), the development of the National Framework has been a collaborative and evolving process drawing upon inputs from various projects and both inter- and intra-governmental processes. Stakeholder feedback was gathered during public hearings for the Air Quality Bill, as well as through a public participation process that was an integral component of developing the National Framework.

The following projects formally became the information bases that contributed to the development of the National Framework*: Development of a South African Air Quality Information System (SAAQIS)- Phase One project; AQA Implementation: Listed Activities and Minimum Emission Standards Project; APPA Registration Certificate Review Project; Air Quality Management Planning Implementation Manual Development Project; Vaal Triangle Air-shed Priority Area Air Quality Management Plan Development Project; Framework for Setting and Implementing National Ambient Air Quality Standards [South African National Standards (SANS 69)]; Limits For Common Air Pollutants (SANS 1929);* and *Greenhouse Gas Information Management Project*.

AQMPs are detailed in Chapter 5 of the NFAQM, with instructions for developing AQMPs outlined in the Manual for Air Quality Management Planning (DEA, 2012a) (herein referred to as *the Manual*). The Department of Environmental Affairs (DEA, later DFFE) first issued the Manual for Air Quality Management Planning in South Africa in 2008, aiming to standardise the process of developing AQMPs, thereby ensuring consistency and coherence in the planning process. The Manual was compiled by consultants from Zanokuhle Environmental Services (ZES) on behalf of DEAT (RSA, 2008). The development of this initial Manual was based on a comprehensive examination of ongoing air quality management initiatives in South Africa (RSA, 2008). This ensured a consistent approach to implementing and reporting air quality management plans throughout the country, adhering to the most effective practices available. The review process involved forming a project reference group comprising Air Quality Officers from all South African provinces and representatives from municipalities engaged in AQMP initiatives. This group shared insights, exchanged information, and fostered collaborative partnerships and networks. Throughout the review, particular attention was given to the air quality management system in the South Durban Basin, identifying it as a focal point for air pollution concerns within the region (RSA, 2008). A case study was developed to address acknowledged pollution issues within this area, as documented in the DEAT Air Quality Government Publication Series C, Book 12. The insights gained from this project proved invaluable in refining and enriching the content of the Manual. The initial Manual refers to several local and international scientific sources such as research studies, reports (such as previous AQMPs), guidelines and standards (such as WHO air quality guidelines and SANS ambient air quality), which informed its development. The second revision of the manual was published in 2012.

As outlined in the Manual, there are six steps to follow in developing AQMPs. These steps include: (1) setting up stakeholder groups, defining the AQMP's geographic scope, and establishing a baseline; (2) analysing gaps and problems; (3)

setting air quality goals; (4) creating interventions and a plan to reach air quality objectives; (5) putting intervention strategies into action; and (6) monitoring, reporting, and evaluating progress. However, according to a survey conducted in the 2011 assessment of the National Air Quality Management Planning Report, not all the consultants who developed the AQMPs used the Manual to develop the AQMPs (RSA, 2011). Those who did also suggested that they supplement the manual with inputs from other sources such as the UK – *Urban Air Quality Management Toolbook*, parts of the *United Nations Environment Programme* and *United Nations Human Settlements Programme; National Framework, Environmental Protection UK; US EPA* and *South Coast AQM District; Environment Canada;* specific requirements outlined by the client and reference to plans developed internationally (RSA, 2011).

This raises the question, signalled by the literature, of whether the results of the scientific evidence on which interventions in other localities rest can easily be applied to South Africa (see Ettelt et al., 2012). Cairney writes, "Evidence of success from other countries or regions is a key source of inspiration for new policies in an 'importing' country" (2016, p. 36); and also, "the emphasis in some policy transfer studies on the potential risks to transferring the policy to another region without local 'ownership', and the different cultures and expectations in each policy field that warn against the assumption of a one-size-fits-all approach" (2016, p. 75).

The scientific input in AQMP development and implementation is found in the development of baseline air quality assessment, which is incorporated into an AQMP report. Baseline air quality assessment is a technique used to collect data on the historical and current conditions of a specific geographic area, enabling the evaluation of temporal variations and trends (Sivertsen & Bartonova, 2012). Conducting a baseline assessment helps to determine whether additional studies are necessary, utilising existing knowledge of ambient air levels. The assessment should identify emissions sources, pollutants, areas of concern, and unaffected background areas (RSA, 2012a; Sivertsen & Bartonova, 2012). This baseline assessment

provides crucial information for input into pollution area modelling and simulating dispersion characteristics (Moreoane et al., 2021). Dispersion models are used in the quantification of ambient air quality concentrations by applying software tools that use scientific data as inputs from various sources of emissions, as well as localised meteorological data to estimate the concentration of pollutants in the atmosphere (Haripursad, 2007; Tshehla & Wright, 2019). Results from air pollution dispersion modelling can be used in various ways, such as predicting of current and future air quality status quo of an area, predicting pollution episodes, assessing impacts arising from the emergency release of emissions from industries and identifying a suitable location for placing the ambient air quality monitoring station (Haripursad, 2007).

The DEA formulated the Air Dispersion Modelling Regulations and the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa. This code of practice serves as an adjunct to the air dispersion modelling regulations, outlining technical standards for the implementation of air dispersion models. Developed under Section 53 (f) of the NEM: AQA, these regulations are applicable in various contexts, including the drafting of AQMPs as outlined in Section 15 of the NEM: AQA, priority area AQMPs specified in Section 19 of the NEM: AQA, atmospheric impact reports as detailed in Section 30 of the NEM: AQA, and in applications for atmospheric emission licenses (AEL) as stipulated in Section 37 (2)(b) of the NEM: AQA. The air dispersion regulations aim to establish uniformity in model usage and to ensure that dispersion modelling procedures in South Africa are executed consistently to ensure that results from one dispersion modelling study can be compared to those from another. These regulations will guarantee uniformity and fairness in model applications, fostering trust and clarity in their appropriate usage.

The development of the regulations and code of practice was done by the DEA in collaboration with an Air Dispersion Modelling Working Group. Established in 2010, the working group consists of atmospheric science and modelling specialists. Its primary objective is to assist the DEA in

offering nationwide guidance on air dispersion modelling. Comprising professionals from government entities, industries, environmental consultancies, academia, and research institutes familiar with South Africa's regulatory framework, the group operates voluntarily. Coordination and leadership of the group are overseen by the DEA's Chief Directorate: Air Quality Management. The development of the guidelines was influenced heavily by the British Columbia dispersion modelling guideline (DEA, 2012a). In addition, in the Code of Practice for Air Dispersion Modelling in South Africa, all recommended models originate from the scientific evidence of the US Environmental Protection Agency's (US EPA) regulatory framework. The US EPA guidelines require that, in selecting and employing the most suitable model, it is essential to take into account the meteorological and topographical characteristics of the modelling area, the intended outcomes, the reliability of input data, and the technical proficiency of the modeller (Haripursad, 2007).

Baseline assessment and dispersion modelling are, therefore, tools using scientific evidence that must inform the development and implementation of intervention strategies within the AQMP report. Intervention strategies are the steps and measures taken after the baseline air quality assessment to mitigate further impacts on the environment (Gulia et al., 2015; Miranda et al., 2015; Sivertsen & Bartonova, 2012). Once the emissions sources have been identified and quantified, the interventions are developed and implemented either in combination or individually (Gulia et al., 2018). In the end, the AQMP needs to influence decision-making, especially in government institutions, by being incorporated into decision-making instruments such as the integrated development plan (IDP) and other sector plans such as environmental implementation plans (EIPs) and environmental management plans (EMPs) (Mukwevho, 2023).

5.2 Example: Waterberg-Bojanala Priority Area (WBPA) AQMP (October 2014)

The following information can be considered as scientific evidence that is found within the WBPA AQMP baseline characterisation report (RSA, 2014a):

- Meteorology and climate description, i.e. description of the climate of the area;
- Presentation of wind, temperature stability inversions, and precipitation data;
- Identification of sources and pollutants of concern: a list of pollutants and compounds and their main sources and types (point, line, area) identified;
- Assessment of the impact of industrial activities, greenhouse gases, indoor exposure and other regional issues, including acid rain, regional ozone and transboundary issues
- Pollutants impacting health, environmental impacts, and climate change related
- Assessment of available emissions data and emissions inventories;
- Atmospheric Dispersion modelling conducted for the area.

(The WBPA AQMP assessment used the CALPUFF model to estimate ambient concentrations of SO_2, NO_2 and PM_{10} resulting from listed activities, residential fuel burning, mining, and transboundary sources in Botswana. The report indicated that the model performed the best in terms of the predicted zone of maximum influence and the magnitude of predicted concentrations).

The report was compiled by uMoya-NILU Consulting (Pty) Ltd.

5.3 National Ambient Air Quality Standards

National ambient air quality standards are a key command and control policy instrument in air quality management in South Africa (Garland et al., 2021). The implementation of the NAAQS in South Africa provided a transition in air quality management with a shift in emphasis from source-oriented to receptor-

oriented, which commenced with the inception of the NEM: AQA. NAAQS were formulated on 24 December 2009, considering health effects, prevailing ambient conditions, and the evolving economic landscape of South Africa (Garland et al., 2021; Okello et al., 2020). These standards were developed based on adopting and adapting the WHO guidelines and interim targets. Like the WHO guidelines, the NAAQS specifically focuses on the following priority pollutants: NO_2, O_3, CO, C_6H_6, Pb, PM_{10}, $PM_{2.5}$ and SO_2 (Garland et al., 2021; Mdluli, 2010; Okello et al., 2020; Tshehla & Wright, 2019). According to Garland et al. (2021), the new WHO guidelines are based on the evidence of the effect of air pollution on human health. The limits for these pollutants in South Africa are less stringent than the WHO limits (WHO, 2005).

To comply with these limits, various emissions reduction technologies and measures have been developed in many countries, including South Africa for industries to reduce emissions of PM, SO_x, and NO_x (Tshidzumba 2024). These measures may vary in terms of efficiency and the extent of application. For example, some industries use water to control dust, while others prefer using chemicals for the same purpose. Regarding emissions from specific sources, strategies for emissions reduction and technologies for controlling pollution can also vary. These strategies might include lowering production rates to decrease particulate emissions, using technologies such as low NO_X burners to reduce NO_X, and employing pulse jet fabric filter (PJFF) plants or electrostatic precipitators (ESPs) to tackle particulate matter emissions (Tshidzumba, 2024).

5.4 Air quality offsets and a strategy for air pollution in low-income settlements

In 2016 and 2019, the Minister of Environmental Affairs published two documents that, although not obligatory for all role-players in air pollution, form part of the legal framework of air quality government. They can be described as 'soft law'. These are the *Air Quality Offsets Guideline* (RSA, 2016) and the *Strategy to Address Air Pollution in Dense Low-income Settlements* (RSA, 2019a). Mitigation interventions thus rely not only on

the traditional command and control approach but could be undertaken in a hybrid manner with other approaches, such as civil-based approaches (Mukwevho et al., 2022).

Both documents show a resolve of the Department to evidence-informed interventions. In the offsets guideline, one of the principles is that offsets must be measurable and scientifically robust: "The measure of impacts on air quality and the design and implementation of air quality offsets should be based on relevant and sound science" (RSA, 2016, pp. 10–11). In the strategy document, the following undertaking is given: "Government will actively support research aimed at ensuring that decisions relating to the selection and prioritisation of interventions to address poor air quality impacts in dense low-income communities are informed by reliable science, i.e. good science must inform decisions on where interventions must be prioritised and what activities should be prioritised" (RSA, 2019a, p. 28). This will be informed by, amongst others, basic research and technical testing.

5.5 Conclusion on the current air pollution situation in South Africa

Despite the existence of these scientifically informed or evidence-based instruments, the problems associated with air pollution in South Africa are far from being resolved, particularly with the observed levels of PM and O_3 in areas declared as hotspots (Feig et al., 2019; Govender & Sivakumar, 2019, Tshehla & Wright, 2019). PM and O_3 are two pollutants for which there is non-compliance with the NAAQS in all priority areas, of which a comprehensive scientific study may be required to identify and assess all sources of PM and O_3. This would be necessary to develop abatement strategies for these sources (Tshehla & Wright, 2019).

Regarding the AQMP system in South Africa: since the promulgation of NEM: AQA in 2004, not all spheres of government, such as some provinces, and district and local municipalities, have developed their AQMPs as required by Chapter 3 of the Act (RSA, 2021a; Tshehla & Wright, 2019).

Mukwevho (2023) highlights that some of the underlying issues that can be attributed to the lack of scientific evidence include inadequate availability of key resources, such as ambient air quality monitoring networks within municipalities and no existing or functioning monitoring stations or useable data. In addition, other underlying issues pertain to the quality and completeness of AQMP reports on key scientific aspects such as poor description of geographical area, land use, topography, landscape and natural resources, list of areas that use fossil fuels for domestic use, health status, inventories of industries that may cause air pollution and are not listed (e.g., controlled emitters, pollutants affecting health, environmental impacts and matters related to climate change) (Mukwevho, 2023).

Regarding the NAAQS, the South African government is currently embarking on a process to review the existing NAAQS to align them with the new WHO Global Air Quality Guidelines (AQG) published in September 2021 (WHO, 2021). Interestingly, the new WHO limits for PM and NO_2 are considerably lower than the previous ones, and this may indicate that there is a risk to human health with almost any exposure to these pollutants (Garland et al., 2021). Garland et al. (2021) further highlight the fact, which cannot be ignored, that many countries, including South Africa, have been unable to comply with the limits in the existing WHO guidelines. This can somewhat be attributed to emissions from different natural sources such as dust, biomass burning, biogenic and marine sources. Furthermore, the gap between current air pollution levels in South Africa and the NAAQS limits, as well as the new WHO limits, can be worrying, as these targets may seem unattainable (Garland et al., 2021). There is, therefore, a great need for extensive scientific informed assessments to quantify emissions from natural sources that need to be considered in the review of the NAAQS. However, this does not erase the current need for action to also mitigate the current air pollution levels, which are exceeding the NAAQS in many parts of South Africa (Garland et al., 2021).

6. Scientific evidence towards waste-related[4] policy and legislation

6.1 Introduction

Scientific understanding of the environmental impacts of various waste management practices, as well as the potential risks to human health, forms the foundation upon which policies should be built. By relying on empirical data and rigorous research, policymakers can design regulations that address the specific challenges facing the country, whether it be the management of hazardous materials, the promotion of recycling initiatives, or the reduction of overall waste generation. In an ideal world, scientific evidence provides the necessary framework to assess the long-term consequences of different waste management strategies, enabling policymakers to make informed decisions that balance economic, social, and environmental considerations. In a country as diverse and ecologically rich as South Africa, a science-based approach would ensure that waste policies are not only robust but also tailored to the unique circumstances and challenges of the region (Roux et al., 2006).

The *Waste Research, Development and Innovation Roadmap for South Africa* (2015-2025) is signalled on its webpage as "a Government initiative aimed at supporting South Africa's transition to a circular economy, through the generation of scientific evidence for the waste sector". It has a specific outcome related to evidence-informed decision-making:

> *"Strengthening skills and generating evidence to inform decision-making, planning and policy development by government and industry"* (RSA, 2014c, p. 9).

Furthermore, the National Waste Management Strategy (RSA, 2021b, p. 52) highlights the importance of scientific information

4 Editors' note: Compare Chapter 4 for a discussion of the problem and specific interventions to mitigate.

gleaned through the Waste RDI Roadmap towards informed decision-making:

> The Waste Research Development and Innovation (RDI) Roadmap has a critical role to play in building technical capacity within the waste sector and undertaking research to support development and innovation in the Waste Sector. As such, the implementation of the Waste RDI Roadmap should provide scientific support for informed decision-making and policy development, integrated waste management planning by provinces and local government on Integrated Waste Management Plans (IWMPs), and to the private sector in terms of Extended Producer responsibility (EPR) schemes.

A meeting of the National Assembly Committee for Forestry, Fisheries and the Environment in February 2022 (PMG, 2022) dealt with the *Status of Waste Management in South Africa*. The meeting noted that the Department of Forestry, Fisheries and Environment (DFFE) collaborates with scientific institutions such as the Department of Science and Innovation (DSI), the Council for Scientific and Industrial Research (CSIR), and the Technology and Innovation Agency (TIA) to develop strategies such as the Waste Research, Development, and Innovation Roadmap. This collaboration indicates a reliance on scientific expertise to inform policymaking in waste management.

However, the scientific evidence-policymaking nexus is not always achieved within the South African context, and waste management policymaking at times falls short in terms of incorporating scientific evidence. As highlighted by Strydom et al. (2010, p. 3), there are several barriers to "using science in policymaking". These include different world views and priorities of scientists and policymakers; factors related to accountability and vested interests; poor communication and lack of engagement; uncertainty, credibility, and risk; timing and timeframes, amongst others (Strydom et al., 2010).

The next section provides a brief overview of the legal framework (already alluded to in Section 3 above) for waste

management in South Africa since the National Environmental Management: Waste Act (59 of 2008) was promulgated in 2009.

6.2 Overview of the legal and policy framework for waste management in South Africa

This section provides a brief overview of the legal framework for managing waste in South Africa. The purpose of the section is not to provide a comprehensive legal framework but rather to give an illustrative overview of the laws and regulations regulating waste in the country.

National Environmental Management: Waste Act (NEM: WA): Enacted in 2008, this Act establishes the fundamental principles and objectives for waste management in South Africa. It provides a legal framework for the classification, monitoring, licensing, and control of waste management activities.

National Waste Management Strategy: The National Waste Management Strategy (NWMS) in South Africa provides a comprehensive framework for the country's approach to managing waste in an environmentally sustainable and socially responsible manner. The NWMS is aligned with the National Environmental Management: Waste Act (NEMWA) and serves as a guiding document for waste management practices across the nation.

Waste-related regulations: Since the NEM: WA came into effect in 2009, various regulations have been promulgated to give effect to the Act. For example:

- *List of waste management activities that have, or are likely to have, a detrimental effect on the environment* regulates the authorisation of waste management activities and infrastructure (GNR 718 of 2009, replaced by GNR 921 of 2013).
- *Waste information regulations* (GNR 625 of 2012) regulate the submission of waste-related information to the government.

- The *Plastic Bag Regulations* aim to reduce the use of plastic bags through a plastic bag levy and regulate the thickness and composition of plastic carrier bags (GNR 317 of 2021).
- *Waste Classification and Management Regulations* (GNR 634 of 2013), which establish a system for classifying waste based on its potential environmental, health and physical hazards. The classification is crucial for determining appropriate management and disposal methods.
- *Regulations regarding the planning and management of residue deposits and residue stockpiles from a prospecting, mining, exploration or production operation* (GNR 632 of 2015): These regulations provide unique requirements for the management of residue deposits and stockpiles.
- *Extended producer responsibility regulations:* NEM: WA provides for the principle of extended producer responsibility (EPR), which places responsibility on producers for the entire life cycle of their products. Producers are required to take measures to minimise the environmental impact of their products and manage post-consumer waste. The EPR regulations took effect in 2021 and require certain industries (such as paper and packaging, lighting, electrical and electronic equipment) to implement these regulations.

Norms and standards: Since 2013, South Africa has seen a progressive shift from regulating waste management activities through a waste management licence application process, supported by a basic assessment or scoping and full environmental impact assessment (EIA), to regulating through norms and standards determined by the minister. This occurred with the introduction of Category C as part of GNR 921 of November 2013. The advantage of regulating through norms and standards is that the administrative burden is less on the regulator, while the applicant/proponent (person or entity conducting the waste management activity) does not need to go through an expensive and lengthy EIA process. Some of the norms and standards applicable to the management of waste include:

- Norms and standards for the storage of waste (GNR 926 of 2013);
- Norms and standards for the flaring of landfill gas (GNR 924 of 2013);
- Norms and standards for the sorting, shredding, baling, crushing, screening and baling of general waste (GN 1093 of 2017);
- National norms and standards for remediation of contaminated land and soil quality (GN 331 of May 2014); and
- Norms and standards for organic waste composting (GNR 561 of 2021).

6.3 Case studies or examples where scientific evidence has influenced the development of waste-related legislation

The next part provides a few illustrative examples of the incorporation of scientific evidence or science into the development of waste-related legislation.

6.3.1 Framework for the Management of Contaminated Land and Norms and Standards (2010); and National Norms and Standards for Remediation of Contaminated Land and Soil Quality (GN 331 of May 2014)

The compilation of the *Framework for the Management of Contaminated Land* (DEA, 2010) was undertaken to carry out Part 8 of Chapter 4 of the National Environmental Management: Waste Act (59 of 2008). The purpose was, amongst others, to establish norms and standards facilitating the identification and registration of contaminated sites and to develop a risk-based decision support protocol for site assessment. Section 6 of the document (*Application of Site Specific Quantitative Risk Assessment*) is pertinent to our research question. It exhibits a high degree of reliance on scientific results, albeit from international sources, but also a critical awareness of the limitations of such results (DEA, 2010, p. 42).

This framework incorporates a tiered system of soil screening values for priority soil contaminants. The soil

screening values are informed by toxicological research on contaminants of concern. The collaborative development of the framework involved engagement with stakeholders from government, industry, specialist consultants, and the public, encompassing national workshops and sector-specific forum groups. The framework outlines:

- A Protocol for Site Risk Assessment;
- Reporting Norms and Standards for Contaminated Land;
- The Derivation and Use of Soil Screening Values;
- Application of Site-Specific Risk Assessment; and
- Quality Control and Quality Assurance of Field Sampling and Laboratory.

In May 2014, the Department of Environmental Affairs published the *National norms and standards for the remediation of contaminated land and soil quality* (GN 467).

> The purpose of these norms and standards is to (a) provide a uniform national approach to determine the contamination status of an investigation area; (b) limit uncertainties about the most appropriate criteria and method to apply in the assessment of contaminated land; and (c) provide minimum standards for assessing necessary environmental protection measures for remediation activities (RSA, 2014b, p. 5).

We next present an example illustrating one kind of limitation of evidence-based policy. Scientific evidence was used to make policy (*Framework for the Management of Contaminated Land*), but allegedly based on unreliable results. Papenfus et al. (2015) critique and question the scientific correctness of the soil screening values proposed in these policies The regulations determine a soil screening value (SSV) for the protection of groundwater resources, which relies on a two-phase equilibrium partitioning and dilution model, incorporating a dilution factor and partitioning coefficient (K_d), thereby translating the water quality guideline into a comprehensive soil screening value. Concerns have arisen regarding the validity of these screening values, particularly caused by uncertainties surrounding the

K_d values utilised within the *Framework for the Management of Contaminated Land*. The research by Papenfus et al. (2015) delve into the K_d values of copper (Cu), lead (Pb), and vanadium (V) across selected South African diagnostic soil horizons to assess the reliability of current K_d values employed during Phase 1 screening (as in the *Norms and Standards for the Assessment of Contaminated Land*). The study found that the K_d values for Cu ranged from 13 to 19,044 $\ell \cdot kg^{-1}$ across the 10 horizons, surpassing the Framework's value of 10 $\ell \cdot kg^{-1}$. Similarly, Pb values ranged from 25 to >252,294 $\ell \cdot kg^{-1}$ compared to the Framework's 100 $\ell \cdot kg^{-1}$, while the recommended V value of 200 $\ell \cdot kg^{-1}$ exceeded the measured values of 15 to 173 $\ell \cdot kg^{-1}$ across all 10 diagnostic horizons. These wide K_d value ranges were attributed to variations in fundamental soil properties such as pH, organic carbon, clay, iron (Fe), and aluminium (Al) content. Consequently, the K_d values for Cu, Pb, and V currently utilised by the Framework do not accurately reflect typical South African diagnostic soil horizons. Papenfus et al. (2015) have developed linear regression models to predict Cu, Pb, and V K_d values based on measured soil properties, offering the potential for soil-specific K_d values.

Given the implications under the National Environmental Management: Waste Act (NEMWA), precise Phase 1 screening assessments are crucial, yet uncertainties persist because of K_d value variability across soils. The authors argue that relying on a single K_d value, as suggested by the *Framework for the Management of Contaminated Land*, could lead to erroneous Phase 1 screening outcomes, carrying environmental and economic ramifications (Papenfus et al., 2015). The study advocates for the consideration of soil properties such as pH, organic carbon, clay content, cation exchange capacity (CEC), Fe, Al, and manganese (Mn) contents in calculating soil screening values. Moreover, it emphasises the potential for more reliable K_d value estimations through regression analyses, offering equations that account for these soil properties. In the absence of detailed measured soil properties, preliminary K_d values generated from this study for a range of diagnostic horizons could serve as a valuable resource.

Papenfus et al. (2015) motivate an alternative approach to determine the water-soluble fraction of samples in addition to the total analysis required by the *Norms and Standards for the Assessment of Contaminated Land*. This would increase the certainty with which screening is conducted and could prevent significant inappropriate screening. The authors highlight that cost could be justified through the potential cost savings, thus preventing unnecessary Phase 2 assessments or the reduction of undetected risks that could impact the environment. The authors conclude that their results may be useful when reviewing and revising legislation applicable to contaminated land assessment. Whether their research led to policy amendments is not known to us.

In his dissertation, Muller (2020, p. 60) reports that the legal framework for the rehabilitation of contaminated land is:

> largely technical, which prescribes scientific and technical standards and methods for obtaining and reporting contaminated land information in terms of Part 8 of [the NEM: WA]. This is not surprising as determining the human and ecological risk of contaminated land is a highly technical and complicated matter. As part of its Protocol for Site Risk Assessment, for example, it sets out a scientific methodology for the screening of soil.

Muller (2020) concludes that although these details are useful and based on scientific information, the "technical or scientific information could confuse" the end user of these documents.

6.3.2 *Waste Classification and Management Regulations (GNR. 634 of 2013)*

In 2013, the *Waste Classification and Management Regulations* (GNR. 634) were published to replace the classification process prescribed by the *Minimum requirements for the handling, classification and disposal of hazardous waste* (RSA, 1998b). According to these regulations, all waste streams, except a few pre-classified ones, must be classified within 180 days of generation and reclassified every five years or within 30 days

of any process modification leading to waste generation. This classification is crucial for labelling and preparing safety data sheets for waste transport. According to the *Waste Classification and Management Regulations* (2013), waste classification adheres to the *Globally Harmonized System of Classification and Labelling of Chemicals* as applied in South Africa by the National Standard (SANS 10234).

The *Globally Harmonized System for the Classification and Labelling of Chemicals* (GHS) (UN, 2011) is an internationally recognised framework developed to standardise the classification and labelling of chemicals. It provides a comprehensive and consistent approach to conveying information about chemical hazards, facilitating global communication and trade. The scientific basis for the classification of chemicals under GHS is rooted in a rigorous scientific assessment of their properties, potential risks, and effects on human health and the environment.

The groundwork for the Global Harmonized System (GHS) commenced in 1989 when the International Labour Organization (ILO) passed a resolution aiming for the alignment of classification and labelling systems. During the initial stages of formulating this universally harmonised system, various international organisations' and countries' existing chemical classification and labelling frameworks were considered.

This collaborative effort involving the World Health Organization, the International Labour Organization, the Organisation for Economic Cooperation and Development (OECD), and the United Nations, along with member countries, enjoyed broad support from the chemical industry and scientific community (Winder et al., 2005). The harmonisation process was overseen by the Inter-Organization Programme for the Sound Management of Chemicals (IOMC).

The GHS encompasses all hazardous chemical substances, dilute solutions, and mixtures. It is emphasised that the classification of a chemical substance relies on defined criteria and the reliability of associated test methods. Tests determining hazardous properties, conducted per internationally recognised

scientific principles, can inform hazard determinations for health and environmental risks. The GHS criteria remain neutral towards test methods by specifying criteria rather than tests, thus emphasising performance and scientific validity according to international standards. Specific test methods are linked to criteria for physical hazards such as flammability and explosivity (Winder et al., 2005).

The GHS employs a hazard classification system that considers physical, health, and environmental hazards. The scientific criteria for classification encompass a range of factors, including acute and chronic toxicity, carcinogenicity, mutagenicity, and environmental impact. This systematic approach ensures that chemicals are classified based on their intrinsic properties, promoting transparency and enhancing the understanding of potential hazards associated with their use. The classification process is based on toxicological research, ecotoxicological studies, expert review and consensus, and international collaboration (Winder et al., 2005) and is considered to be based on "scientifically sound data, validated according to international procedures and criteria already referred to in existing systems for the hazard class of concern" (UN, 2011, p. 6).

Overall, the development of the GHS was a science-driven process, with scientific evidence serving as the foundation for hazard classification criteria and labelling requirements. By integrating the latest scientific research and expertise, the GHS provides a standardised approach to chemical classification and labelling that promotes the protection of human health and the environment on a global scale.

6.3.3 National Norms and Standards for the Assessment of Waste for Landfill Disposal (GNR 635 of 2013)

The assessment of waste for landfill disposal follows the *National Norms and Standards for the Assessment of Waste for Landfill Disposal*, deviating significantly from the methodology outlined in the *Minimum Requirements for handling, classification, and disposal of hazardous waste* (RSA, 1998b). The new protocol involves a distinct analytical procedure based on the Australian

Standard Leaching Procedure (Australian Standard AS4439), incorporating total concentration analysis alongside leachable concentration analysis and prescribing different leaching solutions based on waste type. The outcome of the assessment process indicates the waste type (Type 0 to 4).

The Australian Leaching Procedure is a standardised method used to classify waste materials, focusing on assessing the potential environmental impact of waste during disposal through its leachability. This procedure is scientifically grounded in the principle that certain contaminants can leach out from waste materials when they come into contact with water, potentially leading to groundwater and soil pollution. The method involves simulating the leaching process in a controlled environment to measure the concentration of contaminants that can be released into the environment under specific conditions (Scott et al., 2005). The scientific basis of this procedure lies in understanding the chemical behaviour of contaminants within the waste matrix and how they interact with leaching media. It evaluates the mobility of hazardous substances, providing critical data for determining the environmental risk associated with the disposal or reuse of waste materials.

In her PhD thesis titled *Investigating the leaching of heavy metals from cementitious waste and contaminated soil: assessing the applicability of standard leaching procedures,* Halim (2004), however, argues that the Australian Leaching Procedure (AS4439) may not be the most appropriate method to assess waste types for landfill disposal. The study highlights that AS4439, along with other leaching procedures such as the Toxicity Characteristic Leaching Procedure (TCLP), may not fully capture the complexities of leaching behaviour under landfill conditions. Specifically, the comparison with municipal solid waste (MSW) leachate indicates discrepancies in metal leaching estimations when using synthetic leachates. However, the study also suggests that certain components of AS4439, such as water and sodium tetraborate buffer, may be appropriate for estimating leaching by non-putrescible landfill leachate. Overall, while the application of AS4439 for waste assessment is not outrightly dismissed, the study emphasises the need

for careful consideration of various factors and conditions when utilising it for waste assessment for landfill disposal. It emphasises the importance of recognising the limitations and potential shortcomings of standardised leaching procedures and encourages a comprehensive approach that considers the specific characteristics and conditions of the waste and landfill site in question. If the application of AS4439 in Australia is not straightforward, the application to South Africa must be handled very carefully.

6.4 Towards improving evidence-based waste regulation: The National Waste Information Regulations

Since the late 1990s, South Africa has made several attempts to gather data and information on waste generation and management, primarily through voluntary systems, most of which proved unsuccessful (Godfrey and Nahman, 2007). Before the enactment of the NEM: WA in 2008, the initial NWMS and the White Paper on Integrated Pollution and Waste Management (IP&WM) emphasised the necessity of establishing a waste information system. These documents advocated for the creation and maintenance of databases and information management systems to serve the needs of local, provincial, and national governments by gathering reliable national waste data (RSA, 1999).

Since the implementation of NEM: WA in 2009, the South African Waste Information System (SAWIS) has been formally regulated and enforced through the 2012 *National Waste Information Regulations* (referred to as "Waste Information Regulations") (GNR 625 of 13 August 2012) (RSA, 2012b). This system was developed to act as a national repository of waste information, covering various waste management activities such as hazardous waste generation, recovery, recycling, treatment, exportation, and disposal to landfills (ibid).

Data from waste information systems is crucial for monitoring waste processes such as generation, storage, transport, and disposal and for pinpointing potential pollution sources. This information on waste – including its sources,

amounts, trends, types, and composition – is vital for planning effective waste management (UNEP, 2015). Most importantly, it serves as a foundation for setting policy objectives and evaluating the effectiveness of existing policy interventions, such as reduction, recovery, and recycling (Godfrey et al., 2012). However, it is acknowledged that managing waste data is complex, as it involves an interconnected system that is difficult to measure or model because waste can be both an output and input of different processes (RSA, 2018a).

Research by Sehaswana (2021), *A critical reflection on the challenges in implementing waste information systems: A case of the South African Waste Information System*, highlighted various challenges in implementing the SAWIS, such as data capturing, lack of equipment to accurately measure waste quantities, capacity and resource limitations, high staff turnover, confidentiality of data, and Internet accessibility. The findings support the notion that for waste information systems to be successful, there must be investment in infrastructure, improved skills and capacity of SAWIS users and administrators, and stronger enforcement of the waste information regulations. An absence of correct and reliable waste information renders waste information systems useless in contributing to evidence-based policy development.

6.5 Waste: Conclusion

The preceding sections illustrate the incorporation of scientific and evidence-based information into waste-related legislation in South Africa. It is, however, recognised that evidence-based information does not always find its way into legislation. As highlighted by Godfrey et al. (2010) in their abstract, "To support the uptake of evidence in policy, it is also important to stimulate an environment of 'evidence pull' by the policy community from the research community, as well as increasing the dialogue between these communities". This still leaves some work to be done in terms of stimulating collaboration between the scientific community and policymakers.

7. Scientific evidence towards water-related policy and legislation

7.1 Introduction

The evolution and transformation of water-related policy and legislation in South Africa can be traced back to pre-colonial times and have ever since been sculpted by the social, political, and economic philosophy of the ruling regime (Tewari, 2009). During the mid-1850s, the British colonisers of the Cape regulated the use of water based on the *riparian principle,* which granted the exclusive ownership and use of water to property owners adjacent to rivers. The riparian rights system was later adopted in the 1956 Water Act and further distinguished between private and public water. The implications of these concepts would see the majority of the population - mainly the black population - be excluded from accessing and using water to ultimately benefit a minority white population. With the looming political changes in the early 1990s, an overhaul of water-related policy and legislation was on the table to ensure that water would be an imperative human right for all in post-apartheid South Africa.

7.2 Overview of the water-related policy and legal framework for water management in South Africa

This section provides an overview of the most notable policy documents which consequently formed the basis of our current legal framework governing the use of water in the country.

7.2.1 Fundamental principles and objectives for the new water law in South Africa

The water law reform process was initiated through the publication of the *Fundamental principles and objectives for the new water law in South Africa* in 1996, and contained 28 principles concerned with the legal aspect of water, the water cycle, water resource management priorities and approaches and water institutions and services (RSA, 1996b). After an intensive consultation process which relied on inputs from scientific

councils, communities, water users, academic institutions, and national, provincial, and local governments, these fundamental principles were adopted and became the foundation for the *White Paper on a National Water Policy* in 1997.

7.2.2 *White Paper on a National Water Policy for South Africa*

The main objective of the *White Paper on a National Water Policy for South Africa* (RSA, 1997b) was to outline the direction for the development of water law and water management systems in South Africa. One of the directions the *White Paper* took was to abolish the riparian rights system and adopt guiding principles for future water management interventions. For this section, only the most relevant principles of the *White Paper* will be discussed and are summarised below:

1. existing water uses (which also include rights) will be recognised…
2. water required to ensure that all people have access to sufficient water shall be reserved…
3. the quantity, quality and reliability of water required to maintain the ecological functions on which humans depend shall be reserved…

The *White Paper on a National Water Policy* (RSA, 1997b) states: "Ongoing monitoring and assessment of the patterns of resource use, and the response of the resource to use, are critical to our ability to manage and protect those resources on the basis of sound scientific and technical information and understanding. Adequate information is essential for effective resource management and protection" (RSA, 1997b, Section 6.8.1).

The *White Paper* also recognised that the newly adopted principles and objectives will require novel and enabling water resource management interventions. These interventions had to be based on "the application of law, economics, natural resource management approaches and the science of organisations, reinforced with the skills of communication…". (Ibid., Section 6.1). In so doing, the government had to develop an enabling legal framework which made provision for water resource

management approaches, which are based on science and implemented by skilled and competent people.

7.2.3 *National Water Act (36 of 1998)*

This came in the form of the *National Water Act* (NWA) (No. 36 of 1998) (RSA, 1998a), which was applauded for being a progressive, forward-thinking, and ambitious policy intervention (MacKay et al., 2003). They paraphrase the long title of the Act. According to them, it recognises that water is a natural resource which belongs to all people and that the National Government is responsible for equitable allocation of water and aims to achieve sustainable use through the integrated management of all aspects to ensure the protection of the quality of water resources at a regional or catchment level so as to enable everyone to participate.

The Act further sets out its aims, amongst others, to meet the basic human needs of present and future generations, promote equitable access to water, redress the results of past racial and gender discrimination and promote the efficient, sustainable, and beneficial use of water in the public interest.

7.2.4 *National Water Resource Strategy*

The NWA makes provision for the development of a National Water Resource Strategy (NWRS), which serves as a framework for the protection, use, development, conservation, management, and control of water resources for the country as a whole (RSA, 2004b). The NWRS emphasises the importance of "science and knowledge that leads to innovation that benefits the sector" and "the provision of evidence that guides policy and the implementation thereof" as cross-cutting aspects in all the technical domains of the water sector. *Science/scientific* is mentioned eight times in the document, and *evidence* in the sense that we use it four times.

7.2.5 *A notable water-related regulation*

In this section, we discuss the *Regulations for the Establishment of a Water Resource Classification System, GN R810 of 2010* (RSA, 2010).

Before the Reserve determination can be calculated, one needs to follow a seven-step procedure to determine different classes of water resources. These steps require (i) the delineation of the units for analysis and a description of the status quo of the water resources; (ii) linking the socioeconomic and ecological values and condition of the water resource; (iii) the quantification of the ecological water requirements and changes in non-water quality ecosystem goods, services, and attributes; (iv) the determination of an ecologically sustainable base configuration scenario; (v) evaluation of scenarios within integrated water resource management (IWRM) processes; (vi) evaluation of the scenarios with stakeholders; and ultimately (vii) the promulgation in the Government Gazette and implementation of the class configuration.

Numerous policy-based instruments have been developed to assist in realising the overall purpose and objectives of the NWA and the NWRS. The following section will briefly discuss two such instruments: the Reserve and the authorisation for the use of water utilising an existing lawful use (ELU).

7.3 Case examples of where scientific evidence has influenced the development of water legislation

7.3.1 The Reserve

The reform in water legislation in the country provided an opportunity to develop sound policy-based instruments which are founded on scientific, political, and social principles, of which the Reserve is an example of such an instrument (Mackay, 2001).

The Reserve and the determination thereof are regulated by Sections 16 to 18 of the NWA and deal with the (i) basic human needs reserve and the (ii) ecological reserve. It is deemed as the primary right to water, as no water may be allocated to other water users and water uses until the requirements of the Reserve have been met (RSA, 2006). This, however, requires various scientific methods and assessments to determine the necessary water for human needs and ecological functioning.

The following paragraphs briefly allude to these two concepts contained within the Reserve and how scientific and social principles inform determining the Reserve.

Basic human needs reserve

The concept of basic human needs can be traced back to when ancient civilisations recognised their reliance on water for human health and survival (Vuorinen, 2007). Within the South African context, the basic human needs reserve relates to "…the essential needs of individuals served by the water resource in question and includes water for drinking, for food preparation and for personal hygiene" (see Part 3 of the NWA, 1998). In 1997, the *White Paper on a National Water Policy* suggested a 25 litres per person per day quantity to satisfy basic human needs and acknowledged that this quantity is relative and should increase as the standard of living increases. The prescribed quantity at the time was based on the guidelines provided by the World Health Organization to ensure that basic human needs such as cooking, sanitation and personal hygiene can be achieved. More than a decade later, the basic human needs quantum would be legally challenged. Reflecting on the outcome of the City of Johannesburg and Others v Mazibuko and Others (2009), the court held that the 25 litres per person per day, as suggested by the *White Paper on a National Water Policy,* should be increased to 42 litres of water per day based on the availability of water within the municipality. It should be noted that this court judgement is only applicable to the municipality and the related free basic water policies in question. (These volumes of water allocated for basic human needs must be taken into consideration when determining the ecological reserve for water resources (DWAF, NWRS 3, 2023, Chapter 12)). We were not able to find out on what basis the court arrived at the quantum of 42 litres. Nevertheless, it is an interesting example of policy determination by the judiciary where, ideally, scientific evidence should have played a crucial role.

Ecological reserve

The ecological reserve is deemed to be an endogenous South African concept (Biggs et al., 2008) which stemmed from engineering practices implemented for the construction of the Pongolapoort dam in the 1970s (Bourblanc, 2015). Since then, hydro-ecologists have managed to increase their influence on water resources management decision-making and have refined the concept to such an extent that it has been adopted as a legal requirement within the NWA (Bourblanc, 2013). The NWA defines the ecological reserve as "…the water required to protect the aquatic ecosystems of the water resource" (RSA, 1998a) and needs to be determined for all individual water resources, for the quantity and quality of water needed. It requires highly technical administrative decision-making over an extensive period (Kidd, 2011) by using approved methods for quantifying the flow, habitat, and water quality requirements of the ecosystems within the water resource (Thompson, 2006; Quinn, 2012). Since 1989, two comprehensive, holistic scientific methods, namely the Building Block Methodology (BBM) and the Downstream Response to Imposed Flow Transformations (DRIFT), have been applied. Development of the BBM was undertaken jointly by the Department of Water Affairs and Forestry (DWAF) and river scientists and aims to provide scientific guidance on river flows where biological data and the functioning of the river are limited (King & Louw, 1998). At the same time, the DRIFT method was developed in actual water-resource development projects in several rivers, including the Palmiet River, Breede River and the Lesotho Highlands Water Project. The main purpose of the DRIFT is to describe selected potential flow regimes and link them to the biophysical and socioeconomic consequences of the river ecosystem (King et al., 2004). These two methods have been supported by a more recently developed method, namely the Flow Stressor-Response (FSR), which may be used on its own or as part of holistic methods to capture specialist knowledge on the relationship between flow, hydraulic habitat and the response of instream biota (O'Keeffe et al., 2002).

Subsequently, several Reserve determinations have been gazetted for water management areas by using the above-mentioned methods. They include the Inkomati Catchment (see Notice 998 of 2019) (RSA, 2019b), the Mvoti to Umzimkulu Catchments (see Notice 1097 of 2018) (RSA, 2018b), the Olifants to Doorn Catchments (see Notice 189 of 2017) (RSA, 2017a), and the Vaal WMA (see Notice 1019 of 2020) (RSA, 2020b). Notices of the proposed Reserve determinations have also been published for the Olifants and Letaba Catchments (see Notice 1038 of 2017) (RSA, 2017b), the Mokolo to Matlabas Catchments (see Government Notice 1669 of 2022) (RSA, 2022), and the Crocodile West and Marico Catchments (see Government Notice 1050 of 2020) (RSA, 2020c).

7.4 Case example of where scientific evidence has not influenced the development of water legislation

Water use authorisation – existing lawful use (ELU)

According to the NWA, all water uses must be authorised in terms of a water use licence unless the water use constitutes a Schedule 1 water use. It then falls under a General Authorisation, and the need for a licence is dispensed with, or it is recognised as an Existing Lawful Water Use (ELU). For this section, we will only focus on the latter as a case example. An ELU permits the continuation, under certain conditions, of an existing water use derived from a law repealed by the NWA. As mentioned in the introduction, the National Water Policy (RSA, 1996b) specifically highlighted that these existing rights *…will be recognised…* under a reformed water law. The decision to recognise an 'apartheid era water right' under the reformed NWA was purely[5] based on the government not wanting to disrupt the economic sector, which relied mainly on agricultural activities. Ever since the adoption of ELUs into the reformed water legislation has often been criticised for perpetuating inequality in the access to water. This criticism is firmly grounded in the historical context of the country. Historically, apart from customary water rights

5 Editors' note: This "purely" makes for a very strong claim which the authors fail to substantiate.

that applied in the former self-governing territories and 'TBVC states' the black majority was largely restricted from owning land, resulting in a lack of formal water rights. In contrast, the white minority, especially large-scale irrigation farmers, secured water rights through the riparian rights principle and the notion of private water. This historic imbalance enabled these large-scale water users to buy an ELU more easily, reinforcing the existing disparities in water access even after 1998 (Van Koppen & Schreiner, 2014; Van Koppen et al., 2014).

8. Conclusion

Government policy on the environment in South Africa is wide-ranging and complex. We investigated the role of evidence in three fields: ambient air, waste, and water. Legislation and policies in these three areas, although articulated severally, are covered by an umbrella Act, the National Environmental Management Act, 1998 (107 of 1998). However, as far as the governance of water is concerned, the National Water Act (36 of 1998) also has a large part to play.

We contribute to the evidence-policy discourse by exploring the extent to which scientific evidence influences South African environmental policy. We cast light on the question both along the a) time and the b) policy-level dimensions: that is, firstly, the unfolding situation resulting from the democratisation of South Africa, and secondly, the articulation of policy from the level of broad policy and legislation down to the operational level. The environmental policy context is legally complex.

At the same time, we wanted to contribute to conceptual clarity around the notions of evidence and policy. We preferred a narrow definition of evidence but a broad definition of policy.

We found that scientific evidence played a lesser role when the country was still establishing the new democratic order. At the beginning of the democratic order, it was important to recognise the contribution of non-specialists and to show respect for knowledge that was not of scientific research origin.

As the broad policies were articulated in sector-specific legislation at the start of the millennium and regulations and strategies were developing, the role of evidence increased. Sometimes, legislation presumed evidence was available before it was established by scientists. Often, the evidence originated overseas.

The level of norms and standards is where science came into its own. However, we discussed an interesting example in the field of waste assessment where subsequent research cast some doubt on the science on which screening values for the policy in the form of norms and standards were originally determined. Scientific results may thus be inherently fallible, as Karl Popper (1902–1994) has shown, but they do move in the direction of truth. This is another reason why *evidence-based* policy may be too strong a term and why one should rather talk of *evidence-informed* policy. Science is not static but grows in the direction of validity and reliability. This implies that a government must have the capacity to remain au fait with the latest findings. We did not discern a strong in-house scientific research capability in the relevant government departments. There may be an overreliance on consultants.

It is understandable that on the broad conceptual level, scientific results would play a lesser role than the interests of stakeholders and political aims. However, it is in the interest of all that the self-correcting characteristic of science also be applied in the administration of a country. When results show that policies do not work or that the data and information from which, for example, norms and standards are derived are not valid, changes must be made. This requires scientific capabilities in the state and respect for reality. And respect for reality is synonymous with science.

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Chapter 11

A case study of deteriorating services in two South African townships and possible implications for spatial justice for cities in the Anthropocene

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Abstract

This chapter explores the implications for spatial justice in the Urban Anthropocene of the deteriorating services in two South African townships, eMbalenhle and Lebohang, in the Mpumalanga province of South Africa. Utilising data from Nova's Re-baseline Services Report, literature, and government

policies, the chapter investigates how service distribution disparities and the recognition of diverse community needs and identities intersect to shape spatial injustices in urban environments. The findings reveal significant inequities in access to services, highlighting challenges in access to water, electricity, waste disposal, and housing. The analysis emphasises the need for inclusive and equitable urban planning and policymaking that acknowledges and addresses the unique challenges of different groups, particularly in the context of rapid and informal urbanisation. This study contributes to the discourse on urbanisation in Africa, offering insights into the complexities of achieving spatial justice in the Anthropocene era.

Following a theoretical overview and methodological exposition, the chapter presents an analysis of the two townships' context and a detailed discussion of the spatial justice dimensions. The chapter concludes by highlighting key takeaways that are crucial for policy consideration.

Keywords: climate change vulnerability, CSR (corporate social responsibility) programmes, eMbalenhle, Lebohang, service delivery failure, service disparities, spatial justice

1. Introduction

The Anthropocene, characterised by human-induced changes to the Earth's systems (Rockström et al., 2009; Steffen et al., 2007), presents unparalleled challenges (Elo et al., 2024) that demand a fundamental re-evaluation of our approaches to development[1]. Not only has human activity affected more than three-quarters of the Earth's landscapes, but it has also exacerbated already existing inequalities (Watson et al., 2016, p. 2930). As the global population surpasses eight billion, a significant shift towards an older and more urbanised demographic profile is emerging, particularly concentrated in the cities and towns of Asia, Africa, and Latin America (Balk, 2022; UN, 2019). Alongside this demographic evolution, climatic challenges are accelerating. The Intergovernmental Panel on Climate Change (IPCC)

1 Editors' note: Shares ideas with Chapter 1.

anticipates a future marked by more extreme weather events, such as intensified storms, increased flooding, persistent droughts, and rampant wildfires (IPCC, 2023a; 2023b). The impact of these changes in urban areas is twofold; while cities, with their compactness, stand at the frontline in the mitigation of and adaptation to climate change, they also position residents at increased risk of exposure to these climatic hazards (IPCC, 2023b). These trends pose significant challenges to sustainable development, particularly in the world's fastest-growing, least-developed countries, where resources are already under pressure. Efforts to achieve the Sustainable Development Goals (SDGs)[2] (UN, 2015) are challenged by the anticipated population doubling by 2050 in many of these nations, which includes countries especially vulnerable to climate change and sea-level rise (UN, 2019). These regions face developmental constraints and heightened vulnerability to climate-related hazards, emphasising the necessity for adaptation strategies grounded in equity, inclusivity, and rights-based approaches (IPCC, 2023b).

Recent years have seen expansive growth in scholarship surrounding the environmental consequences of the Anthropocene (Bulkeley, 2021), with a multitude of reports (e.g. Arga Jafino et al., 2020; Clement et al., 2021), including those from the IPCC, grounded in robust scientific research, urging immediate action to address the consequences of (human-induced) climate change. This body of work has increasingly recognised the importance of social justice and equity issues (e.g. Swilling, 2020; Swilling & Anneck, 2012), revealing that the most vulnerabilities to climate impacts are not evenly distributed; urban communities, particularly the economically and socially marginalised, bear the brunt of climate adversities. These vulnerabilities are rooted in inequalities linked to a myriad of factors, including gender, ethnicity, and socioeconomic status, and are further magnified by historical contexts such as colonialism (IPCC, 2023b). A minority, primarily in developed countries but also increasingly in developing countries, bears historical responsibility for much of this environmental

2 Editors' note: The reader will probably recall the Planetary Well-being Goals of Chapter 1.

degradation, yet the consequences are felt most sharply by the disadvantaged, both in specific locales such as South Africa and across the globe (Malm & Hornborg, 2014; Satterthwaite, 2009; Sultana, 2022).

Transformative change in socioeconomic and technological systems, as suggested by Swilling (2020), Swilling and Anneke (2102) and others (Díaz et al., 2019; Köhler et al., 2019), is urgently needed, keeping in mind that the "old world of North and South" may be vanishing in the Anthropocene (Hamilton, 2017). By bringing the principle of spatial justice more central to spatial planning, planning can play a prominent role in this transformative change. This chapter thus puts spatial justice forward as a framework able to facilitate a more just and fair approach to spatial planning, capable of integrating social and environmental justice. The experiences of eMbalenhle and Lebohang townships in Mpumalanga, South Africa, emphasise the importance of incorporating spatial justice into urban planning as a response to the challenges posed by the Anthropocene. Situated near the Sasol Secunda plant, a significant source of global greenhouse gas emissions (Sguazzin, 2020), these townships symbolise the critical intersection of social justice and climate change mitigation, highlighting the necessity for urban development strategies that not only address the physical impacts of climate change but also prioritise equitable outcomes for vulnerable communities. The degradation of service provision (electricity and water), the inadequacy of waste management services, and the scarcity of affordable housing in eMbalenhle and Lebohang are amongst the pressing issues that emphasise the urgent need for a re-evaluation of how urban services are distributed and managed.

Drawing on data from Nova's Services Reports and insights into the lived experiences of township residents, the primary aim of this study is to systematically investigate the disparities in service distribution, the intricacies of policymaking processes[3], and the (non)-acknowledgement of diverse community needs within the two townships. By

3 Editors' note: Compare with Chapter 10.

employing a detailed analysis of service provision data and policy documents, alongside interviews with community members and stakeholders, this research intends to uncover the underlying factors contributing to spatial injustices. Additionally, it will evaluate the effectiveness of existing interventions, such as the Sasol air quality offset programme, in addressing the identified disparities.

This chapter unfolds in several sections, each building towards a comprehensive understanding of spatial justice in the context of urban service provision. Following this introduction, we delve into the theoretical support of spatial justice and review the literature on service provision and urban equity. Following this, the methods section describes the socioeconomic and geographical contexts of the two South African townships under study, outlines the data sources, including Nova's Services Reports, and details our analytical approach. The results section presents the findings on service distribution disparities, policymaking processes, and the recognition of community needs and identities. Next, the implications of these findings for spatial justice are discussed, and in conclusion, the main takeaways are presented, reflecting on the broader implications for urban policy and planning in the Anthropocene era.

2. Justice, Space, and the Politics of Urban Inequality

2.1 Spatial Justice

Justice serves as a foundational pillar for social sustainability, echoing John Rawls' (1999) assertion that justice supports the virtue of social institutions just as truth does for thought systems. Influenced by scholars such as Edward Soja and Mustafa Dikeç, the discourse on spatial justice highlights the importance of examining the socio-spatial structures that underlie the distribution of the burdens and benefits of urban development and our life together in society. Soja (2010a), in particular introduced the idea of spatialisation of justice, emphasising the interconnectedness of social and spatial

processes, calling for a "spatial turn" in the social sciences, where the spatial dimension is prioritised over the historical dimension (Soja, 2010b, p. 13), alluding to the "broader spatialisation of our basic ideas of democracy and human rights, as in the revival of Lefebvre's notion of the right to the city" (Soja, 2009:1). The central argument in Soja's call for spatial justice is that the spatiality of (in)justice affects society and social life just as much as social processes shape the spatiality of (in)justice. Without an explicit emphasis on the spatiality of (in)justice, many opportunities for theoretical and empirical analysis and spatially informed social and political action are lost. The emphasis on the spatial dimension is intentional and focused, though temporary (Soja, 2010a, p. 17).

Spatial justice is a multidimensional concept, encompassing distributive justice (the equitable spatial allocation of resources and burdens), procedural justice (fair governance and procedures within the built environment), and recognition justice (the respect and acknowledgement of diverse identities and experiences). These three dimensions are not exclusive and should be addressed together, as inequitable distributions of benefits and burdens, lack of recognition, and limited participation in decisions all work to produce and reinforce injustices and claims for justice (Schlosberg, 2004). Spatial justice is also a multi-scalar concept, defined within the two extremes of the human body and the physical planet, therefore addressing justice debates from individual practices and behaviours to planetary environmental injustices (Soja, 2010a, p. 31). Therefore, the tripartite multi-scalar framework addresses both the formal and informal mechanisms governing spatial relationships, highlighting the significance of spatial justice in fostering equitable urban spaces (Rocco, 2023).

2.2 Sustainable Development, Service Provision, and Urban Equity

Despite progress in sustainable development, global inequalities persist in access to basic services such as water and sanitation. Currently, 2.2 billion individuals lack access to safely managed drinking water, while 3.5 billion lack proper sanitation, and an

additional 1.5 billion lack basic hygiene services (UN, 2023). Inequalities in water and sanitation[4] access persist globally, with many urban centres across Eastern Europe, Latin America, Asia, and Africa still lacking essential water services (Koop & Van Leeuwen, 2017). While access to clean water and sanitation has improved for rural populations in recent decades, the situation in urban areas has either stagnated or worsened (UN, 2023). Similarly, waste management in cities presents large discrepancies when compared globally: The global average municipal solid waste collection rate varies from 50% to almost 100%, and the global average rate of municipal solid waste management in controlled facilities is between 18% and 94% (UN, 2022). In addition, cities in Central and Southern Asia and sub-Saharan Africa present a large gap between the collection rate and management of waste, indicating that many municipalities still rely on dumpsites (UN, 2022). The lack of access to basic services is often compounded by the burdens of urban growth. Air pollution, for example, is associated with increased industrial activity and motor vehicle traffic (Amegah & Agyei-Mensah, 2017; Petkova et al., 2013). These global trends overlap and reinforce spatial inequalities across regional and city-level scales (Nijman & Wei, 2020).

At the city level, various scholars have shown that disadvantaged communities have lower access to urban services and infrastructure (Nicoletti et al., 2023; Pereira et al., 2019). Spatial inequality in service delivery is also a common feature in African cities (Adama, 2012; Cole et al., 2018; Oskam et al., 2021; Rodina & Harris, 2016). Inequalities in water access and usage are stark, with significant variations at the ward, town, and national levels (Cole et al., 2018). In addition, it has been shown that social factors, particularly water access and income, outweigh natural factors such as rainfall in influencing per capita water use (Cole et al., 2018). Disparities in access to water are also prominent within informal settlements, with higher socioeconomic status households more likely to have access to piped tap water and lower socioeconomic status households

4 Editors' note: Compare Chapter 6 which deals with a more rural environment.

relying on inferior, often unsafe, water sources (Oskam et al., 2021). Similarly, the urban poor in African cities are also the ones bearing the burden of insufficient or lacking solid waste management[5], including illegal waste dumping (Niyobuhungiro & Schenck, 2022; Polasi, 2018), and associated unhealthy living conditions (Kubanza & Simatele, 2016; Niyobuhungiro & Schenck, 2022). Moreover, growing evidence not only shows that the impacts of climate change push people and communities into further vulnerability (Kalina, 2020; Sultana, 2022) but also that sustainability transition interventions come to reinforce existing inequalities (Kraaijvanger et al., 2023; Sundaram et al., 2024).

In response to increasing urban inequalities over the past decade (Nijman & Wei, 2020), academics from various fields have turned their attention to questions of justice in cities, echoing old critical research scholarship (Harvey, 1973). Perhaps because distributive injustices clearly manifest in space, the distributive aspect of spatial justice has received more attention so far. The growing volume of data about urban activities, combined with an increasing computational capacity, also contributes to the prominence of distributive spatial studies. However, it is crucial to have a comprehensive perspective on spatial justice that considers the spatial processes through which injustices are (re)produced, not only through the lenses of distributive justice (how benefits and burdens are distributed across space and how space influences such distributions), but also procedural justice (how space influences representation in decision-making, and how decision-making sustains spatial inequalities) and recognition justice (how space contributes to oppression of people and communities across race, gender, and class, and how oppression shapes space for the benefit of a privileged minority).

5 Editors' note: Chapter 5 discusses cases to show that this is a rural problem as well.

3. Case Study and Methods

3.1 Locating eMbalenhle and Lebohang

The Govan Mbeki Local Municipality, situated in the southeastern part of Mpumalanga province and abutting Gauteng province, operates within a complex socioeconomic and environmental context. Approximately 150 km east of Johannesburg and 300 km southwest of Mbombela, the municipality covers a strategic location that influences its development and challenges. It is characterised by a mix of agricultural, rural areas, and urban conglomerates, including Leandra, the Greater Secunda, and Bethal, alongside the townships of eMbalenhle and Lebohang. This area has a significant industrial base, notably dominated by the petrochemical and mining sectors, primarily because of the presence of the Sasol complexes and the world's largest underground coal mining complex (Govan Mbeki Municipality, 2024a).

Govan Mbeki Municipality's economy is the fourth largest in Mpumalanga, contributing 10.9% to the provincial economy and 40.7% to the Gert Sibande district economy in 2021. However, despite its economic contributions, Govan Mbeki Municipality faces critical challenges in service delivery, which have been a concern for its residents and have led to interventions from the National Treasury and the Department of Cooperative Governance and Traditional Affairs. The municipality has been identified as one of the struggling municipalities in terms of meeting its service delivery obligations, which include managing a growing debtor's book and negotiating significant debts with Eskom and Rand Water, the electricity and water providers. To address these issues, a Financial Recovery Plan (FRP) has been implemented. The 2022/2023 report states that 87% of the activities of the FRP have been achieved, and further actions are planned for the 2023/2024 financial period (Govan Mbeki Municipality, 2024a). However, despite its economic achievements, the municipality fails to address the well-being of its most vulnerable residents. The townships of eMbalenhle and Lebohang are notably affected by declining service delivery standards in water, sanitation,

electricity, and waste management, which will be discussed in detail in Section 4. In addition, eMbalenhle and Lebohang have experienced a substantial increase in the growth of informal areas between 2019 and 2022, with the addition of 1,300 and 1,400 informal houses, respectively (Nova Institute, 2023b), further pressuring local urban service systems.

The Integrated Development Plan (IDP) of the Municipality indicates that the municipality is aware of the challenges with service provision, particularly in sanitation, water, and solid waste management: "People of Govan Mbeki, in particular those of Bethal/eMzinoni, have a right to get a better supply. A supply that is sustainable and qualitative" (Govan Mbeki Municipality, 2024b, p. 44). However, the expansion of informal housing amid deteriorating access to essential services highlights a pressing issue of spatial injustice, which requires addressing not only the immediate service delivery concerns but also the underlying factors contributing to service deterioration. This is a complex challenge that demands focused action through targeted policies and collaborative interventions in a united effort from the multiple levels of government, the private sector, and community stakeholders, keeping in mind that there could be factors, for example, political, economic, and social reasons for people migrating to these two communities, that may be difficult to address through government policy. Being part of Mpumalanga, the Province's Spatial Development Framework (PSDF) is also relevant for the municipality of Govan Mbeki Municipality. It operates within the legislative context established by the Spatial Planning and Land Use Management Act (Act 16 of 2013) (SPLUMA)[6] (RSA, 2013), designed to rectify historical spatial inequalities and encourage sustainable settlement patterns. Although the PSDF invokes the principle of spatial justice only twice, its integration in the framework could be the utilising for more elaborate policy articulation. The PSDF's principle of spatial justice outlines the need to correct historical spatial inequalities by including previously marginalised areas. It emphasises the importance of restoring equitable land access to those who have been historically

6 Editors' note: Discussed in Chapter 9.

disadvantaged. Moreover, the PSDF advocates for a systematic approach to the incremental upgrading of underdeveloped areas and the establishment of secure tenure Mpumalanga Province, 2019). Mpumalanga's PSDF and other relevant policy documents are further analysed in the results section below.

3.2 Understanding eMbalenhle and Lebohang

To investigate the dynamics of service distribution disparities (with a focus on four aspects: access to water, access to electricity, waste disposal, and housing), policy frameworks, and the recognition of community needs and identities, several methods are used. The methodological design integrates quantitative and qualitative data to construct a detailed picture of the current situation and shifts over time. The Nova Institute's General Household Survey (GHS) in 1,150 households across four communities establishes the baseline against which changes in service provision from 2013 to 2022 can be assessed. In-depth interviews with 46 households and focus groups provide rich narratives that reflect the diverse life experiences of the residents, highlighting their needs and how they perceive the impact of policy and service delivery on their daily lives.

A re-baseline study conducted in 2022 supplements the initial data, offering a comparative lens through which to view demographics, health and well-being, services and infrastructure, education, and safety and security indicators for both townships. This comprehensive reassessment enables a nuanced analysis of the progress or regress in key areas affecting spatial justice.

To address the disparities in service provision and their implications for justice, it is essential to explore not only the distributional dimensions of justice but also the procedural aspects that support these disparities. This exploration involves an examination of various policies that directly influence these issues. Amongst the policies reviewed are strategic documents and legislation with both broad and direct implications.[7]

7 Editors' note: This is in line with the broad definition of policy used in Chapter 10.

The National Development Plan (NDP) (RSA, 2012) and the Govan Mbeki Integrated Development Plan (Govan Mbeki Municipality, 2024b), along with the Mpumalanga Spatial Development Framework (Mpumalanga Province, 2019), offer strategic guidance at the national, municipal, and provincial levels, respectively. Legal frameworks such as the National Environment Management: Air Quality Act (39 of 2004) (RSA, 2004) and the National Environmental Management Act (107 of 1998) (RSA, 1998), alongside the Air Quality Offsets Guideline (RSA, 2016), provide a national legal basis for addressing environmental concerns. Additionally, municipal bylaws and policies, exemplified by a limited selection discussed in this chapter, such as the Govan Mbeki Spatial Planning and Land Use Management, Public Participation, Electricity, and Control and Management of Informal Settlements bylaws, play a crucial role in shaping local governance and public engagement in these critical issues (see Table 6).

The third dimension of spatial justice, recognition, will be addressed by combining the survey results with the policy analysis by critically enquiring whether policy documents reflect or recognise the lived experience of residents.

After the presentation of the results of the analysis in the next section, the discussion within this chapter will engage in a critical dialogue on how the three dimensions of spatial justice – distributional, procedural, and recognition – are addressed or remain unmet within the policy and service delivery frameworks. The empirical data collected through the Nova Institute's efforts, together with the policy analysis, supports our discussion, facilitating the examination of the interplay between urban planning, service provision, and the lived realities of communities in the shadow of industrial development.

Table 6: The documents applicable to the Govan Mbeki municipality accessed for analysis

The National Development Plan (NDP)	Strategic	National
Spatial Planning and Land Use Management Act	Statute	National
Govan Mbeki Integrated Development Plan	Strategic	Municipal
Mpumalanga Spatial Development Framework	Strategic	Provincial
National Environment Management: Air Quality Act, 2004	Statute	National
National Environmental Management Act, 1998. Air Quality Offsets Guideline	Statute	National
Govan Mbeki Spatial Planning and Land Use Management	Bylaw	Municipal
Public Participation	Bylaw	Municipal
Electricity	Bylaw	Municipal
Control And Management of Informal Settlements	Bylaw	Municipal

3.2.1 Demographics of eMbalenhle and Lebohang (Table 7)

The communities of eMbalenhle and Lebohang have experienced changes over nearly a decade, with data from 2022 revealing shifts in demographic and socioeconomic patterns compared to 2013. eMbalenhle, in 2022, saw a decrease in the average number of persons per household and a slight reduction in the number of households per stand, indicating possible shifts in living arrangements or population density. The working-age population (15 to 64 years) remains a majority, with a small uptick observed. Notably, the percentage of orphans, both maternal and double, has decreased, suggesting improvements in parental survival or effective orphan care strategies. IsiZulu and isiXhosa remain the predominant languages, reflecting cultural continuity. However, there is a marked increase in unemployment, rising to over half of the population, with nominal household incomes increasing slightly since 2013, but the median income has decreased.

While nominal mean household incomes in eMbalenhle and Lebohang have shown a slight increase or decrease, respectively, over the past decade, the real purchasing power of these incomes, when adjusted for inflation, reveals a significant decline. In eMbalenhle, the mean income rose marginally from R2,251 in 2013 to R2,464 in 2022, yet the median disclosed income saw a sharp decrease from R2,000 to R1,400 in the same period. Conversely, in Lebohang, both mean and median disclosed incomes decreased from R2,206 to R2,035 and from R1,500 to R1,450, respectively. This decline in median incomes is particularly alarming when considering inflation; the 2013 median income of R2,000 in eMbalenhle would equate to R3,157 in 2022, meaning that the current median income of R1,400 represents less than half of its former value, adjusted for inflation. Similarly, in Lebohang, the 2013 median income value of R1,500 should have been R2,368 in 2022, emphasising a significant rise in income poverty in both communities. Furthermore, the decrease in household sizes in both communities could impact the perception and reality of income poverty when analysing per capita incomes and comparing them to the StatsSA poverty lines.

Table 7: Key demographic data (point estimate) for Lebohang and eMbalenhle

	eMbalenhle		**Lebohang**	
	2022	**2013**	**2022**	**2013**
Number of persons per household	3.4	3.98	3.13	4.19
Number of households per stand	1.81	2.3	1.11	1.05
Age (mean)	28.15	26.48	29.06	26.69
age 15–64	68.91%	68.70%	66.90%	61.10%
Sex female	52.48%	50.10%	55.48%	52.40%
Orphans maternal	2.91%	5.90%	3.20%	8.00%
Orphans double	1.60%	2.40%	1.84%	3.10%

	eMbalenhle		Lebohang	
	2022	**2013**	**2022**	**2013**
main language isiZulu	66.09%	64.91%	91.74%	81.58%
main language isiXhosa	10.74%	7.58%	2.00%	1.69%
main language Sesotho	8.68%	9.10%	1.83%	4.95%
Employment economically active population % full-time employed	25.90%	30.30%	21.16%	28.70%
% male full time	12.14%		9.72%	
% female full time	8.18%		6.42%	
% unemployed	55.61%	58.80%	67.38%	60.50%
Mean nominal income of household (all sources) R1,000 = 49 euro	R2,463.58	R2,251.12	R2,034.81	R2,206.41
median	R1,400.00	R1,450.00	R2,000.00	R1,500.00
Lower bound poverty line (LBPL) (less than R945/month in 2022; R587 in 2013))	68.00%	55.90%	65.77%	75.00%
Perceived good health (scale 0–10)	7.14	7.10	7.55	7.10

Lebohang's households have also seen a reduction in size, and most of its residents are of working age, although the percentage has decreased slightly since 2013. The female population has seen an increase, and the employment rate has improved marginally. IsiZulu has become even more prevalent as the main language. The household median income has seen an increase, yet a significant proportion of the population, almost 66%, remains below the lower-bound poverty line. Interestingly, perceptions of good health in Lebohang and eMbalenhle have remained relatively stable (Nova Institute, 2023b).

3.3 Interventions in eMbalenhle and Lebohang through Sasol Secunda's air quality offset plan

Sasol, a global energy and chemical company, operates one of its largest facilities in Govan Mbeki Municipality. The implementation of air quality offset measures by Sasol emerges from a necessity to adhere to the Department of Environmental Affairs' revised Minimum Emissions Standards (MES) under the National Environmental Management: Air Quality Act (NEM: AQA)[8]. These standards aim to curtail atmospheric emissions and mitigate their impact on public health and the environment. While Sasol's initiative is positioned within the legislative mandate to improve air quality around its industrial operations, including the townships of eMbalenhle and Lebohang, the effectiveness of these measures and aims, as described in their offset plans, needs critical examination.

For companies operating within South Africa, compliance with the NEM: AQA, and its amendments is crucial. The Act provides a proactive approach to managing air quality, requiring businesses that emit pollutants to obtain atmospheric emission licenses (Chapter 5). This process involves assessing the potential impact of their operations on air quality and implementing necessary mitigation measures to minimise adverse effects. Companies must meet national Minimum Emission Standards (MES), adhere to specific pollutant emission limits, and submit detailed reports on their emissions. In some instances, companies may apply for a postponement to the compliance timeframes for the MES. There are three relevant types of applications (RSA, 2016):

- an application for postponement of MES-compliance timeframes anywhere in South Africa.
- an application for a variation of a license (that could facilitate increased emissions) anywhere in South Africa.
- an application for an atmospheric emission license for a new listed activity in areas where National Ambient Air Quality Standards are being or are likely to be exceeded. The portion of South Africa where this application is relevant

8 Editors' note: Discussed in some detail in Chapter 10.

> to offsets is formally declared Priority Areas. Areas with "poor" or "potentially poor" air quality were formally listed in relevant tables in the proposed 2012 National Framework and in discussions of areas with poor or potentially poor air quality in the published National Framework for Air Quality Management in the Republic of South Africa 2017.

In a move towards innovative environmental protection, the introduction of air quality offsets in 2016 in terms of NEMA has allowed companies to invest in projects that improve air quality in communities near their operations. These offsets are not meant to replace direct emissions reduction caused by industry or regulatory enforcement mechanisms but serve as supplementary measures for achieving broader air quality and environmental goals (RSA, 2016; 2004). The guideline sets a structured approach for the application and implementation of air quality offsets. It specifies the scenarios under which offsets become relevant, such as when entities seek postponements to meet emissions standards when they are applying for a variation of licence or operate in zones that fail to meet ambient air quality standards. The guideline stipulates that "an offset is an intervention, or interventions, specifically implemented to counterbalance the adverse and residual environmental impact of atmospheric emissions to deliver a net ambient air quality benefit within, but not limited to, the affected airshed where ambient air quality standards are being or have the potential to be exceeded and whereby opportunities and need for offsetting exist".

Air quality assessments highlight that, beyond industrial emissions, other sources such as domestic fuel burning, burning of domestic waste, veld fires, vehicle emissions, and mine dumps contribute to deteriorating ambient air quality. These non-industrial emissions sources, because of their complex nature and the cross-departmental mandate for their management, pose challenges. Offset programmes offer an opportunity for collaborative efforts between the government and polluting industries to address these challenges and enhance air quality.

Sasol's air quality offset plan states that it is developed in alignment with the 2016 Air Quality Offsets Guideline (RSA, 2016). It involves a series of interventions aimed at reducing particulate matter (PM) and sulfur dioxide (SO_2) emissions. The plan outlines a blend of community-based projects and innovative solutions targeting emissions from non-industrial sources. However, critical voices highlight concerns regarding the sufficiency of these measures in addressing the root causes of pollution and their alignment with the broader goals of environmental justice and spatial equity (CER, 2021).

Key interventions in eMbalenhle include veld fire management to reduce PM emissions, the insulation of Reconstruction and Development Programme (RDP) (Nelson Mandela Foundation, 1994) homes to decrease the reliance on solid fuel burning, and a comprehensive campaign to establish air quality and quality of life baselines. These measures are designed not only to directly improve air quality but also to enhance the overall living conditions of the community members. In Lebohang, the plan tested innovative solutions to local challenges, such as dust suppression on unpaved roads (its impact proved limited, so this intervention was not further developed) and the exploration of insulation techniques for informal housing. A stove swap programme was introduced to promote cleaner cooking methods, aiming to reduce household PM emissions further (Sasol, 2017).

The plan, spanning from 2015 to 2020, details specific timeframes for each intervention, aligning with the complexity and preparatory needs of the activities. For example, annual veld fire management activities are timed to precede the dry season, while the insulation of solid fuel-burning RDP homes is scheduled to achieve significant coverage (75%) by 2020 (with the remaining 25% to be completed in the subsequent 12 months). The testing of innovative solutions in Lebohang was set to begin with feasibility studies, with the potential for a broader rollout of successful interventions (Sasol, 2017).

An evaluation conducted in 2023 demonstrated the effectiveness of one of these interventions that formed part of

the broader air quality programme, namely, the insulation of RDP homes together with swapping a coal stove for a liquefied petroleum gas (LPG)[9] stove and heater. The assessment of this household intervention used both quantitative and qualitative methods, including a comprehensive survey of 507 households, in-depth interviews with 23 households that had reintroduced coal, and additional telephonic interviews with a control group that had yet to receive the intervention by 2022. One of the standout findings from the study was that 97% of the households surveyed remained free from coal use, illustrating the initiative's success in mitigating reliance on solid fuels for heating. This figure is particularly significant when considering the thermal comfort and health benefits associated with reducing indoor air pollution. The sustained absence of coal use, even amongst new occupants of the intervened houses, further emphasises the lasting impact of the interventions. The programme also highlighted the role of supplementary LPG equipment in facilitating the transition away from coal. The provision of LPG stoves and heaters was met with high satisfaction, as these alternatives effectively replaced coal for cooking, water heating, and space heating, thus contributing to a significant reduction in emissions. Moreover, the project's phased approach to intervention, from initial research and development to full-scale implementation, played a crucial role in its success. By adopting a staged strategy, Sasol was able to refine and optimise the interventions based on real-world feedback and trials, ensuring that the solutions were practical and effective. The Sasol Secunda air quality offset programme stands as a good example of how air quality offset projects can be successfully implemented to address non-industrial emissions in dense, low-income settlements. Its achievements in significantly reducing reliance on coal, enhancing indoor air quality, and improving thermal comfort within homes contribute meaningfully to the Sustainable Development Goals (Murray et al., 2023).

Sasol's air quality offset plan has initiated concrete interventions in the surrounding communities, driven by the

9 Editors' note: Discussed with picture in Chapter 4.

necessity to comply with environmental regulations. These interventions have included comprehensive studies aimed at understanding the impacts of such measures, thereby contributing valuable data for assessing service distribution disparities, policymaking processes, and the recognition of diverse community needs and identities.

4. Results

Schlosberg (2004) maintains that the three dimensions of spatial justice work together. With this in mind, the three dimensions are first scrutinised and then considered in an integrated manner in the discussion section. First, using the results of the Nova reports (Nova Institute, 2023a ; 2023b; 2014), the disparities in service distribution are presented as they are a crucial indicator of the distributional dimension of spatial justice. Next, a more in-depth examination of the policies reveals that while spatial justice is part of the policy narrative, its implementation is lacking. The third dimension, recognition, is addressed throughout both sections.

4.1 Service Distribution Disparities

4.1.1 Access to water

The water service in eMbalenhle experienced a decrease in quality, as indicated by a reduction in satisfaction scores from 2013 to 2022. In 2022, only 88.23% of households reported having a tap or borehole in their yard, a significant decrease from nearly universal access in 2013. The water delivery failure rate increased, leading to reports of toilets not being able to flush because of water unavailability. Respondents in the surveys expressed dissatisfaction with the frequency and reliability of water supply, noting instances where water was unavailable for several days. Similar trends were observed in Lebohang, with the satisfaction score for water services dropping significantly. The proportion of households with access to a tap or a borehole in their yard decreased from 99% in 2013 to 80.71% in 2022. Water supply was reported to be unavailable for an average of 5.85 days in the last 90 days before the survey, indicating a high

level of service delivery failure. Respondents complained about the lack of communication from service providers regarding water cut-offs and the sometimes poor quality of the water supplied (Nova Institute, 2023a; 2014).

Across the municipality, there has been a notable advancement in the provision of piped water, with access extending to 107,191 households, achieving 98.4% coverage. This significant improvement emphasises that the vast majority of residents now enjoy the benefits of direct water access. However, 1.6% of households, amounting to 1,704 homes, remain without this essential service. This achievement contrasts sharply with the situations in eMbalenhle and Lebohang, where, despite the increase in households receiving water services, satisfaction levels have declined. This discrepancy is particularly pronounced in areas witnessing the growth of new informal settlements.

Table 8: Key indicators: water supply services (QoL Surveys Nova 2022 and 2013)

	eMbalenhle		**Lebohang**	
	2022	**2013**	**2022**	**2013**
Satisfaction with water (scale 0–10)	7.24	7.60	5.93	7.68
% hh piped water into the house	54.94%	26.70%	54.67%	59.60%
% hh tap or borehole in yard	88.23%	100.00%	80.71%	99.00%
% hh communal pipe/borehole outside yard	10.31%		15.32%	
% hh from a neighbour	1.46%		1.92%	
Water supply days unavailable per hh (last 90 days)	2.84	0.49 (last 30 days)	5.85	0.95 (last 30 days)
Access to flush system in yard (% hh)	84.86%	100.00%	74.57%	100.00%

	eMbalenhle		Lebohang	
	2022	**2013**	**2022**	**2013**
% flush toilets always working	75.70%		87.80%	
Unventilated pit latrine as main toilet % hh	6.83%	0.00%	15.15%	0.00%
No toilet in yard % hh	6.38%	0.00%	9.97%	0.00%
Access to waste collection service % once a week collected	74.71%	97.00%	74.35%	100.00%

(hh = household)

4.1.2 Access to electricity

The townships of eMbalenhle and Lebohang have been experiencing a notable decline in access to electricity, particularly in new informal areas. This troubling trend is further exacerbated by significant electricity outages that residents encounter, with eMbalenhle reporting an average of 85.49 days and Lebohang 59.23 days out of 90, with outages lasting an hour or more. These statistics reflect the acute challenges posed by load shedding – a controlled power outage measure implemented by South Africa's power utility at the time to prevent the grid from being overwhelmed.

In eMbalenhle, the percentage of households using electricity for any purpose dwindled from 90.89% in 2013 to 84.36% in 2022. This decrease is not only statistically significant but also impactful, as electricity is the main energy source for cooking in most households, a basic daily need. Concerns raised during group interviews about the quality and safety of electrical connections emphasise the precarious situation that residents face, particularly in light of the increased service delivery failures. Lebohang mirrors these issues, with a marked decrease in the proportion of households with access to electricity, from 98.46% in 2013 to 76.29% in 2022. This reduction in access

heightens the vulnerability of the community, most of whom rely on electricity as the primary energy source for cooking. Load shedding's impact was deeply felt here as well, disrupting daily life and highlighting a significant infrastructural challenge (Wentink, 2023).

The phenomenon of load shedding in South Africa is indicative of broader systemic issues, including ageing infrastructure, increased demand for power, maintenance backlogs, and financial constraints faced by the power utility, exacerbated by numerous accounts of corruption and "state capture" (Wentink, 2023). The resultant outages were not only inconvenient but also disrupted economic activities, affected the delivery of other essential services, and posed safety risks. The issue becomes more problematic in informal settlements, where unlawful ad hoc and often unsafe electrical connections put communities at risk of fires and other hazards.

Table 9: Key indicators: electricity supply services (QoL Surveys Nova 2022 and 2013)

	eMbalenhle		Lebohang	
	2022	**2013**	**2022**	**2013**
Electricity use (all applications) % households using electricity	84.36%	90.89%	76.29%	98.46%
Electricity service failure MEAN days per hh failure ≥ 1 hour (last 90 days)	85.49%		59.23%	
Electricity as primary energy for cooking % households cooking	81.36%	84.26%	69.75%	83.33%

4.1.3 Waste disposal[10]

Waste management is a critical component of municipal services, impacting environmental sustainability and public health. In eMbalenhle and Lebohang, a marked disparity

10 Editors' note: Waste is extensively discussed in chapter 5, but mostly in a rural context.

emerges in the effectiveness of waste disposal services between the years 2013 and 2022, as shown in Table 10.

In eMbalenhle, the situation appears particularly challenging. The data from 2022 reveals that 64.83% of households reported waste collection failure more than once a month, a substantial rise from 13.8% in the last 30 days of 2013. This suggests not only a service deterioration over time but also highlights systemic inefficiencies within the waste management framework. The practice of domestic waste burning, which was reported by 15.23% of households in 2022, further emphasises the lack of reliable waste disposal mechanisms. This is reflected in the decrease in satisfaction with "getting rid of domestic waste," which scored 5.57 on a scale of 0 to 10, representing a relatively moderate level of dissatisfaction amongst the residents. Contrastingly, Lebohang exhibits a more positive trajectory in waste management services. While there was a slight increase in waste collection failures, reported by 7.48% of households in 2022 compared to 4.6% in the last 30 days of 2013, the township demonstrates a more robust waste management service relative to eMbalenhle. Additionally, the frequency of domestic waste burning in Lebohang is significantly lower, with only 2.76% of households resorting to this method in 2022, indicating a higher efficacy in waste removal services as opposed to eMbalenhle. Satisfaction with waste disposal in Lebohang is comparatively higher, with a score of 6.00 on the satisfaction scale.

It is noteworthy that the percentage of households that benefited from regular waste collection services once a week stood at 74.71% for eMbalenhle and 74.35% for Lebohang in 2022. This figure, while representing a majority, nonetheless signifies that approximately one in four households do not receive this basic service on a consistent weekly basis. The data presents a complex picture of waste disposal services within the townships. While Lebohang shows relative stability and better performance in waste management services, eMbalenhle's situation calls for urgent attention and improvement. The decline in service delivery quality over the years in eMbalenhle not only jeopardises the living conditions but also poses

significant environmental and health risks, as is illustrated by a reaction from one of the respondents:

> I have a problem because some people use buckets to help themselves and they throw that human waste where we throw away waste, when we go there to look for wood and papers to make fire, we handle human waste with our hands. People are helping themselves inside their houses now.

Table 10: Key Indicators: waste management services (QoL Survey Nova 2022 and 2013)

	eMbalenhle		**Lebohang**	
	2022	**2013**	**2022**	**2013**
Waste collection failure (last 90 days) % more than once a month	64.83%	13.8% last 30 days	7.48%	4.6% last 30 days
Satisfaction with "getting rid of domestic waste" (Scale 0–10)	5.57	6.26	6.00	7.65
Domestic waste burning % hh burning	15.23%		2.76%	
Regular domestic waste burning % hh	10.60%		1.55%	

4.1.4 Housing

Between 2013 and 2022, the townships of eMbalenhle and Lebohang have seen significant growth in informal housing, which is a key indicator of the increasing pressure on existing urban infrastructure and services. In eMbalenhle, approximately 6,792 new informal structures have emerged, constituting around 13.08% of the estimated 51,918 households in 2022. The southwest region of eMbalenhle, particularly the Marikana area, has experienced the bulk of this expansion. In Lebohang, the growth has been even more pronounced relative to its size, with about 2,604 informal houses being added, making up roughly 23.62% of the total 11,025 households in 2022. This growth

is concentrated in Extension 16 to the southeast (Murray et al., 2023).

This escalation in informal housing emphasises the challenges faced by these communities in terms of housing, employment, and access to basic services. The quote below from an interview with a resident is clear:

> But the shack will always be the shack, when it is raining, there will be leaking inside the shack; when there is wind, the wind comes and put all the dust inside, and your furniture and clothes will be full of dust.... When it is cold, it is cold, and when it is hot, it is hot. It goes along with the weather..... our houses want to move or fly away if there is a wind.

The demographic and socioeconomic data from 2022 reflect these underlying pressures, with high unemployment rates and a significant portion of the population living below the poverty line. Yet, despite these difficulties, the perception of good health remains relatively positive, indicating resilience amidst these shifts.

4.2 Policy and Processes

Although references to 'spatial justice' are sparse, the principles supporting it are apparent throughout policy documents at several levels (from the National Development Plan (NDP) to the Provincial Spatial Development Frameworks and local Municipal Integrated Development Plans (IDPs)), suggesting a commitment to rectifying spatial inequities (Govan Mbeki Municipality, 2024b; Mpumalanga Province, 2019; RSA, 2004).

The Spatial Planning and Land Use Management Act (SPLUMA), enacted in 2013 and implemented in 2015, is one of the more crucial legislative instruments to propel the country towards spatial transformation. SPLUMA aims to dismantle the unequal spatial patterns of the past by putting forward a more socially inclusive approach to service delivery. Next to putting the principle of spatial justice high on the agenda, SPLUMA puts forward several other principles and authorises the Minister to

prescribe norms and standards that need to be included on all policy levels to ensure land development and land management that is fair and just (RSA, 2103, pp. 19–20).

SPLUMA includes the principles of spatial justice and operationalises them through its new spatial planning system, placing local municipalities at the forefront of spatial planning and decision-making related to land use management. This role of local governments is also central in effectuating the vision laid out by the NDP for addressing South Africa's socioeconomic issues through spatial transformation (RSA, 2013). However, as discussed later, putting the heavy burden on a governmental level that faces structural capacity problems, corruption, and mismanagement is problematic. SPLUMA pushes the integration of spatial justice principles within local legislative frameworks (RSA, 2013, p. 17), such as bylaws of the Govan Mbeki Municipality. Yet, this commitment often stumbles in the face of practical capacity and implementation challenges at the local level.

The electricity bylaw primarily addresses the distributional aspect, aiming to ensure electricity provision to all residents. However, it falls short by focusing mainly on procedural and technical aspects of electricity supply without considering the spatial disparities that affect access to electricity. The challenge of delivering services uniformly across the municipality is not unique to electricity but extends to all municipal services. This issue is highlighted in the South African Human Rights Commission (SAHRC) report, where the Govan Mbeki municipal manager acknowledges several challenges, such as the difficulties in developing bulk infrastructure for new settlements and managing waste and landfill inadequacies. The electricity bylaw fails to address the specific needs of different community groups, especially those in informal settlements and rural areas, who are often marginalised in service delivery strategies. Additionally, disputes with Eskom over high electricity rates exacerbate the precarious situation of informal settlements, leading to frequent power outages (SAHRC, 2022, pp. 36–44).

The relevant bylaw public participation specifically mentions that in case the municipality is going to decide on the provision of services through service delivery agreements, the public must be invited to submit their views, but while this aims to ensure community engagement[11], this bylaw risks falling short in practice (SAHRC, 2022). The control and management of informal settlements bylaw, with its focus on the classification and management of informal settlements, including the eviction and demolition of structures deemed unauthorised, is technocratic and overlooks the nuanced realities and needs of those living in informal settlements. The procedural guidelines for dealing with land invasions, evictions, and the demolition of unauthorised structures do not align with the broader need for in-situ upgrading of informal settlements as advocated for in, for example, the National Housing Code. The bylaw embodies the very contradictions which Huchzermeyer (2009) highlights as a gap between the recognition of informal settlements as integral parts of urban environments that could potentially positively contribute to society and the prevailing perceptions and administrative practices that view them as problems to be eradicated.

South Africa does not have a Corporate Social Responsibility (CSR) act, and when notions of CSR are embedded in legislation, they are inadequate and fragmented (Kloppers, 2020, p. 103). Conversely, it is worth noting that there are instances where legislation provides incentives for businesses to engage in activities that produce additional betterment of society or public benefits. Relevant to this chapter is the 1998 NEMA Act[12] (RSA, 1998) and, more specifically, the 2016 implementation of air quality offsets (RSA, 2016). As stated previously, the offset scheme does not absolve businesses of their legal responsibilities; however, it does provide the means to establish initiatives that can directly improve the standard of living, particularly for the most disadvantaged members of society. In consultation with local authorities, businesses

11 Editors' note: We want to remind the reader of the IAP2 Spectrum of Public Participation and related ladders of participation discussed in Chapter 9.

12 Editors' note: The NEMA regime is discussed in detail in Chapter 10.

are permitted to determine their own offset implementation strategies. The Sasol plan outlines unambiguous principles (Sasol, 2017). Sasol opted to implement several tangible interventions in eMbalenhle and Lebohang, including techniques for insulating informal housing, implementing cleaner cooking methods, and veld fire management. In addition to allocating resources towards education and awareness initiatives, ongoing efforts are being made to promote STEM (science, technology, engineering, and mathematics) career pursuits amongst students through the awarding of prizes. Despite the existence of research indicating a shortage of STEM professionals (Chrysostome et al., 2019), the direct impact of these investments on the quality of life in disadvantaged communities remains debatable. However, these endeavours do demonstrate that private organisations such as Sasol are performing a portion of the responsibilities that we would anticipate from a local government. The implementation of robust CSR legislation has the potential to enhance the private sector's commitment to societal obligations. This can be established in a framework law in a more tangible and legally grounded manner (Kloppers, 2020, p. 103).

Our analyses have revealed various concerns pertaining to justice, with a recurring theme being the failure to adequately establish recognition justice. Although the NDP and SLPUMA explicitly put forward the concept of spatial justice in their aim to rectify the past injustices of apartheid, a clear roadmap and implementation strategies are missing. It is evident that service delivery problems mostly affect the most vulnerable communities, which are also the most affected, whereby it needs additional acknowledgement that using household-level data hides the inequalities that are present within these households, such as gender or age inequalities. Additionally, procedures and so-called participatory processes fail to adequately address how these groups may effectively express their frustrations and concerns.

5. Discussion

In the introductory section of this chapter, we emphasised the significance of incorporating the notion of spatial justice into spatial planning to facilitate transformative change. The increasing number of essays and scholarly works on spatial justice, the concept of a just city, and the idea of just transitions, as well as their incorporation into the vision and policy documents of international organisations such as the UN, acknowledge the conviction that spatial justice has the potential to be a strong framework for promoting a more equitable and fair approach to urban development. This framework can effectively integrate social and environmental justice. Therefore, it is unsurprising that similar principles are also permeating the policies and legislative instruments of subnational governments, such as provinces and municipalities. Nevertheless, the analyses conducted in this chapter, which commenced with an exploration of the disparities in the provision of services in eMbalenhle and Lebohang and subsequently delved into the policies that influence these disparities, have unequivocally demonstrated that despite explicit policy involvement, we are still far from attaining a more equitable living environment. This concluding section clarifies essential factors that impede the execution of spatial justice principles and argues that the existence of spatial justice as a comprehensive framework is contingent upon the presence of a well-developed implementation strategy, active involvement of local governments, adequate human and financial resources, and commitment from the private sector rooted in concern for society. Commitment to planetary well-being values should be part of industries' corporate identity and be strived for, not only in the context of regulations such as keeping environmental and social licenses to operate, but also through voluntary contributions as part of a responsible ESG corporate culture (Bai et al., 2024). Four aspects are discussed in more detail: (1) the critical issue of human capacity, financial constraints, and corruption; (2) the historical legacy of apartheid; (3) the ambivalent role of the private sector and (4)

the need to move from policy intention and fluffy programme writing to evidence-based planning.[13]

5.1 Critical issues of human capacity, financial constraints, and corruption

Palmer et al. (2017) acknowledge that South Africa is a capable state, but they also recognise that this capability is fragile. This fragility is evident in the difficulties that governments face in consistently delivering services and effectively addressing the negative consequences of apartheid rule. The South African democratic system is presently confronted with challenges of corruption, as well as concerns regarding the integrity and effectiveness of the government. However, the authors believe that at the local level, the municipalities have the necessary competencies to take the country forward post-apartheid. Initially, there existed environmental capacities, encompassing thriving urban and commercial agriculture economies, as well as a substantial population of affluent individuals, notwithstanding racial and regional disparities. Urban municipal governance systems that have evolved over several decades or even centuries and are thus robust can be redirected to foster democracy and facilitate economic progress. The national ministry specifically focused on municipalities, formulated novel policies for local administration to promote development, and overhauled organisational cultures to prioritise poverty eradication strategies (Palmer et al., 2017).

Presently, it is evident that numerous local governments, with Govan Mbeki Municipality serving as a prominent illustration, are facing a significant deficiency in sufficiently skilled personnel (Huchzermeyer, 2009; Pieterse, 2021; Sartorius & Sartorius, 2016). The issue is further exacerbated by the inconsistent and insufficient allocation of funds towards capacity-building. Consequently, a significant portion of the city's responsibilities are frequently outsourced.

13 Editors' note: Closely related to evidence-based or evidence-informed policymaking discussed in Chapter 10.

Nevertheless, consultancy companies also face the same issue of limited capacity.

The municipality of Govan Mbeki has been subjected to legal action because of the ongoing disagreement with Eskom on electricity supply and the municipality's failure to pay financial obligations, resulting in power outages. Municipalities are insufficiently overseeing their resources. The South African Human Rights Commission (SAHRC, 2022) explains that the existence of corruption exacerbates the strain on these resources, resulting in the diversion of essential funds from the development of services and facilities. This contributes to the overall sentiment of the residents, who are very distrustful of the government, as becomes clear by the following statement made by one of the residents:

> I blame the municipality. The municipality is the one that must come and collect waste here in the community. And if they do not come, we are also able to do other things and clean up in the community.

Greffrath and Van der Waldt (2016) contemplate whether, in the current situation, whereby the state is dysfunctional, self-help governance could be a temporary solution. Self-help governance refers to the practice of communities helping themselves. While this approach can assist communities in addressing immediate challenges, it is not a long-term solution. It necessitates communities to effectively mobilise and collaborate with other entities, such as the state or private actors. However, it cannot absolve the state of its responsibility.

5.2 Historical legacy and spatial embeddedness and the (un) capable state

Today's situation cannot be understood without acknowledging the legacy of the apartheid regime and colonial practices before that. Its influence continues to reverberate in the present day, both in terms of spatial structure and governance practices.

The National Party (NP) took power in 1948 and further codified and intensified existing racial discrimination, resulting

in the passage of undemocratic and racist legislation such as the "Natives Land Act" (1913), "Natives Trust and Land Act" (1936) and "Natives (Urban Areas) Act (1923)." The "Group Areas Act" (1950) was critical in urban planning since it limited distinct demographic groups to designated areas, resulting in terrible results. The division of the state was a cornerstone of the government's aim of ensuring white supremacy. Urban planners developed plans for the 'perfect apartheid city' that were adapted to the local geographical circumstances (Newton, 2008). These pieces of legislation and approaches have fundamentally influenced the spatial distribution of economic opportunities and wealth, on the scale of the country and on the more local scales (Sartorius & Sartorius, 2016). It is not surprising that when discussing justice, the NDP, SPLUMA, the provincial and local development plans put reparation and rectifying the injustices of the past central. However, the justice question cannot limit itself to reparation. Justice needs to be anchored in systems that allow structural and long-term change. If spatial justice is included in policy, it must be undertaken by recognising "the inherent spatiality of the processes that (re)produce social inequalities within and across regions" (Madanipour et al., 2022, p. 810) and over longer periods. These processes must "be recognised as intrinsic to public policies of resource allocation, market investment decisions, and individual and group life trajectories" (Madanipour et al., 2022, p. 810). Thus, achieving spatial justice cannot be achieved by only rectifying past injustices but requires a sustained commitment to the different tenets of spatial justice (distributional, procedural and recognition).

Next to the historically embedded spatiality of injustice, the municipal organisation and processes are also still impacted by history. Rural municipalities, in particular, had little organisational capacity from the start, and the national government either failed to give or was incapable of providing the necessary support in and after 1994 (Palmer et al., 2017). As argued above, municipal efficiency, technical knowledge and governance capacity need urgent improvements, together with

fighting corruption and nepotism (Greffrath & Van der Waldt, 2016; Huchzermeyer, 2009; Sartorius & Sartorius, 2016).

5.3 The ambivalent role of the private sector

Neoliberal principles have permeated different aspects of society, including spatial planning. Within a neoliberal paradigm, space is a commercial asset. Its value, particularly for investment and development, is determined by factors such as its location (Tasan-Kok & Baeten, 2012). Cities and places try to brand themselves to attract international companies, investors, and higher-income classes in the (global) competition for growth and wealth, turning urban landscapes into places for capital accumulation and socioeconomic difference. Companies are strong stakeholders and powerful negotiators that frequently secure advantageous conditions by claiming to promote job creation and economic prosperity. The private sector can likewise generate opportunities by recognising its potential influence. Incorporating the private sector into equitable and environmentally sound urban development and service provision can manifest in several forms. Only a few potential options are examined here.

Sasol's air quality offset programme illustrates how a legal framework can direct private actors towards creating public benefits. The NEMA, by making the air quality offset approach possible, stimulates companies to engage in community-based projects to improve the direct quality of life of residents. However, these initiatives do not address the root causes of the injustices but are merely mitigating their effects. Kloppers (2020) argues that South Africa requires more comprehensive CSR legislation for companies to take up their social responsibility. The present voluntary character of CSR results in fragmented and occasionally superficial involvement (Kloppers, 2020). However, it remains uncertain to what extent the implementation of a legal framework may provide a more organised and sustainable contribution of private companies to societal well-being. Another point of concern, as explained below, is that corporate involvement in local development should be grounded in evidence. This means that

the interventions funded through CSR should not only focus on educational and training initiatives or awards but should also have a direct and measurable impact on the quality of life of the local communities.

Palmer et al. (2017), when describing what a capable state could look like, are supportive of partnerships between the private sector, government, and civil society. They argue that the private sector could potentially play a role in compensating for municipal capabilities, especially in those areas where the state or the local government lacks capacity and resources. As we have discussed above, patronage, lack of capacity, also with service providers and mismanagement, raise doubts about the success of these partnerships. Thus, these partnerships need strict guidelines that define roles, expectations, and accountability mechanisms to ensure that the outcomes are equitable and beneficial to all, especially the underprivileged communities (Palmer et al., 2017).

5.4 From policy intentions to evidence-based planning

The measures implemented by Sasol as part of the air offset programme encompassed both tangible spatial solutions and the enhancement of human capacity through training programmes and school awards, amongst other initiatives. While acknowledging the importance of improving human capital, as evidenced by a significant shortage of STEM professionals and adequate expertise within both municipalities and consulting firms that frequently serve as subcontractors for these local governments, the primary requirement is to implement specific and quantifiable interventions.

These pragmatic interventions emphasise the feasibility of sustainability transformations and their potential to enhance residents' lived experiences immediately. Measurable impacts are crucial, as they enable municipalities and governments to establish stringent regulations that firms can effectively implement through programmes such as air offset programmes and CSR initiatives. The importance of such measurability is highlighted by findings from Nova's surveys, emphasising

the need for well-defined protocols for continuous evaluation and monitoring.

6. Conclusions

Starting from the very tangible outcomes of service delivery failure in eMbalenhle and Lebohang, two townships in the Govan Mbeki Municipality, this chapter has looked into *if* and *how* spatial justice principles have been integrated into policy and implemented in reality.

The pursuit of spatial justice necessitates a dual approach: addressing historical injustices while simultaneously tackling the pressing, everyday concerns of people. Urban policies should not only focus on long-term visions but must also consider the immediate realities and hardships faced by vulnerable communities. Thus, in policymaking and planning, a balance must be struck between rectifying past wrongs and ensuring the current well-being of all city dwellers (and especially the marginalised communities) on the one hand and developing a long-term vision that is anchored in principles of sustainability and justice on the other. The current policies are very good in describing the long-term visions and the principles on which these are based, but fail to translate these into actionable plans and legislation, as is illustrated by the several bylaws that fail to make a real difference on the ground.

Secondly, establishing a more diverse range of partnerships could potentially support the implementation of spatial justice aspects. The Sasol example is but a first experiment. New forms of collaboration amongst the state, private sector, and civil society could shape preferred development or act on urgent challenges that the government, by itself, is incapable of tackling. However, it will be crucial to ensure that these public-private partnerships are structured in such a way (with tangible and measurable deliverables) that private enterprises contribute meaningfully to public welfare.

Thirdly, capacity-building on the local level is essential, as emphasised by Palmer et al. (2017), the intrinsic capabilities within South African municipalities do exist. However, these

capabilities need to be harnessed through adequate training, resource allocation, and national support to empower local entities to overcome mismanagement, service delivery failures, corruption, etc.

A final aspect that will also contribute to overcoming the capacity challenges at the local level is the need to rethink governance structures, whereby transparency (enabling accountability and responsibility) and participation need to be central. Urban governance should move beyond traditional frameworks to embrace innovative, participatory models that engage communities directly in the decision-making processes affecting their lives, ensuring that policies and plans address the diverse needs of urban populations, especially the underprivileged.

Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used *Grammarly*, *Quillbot*, and *GPT-4* to improve the readability and language of the chapter. After using these tools, the authors reviewed and edited the content as needed. The authors take full responsibility for the publication's content.

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Chapter 12

Case studies in the quality-of-life assessment of cleaner energy interventions through 'narratives of impact'

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Abstract

In air quality programmes, interventions must be found to reduce air pollution from local sources of emissions in low-income contexts[1]. These sources include the burning of domestic fuels such as coal, wood, and paraffin, as well as the burning of domestic waste and vehicle-entrained road dust. Households use domestic fuels that cause harmful emissions: either as primary energy carriers or as stacking fuels for utilities such as cooking, space heating, and heating water for bathing and cleaning. When alternative cleaner energy options are introduced to households, it is crucial that these alternatives improve the quality of life of end users and do not introduce unforeseen negative side effects. Nova investigates the feasibility of interventions or intervention combinations before proceeding to larger-scale implementation.

1 Editors' note: Discussed in some of the preceding chapters, notably Chapters 3 and 4

This chapter scrutinises the process and results followed in feasibility assessments of interventions aimed at replacing or reducing wood use, the burning of domestic waste, and the use of paraffin. The feasibility assessments are done with a novel tool that Nova developed, the *Particular impact on quality-of-life assessment* (Piqola) tool. The chapter introduces the Piqola tool and provides case studies to show how it is used in practice. Specific focus is placed on the role of 'narratives of impact', that is, the information gained from verbatim feedback from participating end users describing how interventions impacted their quality of life. The Piqola tool results are contextualised and evaluated with reference to the broader field of quality-of-life studies.

Keywords: air quality in low-income settlements, energy poverty, narratives of impact, Particular impact on quality-of-life assessment (Piqola), quality-of-life assessment, quality-of-life studies, qualitative research

1. Introduction

As part of its mission to work towards improving the well-being of low-income communities in a responsible way, the Nova Institute, together with households and other stakeholders, is conducting community projects to improve air quality in line with national guidelines in provinces of South Africa that are home to mining operations and coal-fired power plants. The Nova Institute has initiated a novel approach to assessing how introducing interventions to improve everyday lives makes a difference in the quality of life of low-income households in South Africa. It is essential to test potential interventions before scaling these interventions up to the community level. Likewise, in air quality offset programmes, interventions are aimed at reducing harmful emissions caused by domestic energy use. Alternative energy usage patterns introduced to households will only be sustainable if the end users are satisfied with these interventions. Ultimately, end users must be placed in a better situation post-intervention than before the intervention. Therefore, much effort needs to go into planning community projects carefully and systematically to ensure

that the information needed to carry out interventions at scale is known in advance. No stone is left unturned to ensure that interventions fit with householders' needs and lifestyles, as well as their expectations of a better life in future.

Organisation of the Chapter

In this introduction, we first brief the readers on the Nova Institute's novel Piqola tool that is used to evaluate the feasibility of Nova's interventions by assessing the quality-of-life impact on end-using households. The next sections detail Piqola case studies to demonstrate step by step how the Piqola tool was applied in practice. We describe the Piqola indicators that measured how households went about and were satisfied with their daily routines before and after interventions to offset wood and waste burning and paraffin use. We then present findings from the Piqola case studies that showcase the value of narrative responses to inform decisions to implement interventions to scale in the communities under study. The final section discusses the contribution of Piqola to quality-of-life studies and the Social Indicators Movement. The context is the Anthropocene from a developing world perspective.

2. The Qola and Piqola Tools

Nova researchers have developed two original research tools to assess quality of life. The first tool, the Nova *Quality-of-Life Assessment (QOLA) tool, is used to gain a broad overview of an individual's quality of life within* the context of household life. The development and application of this tool are described in an article in the *International Journal of Sustainable Development* by Murray and Pauw (2022). The second tool, the *Nova Particular impact on quality-of-life assessment* (*Piqola*) tool, is used to assess the impact of a particular intervention on the quality of life of an individual in the context of household life. In this chapter, the authors will describe how the Piqola tool works and provide practical examples of how the tool was successfully used to assess the impact on quality of life of interventions to reduce air pollution.

Both the Qola and the Piqola tools build on the conceptual work of Manfred Max-Neef[2] (Max-Neef et al., 1991). For Max-Neef, quality of life depends on the possibilities that people have to adequately satisfy their fundamental human needs. Max-Neef differentiates between needs and satisfiers. For Max-Neef, needs are finite, few and classifiable and do not differ between cultures. Needs are values that include both the aspects of *deprivation* and *potential* (or *capabilities*). His typology of needs is based on nine values: *subsistence, protection, affection, understanding, participation, creation, idleness, identity,* and *freedom*, to which a tenth, *transcendence*, could be added. Thus, what differs between people is not their fundamental human needs but how these needs are satisfied or actualised (Murray & Pauw, 2022).

The development of Nova's quality-of-life assessment tools involved designing a conceptual framework and database for *need-satisfier-interface-analysis*. This was performed by extending Max-Neef's fundamental human needs typology to include aspects of needs and by identifying hundreds of aspects of the household as a complex system and reducing it through a process of semantic clustering to 25 constitutive elements. When the 10 fundamental human needs are placed on the x-axis of a matrix and the 25 household elements on the y-axis, there are 250 need-element interfaces, which Nova uses to analyse need satisfaction in the context of the household.

The difference between the Qola and Piqola tools. The Qola tool starts with a survey with 250 questions that probe need-element-interfaces to get an indication of the quality-of-life perception of an individual in the context of household life. In contrast, the Piqola tool does not start with an existing questionnaire - it is a hermeneutic tool that is used to generate questionnaires. The well-known strengths, weaknesses,

2 Editors' note: The thoughts of Max-Neef (1932-2019) underlies much of this book although it is explicitly mentioned only here and in Chapters 1 and 4. He was known as "The Barefoot Economist" because of his work amongst the poor and his interpretation of development.

opportunities and threats, or SWOT,[3] analysis could perhaps assist in explaining the approach: In a SWOT analysis, one would typically think or brainstorm about issues that confront your business. You will then consider per issue if it is a strength, weakness, opportunity, or threat. Thus, you creatively place an issue, your business, and one of the four SWOT categories together in a hermeneutic domain. SWOT's originator, Robert Franklin Stewart, emphasised the crucial role that creativity plays in the planning process (Puyt et al., 2023). The process aims to facilitate an enhanced understanding of the issues that confront your business to conduct better strategic planning. Whereas the SWOT analysis has four hermeneutic domains, the Nova Piqola framework has 250 hermeneutic domains, or one could also refer to these domains as *need-element-interfaces*.

When using the Piqola tool to generate a questionnaire to measure the impact of an intervention on quality of life, the researcher starts by considering whether the intended intervention could impact on quality of life in each of the 250 domains. Questions that could probe impact are written down in a matrix per domain. This leads to a comprehensive set of questions, which is later analysed and reduced to a practical number of questions for a pre- and post-intervention Piqola survey. Thus, the Piqola tool facilitates a process of *need-element-interface-brainstorming* to generate fitting questions to assess the particular impact of an intervention on the quality of life of end users.

The Piqola survey usually arranges these questions into three categories:

1. Broad semi-structured questions, which are open-ended questions that lead to narrative feedback from respondents. An example of such a question is: Could you please tell us how your household cooks?
2. Satisfaction questions that apply a numeric scale (0–10) that offer respondents the opportunity to rate their satisfaction with aspects of an intervention. An example of such a

3 Editors' note: This is also used as a method of analysis in Chapter 9.

question is: How satisfied are you that you can cook the way that you want to? (0–10)

3. Likert scale questions, which are statements with which respondents can *strongly disagree, disagree, agree, or strongly agree*. An example of such a statement is: Men and women should share cooking responsibilities.

Applying Piqola creatively. The Piqola tool requires experience and creativity from the researcher who applies the tool. Therefore, it is like a wood chisel in the hand of a sculptor rather than a lawnmower that does not require sophisticated skills from the user. The tool facilitates a comprehensive approach to quality-of-life impact assessment, maximising the chances of including relevant questions to explore the impact that the introduction of a new usage pattern can have in the context of a household as a complex system. The tool provides a way not only to gain insight into end user perceptions but also to compare pre- and post-intervention perceptions of participating respondents.

Community engagement. Perhaps the most discernible value of the tool is that it allows for the participation of community members as research partners to share narratives of their lived experiences. Therefore, if applied correctly, the tool does not enforce a preconceived model onto respondents. The comprehensive brainstorming exercise maximises the chance that relevant questions are included. In terms of the approach, the questionnaire starts with open-ended questions, which must allow the respondent to answer spontaneously without being influenced by the interviewer.

Table 11 lists the ten fundamental human needs as proposed by Max-Neef et al. (refer to the left columns of the table), and the 25 household elements identified by Murray and Pauw (2022) (refer to the right columns of the table). These household elements can further be arranged in six element categories (refer to the middle columns of the table).

Table 11: Fundamental needs and quality of life

	Fundamental Needs		**Element categories**		**Household elements**
1.	Subsistence	a.	Basic necessities:	1.	Water
2.	Protection			2.	Food
3.	Affection			3.	Waste
4.	Participation			4.	Clothes
5.	Understanding	b.	Localisation:	5.	Terrain
6.	Creation			6.	Air
7.	Idleness			7.	House
8.	Identity			8.	Climate
9.	Freedom			9.	Sound
10.	Transcendence	c.	Basic activities:	10.	Care
				11.	Work
				12.	Rest
		d.	Relationships:	13.	Self
				14.	Closest partner
				15.	Household members
				16.	Non-household member
		e.	Consciousness:	17.	Trust
				18.	Sensation
				19.	Motivation
				20.	Communication
				21.	Choice
				22.	Discovery
				23.	Meaning
		f.	Body structure:	24.	Gender
				25.	Development phase

3. Piqola in action: assessments of interventions

This chapter aims to introduce quality-of-life researchers and other readers to the Piqola tool in action. We describe how Nova conducted research in target communities to assess the impact of different types of interventions for beneficiaries. We systematically follow each step of three real-life community research projects to illustrate how Piqola generates the most appropriate social indicators to measure the impact of interventions. We present the set of questions that invited households to share their lived experience of daily routines before and after interventions. The open-ended Piqola questions invite respondents to produce 'narratives' that are key to a better understanding of the practical impact of interventions on different aspects of life as well as on overall quality of life. We hope to convince readers that Piqola may become the future research tool of choice for scholars involved in community quality-of-life studies, particularly in a developing country context, where the particular impact on the quality of life of interventions needs to be assessed.

3.1 Piqola case studies

We outline how Nova conducts its research to evaluate air-quality offset intervention options in selected target communities to reduce emissions from domestic wood and paraffin use, and waste-burning. For an intervention to be feasible, it should reduce emissions, have a positive (or at least neutral) impact on quality of life, and be practically implementable. The Piqola tool is used to assess feasibility from a quality-of-life perspective. The intervention should provide better utility to end users than the technology or practices that they are currently using without additional costs, negative side effects, or risks. The in-field feasibility testing using the Piqola tool informs Nova whether the interventions can be upscaled to the whole community.

Research methodology. Target research participants in each of the five different communities under study were assigned to experimental groups and control groups of 20

respondents each. The main person responsible for household tasks was interviewed. Interviews were conducted in the local language. Fieldworkers drawn from the target communities were trained to conduct the interviews. The same fieldworker interviewed the same person in the experimental groups before and after the intervention using Piqola to assess satisfaction with the intervention. Householders' responses were recorded with their permission and translated into English.

In the three **wood-burning communities**, the in-field feasibility study was conducted with six experimental and three control groups of 20 households each. The experimental groups were provided with different combinations of interventions, including the solar water heater, rocket stove, liquified petroleum gas (LPG) stove, as well as a *Wonderbag*[4], as shown here and in Table 12.

Solar water heater

The solar water heater (SWH) installation comprises two distinctive components: the SWH unit (Apollo Solar Technology, 100-litre, low-pressure system) with mounting frame, and a wooden pedestal on which the SWH is mounted. The design attempts to eliminate the safety risk, structural risk and maintenance risk associated with working on the roofs of low-income houses.

4 Editors' note: See Chapter 4.



Figure 27: Solar water heater

Rocket stove

A rocket stove is an efficient and hot-burning stove using small-diameter wood fuel burned in a simple combustion chamber with an insulated vertical chimney. This design ensures almost complete combustion before the flames reach the cooking surface. A *Burn Kuniokoa* stove was selected for the feasibility testing.



Figure 28: Rocket stove

Wonderbags

The *Wonderbag* is a non-electric slow cooker that uses heat-retention technology to continue cooking food once the pan has been removed from the heat source. Nova fieldwork teams distributed the *Wonderbags* with pots to participating households and trained them on usage.



Figure 29: Wonderbags

LPG stoves and cylinders

A 4-burner LPG stove and oven from Totai was selected for the feasibility testing.



Figure 30: LPG stove and cylinder

The fieldwork in the **paraffin-use community** was conducted with an experimental and a control group of 20 households each. The experimental group was provided with LPG stoves to replace their paraffin stoves as a potential offset intervention to reduce domestic paraffin use, as well as a *Wonderbag* (see Group 7 in Table 12).

Separation at source waste model

The intervention in the **waste-burning community** was a locally operated, full recycling with separation at source waste model. Three bins for the separation of recyclable, non-recyclable, and organic waste were provided for a stand, also known as a service centre, consisting of single and multiple households. The intervention further included a service provider (locally recruited waste-pickers[5]) and a central material-sorting facility. The experimental and the control group, of 20 households each, were randomly drawn from the first 50 stands included in Nova's in-field feasibility testing.

Table 12: Interventions provided to experimental households participating in the in-field feasibility studies

	Interventions				
Community Type	**Solar water heater**	**Rocket stove**	**LPG stove**	**Wonder bag**	**S@S waste model (bins)**
Wood-burning					
Community 1					
Group 1	X	X		X	
Group 2		X		X	
Group 3	X			X	
Community 2					
Group 4		X	X	X	
Community 3					
Group 5			X	X	

5 Editors' note: Also see Chapter 5.

	Interventions				
Community Type	**Solar water heater**	**Rocket stove**	**LPG stove**	**Wonder bag**	**S@S waste model (bins)**
Group 6		X		X	
Paraffin use					
Community 4					
Group 7			X	X	
Waste-burning					
Community 5					
Group 8					X
Total	**2**	**4**	**3**	**7**	**1**

The Piqola research in the five communities was conducted in two phases: The experimental and control groups were interviewed before intervention; the experimental groups were both interviewed pre- and post-intervention.

4. Piqola pre-intervention indicators

The Piqola tool lends itself to evaluating the feasibility of the different interventions from a quality-of-life perspective. The following sets of broad semi-structured questions, as outlined in the introduction, were posed to householders initially, before receiving interventions.

4.1 Overall Quality-of-life Indicators

Members of the experimental and control groups were posed three of the most frequently asked questions in quality-of-life studies conducted worldwide. Respondents were asked to rate their hedonic quality of life, that is, life satisfaction and happiness, and their eudaimonic quality of life, which refers to meaning and purpose in life. The following three questions were put to respondents:

> "All things considered, how satisfied are you with your life as a whole these days?"

"How happy did you feel yesterday?"

"To what extent do you feel that the things you do in your life are worthwhile?"

4.2 Descriptive Daily Routine Indicators

The initial broad-based questions put to respondents participating in the Piqola feasibility studies aimed to understand how their households went about their daily routines for cooking, heating, and waste removal. Respondents were encouraged to explain in greater detail when replying to the indicators.

4.2.1 Wood-burning and paraffin-use communities

Pre-intervention, all respondents, members of the experimental and control groups in the wood-burning and paraffin-use communities, were asked about their daily household routines that used energy. They were invited to describe how they went about cooking, heating water, bathing, washing and ironing clothes. They were asked about personal preferences and safety related to such household tasks ("Does the way that your household cooks suit you as a person?" "Is the way that your household uses warm water safe?"). Wood-burning households were also asked, "What do you like best, and what do you like least about cooking on an open fire?" The paraffin-use households were questioned about where they had bought their current stove and how they felt about the presence of the stove in their house.

4.2.2 Waste-burning communities

Similarly, the waste-burning experimental and control groups were asked to describe their waste disposal routines: Where and when they usually dumped or burned household waste ("Does your household sometimes burn waste inside your yard?"); what type of waste and how often they burned waste; as well as preferences and problems with the disposal of waste. Households with small children were asked how they disposed of diapers.

4.3 Satisfaction Indicators

Satisfaction questions are amongst the most frequently used social indicators to assess quality of life overall and across specific domains of life. They are sometimes used as 'dashboard' indicators that show how social policy and interventions impact community quality of life. The World Happiness Report (WHR, 2025) uses the Cantril (Cantril, 1965) ladder as its satisfaction measure. The extensive World Database of Happiness includes satisfaction measures from around the world (Veenhoven, 2023). The Diener et al. (1985) Satisfaction with Life Scale, and Multiple Discrepancy Index are based on satisfaction ratings.

Nova's Piqola tool measures satisfaction with the standard 11-point scale from zero to ten, where zero is not at all satisfied and ten is completely satisfied. Respondents were asked to rate their satisfaction with various aspects relevant to the understanding of the impact that the intervention could have on the quality of life of participating households. The satisfaction questions indicated below were put to the experimental and control groups.

4.3.1 Wood-burning communities

Piqola satisfaction items picked up on the descriptive indicators that enquired about how the household went about daily routines. The nine satisfaction items used in the wood-burning groups enquired: "How satisfied are you with the warm water that your household has for cooking / for bathing / for washing clothes / and for washing dishes?" "How satisfied are you that you can cook / your family can bathe / your household can wash clothes / dishes / iron clothes the way that they want to?"

4.3.2 Paraffin-use community

Similarly, the paraffin-use households were asked about their general satisfaction with the stove that they currently use, and how the stove "cooks / heats water / heats the house", and whether the stove "is right for you as a person" and "for your household?" Respondents were asked to share their views on how safe it is to cook with electricity, wood, and paraffin.

4.3.3 Waste-burning community

Households were asked to give a satisfaction rating for five items: "How satisfied are you with the way that your household currently manages your domestic waste / with how waste is managed in your community / with the cleanliness of your community / with the cleanliness of your yard outside your home / that the way that your household manages waste suits you as a person?"

As was the case with wood-burning and paraffin-using communities, the experimental group respondents were asked post-intervention to rate their satisfaction with the waste intervention and to respond to the same set of pre-intervention satisfaction items as described above.

4.4 Likert Scale Indicators

Likert scale questions are regularly used in social indicators research to sound opinions and viewpoints. The Piqola used Likert scale indicators on viewpoints held by community members to gain a better understanding of the impact that the Nova interventions could have on the quality of life of beneficiary households. Likert-style questions help to gain an indication of how many respondents share specific viewpoints. Consequently, it is one way to integrate quantitative and qualitative responses.

The Likert scale questions asked respondents whether they strongly agreed, agreed, disagreed, or strongly disagreed with statements related to energy use and to waste management. Questions eliciting the following responses were put to experimental and control groups:

4.4.1 Wood-burning communities

The experimental and control groups in the wood-use communities were asked Likert scale questions related to their possible concerns, preferences, and viewpoints.

Concerns: "I have enough energy for cooking food at times that I want to", "I can get burnt when I work with hot water", "My children can get burnt by hot water."

Preferences: Other statements enquired about energy use and wood-burning preferences: "I like the way that we heat water for bathing in our household", "I like it most to bath with water heated on an open fire", "I like the smell of smoke of a wood fire", "In winter times, we sometimes stand around the fire outside to stay warm."

Viewpoints: "Water that is boiled on a fire stays warmer longer than water boiled with electricity." "The smoke of a wood fire can heal your eyes." A statement also enquired about respondents' views on gender equality: "Men and women should share their cooking responsibilities."

4.4.2 *Paraffin-use community*

The experimental and control groups in the paraffin-use community were asked similar Likert scale questions related to their possible concerns and preferences. They were also asked about dependency on paraffin use and culture-related issues.

Concerns: I am satisfied that "I have enough energy to cook my food when I want to", and "Our household has enough energy to heat our house to a comfortable temperature when it is cold", and "I sometimes worry that my way of cooking / heating water is not safe."

Preferences: "I like my current way of cooking / the smell of a paraffin stove / wood fire." "Food cooked on a paraffin stove / wood fire tastes better than food cooked on a paraffin / electrical stove."

Dependence on paraffin: "I sometimes borrow paraffin from neighbours or family." "My neighbours or family sometimes borrow paraffin from me."

Culture: "Making an open fire connects us with our ancestors."

4.4.3 Waste-burning groups

Respondents were asked if they agreed or disagreed with the following twenty statements related to waste disposal practices in their community, as well as personal viewpoints.

Waste disposal routines:

Our household sometimes feeds animals with our organic waste.

Our household makes compost from our organic waste.

Our household currently has a vegetable garden.

A vegetable garden will not work for our household.

Most people in our community burn their waste at night.

Our household keeps glass bottles aside for recycling.

Our household keeps plastic aside for recycling.

Our household currently makes an income from waste recycling.

Problematic waste disposal issues:

I am often bothered by the smell of smoke from waste burning.

At our home, we often get bad smells from waste lying around in the community.

Animals digging in the waste of our household is a problem.

Viewpoints on waste disposal:

Burning non-recyclable waste is the best way to get rid of it.

It is acceptable to burn waste during the day.

Burning waste has a bad impact on the health of our community.

It is wrong to throw waste in the street.

Gender issues:

Waste burning is a woman's job.

Dumping waste in public is a woman's job.

Agency:

My household can help to keep our community clean.

I would like to learn more about how my household can recycle waste.

Waste picking is a job I would consider.

5. Piqola post-intervention indicators

5.1 Follow-up Overall Quality-of-life Indicators

The three frequently asked quality-of-life questions of the pre-intervention survey were again posed in the follow-up post-intervention Piqola survey.

5.2 Follow-up Descriptions of Daily Routines

The same questions asked of the experimental groups at the outset were again posed to them to learn how their interventions were utilised, about their safety, and how well they suited householders and impacted their daily lives and well-being.

As shown in Table 12, the experimental groups in the wood-use communities had received one or a combination of interventions (solar water heater, rocket stove, LPG stove) as well as a *Wonderbag*. The paraffin-use experimental group had been provided with the LPG stove and a *Wonderbag*. The waste-burning experimental group had received bins in which to deposit their separated waste, which was collected regularly.

5.3 Follow-up Satisfaction and Likert Scale Ratings

The respondents in the experimental groups were again asked to rate the same satisfaction and Likert scale items as in the pre-intervention phase. In addition, the waste-burning experimental group was asked to indicate their overall satisfaction with the waste project: "How satisfied are you in general with your participation in the waste project?"

5.4 Post-intervention Piqola 'Narrative' Questions

The selection of the most appropriate questions to evaluate the impact of the Nova interventions covered the fundamental human needs as set out in Table 13. The list of general and specific broad semi-structured questions put to the experimental groups post-intervention invited respondents to narrate the lived experience of using the intervention combinations. The fieldworkers were instructed to ask respondents to explain their answers in greater detail, especially in the case of questions that could be answered with a simple 'yes' or 'no' reply. In the lists below, such questions have one or two asterisks added. The narratives produced qualitative evidence that Nova would use to evaluate whether the interventions had indeed impacted positively on the quality of life of the target households participating in the case studies.

Table 13: Piqola: selection of the most appropriate post-intervention questions for households in the wood- and paraffin-use / waste-burning communities

1.	How do you feel about the intervention (different combinations of SWH / rocket stove /LPG or *Wonderbag*) / the waste project you are participating in?
2.	What is the best thing about your intervention / the waste project?
3.	What is the worst thing about your intervention / about the waste project?
4.	Has the intervention / waste project impacted on your household? *

5.	Would you recommend this intervention / the waste project to other households in your community? *
6.	Is there anything that you miss from your old way of doing things? *
7.	Has the intervention / the waste project made life easier or more difficult? *
8.	Will you continue to use the intervention when this project finishes? / Do you plan to continue to separate your waste? *
9.	Is the intervention equally acceptable in your culture as the way that you cooked and/or heated before? / Would you say that the burning of waste is more accepted in your culture than the separation of waste? *
10.	Do you pay more, less, or the same for energy since you started the intervention?" * (Not asked of waste project respondents)
11.	Has the intervention / the waste project changed the way you feel about yourself? **
12.	Has the intervention / the waste project changed the responsibilities of your household members? **
13.	Has the intervention / the waste project changed the way your closest partner appreciates you? **
14.	Has the intervention / waste project influenced your relationship with your neighbours? **
15.	Has the intervention / waste project changed the way you feel as a woman/man? **
16.	Has the intervention changed the amount of time that you spend inside your house?" ** (Not asked of waste project respondents)
17.	Has the intervention / waste project changed the way that you utilise your stand? **
18.	Did you have to do any repair work on the intervention since the project started / Are any of your (waste) bins broken or damaged? **
19.	Has the intervention / waste project impacted on the health of anyone in your household? **
20.	Has the intervention / waste project impacted on the amount of rest you get? **

** Respondents were asked: "Please explain your answer."*

*** Respondents who replied 'yes' to the question were asked "to please explain."*

5.5 Persistence of Pre-intervention Habits

Additional questions put to the experimental groups explored whether households still practised some of their pre-intervention wood-burning or waste-disposal habits.

5.5.1 Wood-burning and paraffin-use experimental groups

Respondents were asked if their household had made an open fire outside since they had started using their interventions. Respondents in the paraffin-user group were asked if they still sometimes use paraffin, and whether they had lent paraffin to anyone since the intervention started.

5.5.2 Waste-burning experimental group

Pre-intervention experimental and control groups in the waste-burning communities had been asked how and where they burnt or dumped their waste and disposed of diapers. Follow-up questions put to the waste project's experimental group repeated these questions. Post-intervention, respondents in the experimental groups were asked how the waste project had changed the way that they felt about the waste situation in their community. They were asked to give feedback on how they felt about the training and the waste bins that they had received, as well as about the waste collector who collected their waste. Had the project changed the way that they felt about waste collection as a possible job option for themselves? Lastly, respondents were asked if they had continued to burn or dump household waste in their yard or in a public place since the project started.

6. Data analysis

The results of all Piqola indicators collected before and after interventions for each of the control and experimental groups were compared to measure the impact on quality of life. The comparison of the values of the satisfaction and Likert scale indicators from pre- to post-intervention provided quantitative evidence of successful outcomes.

In the case of the qualitative selection of the most appropriate questions generated by the Piqola, narratives given by the experimental and the control groups in response to each question were content-analysed and collated into exhibits. The exhibits summarised the narratives along with 'quotable quotes.' Comparison of the pre- and post-intervention narratives showed how the interventions had impacted different aspects of the lives of beneficiaries of the Nova interventions and overall quality of life.

7. Reporting of Piqola indicators

The reports on the in-field feasibility studies for the three case studies covered the results of all the Piqola indicators collected from the participant experimental and control groups.

7.1 Satisfaction Indicators

Satisfaction ratings given pre- and post-intervention were compared to measure the impact on quality of life. For example, in the case of the **wood-burning** experimental group that had been issued a combination of three offset interventions (see Table 12), the solar water heater scored the highest mean satisfaction rating of 9.95 out of 10, followed by the rocket stove with 9.20, and the *Wonderbag* with 8.86.

In the **paraffin-use community**, participant households in the experimental and control groups were dissatisfied with the stove that they were using. The participants, who were provided with an LPG stove, experienced a significant increase in satisfaction from a median 3 out of 10 to a 10 out of 10 rating when switching from a paraffin to LPG, also considering the perceived safety considerations when using LPG.

In the **waste-burning community**, satisfaction increased in response to all questions from before to after the intervention. For example, on a scale of 0 to 10, satisfaction for "the way that your household currently manages your domestic waste" increased from a median of a 3 score before the intervention to 10 after the intervention. Post-intervention, respondents scored

a median of 10, indicating that they were completely satisfied with their participation in the waste programme.

7.2 Likert Scale Indicators

Results on the Likert scale indicators pre- and post-intervention were compared for each experimental group, as in the following examples:

In one of the **wood-burning** communities, the LPG / rocket stove / *Wonderbag* experimental group's agreement with the statement "I am satisfied that I have enough energy to cook my food when I want to" increased from 50% pre-intervention to 100% post-intervention. Conversely, the group's agreement with the statement "I like it most to bathe with water that was heated on an open fire" decreased from 81% pre-intervention to 75% post-intervention.

In the **paraffin-use** community, a large improvement in reported energy needs and uses was reported post-intervention. For example, 100% of the experimental households agreed that they could cook food when they wanted to, compared to 13% before the intervention.

In the **waste-burning** community, 100% of respondents agreed pre-intervention with the statements: "At our home, we often get bad smells from waste lying around in the community", and "I am bothered by the smell of smoke from waste burning". Post-intervention, only 21% and 29% agreed with each of these statements, respectively.

7.3 Piqola Narrative Responses Summarised in Textboxes

The narrative responses to the set of 20 Piqola questions in Table 13 and any additional questions were recorded for each experimental group. The narratives were content-analysed to assess changes in the daily routines of cooking, heating water, bathing, or disposing of household waste pre- and post-intervention.

Textboxes were prepared for the narrative responses to the descriptions of daily routines and to each of the Piqola

'best' questions in Table 13. Each textbox presents a summary of responses along with a selection of narratives, the most informative 'quotable quotes'.

The textbox assists Nova researchers in understanding better how an intervention impacts a particular aspect of life or overall quality of life. The following three textboxes illustrate how narrative responses to Piqola questions are summarised with quotable quotes.

7.3.1 Textbox 1

Paraffin-use community. The first textbox presents narratives in response to a descriptive daily-routine indicator on safety put to respondents pre- and post-intervention in the paraffin-use households. The textbox compares the results of the experimental group that received the intervention and the control group that did not.

"Is the way that your household cooks safe? Please explain."

Paraffin-use Experimental Group	
Pre-intervention result summary	**Post-intervention result summary**
Only three respondents say that it is safe to use the paraffin stove: the 1st respondent because he stays alone and there are no children; the 2nd because she has not had an accident, but she is aware of the risk; and the 3rd says it is a "little safe", because she knows how to use it, but paraffin is not safe. The danger that the paraffin stove can burst or explode, and that one must stay close to it to guard it, has been mentioned repeatedly before, and 13 respondents emphasise it again; of these, 2 say that it is dangerous to have children around. Another 4 mention the danger of smoke "getting into your chest", or giving you the flu.	All participants agree that the new stove is safer than their previous methods: Mentioning that the LPG stove is safer when there are children in the house, it cannot burst, and the safety allows them to also leave the house while food is cooking.

Pre-intervention quotable quotes	Post-intervention quotable quotes
HH7: "It is not right. Because of this smoke, you'd find us even being dark in complexion." HH14: "No, it is not safe. I have mentioned when I cook with this stove, it will burst and make a boom sound. It has never happened that it burned the house. But you must always observe it and make sure that the fire is heating okay. And that it is in the right position for cooking." HH19: "No, it is not safe. I can only say it is safe because we can eat. The smoke causes flu, and even if you are craving tea, you cannot light the stove and heat water because of the smoke that it causes." HH20: "No, it is not safe. I have mentioned it before that the paraffin has a problem of getting into your chest. And if I cook food late, I cannot leave the door closed. I must leave it opened so that the smoke goes out."	HH6: "The new method is safer because with the paraffin, when there is a child in the house and you make a mistake by spitting the paraffin on the floor and if the stove falls, the house could burn." HH10: "This one I am using now. Because the old way used to give me problems when I cooked using a flame stove. I had to not go out of the house; I had to stay in the house. Now I can go out of the house; there is not much problem."

Paraffin-use Control Group (pre-intervention only)
Pre-intervention result summary
The majority of participants said that the way that they are currently cooking is not safe; the main concern is the paraffin stove bursting. Other participants mentioned problems with smoke, burning risks for children, and that they need to keep an eye on the stove while they are cooking. However, a few participants mentioned that the stove is safer, specifically that it is safer than a wood fire. They make fire outside, which is safer than inside, and their specific stove does not burst.
Pre-intervention quotable quotes
HH8: "No, it is not safe. The stoves burst sometimes and the smoke from the paraffin is not okay when you sleep. At other times, when you breathe, you feel blocked in the nose." HH15: "Yes, it is safe because paraffin is better than the open fire." HH17: "No, I do not see it safe. Because the stove sometimes bursts, so when you cook with it, you must be careful."

7.3.2 *Textbox 2*

Wood-burning community. The second textbox summarises narratives in response to Piqola question 1 on the overall quality of life in Table 13 for an experimental group post-intervention. The quotable quotes illustrate how happiness peaked in this group of households.

Experimental group 1: Supplied with solar water heater, rocket stove, and *Wonderbag*

"How do you feel about the intervention?"

Post-intervention result summary
All participants reacted very positively to the intervention, especially mentioning the solar water heater. Respondents say that they can now save time and especially electricity. Several respondents mentioned that they enjoy bathing in hot water without using electricity or fire to heat it.
Post-intervention quotable quotes
HH9: "Do you know how happy I am?! I am happy, happy, happy, I wish I had everything that could make me use them every day, like the food; the wood I can burn with the water, I don't even want to say, we bathe very nicely, we even save electricity units even when we boil water." HH6: "I am so happy, especially with the geyser, because I don't have to use so many woods and I always have hot water. Even the stove is wonderful; I cook the way I like." HH17: "I feel very happy because they've reduced the hard work. We used to have to wake up early in the morning to make fire to heat water. Things are easy now."

7.3.3 *Textbox 3*

Waste project community. The third textbox showcases narratives in response to Piqola question 5 in Table 13 on whether the waste project should be recommended to other households in the community.

"Would you recommend the waste project to other households in your community? Please explain your answer."

Post-intervention result summary
All but one of the participants would recommend other households to take part in the waste project. Most participants said that others should take part because it works and keeps their area clean. The participant who would not recommend it said: "No, I don't know, it is your work. If I get R1,000.00 to send to my children?"
Post-intervention quotable quotes
HH5: "Yes, I can be able to tell people that I like this project because it has made this place clean. Since this project took place, there is a difference; we can see change from it."
HH14: "I would tell people, even now, I do tell them. I tell them about the goodness of it. I wish that if everyone could get these dustbins, it would be a very beautiful, good thing. As it is beautiful for us too."

8. Final assessment of the impact of interventions on quality of life

The final reports on the three case studies outline how the interventions impacted the quality of life of the target experimental groups post-intervention, drawing on the quantitative and qualitative responses to Piqola questions. The survey results are used to assess whether it would be advisable to upscale the distribution of the Nova interventions to all households in the communities under study. For the Nova interventions to be feasible for further testing and upscaling, three questions must be answered in the affirmative: Did the intervention reduce emissions from the target pollutant? Was the quality-of-life impact on end users positive or neutral? Was the potential offset intervention implementable? The Piqola assessment results are used to answer the second question, namely, what quality-of-life impact did the intervention have on the end users.

We provide an example of how the narrative responses to the Piqola selection of the most appropriate questions might be reported in a final assessment.

> Generally, the interventions to offset wood and paraffin use and waste dumping were well-received. Some respondents even enthused about how the interventions had impacted them personally and in daily life in their

households. The satisfaction and Likert scale ratings were generally higher post-intervention for end users. Only a few respondents missed the older ways of doing things. The majority stated that they would continue using the new cooking and water-heating interventions or practise the new waste management system and would recommend them to other households in their community. The interventions and the waste project had made life easier, saved time and money, and were also accepted in their culture. Members of the solar water heater / rocket stove / *Wonderbag* experimental group expressed gratitude that the interventions allowed them to save wood and to make progress in life, sentiments best captured in a quotable quote: "No, I miss nothing. Life has changed, life goes on. That's the old life, that's the poor life, it must stay behind, we're moving forward". Respondents indicated that the interventions had made them feel more positive about themselves. Their homes and yards were cleaner and more beautiful, and they felt more respected in their community. Some respondents in the wood-burning communities were grateful that their clothes no longer reeked of smoke or the smell of paraffin. Participants in the waste project no longer had to put up with the smell of rotting or burning garbage. Post-intervention respondents described in what ways they felt more appreciated by their closest partner, some of whom now more readily shared household responsibilities. For example, now that their households were equipped with interventions that were easier and safer to use, children were able to be more independent and could assist with household tasks. Post-intervention relationships with neighbours in the wood and paraffin-use communities tended to be mixed. Some neighbours were jealous and felt that they had been overlooked, while others hoped that they would become beneficiaries in future. Some neighbours were pleased for the beneficiaries next door and enjoyed being allowed to use their new stove or hot water occasionally, or during electricity blackouts. Respondents in the waste-burning communities

commented positively on their waste workers, and some said that they might even consider the job of waste worker as an employment option. Some householders in the wood-burning communities indicated that they did spend more time in the house post-intervention: they appreciated not having to collect wood or cook or heat water outdoors, particularly when it rained or in winter. There seemed to be few changes in utilising the households' stands, apart from a few mentions of planting a garden or having a tidier backyard, now that no waste was deposited or burnt there. In the few cases that the interventions had given problems, the need for repairs had been reported to Nova and were carried out promptly. In contrast, one experimental group noted that their community had received solar water heaters in the past that were faulty - they had not been repaired and were now in disuse. Householders reported that many of their pre-intervention health concerns had lessened or had been resolved now that their heating and cooking interventions were more efficient and safer to use. In particular, the paraffin stove had been tricky to operate and tended to 'explode'. The interventions allowed for more rest: Households in the wood-burning communities no longer needed to rise early to cook or heat water in the morning, and did not go to bed late after cooking supper at night. In some cases, the shorter cooking times and no longer having to watch water heat over the fire or mind the *Wonderbag* allowed for greater freedom to meet friends and pursue spare-time activities. Similarly, households participating in the waste management project did not need to dump or burn their waste at specific times of the day to be considerate of their neighbours.

9. Discussion

9.1 A homegrown instrument

Until recently, most instruments that measure quality of life have been developed by scholars in the Global North. The Piqola tool represents a pioneering effort to develop a homegrown instrument for use in developing countries.

Land and Michalos (2018), in their review of 50 years since the launch of the 1960s Social Indicators Movement, stressed the importance of documenting quality of life in a changing world. They invited suggestions for the way forward. In response to this call, three of their colleagues based in the Global South identified the need for a wider range of research approaches to widen the scope of quality-of-life and social indicators studies. For example, there was a need to enhance the policy relevance of the Social Indicators Movement (Rojas, 2018), to make more use of mixed-method data collection (Shek & Wu, 2018), and to enquire into human agency to improve quality of life, in particular on the part of women and mothers (Tsai, 2018).

The Piqola tool is a unique instrument that meets these recommendations. It represents a theoretically grounded approach to community quality-of-life research. Piqola's unit of analysis is the household[6] that provides for fundamental human needs, including relational well-being (Wissing et al., 2019), which reflects the African philosophy of *Ubuntu*. Piqola makes optimal use of narrative social indicators in line with Africa's oral culture that values storytelling. Included in Piqola's selection methodology for the most appropriate questions is one that enquires about the cultural acceptance of the interventions tested, lest they be rejected by local communities for this reason.

What is noteworthy is that Piqola follows in the footsteps of earlier quality-of-life pioneers, such as Hadley Cantril,

6 The household is also the unit of analysis for Statistics South Africa's household survey and for The National Income Dynamics Study (NIDS), South Africa's first national household panel study that tracks the welfare of household members over time.

who collected narratives of the real-life experiences of people living in 13 countries across the globe in the 1960s to document their hopes and fears in life. In his book, *The Pattern of Human Concerns*, Cantril devoted a whole chapter to comparing narratives on the meaning of a 'decent life' for survey respondents from rich and poor countries, the equivalents of Piqola's 'quotable quotes' (Cantril, 1965, pp. 203-207).

The Afrobarometer (Mattes, 2008) has the distinction of being the only barometer of quality of life around the world that does not use a life satisfaction measure (Veenhoven, 2023). Instead, the Afrobarometer's proxy experimental measure of 'lived poverty' asks households if they have made do without the basic necessities of life during the course of a year (see Mattes, 2008; Møller et al., 2008). Similarly, the Piqola post-intervention narratives on the use of alternatives to offset wood use and waste burning capture the 'real-life' experiences of low-income households in meeting their everyday needs.

9.2 Agency

Many of Piqola's narratives in response to the 20 broad-based specific questions lend voice to women's greater sense of self, their newfound freedoms, and greater appreciation and support from their partners and family. The narratives collected for the Nova case studies showed how women use their agency when taking measures to prevent harm to children and other members of the household when heating water or cooking. The narratives also revealed constraints on agency for respondents, who stated, pre-intervention, that they had 'no choice' but to burn or dump waste. "We are not satisfied, but we do not have a choice. The wood is a struggle; sometimes you are too lazy to go get wood, then you go and get impaled, now you are limping -- we only do it because we do not have an option". Similarly, 'no choice' households said that they were forced to use or revert to wood-burning during electricity outages, or when their budgets did not allow them to purchase cleaner, more efficient and safer energy for cooking or heating water.

9.3 Unintended intervention consequences

Piqola narratives alerted the Nova researchers to the harmful use of the rocket stove. The rocket stove is designed to be used outdoors. However, some target households reported using the stove to heat their homes in winter, which is a safety risk and causes harmful exposure to pollutants indoors that may result in negative health impacts. Based on this finding, future wider distribution of the wood burner to the target communities was not recommended, although the rocket stove received mostly high satisfaction and Likert scale ratings.

One of the Piqola questions enquired into the cultural acceptance of the tested intervention combinations, lest they be rejected for this reason. Generally, target households said that the interventions were acceptable in their culture. However, Piqola narratives revealed that some households did make use of and preferred different energy carriers for the slow-cooking of certain traditional dishes, and used wood fires for traditional ritual purposes.

9.4 Interventions that 'make good use of time'[7]

Time-use research for quality-of-life studies was first launched to record how the introduction of television into households affected family life in the last century. Time-use studies typically track the activities of household members every quarter of an hour throughout weekdays and weekends. Division of labour in households and likes and dislikes of activities have been of particular interest to time-use researchers. Piqola narratives revealed the importance that respondents placed on trying to avoid drudgery tasks, such as having to watch over cooking pots or rising before dawn to heat water for bathing before going to school or work. They welcomed the 'modern conveniences'[8] that

7 The International Association for Time Use Research (IATUR) held its 46th conference in 2024. Conference delegates traditionally give a toast 'to the good use of time' when gathered for the conference dinner.

8 The impact of 'modern conveniences' on quality of life in the 1960s was recorded by Cantril (1965). 'Modern conveniences' served as one of the survey categories that recorded respondents' hopes for a better life.

allowed for greater leisure, rest and participation in activities away from home, as well as the sharing of routine household tasks. In this respect, the *Wonderbag* intervention, which could be left to its own devices to slow cook, should be considered an ingenious invention. Thus, although it was found that the *Wonderbag* does not lead to significant emissions savings, it does contribute positively to the quality of life of the women who do occasionally use it.

'Always something new coming out of Africa' is the saying attributed to the 1st century Roman, Pliny the Elder. However, inventions must also be useful if they are to be adopted in Africa (see Bruton, 2015; Møller & Roberts, 2021). The Piqola questions that enquire about the practicality of the tested intervention combinations will ensure that this is the case: the Piqola narratives described whether interventions were correctly used and not faulty, as had been the case for earlier handouts of solar heaters received by some of the wood-burning households.

10. Conclusions

The innovative Piqola tool promises to inject new energy into social indicators research in the Anthropocene era, particularly in Africa and the Global South. Quality-of-life scholars believe that individuals themselves are the best judges of their own well-being[9], and Piqola studies give voice to survey respondents to do this. Piqola is versatile; it can be adapted to assessments of a wide range of applied and policy-relevant research projects. Piqola has pioneered a mixed-method research approach that makes use of quantitative and qualitative indicators to identify the capacities, and resources or constraints on agency in low-income households. Essentially, Piqola assists researchers in selecting the best indicators that will identify any unintended consequences of new policies and practices in advance of larger-scale implementation. Of importance, the method allows for

9 Editors' note: This stands in contrast (not contradiction) to the discussion of Chapter 10 where the issue was the use of scientific evidence as something objective to measure the validity of interventions, for example, air quality interventions necessitated by policy.

the participation of community members as research partners[10] to share their lived experiences and their narratives to inform policy and practice.

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Part Four

Autoethnography

Chapter 13

Involvement with a Not-For-Profit Company: An Insight from a Mission Worker

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Abstract

This chapter is an autoethnographic reflection of the author, a mission worker under an organisation called InnerCHANGE, and involved with a not-for-profit organisation called Nova. Nova's goal is to be a centre of excellence in the development and implementation of products and services that improve the quality of life of low-income households and to take the solution to scale in Southern Africa with households and networks. The author is a mission worker serving incarnationally in a community of poverty in South Africa. His goal is to communicate the good news of the gospel in tangible and transformational ways. He is therefore constantly on the lookout for new strategies and new skills to achieve his goal. He sees his efforts as an attempt to be a good news agent in society. He lives in a local community where the presence of Christian churches of various denominations is prominent and visible. Yet, this is a local community where residents long for love in action to be demonstrated by the church and other institutions. This research asks: How can the church remain teachable about what it means to be good news to the world around it? The author uses the book of the Bible, Jeremiah 29:7, as an interpretive framework to reflect on his experiences of learning from Nova and how he could contribute to the improvement of Nova's output in its aim to improve the quality of households located

in communities of poverty. He discovered that Nova's vision of healthy household culture has challenged InnerCHANGE to seek to minister to an entire household, not an individual alone. He has also discovered that pursuing a good quality of life through practical ministry is a valid form of evangelism. He has learned to entertain partnerships with various organisations that believe in making a difference in ordinary people's everyday lives. He is finally learning to be involved in various communities of poverty so that everyday lives can be transformed positively. The chapter concludes that a healthy partnership between Nova and InnerCHANGE South Africa could be mutually beneficial. Nova could improve its ability to involve residents of communities of poverty where it is working in their participation in solution-seeking. InnerCHANGE South Africa could strengthen its incarnational approach through tangible projects that improve the quality of life of ordinary people.

Keywords: agency, household, incarnation, love, multiplication, partnership, relationship

1. Introduction

This autoethnographic reflection undertakes "to describe and systematically analyse" the author's involvement in incarnational mission in communities of poverty as well as with a not-for-profit company, Nova (Ellis et al., 2010, p. 1). He understands incarnational mission as living in and serving alongside residents of communities of poverty with the goal of making them disciples of Jesus Christ. Nova's goal is to be a centre of excellence in the development and implementation of products and services that improve the quality of life of low-income households and to take the solution to scale in Southern Africa with households and networks. This organisation "explores with low-income households and other stakeholders, effective combinations of thoughts and things that can improve quality of life" (Murray & Pauw, 2022, p. 95). The mission organisation that the author is a part of is called InnerCHANGE. InnerCHANGE members "pursue agency from below in catalysing community transformation inspired by the biblical passage to do justice, love mercy and walk humbly with

our God" (Kabongo, 2021, p. 1). Their incarnational approach is about identification with the poor and a search to emulate biblical values in a way that is understandable, meaningful, and tangible. One of their main goals is to catalyse the improvement of quality of life from the inside out. The author's involvement with Nova has to do with his desire to learn new strategies and skills that could improve InnerCHANGE South Africa's (ICSA hereafter) capacity and ability to improve the quality of life of residents of the neighbourhoods of poverty that it serves. ICSA staff and volunteers' main goal is to be good news agents. They describe a good news agent as "a follower of Jesus who seeks the peace and prosperity of their context in tangible ways and invites other people to do the same so that quality of life can be improved, lives can flourish and communities can be built from the inside out" (Kabongo, 2020, p. 6). This understanding is inspired by Jeremiah 29:7: "Also, seek the peace and prosperity of the city to which I have carried you into exile. Pray to the Lord, because if it prospers, you too will prosper" (NIV version). This passage will serve as an interpretive framework for this research as it answers this question: How can the church remain teachable about what it means to be good news to the world around it? The author's historical involvement with ICSA and Nova could shed some light on his quest to remain teachable as a good news agent.

2. Historical involvement with ICSA and Nova

This historical overview seeks to connect the author's "personal experiences to wider cultural, political and social meanings and understandings" (see Ellis et al., 2010, p. 3) as he tries to make a transformational impact in the everyday lives of people from below. He joined ICSA, a Christian order amongst the poor, in 2007. ICSA started in 1984 in the United States of America. Its founder, John Hayes, is a former businessman who responded to God's call to serve and live incarnationally amongst the Latino and Cambodian refugees.

The author and his wife pioneered ICSA work in South Africa. They moved to the township of Soshanguve[1] from a suburb [2]of Pretoria North (Florauna) on 1 April 2008. The author was part of another mission organisation called NieuCommunities, where the focus was to train missional leaders cross-culturally. NieuCommunities partnered with various ministries across the city of Pretoria, including the township of Soshanguve. It is from the many connections that NieuCommunities had made in the township of Soshanguve that the author and his wife started ICSA work. Their ministry focus has been to make disciples of Jesus through relationships and practical ministry initiatives in their local community. They also emphasise developing their disciples into good news agents.

The author came into contact with Nova through his interaction with one of its founders, Attie van Niekerk[3]. The latter was his study supervisor at the University of Pretoria, starting from 2008 while reading his honours degree studies until 2019 when he completed his doctoral studies with the thesis titled *A missional approach to school dropout in a poor urban area of South Africa*. It is through his interactions with Attie van Niekerk that he learned to integrate the expression 'good quality of life' into his ministry goals. He is continuously learning to develop and promote ways to improve the quality of life of ordinary people living in a community of poverty, such as Soshanguve. Van Niekerk (2014, p. 3) states that "quality of life is determined by the interaction between standard of

1 The name Soshanguve is an acronym of the ethnic groups that lived in that location when it was recognised as a township in 1974. These ethnic groups are SO (Sotho), SHA (Shangani), NGU (Nguni) and VE (Venda). The former South African system of apartheid (meaning separatedness) was implemented in that location because people from one ethnic group were placed in one specific section of the township. In South Africa, a township is an underdeveloped, racially segregated urban area that, from the late 19th century until 1994, was reserved for non-whites. They were usually built on the periphery of towns and cities. Soshanguve was a location for black people only. It is located 40 kilometres north of the city of Pretoria (Kabongo, 2019:1).

2 In the South African context, "suburbs are referred to as small residential communities found within travelling distance to a city centre"(Logan, 2020, p. 1).

3 Editors' note: One of the authors in our book.

living, perceived well-being and bodily functioning". The author is also learning "to measure and monitor the impact" of what ICSA is doing in the improvement of the quality of life of ordinary people. He now serves as a non-executive director of Nova. He would like to see this role be an added value both to Nova and ICSA.

3. Interpretive framework of Jeremiah 29:7

The text

The book of Jeremiah narrates a turbulent period of the kingdom of Judah, beginning with the death of King Josiah (609 BCE) and the loss of independence that followed, through the destruction of Jerusalem by the Babylonians and the exile of much of its population (587-586) (Ofo'ia, 2017). One may argue that this book describes God's covenant with believers and His expectations of His believers in playing an "active role in society" (Suderman, 2014, p. 52). The exile situation was understood by the Israelites as a punishment because of disobedience. A move back home could have been seen as God forgiving the Israelites. The prophet Hananiah emerged during that turbulent time and gave false hope to the Israelites by telling them that "God was going to free them and help them return to their homeland after 2 years" (Ofo'ia, 2017). The prophet Jeremiah came to challenge Hananiah's message and invited the Israelites to see themselves no longer as exiles, but as citizens of the context they lived in because "they will be there for another 70 years" (Ofo'ia, 2017).

The prophet Jeremiah's message helps to change the victim's mindset of feeling punished by God to that of active participation in building up their new places of residence. Jeremiah 29, especially its beginning verses until verse 7, portrays God as someone who is concerned with the improvement of the everyday lives of peoples and stresses "the role believers should play" to improve the quality of life around them (White, 2015, p. 1). Verse 7 will help to frame the author's interpretation of his involvement with ICSA and Nova. This verse

"tells us how it is important for religious people to participate in national development in order to transform society" (White, 2015, p. 1). The author believes that one of the effective ways to participate in transforming society is to start small at a local community level. The church should challenge itself to become involved in transformational work at the local community level. Such involvement could be a prophetic witnessing of "God's commitment to restoration and peace through his children" (Suderman, 2014, p. 54)

Nova and ICSA value participation in the restoration and improvement of the quality of life of ordinary people through their efforts. Through his involvement with ICSA and Nova, the author is learning to minister to a whole household in his incarnational approach to ministry. He is increasingly comfortable in his understanding that good deeds could be an effective tool for evangelism. He is also building his networking muscles with like-minded organisations that believe in making a difference in people from below in their everyday lives. He is finally learning to involve ICSA in various communities of poverty so that everyday lives can be improved.

4. Embracing the whole household

As a community-based ministry, ICSA usually starts building relationships with an individual. It is learning to be intentional about becoming involved with a whole household. It has been learned from Van Niekerk (2015, p. 2) that "the household has always been the centre of social, economic and religious life in African culture". However, townships such as Soshanguve are typical urban communities characterised by many "unstable families" (Magezi, 2018, p. 2). In the context of South Africa, one would argue that industrialisation and modernisation are contributing factors to this lack of stability of families. This situation has caused issues such as "high population growth, sexually transmitted diseases such as AIDS, malnutrition, poor school results, violence and crime, pollution, homelessness and street children" (Van Niekerk, 2015, p. 2).

Unstable families also seem to be caused by aspects of culture. Marriage is an important institution in African culture. This institution seems to be under threat because it is increasingly commodified, and few people in places such as Soshanguve can afford to become married. Many adults resort to "cohabiting" although their families may disagree with such a decision (Kabongo, 2020, p. 1). Countrywide in South Africa, there seems to be a "rising trend in cohabitation" (Semenya, 2016, p. 3). Cohabitation does not seem to offer the support that a household needs from their extended families to thrive, because the only acceptable situation when a man and woman live together is to become married.

Another issue that a local community such as Soshanguve faces is the decline in the support system within households and families from one generation to another. African traditional societies prided themselves on parents "passing on material resources and wisdom to their children" (Magezi, 2018, p. 2). However, with the boom of industrialisation and urbanisation, children moved away from their homesteads, got jobs and became independent from their customary ways of living" (Magezi, 2018, p. 2). Another noticeable issue in urban communities such as Soshanguve is weak "solidarity" amongst neighbours and that the "formation of social networks" is hard (Puschmann & Solli, 2014, p. 2). It is, therefore, sensible for incarnational ministries such as ICSA to proactively participate in restoring "households and families" in communities of poverty such as Soshanguve if they wish to improve the quality of life of its residents (Van Niekerk, 2015, p. 4). ICSA staff and volunteers conduct regular house visits to families of the people whom it serves. Through this action, it seeks "to understand the needs, perceptions, expectations and survival strategies" of these neighbours (Van Niekerk, 2015, p. 4). ICSA's home visits aim to listen to neighbours so that it can act in serving in relevant and sustainable ways. During those visits, ICSA staff and volunteers aim to learn more about the living circumstances of its beneficiaries and the quality of life of the household that cares for a beneficiary. The majority of its ministry initiatives, such as children's clubs, tutoring clubs, reading clubs, football,

and beadwork clubs, started as a response to how the local communities that it is involved in wanted to be served.

5. Good deeds as an evangelism tool

ICSA strives to serve local communities in practical ways. It runs a variety of initiatives in areas such as sports, education and farming. These practical initiatives are inspired by John 13:35, which mentions how Christians should be known in society: by the way that they love others around them. In African communities of poverty, such as Soshanguve, love seems to be best communicated when it is tangible. It is felt when "it can be seen, touched and handled" (Hayes 2006, p. 113). Communities of poverty long for love. ICSA has come to understand poverty as the lack of love. Through its interaction with many of its neighbours, it has come to see poverty as "the result of relationships that do not work, that are not just, that are not for life, that are not harmonious or enjoyable…[It] is the absence of shalom in all its meanings" (Myers, 2011, p. 89). ICSA intends to build functional relationships with the people whom its serves and ideally with all the residents of the local communities it serves in.

Nova seems to share the same value of building functional relationships with households located in communities of poverty towards a common good. Its "Brickstar programme is a good example" of that (Nova Institute, 2024). It helped to mobilise the residents of the village of Molati in the northern province of Limpopo to build an efficient cooking stove using available resources such as cow dung, clay, salt and water. The project was executed successfully. This was and is still a significant symbol of "co-creating a solution"[4] between a local community and an organisation (Nova Institute, 2024). Practical projects such as Brickstar and practical ministry initiatives that ICSA runs could be effective ways to nurture agency from below, which is arguably one of the best ways to develop communities of poverty. The fruits of nurturing agency from below could be good news to people. For a mission organisation such as ICSA,

4 Editors' note: The message of Chapter 9.

such fruits have been platforms to evangelise in sharing the gospel with non-believers. This platform is also used to disciple believers who multiply other believers.

6. Networking

The goal of nurturing agency from below so that the quality of life of residents from a local community could be improved is a big task. One organisation cannot do that. A collaborative partnership with various role players could be the solution. ICSA works in partnership with different organisations as it serves local communities of poverty. Nova works on developing resources that could allow institutions such as the church to meaningfully become "involved with issues in their local communities" (Nova Institute, 2024). Partnership with like-minded organisations improves "effectiveness" in output (Alawode, 2024, p. 1). Christians believe that "God created the world to function in mutual relationships" (Alawode, 2024, p. 1). Christians are therefore encouraged "to build relations, which would contribute to community building (Van Niekerk, 2014, p. 4).

As a mission organisation, ICSA's experience is that mission is most fruitful when it is "carried out through partnership" (Alawode, 2024, p. 6). Hence, it is important for ICSA to network with an organisation such as Nova. Networks could be understood as "selective connections (edges) between several elements (nodes), which may form in a certain pattern" (Holzer, 2010, p. 34). Networks could also be understood as "hybrid forms of formal and informal ties that have an undefined or open edge, which facilitates access to them" (Eurich, 2020, p. 5). Networking should have the goal of helping an incarnational ministry such as ICSA relate better to its context and "the needs that arise within it" (Eurich, 2020, p. 6).

7. Expansion/multiplication

ICSA is an organisation that was founded in 1984. Traditionally, ICSA focuses its efforts in one local community. Over the past few years, ICSA has been expanding its efforts in various

local communities. Nova has been a good role model in this new approach. Nova has performed work in several local communities in South Africa.

8. Reflection

The author feels called to the incarnational approach to ministry. He is aware of other approaches. However, his reflection is on the incarnational approach that has influenced his worldview. A simple understanding of incarnational ministry is "mission with others" (Riemer & Banda, 2016, p. 6). This understanding comes from the biblical interpretation of John 1:14, which states that the Logos chose to become human and lived in his world side by side with other humans. Then the Logos metamorphosed into a human being who chose to partner with ordinary human beings during his active ministry in this world (Mark 1:16–20). The above-mentioned Logos is understood to be Jesus. Through incarnation, Jesus moved into a "neighbourhood" to be, live and journey with fellow human beings. The concept of incarnation helps Christians to see Jesus "become flesh in every…context" (Bosch, 1991, p. 21). It also challenges Christians "to hold the Word in one hand and the world in the other, engaging them both in a long conversation" (Van Dyke & Rocke, 2012, p. 46).

The author would like to see ordinary people participate in the *missio Dei* in the world as Jesus did. He believes that ordinary people are assets in making a positive difference in their everyday lives. ICSA believes that an effective way to make a positive difference in the lives of ordinary people is by focusing on one local community at a time. It believes that "a comprehensive missional approach to ecclesiology needs to embrace place. Christian life… must be grounded in the surrounding context – the neighbourhood" (Niemandt, 2019, p. 1). It is in "one concrete place" where there is a potential that Christian values and principles can be felt as good news to the world (Fitch, 2016, p. 401). It is in a concrete place where a tangible "interaction between God and the world" can be experienced meaningfully (Inge, 1999, p. 46).

Nova's work on households located in South African communities of poverty is deepening the author's understanding of incarnational ministry. Nova's approach seems to value the inputs of local residents in problem statements and solution-seeking. Like Jesus' approach, 'work with' is valued. For example, in a Re-baseline Services Report conducted as part of the Sasol Secunda Phase 2 Offset Programme re-baseline, Nova interviewed many residents of the communities of eMbalebhle and Lebohang to assess their service delivery satisfaction in areas of access to water, sanitation, electricity and waste[5] (Nova Institute, 2013). Through this process, Nova reported that the "overall household satisfaction with services related to water, waste, sanitation, electricity and housing is poor". Nova found out that the reason behind the "decreased satisfaction" was because of new unserviced informal areas, which decreased the proportion of households with access to services, and an increase in reported service delivery failure frequency. It is encouraging to see that the findings and the lessons were generated from below. This is the kind of approach that made the author accept the role of a non-executive director at Nova.

The author believes that involving people from below in mission and community development offers a better prospect for a sustainable model to improve the quality of life of Africans living in communities of poverty. Such involvement also has the potential to improve people's well-being[6]. The latter concept "can be understood as how people feel and how they function both on a personal and social level, and how they evaluate their lives as a whole" (Jarden & Roache, 2023, p. 1). Well-being also has a positive effect on someone's mental balance. It can improve "a sense of tranquillity resulting from inner peace and harmonious interactions with external environment (Jarden & Roache, 2023, p. 2). Such involvements offer better wisdom in framing "decisions in terms of years and decades" to come (Mollenkamp, 2025). ICSA's central ministry focus is to make disciples of Jesus and develop local leaders. The development

5 Editors' note: Discussed in Chapter 11.
6 Editors' note: In the light of the definition of *Planetary Well-being* in Chapter 1, this should also contribute to planetary well-being.

of local leaders is seen as a sustainable way to continue God's mission in communities of poverty. This is still a work in progress because the majority of ICSA's top leaders are not local leaders although it is 40 years old. Additionally, ICSA's recruitment of local leaders is happening at a slow pace. One could argue that this pace of recruiting local leaders may be the result of ICSA's understanding of its contribution to the *missio Dei*. It sees itself as "mission communities that are part team, part tribe, part family" (Hayes, 2006, p. 14). It is known that families and tribes have customs and practices that make them unique and define their rule of life. These customs and practices are never culture blind. ICSA was started in the United States of America by a white male North American. Currently, most of its top leaders are white Americans. The author continues to wonder what it would take to diversify the face of the top leadership team culturally.

A similar observation can be made about Nova. The majority of its top leaders are white South Africans. Yet the majority of its projects on households are meant to benefit the poor who are black in their majority. The author is still wondering how much of the insider voices (people living in communities where the researches are conducted) are included in the final reports that are produced and submitted for implementation.[7]

The author believes that the primary assets in improving the quality of life in households located in communities of poverty are members of those households. It can be said that 'people who are in need' usually have half the solution to their problem (Linthicum, 2003, p. 19). It therefore makes sense to involve them in solution-seeking. ICSA conducts home visits regularly as it attempts to be a relevant and meaningful incarnational ministry. ICSA is primarily a team of local leaders feeling called to be good news agents. The team only has one foreign national, the author, who grew up in the Democratic Republic of Congo. Many of these local residents have informed the kind of practical ministries that ICSA performs. These

7 Editors' note: Compare the text boxes of Piqola discussed in the previous chapter, Chapter 12.

practical ministries have been fertile grounds. ICSA is making disciples and developing local leaders. The ICSA experience seems to be in agreement with the historical fact that when the Christian movement has emphasised disciple-making, two things have happened: new disciples have been made, and Christians have a social influence out of proportion to their numbers (Hunter, 2011). ICSA's prioritisation of discipleship depicts its desire to be a tangible sign of seeking the peace and prosperity of the contexts it serves, as well as multiplying its efforts and impacts in new local communities.

9. Conclusion

This autoethnographic chapter used Jeremiah 29:7 as an interpretative framework to reflect on the merit of the author's involvement with both ICSA and Nova. It aimed to discover how the church can remain teachable about what it means to be good news to the world around it. A church that values incarnational ministry should stress embracing a whole household as it engages in relational ministries. It should also be open to networking and partnering with like-minded organisations that seek to improve the quality of life of people from below. An incarnational ministry such as ICSA should be open to expanding and multiplying into different local communities as part of its contribution to participate in the great commission. It was stressed that organisations such as ICSA and Nova need to prioritise the recruiting of local leaders to reflect the concept of ministering with or working with, which they value. The recruiting of local leaders communicates the intent to contribute to and participate in the work of reconciliation of all races, as well as reconciliation of residents in communities of poverty who seem to still have strong ethnic identities that sometimes hurt cohesion within local communities.

It seems like a healthy partnership between Nova and ICSA could be mutually beneficial. Nova could improve its ability to involve residents of communities of poverty where it is working in their participation in solution-seeking. ICSA could strengthen its incarnational approach through tangible projects that improve the quality of life of ordinary people.

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Chapter 14

Sceptical environmentalism

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Abstract

Using an autoethnographic approach, the author examines the evolution of his scepticism towards the environmental movement, influenced by personal experiences and reflection. Key themes include the challenges of integrating faith and critical thinking, the practical implementation of air quality initiatives, the critique of environmental activism, and the potential of blockchain technology for environmental impact accounting. The narrative highlights the complexity of integrating environmental protection and human development goals, advocating for freedom of speech and evidence-based approaches.

Keywords: autoethnographic, economy of attention, environmentalism, open society, political influences on science, scepticism and coercion

1. Introduction

This book is about development in the Anthropocene. Most people would likely interpret the title as juxtaposing human development and environmental protection, thinking that the challenge is to strike a balance between the two. In recent years, I have found myself becoming increasingly negative about what can broadly be termed environmentalism. This is not because I do not love nature or think that CO_2 does not absorb and re-emit infrared radiation, but because I think, to use a

metaphor, the medicine that is prescribed for the disease may be more dangerous than the disease. I am inclined nowadays to think that we should vigorously pursue human development (even under the traditional understanding of the term) and that environmental benefits will follow, as has happened in developed countries. From where I am now, an environment-first approach looks misguided and dangerous. I fear that excessive attention and resources are being allocated to the so-called environmental crisis at the cost of other, more important issues. Although I think that I have reasons to believe what I do, I admit I am inclined nowadays to view the prescriptions of the environmental movement (such as reducing consumption, mass adoption of renewables, carbon taxes, disincentivising travel and changing diets) with a large degree of scepticism. The realisation that somewhere along the way, I may have turned into an environmental sceptic prompted me to ask how this came about. This chapter takes an autoethnographic approach to the question of attitude and perspective around the main theme of this book. How are ideological positions formed, and how does one act to make up one's mind on issues that are so complex that no one can claim to be an expert, all while acknowledging the emotional component of the cognitive and ideological positions that one takes? In answering this question, I will try to trace key moments that impacted the emotional and the cognitive elements (or, attitude and opinion) of my stance towards the theme of this book.

2. Theological education

After a year as a white conscript in the Signal Corps of the South African Army (I was still 17 in January 1991 upon conscription), I started studying Theology at the University of Pretoria. I was not a particularly successful school pupil, but I took to my theological studies with great enthusiasm and dedication, possibly because of my sense of conviction that this was my calling and also because university suited me much better than the constricted environment of the school. I performed surprisingly well in the biblical languages, Hebrew and Greek,

which is sometimes a huge obstacle to students, and eventually also in the other subjects.

I do not think that I ever had a particularly literalist reading of the Bible. Even at a young age, it seemed obvious to me that from all classes – from labourers to teachers and doctors – the creation accounts in Genesis were not to be taken literally. However, the introduction to literary and historical criticism of the Bible necessitated significant personal and intellectual recalibration for me. I have been warned earlier, by people of a certain theological sway, that the professors at the University are too clever and that my faith will suffer from exposure to all their talk. Once one is induced into the way of thinking of historical and literary criticism, it is impossible to ever read the Bible again in a naïve literal sense. The personal impact is limited when literary criticism is applied to the parts of the Old Testament, like Genesis 1–11, where one already had the intuition that a literal reading wasn't called for. However, once you start looking at the Gospels and realise that the accounts of the words and deeds of Jesus came to us through a complicated process of oral and written transmission, a fairly dramatic reorientation has to take place. This reorientation is not successful for all. Some feel that they must give something up: either their studies or their faith. The integration of faith with critical thinking is, in a sense, the task of theological education because theology is the church's self-critical assessment of its own life and beliefs. In the end, the truth matters, especially in a theological sense, because, as the epistle of John says, the Spirit is the truth. One lesson which I have learned in the process of my theological studies is to discern between criticism and scepticism. A critic is someone who wants to discern the truth, often by pruning away spurious ideas and unwarranted beliefs. If the Spirit is the truth, and the truth will set us free, criticism is a holy calling. A sceptic, on the other hand, is someone who does not want to believe, regardless of reason or evidence.

As a student, I participated in and eventually led outreaches from the Universiteitsoord congregation of the Dutch Reformed Church to rural areas in the then Natal and Venda. Universiteitsoord was a white, Afrikaans-speaking congregation

with a large number of student members. In Venda, near Thohoyandou, we worked with the Uniting Reformed Church's Tshilidzini congregation. Tshilidzini was a mostly Venda-speaking congregation that had members with varied social backgrounds, from labourers to professionals. This was the first time that I had entered the houses of black people and encountered the day-to-day life of low-income rural people in South Africa. I became friends with Wilhelm and Claire van Deventer. Wilhelm was the minister at the Tshilidzini congregation, and Claire was a doctor at Tshilidzini Hospital. Wilhelm had a friend, Attie van Niekerk[1], who wrote a book, *Dominee, are you listening to the drums?* (Van Niekerk, 1982) which we read as part of our second-year course in Philosophy. Wilhelm gave me his contact details. A friend who studied under the *Hervormde Kerk*[2] (and later went on to become an ordained minister, a chartered accountant, and an advocate) and I went to speak to Attie one afternoon at his house in Garsfontein about the theme that he had been thinking about for years: Africa, the West and Christianity. I became married in my sixth year of study. In that same year, Attie was one of our lecturers and taught a course on culture and Christianity.

After completing three degrees, I was licensed as a probationer in the Dutch Reformed Church and immediately enrolled for a DD (Doctor Divinitatis) degree. At the beginning of my doctoral studies, my future path was somewhat unclear to me. At that stage, I went to a few interviews for positions such as pastoral assistant, youth worker, and the like. Then, the Dutch Reformed Church had about 400 additional ministers and probationers on its books while membership numbers were declining. It soon became clear to me that even if I wanted to enter the ministry, it would be hard to do so. My experience at the interviews also made it clear to me that I was not the type of person most congregations wanted. In the year in which I started my doctoral studies, I landed a temporary post as a

1 Editors' note: Also mentioned in the previous chapter, Chapter 13, and author in this book. Attie van Niekerk clearly has an important mentoring role in this environment.

2 Another of the Afrikaans reformed churches. It's difficult to explain what the differences are.

lecturer in Old Testament for the first year. I enjoyed teaching. Maybe an academic career was an option?

The DD degree at the Faculty of Theology at the University of Pretoria has two components: a series of qualifying oral exams (*tentamena*) in three theological subjects, ending with an oral doctoral exam before an examination panel, followed by a dissertation. I switched my main subject from Old Testament to Systematic Theology because I became convinced that the main theological problem is not understanding the biblical text but the integration of everything that we believe. In the second half of the first year of my doctoral studies, Attie approached me to help on a project that he was working on with a not-for-profit company of which he was a director. The company was called The Nova Institute. The project had to do with pollution from domestic coal burning in a township near Secunda. Little did I know what an important role Nova would play in my life.

3. Forays into air quality

The first township I then came to know intimately was eMbalenhle[3], near Secunda on the Mpumalanga Highveld. We worked in Extension 14, where there was no electricity and only informal houses. The settlement had dirt roads, but the houses were numbered, and stands were fenced with simple wire fences. Most households used coal. The project that I worked on was an in-use evaluation of measures to reduce pollution from coal use that was set up as an experiment. We tested new smokeless coal stoves, LP gas stoves, insulation, low-smoke coal, repaired chimneys, and repaired stoves (many stoves were old and had cracks) compared to a control group. The success of the interventions was judged by people's satisfaction with the technology and the difference in indoor air pollution between the different treatment groups and a control group. Together with a local fieldworker, I conducted surveys, weighed coal, and delivered low-smoke coal. With our service provider, who repaired the stoves, I swapped stoves and climbed on roofs to fit

3 Editors' note: By now familiar to the reader and discussed intensively in Chapter 11 amongst others.

chimneys. With a contracted air quality expert, we arose before 04:00 in the morning and went house-to-house in the smoky pitch-dark to our participating households to switch on the pumps on the instruments that measured the air quality inside the houses. I also had to conduct meetings with stakeholders and attend meetings with the project sponsor. All these experiences were new to me.

I learned a lot on the practical but also philosophical level. The philosophy underlying the experiment was that interactions between complex systems, such as nature, technology, and Western and African culture, cannot be predicted (that is what *complex* means), but one can heuristically explore the interactions and find optimal solutions (Le Roux et al., 2024, p. 190). I also learned the value of direct engagement with the intended end users of a technology or service. Another lesson that I learned is that since success or failure cannot be predicted, keeping the scale small while one is experimenting together with the end users is a good way to proceed.

This project had a good result in the sense that the experiment was a success and a lot had been learned, but it took a while for an implementable solution to emerge. I was not directly involved in air quality for about five years, but I kept up to date with developments through interaction with Attie.

4. The dismal science

After this project, I found a job from a privately funded education trust to promote education for job creation in Soshanguve, north of Pretoria. As part of this, I had to read up on the relationship between education and employment. It was not as simple as I thought. I decided that since I was now professionally involved in an economic problem, I should at least be literate in Economics. I enrolled on first-year Economics at Unisa. At this point in my life, I already knew how to study, so I completed my assignments, sat for the exam, and passed with distinction.

I further learned the value of a quantitative approach and a systems perspective, and how the system is made up of the interaction of all the individual choices. I also learned

that there is a tension between intentions and outcomes and that the power of the state is limited; for example, you can create a famine by capping the price of food. I learned about the importance of incentives and that the system follows the incentives. I learned that supply and demand are independent and that it is the supply side (the real production possibilities) that drives the economy. I did find the anthropology expressed in our handbook and by our lecturer to be flat and unrealistic.

Now that I was at least literate in the field, I started reading other economists, Manfred Max-Neef[4] (Max-Neef et al., 1991; Murray &Pauw, 2022), Paul Ekins (Ekins & Max-Neef, 1992) and Amartya Sen (Sen, 2001). Max-Neef had a view of humanity that I could relate to and formulated a rich and nuanced view of what human needs and satisfiers are. Together with colleague Montagu Murray (whose doctorate is also in Systematic Theology), we later made extensive use of Max-Neef's work for the quality-of-life instruments that Nova uses, as discussed in this book, inter alia in Chapter 12. Ekins has an elegant way of talking about the means of production. Sen emphasises the importance of freedom as the real possibility to realise valued states.

5. Into the carbon market

Between 1999 and 2003, Nova's air pollution initiative moved out of research and development, through a pilot phase, into full-scale implementation of the alternative top-down ignition technique for coal fires (known as *Basa Magogo!*)[5]. In 2003, the national government became involved and implemented a project in Orange Farm and thereafter in Tembisa. A tender came out to determine the effect of the Tembisa project. We tendered with Business Enterprises at the University of Pretoria and landed the job. This was the first full-scale survey that I coordinated end-to-end. It was clear from the results that the contractors who worked for the government did not use the

4 Editors' note: Important source for this book. We have already emphasised the role of Max Neef in a previous note.

5 Editors' note: Should also be known to the reader by now. See Chapters 9 and 12.

same implementation methods as Nova and achieved inferior results. Our results, as well as the results of the evaluation of the Orange Farm implementation, seem to have countered Nova's initial idea that a solution could be discovered, developed, and refined by someone such as Nova and that the implementation and monitoring method could then be transferred to the government. The realisation grew that if the alternative ignition technique was ever going to have a large impact, we were going to have to undertake it ourselves.

Nova undertook an internal strategic development process in 2005 with the help of a management consultant. As a result of this process, I received some new responsibilities. I found an email from a broker in London in a string of unanswered emails when I took over my new function. The broker dealt in greenhouse gas emissions reductions – carbon credits, as it is colloquially known. After reading up on the concept, we began to wonder if this was not the funding avenue that would enable us to perform it ourselves. It was indeed. Between 2006 and 2016, we implemented the project in areas with significant coal use in four provinces. We sold more than 200,000 Gold Standard verified emission reductions (VERs). To achieve this, however, we had to develop a baseline and monitoring methodology that could be used to quantify the reduction in greenhouse gases that resulted from the project. We also had to develop the management and business processes that would enable us to operate and monitor multiple projects over a vast area.

The enduring legacy of our experience in the carbon market is that we bought into the value of outcome-based financing. The ideal situation for both a financier and an organisation with a specific mission, as well as the intended beneficiaries, is that money flows must be connected to verified outcomes. We would later try to implement this paradigm in other areas as well (such as water credits). At the time of writing, we are working on an initiative to implement the outcome-based finance model for a broader range of planetary well-being goals using 4IR (Fourth Industrial Revolution) technology.

6. Telling the truth with statistics

There is a, by now, pretty lame saying about "lies, damned lies and statistics". I developed a great appreciation of statistics mainly because my wife and my father-in-law are statisticians. The first time I worked for Nova, I was impressed to see how my colleague Pierre Schoonraad (also an old Theology student recruited by Attie) created a database to organise data from a household survey that we conducted. After further studies, Pierre moved on to a job in the civil service. For some reason, I became the one who did the data processing - maybe because I could ask my wife for help. I learned to use statistical software, for which the University had a license, to quickly summarise data, perform data transformations, and conduct simple statistical tests.

A big breakthrough, although slow in the making, was when Nova changed our statistical software to the open-source R language at the end of 2008 (R Core Team, 2014). R is more difficult to work with initially, but it offers much more control and the ability to programmatically control and customise every aspect of the workflow. We needed this when we started rolling out carbon credit projects at scale. I eventually mastered R and took a first-year and later a second-year course in statistics at Unisa. In between, I learned about epidemiology through an online course and improved my programming skills through books, online resources, and practice. At the end of 2008, we decided to henceforth only capture data on mobile devices (and not on paper). This revolutionised the way that we worked and mushroomed the volume of data to be processed. My role as an accidental analyst grew into an information business unit in Nova that currently has four full-time personnel apart from myself.

In the beginning, we analysed and reported on a lot of survey data, but later, our analysis task also included data from sensors as well as air quality data. During the process of formal and informal studies, and learning by doing, I developed literacy in, and an appreciation for, the quantitative disciplines. The quantitative disciplines are inherently conservative since they

place constraints on the conclusions that one can draw from your data and they force one to express your conclusions in terms of probabilities.

Nova's capacity grew through our large-scale implementation, monitoring, and reporting and through the process of having our process and results audited numerous times per year. The way in which we acquired, quality-controlled, and analysed our qualitative and quantitative data became quite sophisticated. We continued the practice of a tried-and-tested approach to developing interventions by engaging with households to test solutions at a small scale while at the same time taking objective measurements of the success of the intervention[6]. Work in the field of air quality, with or without a link to climate change, continued to be our largest source of income from 2007 onwards.

7. Encountering environmentalism

7.1 Meeting the other kind of NGO

In the course of our work on air quality and climate change mitigation, we occasionally encountered environmental activists. I had the opportunity to attend two climate conferences: COP 18 in Doha, Qatar, and COP 27 in Sharm el-Sheikh. Coming from a background where we endeavour to be accurate, balanced, and realistic, the ethos of environmental activism struck me as something different. The activists struck me as more belligerent (and therefore more self-righteous), more prone to exaggeration, and more irrational than I expected them to be. The local environmental activist group focusing on air pollution were also not very informed on the basic facts of air pollution (e.g., understanding the difference between environmental *pressures* and *states*).

I concluded that there were two kinds of NGOs: screaming NGOs and doing NGOs. I wanted to be on the doing side: Thinking, then doing a little bit, then thinking again (learning),

6 Editors' note: This is evident from several of the preceding chapters.

then doing a bit more – the point of view that I learned from Attie when I first started is that of complexity. Where complex systems interact, one cannot be sure what will happen. Seeking to understand is the first essential step in the quest for a beneficial solution. One needs to proceed carefully and not let the scale of implementation outrun the scale of understanding. Another thing that I learned from Attie, as well as from my Economics studies, is that you can do harm by trying to do good. I rarely encountered this type of thinking in the environmental activists whom I met in person or whose documents I studied.

7.2 Increased scepticism

Two events cemented my scepticism against a certain kind of environmentalism (the screaming kind). The one was a video by an environmental organisation about air pollution on the Highveld. The overall message was that the power stations and the large industries were to blame for air pollution on the Highveld. There is one scene where a group of children sit around a smoking *mbaula* (brazier). This immediately struck me as strange. I have seen many burning *izimbaula* in the course of my work. The typical practice is that one lights up the *mbaula* in the furthest corner of the stand (especially if you are not using the alternative top-down ignition technique), and then wait for the smoking to stop and the coals to glow red before using it as either a heat source or for cooking. The scene in the video was of children around an *mbaula*, clearly ignited from the bottom, still smoking, and with no glowing embers. At this stage, there is no appreciable heat. Sitting around an *mbaula* at this stage has no utility and considerable disutility from the smoke – which is why no one does it. The whole scene appeared to me to be staged for maximum emotional effect: poor children sitting around in the smoke. Apart from the fact that the scene was staged and inaccurate, and a cheap attempt at emotional manipulation, it is active child abuse. The producers of the video apparently orchestrated the children to sit in the smoke – thereby deliberately exposing them to the very thing that they pretend to protect them against. The other irony is that local sources, such as domestic coal burning, are indeed important

to address, but the video is part of a campaign that targets the power stations and big industries – sources that generally cost more to address and achieve less in terms of their effect. This whole thought process went through my mind in about a second – it filled me with an immediate sense of loathing. It made me think of the first time that I saw the video of Greta Thunberg speaking at the UN (United Nations) (Thunberg, 2019). Although she was young, the completely unwarranted and exaggerated sense of victimhood[7] was striking. I also wondered who orchestrated her appearance at this event.

The other, slower, experience that deepened my scepticism towards the screaming sort of environmental activist was my experience in engaging with other stakeholders around air quality offsets. In 2010, I was the co-author of a conference paper on air quality offsets with Theo Fischer, an environmental scientist with EScience Associates. We proposed a framework for air quality offsetting. The paper was very well received. Shortly after, we were invited by Eskom for a discussion on the topic. In the end, EScience was contracted by Eskom to conduct a pre-feasibility assessment on air quality offsets as an alternative way of compliance for Eskom's power stations. They, in turn, subcontracted Nova for a part of the work. Together, we had the opportunity to develop the technical framework and set in motion the process that would lead to the practical implementation of air quality offsetting. As part of the process, we consulted with the government and other stakeholders. We discovered that the government was also working on the idea and had a fairly mature conceptual framework for environmental offsets in general. The government published a draft air quality offset guideline in 2013 and gazetted a final version in 2016 (RSA, 2016). After our pre-feasibility study, we moved into the feasibility phase, where we tested intervention concepts on a small scale and conducted substantial measurements of objective and subjective success criteria. In parallel, we worked for Sasol on a similar programme. Sasol's programme would

7 "You have stolen my dreams and my childhood with your empty words."

eventually lead to the first successful full-scale implementation of an air quality offset project in South Africa.

The idea behind air quality offsets is that one should try to compare two alternative courses of action and select the most beneficial one. I thought that this principle could hardly be controversial and that the discussion would centre around how a beneficial outcome is to be defined and measured (i.e., impact metrics) or around how one would know what the outcome of a certain course of action would be (i.e., quantification methodologies) or how to compensate for uncertainties (safety margins). Throughout the whole process in which I was personally involved, and in the media reports and documentation I read subsequently, the environmental activist organisations were hardly ever interested in these themes. This made me wonder what it was that they were interested in.

7.3 Deep environmentalism

Having had at least an introduction to macroeconomics and from my experience in domestic energy and my participation in climate change mitigation projects, I also developed an interest in the macroeconomics of energy and the environment. As far as I could determine, the best long-term prospect to meet humanity's energy needs is a combination of renewables (in the niches where they work well) with a backbone of nuclear power. Practically no one will dispute that nuclear cannot be beaten for energy density. Delving into the available information also convinced me that it is far cleaner and safer than popularly perceived. I wondered why the international environmental movement (such as Greenpeace) was so vehemently opposed to nuclear power.[8] The other thing that they are opposed to is genetically modified food crops. This struck me as strange: why would an organisation that supposedly cares about the future of humanity and the preservation of biodiversity, oppose the exact technologies that can provide the physical basis for the achievement of that objective? The hypothesis that I came up

8 I first noticed this on own soil when Greenpeace activists illegally entered Koeberg Power Station to place a banner reading NUKES OUT OF AFRICA (Smetherham, 2002).

with was that somehow, deep down, they hated humanity. While some articulate the view that humans should cease to exist[9], most environmentalists would vehemently deny being anti-human. Yet, the opposition to what appears to me obvious, long-term solutions to food and energy makes it hard to believe that there is not at least an unconscious anti-human element in organisations such as Greenpeace. My daughter noticed another feature: nuclear power and genetic engineering represent human mastery of nature on a very fundamental level, that of the atom and the gene. It is almost as if there is a feeling that nuclear energy and genetic engineering represent humans stepping into nature's holy of holies. I started to see a religious substructure. That realisation remained an indelible part of my understanding of environmentalism.

7.4 Playing for the pavilion

Since I was involved in air quality, I started paying attention to how particular environmental NGOs communicated in public about air quality issues in South Africa. Three aspects stand out: they almost always exaggerate the scale of the negative consequences[10], there is a lack of awareness that the situation is complex and that optimal trade-offs must be found, and the underlying narrative is often anti-industrial. At some point, I realised that there is an economic principle at work. Messages about more impactful events attract more attention. Negative news generally attracts more attention than positive news (see Kätsyri et al., 2016, p. 2 for sources). If one were to construct an attentional hierarchy of potential messages, news of immediate impending doom would come out on top. However, like the boy who cried wolf, this trick cannot necessarily be repeated too often. Impending doom in the not-too-distant future is a far

9 Such as Stop Having Kids (https://www.stophavingkids.org/) and the Voluntary Human Extinction Movement (discussion in La et al., 2023

10 For example: Euripidou et al. (2022) use the estimate of Myllyvirta (2014) that "Eskom's coal-fired power plants (CFPs) would be responsible for 2,400 premature deaths per year" (Euripidou et al. 2022, p. 1) but the estimate of Myllyvirta is in all likelihood a significant overstatement. For details see Langerman and Pauw (2018).

safer bet. You can generate interest but stave off the falsification until a bit later. For an organisation that receives donations from the public, attention is an economic incentive. The NGO with a message such as: 'Nature, society, and the economy are complex systems that all have their own internal logic, constraints, and requirements. We must collaboratively seek optimal trade-offs and slowly forge ahead towards an optimal solution', is clearly at an economic disadvantage to one with a message of: 'Pollution from filthy industries owned by heartless capitalists is killing thousands of poor people as we speak. We are the brave ones stopping them, but you must help us.'

8. Brooding during lockdown

I think I am as sceptical of politicians as a group as the next person. I was also aware that there was a disproportionate number of psychopaths amongst CEOs (see for example Kets De Vries, 2012; Babiak et al., 2010). I was growing increasingly sceptical of environmental activists as well as of the reporters who presented their views in the media. However, I never deeply questioned the scientific community. I quite liked the scientists whom I came to work with and appreciated their methodical and disciplined approach. My criticism of the environmental NGOs was exactly that they were not scientific enough in their approach.

A new dynamic emerged for me during the coronavirus disease 2019 (COVID-19) pandemic. Governments worldwide appealed to science to enforce hitherto unknown restrictions on public life. When the pandemic started, I took to the habit of looking at the statistics every day. I also followed the discussion about the possible treatment options and how the pandemic would end. There was one report in May 2020 that I continued to think about for a long time. A group called *Pandemics Data and Analytics* (PANDA), led by actuaries, compared the projected number of fatalities caused by the virus to the projected number of deaths caused by the lockdown measures in South Africa. They showed that a tipping point emerges very soon when the lockdown, because of the physical restrictions and the economic damage, leads to more deaths than the virus. As

they said, *Viruses kill. But the economy sustains lives, and poverty kills too*. PANDA was viciously attacked by *The Daily Maverick* and consequently lodged a case with the Press Council, which upheld a small part of their complaint and dismissed the rest (Press Council of South Africa, 2021).

The improvised and haphazard nature of the measures did not give me the impression that the people who made the decisions really knew what they were doing. When they opened the schools at the height of the wave, which was characterised by a variant that affected children, after shutting the schools during the waves that did not make sense?

A doctor whom I have known for a very long time, and whom I trust unreservedly, mentioned using an old medication, called *Ivermectin*, prophylactically and in the early stages of the disease. I also noticed it being mentioned in circles where, shall we say, more unrestrained speculative theorising around the nature and causes of the pandemic was in vogue. I also noted the dismissive reaction from official sources locally and internationally, often descending into condescension while side-stepping the available facts. Something bothered me about this. There seemed to be at least prima facie evidence that *Ivermectin* could help, and it was cheap and had a proven safety record (literally billions of doses had been given). This was confirmed when a local civic rights organisation won a court case to allow doctors the emergency use of *Ivermectin* for COVID-19 without having to wait for the South African Health Products Regulatory Authority. Thus, if the high court could be convinced, it meant that there was not a lack of evidence. Why did the official health authorities not at least initiate large-scale clinical trials?

I found an online resource that ran a real-time meta-analysis on *Ivermectin* for COVID-19[11]. Having worked on automated statistical reporting myself, I was impressed by the site just on a technical level. My wife had an academic interest in meta-analysis, and I had some exposure to the technical side of epidemiology, so the analytic aspects also triggered my

11 https://c19ivm.org/meta.html

interest. The site was updated daily; it linked all the original research and differentiated between the stage of the disease where the medication is given, the types of outcomes, the study designs and indicators of data and research quality. As far as I could see, it followed the best practice for meta-analysis. I thought this was a prime example of what public science should look like. The meta-analysis, no matter how you constrained it (all studies, only peer-reviewed studies, only randomised controlled trials), all pointed in the direction of a significant effect, especially as prophylaxis and early in the disease. I was so perplexed by the difference between the official position, as I understood it from the media, and the available data that I started wondering if I was missing something. I asked a friend who was a professional medical researcher to check it out and gain some input from colleagues. I thought if this was the work of Russian hackers, they really outdid themselves this time. But we spoke a while later, and the consensus was that the site and its content were legitimate.

I was not in a high-risk category, but I was vaccinated on the premise that vaccination would help prevent the spread of the disease. Looking back now, that seems a bit gullible. I thought that there were many uncertainties related to the mRNA-type vaccines, so when I had the chance to receive the Johnson & Johnson vaccine, I went for it. I tried to better understand what was going on with the mRNA vaccines as best I could by accessing the original sources whenever possible. One such source that puzzled me for a time was the article in the *New England Journal of Medicine* that reported on the 6-month follow-up of the Pfizer BioNTech mRNA vaccine (Thomas et al., 2021). It mentioned that there were more deaths in the treatment group than in the placebo group (not statistically significantly more, but more nonetheless)[12]. I understood the

12 "During the blinded, placebo-controlled period, 15 participants in the BNT162b2 group and 14 in the placebo group died; during the open-label period, 3 participants in the BNT162b2 group and 2 in the original placebo group who received BNT162b2 after unblinding died. None of these deaths were considered to be related to BNT162b2 by the investigators. Causes of death were balanced between BNT162b2 and placebo groups (Table S4)."

explanation that death was not the outcome of concern, but since prevention of death seemed to be the ultimate aim of the whole exercise, that explanation left me unsatisfied. At least it showed that with a treatment and placebo group of ~22,000 each, over six months, no difference in all-cause mortality could be proven. Another aspect that I wondered about was the fact that Thomas et al. reported the vaccine efficacy[13] (which is high at 91%) but not the reduction in absolute risk (which is about 3%). I was under the impression that it is a good practice to report on the absolute risk reduction of a treatment because that gives a better idea of the real-world impact of the treatment.

The reluctance of the people behind the *Ivermectin* meta-analysis to take credit for their obviously thorough work was my first clue that all was not well. I have always understood that science is embedded in a social and economic substrate, but that never prompted any serious reservations about the scientific undertaking in general. The way in which coercive measures were implemented inside democratic countries, supposedly with scientific justification, during the COVID-19 pandemic, disturbed me. I repeatedly picked up the message that this or that measure was backed by settled science (or equally that an alternative proposal was not backed by science) as if science were like dogma or law in which there is one and only one correct answer to which everyone must agree or face excommunication. I viewed science rather as a collaborative process of discovery that is never really finished but that succeeds asymptotically, and one in which the lone dissenting voice often represents the start of a leap forward. I started following news about experts, such as Dr Jay Battacharya, who had dissenting views, or even just pertinent questions and experienced professional persecution of some kind. I realised that if science progresses by disagreement and openness to a re-evaluation of established positions in the light of new (or

13 "Vaccine efficacy was calculated as 100 × (1 − IRR), where IRR (incidence rate ratio) is the ratio of the rate (number per 1,000 person-years of follow-up) of confirmed cases of COVID-19 in the BNT162b2 group to the corresponding rate in the placebo group" (Thomas et al., 2021, p. 1767).

even sometimes the same) evidence, then censorship of data or scientists is science's enemy number one.

I don't think I am a sceptic yet, but I have come to appreciate the emotional impact of coercion on one's attitude towards certain matters. Looking back at my journey, I am convinced that few things create mistrust as much as coercion. Especially if an authority changes its position but retains its arrogance. I also started to develop the intuition that one should pay more attention to how economic and ideological incentives shape the creation of scientific knowledge and how it could derail scientific and societal progress.

9. Climate and blockchain

Although we achieved a lot in climate change mitigation projects, our focus was always primarily on the quality of life for low-income households rather than on climate *per se*. The Nova Institute's vision is *A healthy household culture in Southern Africa*. We used the market for voluntary greenhouse gas emissions reductions (the so-called carbon market) primarily to fund projects that had an air quality and quality of life benefit. The premise on which the carbon market is based is that a beneficial outcome, that would not have occurred outside of a project activity implemented specifically for that purpose (this is called *additionality*), can be objectively verified and turned into a sellable asset. Our work on air quality offsets focused on the quantification and verification of an air quality benefit, but not necessarily on the commodification of that outcome.

We wanted to extend the principle we learned in the carbon market, namely that one can create assets based on verified additional communal benefits, to a much larger range of benefits than just greenhouse gas emissions reductions. Although we had success in air quality offsets, it was initially unclear how the ideal of creating assets based on a much broader range of outcomes could be implemented until the boom in cryptocurrencies and blockchain-based assets in 2017. The emergence of blockchain technology provided a potential mechanism to create a decentralised ecosystem for

the definition, quantification, and verification of such assets. In 2018, we started working on a concept of an ecosystem for defining, creating, verifying, selling, and using cryptographic tokens of communal benefits.

Distributed ledger technology (which includes blockchain technology) is revolutionary because it allows solutions for self-sovereign identity and trustless transactions. Trustless transactions are those that can take place without a trusted intermediary (Uggla & Hallström, 2018). We envisioned that these technologies could help us to set up a network where independent producers and verifiers of a wide range of assets (conceivably covering all planetary well-being goals) could transparently create and verify assets. Trust would be facilitated through the cryptographically guaranteed transparency mechanisms provided by the technology. We also envisioned that the technology would enable us to create a reputation system that gives reputation to actors based on their history of contribution to the network.

After developing our basic concept, we realised that the first step would be to create a basic framework into which all types of impact accounting could fit. In 2020, a colleague and I joined the Hyperledger Foundation's Climate Action and Accounting Special Interest Group (CA2SIG). The Hyperledger Foundation is a non-profit consortium hosted by The Linux Foundation, that fosters and supports the development of enterprise-grade, open-source distributed ledger technologies. In the CA2SIG, we formed a standard working group that took it upon itself to develop a formal ontology for Anthropogenic Impact Accounting (known as AIAO) using standard semantic web technologies such as the Web Ontology Language (OWL). This provides a consistent vocabulary for describing how a particular activity impacts an environment. The work on this has progressed far, but is continuing.

10. Speaking the truth in love

There is a biblical exhortation to speak the truth in love. The opposite of that is cynical lying (having no love and not telling

the truth) or cynical scepticism (having no love and being unwilling to believe the truth). Between truth and love, truth is the easier one to incentivise. There is not much one can do about the intentions of other people, but there are ways to incentivise telling the truth or to present evidence in such a way that people can understand and believe it.

The question I ask myself is how one can implement the principle of speaking the truth in love in the area where I work, namely, on the interface between society, technology, economy, and the environment. Love means that one seeks the benefit of the one loved. Truth is about how the representations one makes correspond to reality. Those representations also include the ones that one makes to oneself.

The interaction between societal, technical, economic, and environmental systems is complex and knowing and speaking the truth is difficult. Knowing how to act is also difficult – especially when realising that harm can follow from trying to do good.

One part of the antidote to scepticism is clear articulation because clear articulation enables the counterparty the opportunity to evaluate what is communicated. During the discussions of the CA2SIG standards working group mentioned earlier, I realised that prescribing a specific universal standard for anything cannot be done. In the US, they still weigh things in pounds. Even if you think the metric system is better in some way, it would be naïve to think that the metric system should be universally adopted in the US. A simpler solution is to make sure that the unit is always communicated with a measurement and that the conversion formulae are known.

Following this line of reasoning, the standards working group decided to create a consistent language for talking about anthropogenic impact rather than prescribing a universal accounting standard for anthropogenic impact (that had no chance of ever gaining universal recognition). In the context of the Hyperledger Foundation, we were thinking specifically of digital artefacts, typically ones representing greenhouse gas emissions or reductions. Even within the carbon market, there

are differences of opinion about matters such as whether using emission reductions is an acceptable offset for emissions or whether only true sinks can be used for this purpose. Giving the prospective buyer of a digital environmental artefact clear information based on which they can decide according to their own priorities seemed to be a better approach compared to pretending that these differences can ever be solved.

With the use of precise and strictly defined terminology, articulation is part of the scientific discipline. This includes the empirical social sciences. At Nova, we make extensive use of social indicators[14] when we monitor communities over time, where an indicator is precisely defined, and its data collection and calculation method is explicitly defined.

But science must describe. The question is to what extent this is true for normative disciplines, such as Auditing, Accounting, Management, Public Administration and Development Studies. In these undertakings, there is value in stating one's goal because it enables other people to judge the outcomes in a particular light. Articulation is at least part of the antidote to scepticism. At Nova, we try to pursue the ideal that we say what we do and do what we say.

When I first worked with the World Business Council for Sustainable Development (WBCSD) / World Resources Institute (WRI) Greenhouse Gas Protocol (WBCSD et al., 2004), I was struck by the elegance of its five accounting principles: relevance, completeness, consistency, accuracy, and transparency. As with clarity of expression, transparency enables the counterparty to evaluate the evidence and determine their position. When we were operating multiple greenhouse gas emissions reduction projects, we submitted up to ten monitoring reports per year. All those had to be audited. During that time, I started taking an interest in the concept of *reproducible research*. Reproducible research is the approach to reporting research results that keeps the data and reporting together and directly links the reported results to the underlying data. This is done by making the data, the code that generates the output and the

14 Editors' note: The topic of Chapter 12.

output itself available as one unit. Reproducible research is a way of realising the ideal of transparency.

Together with a former colleague, I became involved in a community that develops distributed ledger-based software systems to make reporting things such as climate impact transparent on a large scale. This work is also continuing.

Trust is an interesting concept in the context of distributed ledger ecosystems; in fact, *trustlessness* is a key concept. It means you do not have to trust the counterparty or a central authority, such as a bank, to transact since the validity and security of transactions on the network are cryptographically guaranteed. At face value, this seems like a very attractive feature for the sceptic. The problem is that trustlessness only applies to transactions on a distributed ledger. Full trustlessness only applies to transactions of pure cryptocurrencies. This is because pure cryptocurrencies represent nothing outside of the network. Even then, it is just the validity of the transaction and now what it represents. For example, if you buy a pizza with a cryptocurrency, the counterparty can know when the transaction is written on the distributed ledger, and it cannot be cancelled, but you still have to trust that they will hand over the pizza.

As soon as something in the real world is represented on the distributed ledger (a cryptographic representation of a thing or a right is called a *token*), the process cannot be trustless. Another strategy must be employed where tokens are concerned. The aim is to reduce the likelihood of a misrepresentation. The main mechanism of such a strategy is transparency and redundancy. Distributed ledger technology is well-suited to employing the principles of reproducible research, namely data sharing, code sharing, documentation, and version control. Redundancy means that there are multiple layers of safeguards. The more layered and the more robust the safeguards, the less scepticism is warranted. Safeguards that are traditionally used are the concepts of liability and reputation. Insurance firms protect their clients against uncertainty, but they, in turn incentivise risk-avoidant behaviour on the side of their clients. Insurance translates the degree of uncertainty

or risk exposure directly into an immediate financial cost for the client. Institutions such as banks and audit firms, whose business is built on trust, go to great lengths to protect their reputation (in the first place by maintaining internal discipline) because they realise that the public's or a regulator's trust in them is the basis of their business. We are currently working on ways to employ these same concepts within a distributed ledger ecosystem as a way of ensuring the quality of representation of realised benefits, for example, ecological benefits.

11. The march of folly

Years back, I read American historian Barbara W. Tuchman's book *The March of Folly: From Troy to Vietnam* (Tuchman, 1985). The book is a series of historical case studies of institutions acting against their own interest. Approximately half of the book covers the involvement of the US in Vietnam. The insight of this book is that institutions sometimes vigorously and diligently pursue courses of action that they should know can only result in their demise. Powerful institutions can make poor decisions driven by a combination of arrogance and naivety.

After Vietnam, the US lost two additional wars: in Iraq and Afghanistan. *Lost* is the word that Daniel Bolger, a retired US Army lieutenant general, used already in 2014 in his book *Why We Lost: A General's Inside Account of the Iraq and Afghanistan Wars*. If Tuchman's book were to become like the Rocky films and have sequel upon sequel, what events would be in subsequent volumes? Apartheid may make the list. Communism is a difficult one because it depends on how one defines the interests of the group. The wars in Iraq and Afghanistan are obvious candidates.

As the dust settled on the COVID-19 pandemic, I became aware of studies like that of Classen (Classen, 2021), Michels et al. (2023) and Bendavid and Patel (2024). I wondered if extended lockdowns, school closures and vaccine mandates for students would also be one day counted amongst the follies of history. Even though many mistakes were made, I did not think that the way that many governments acted during the initial waves of the COVID-19 pandemic could be classified as folly.

Things were happening fast and there was truly an unknown and urgent threat. Even now, with the benefit of hindsight, there is no agreement on what should have been done. However, in his presentation to the Actuary Society of South Africa, Nick Hudson, co-author of the PANDA report, described the lockdowns as "acts of immense folly" (Hudson, 2023). Even where experts disagree so vehemently, it is difficult for a non-expert to understand what is going on. What would be clearly folly would be not to learn from the experience.

In his book, *The Open Society and Its Enemies* (Popper, 2013)[15]Karl Popper argues for an open society based on individual freedoms. He warns against what he calls *historicism* (the belief in the inevitability of the unfolding of history), and utopian ideals because these beliefs are used to justify the suppression of individual freedoms. Totalitarian institutions need high ideals and the presence of imminent threats to justify their authority and the drastic changes to society that they bring about. Saving or restoring the environment provides a high ideal and, in the eyes of many, prevents an imminent calamity.

I often wondered if a certain type of environmentalism (the anti-nuclear, anti-GMO - genetically modified organism - type that speaks about a climate emergency) would make it into a sequel to *The March of Folly*. There is certainly an obsessive and self-defeating element. The failure of energy policies in Germany in recent years shows how so-called progressive policies can have exactly the opposite effect than intended. A 2019 survey of 1,811 adults in Germany and Poland found that pro-environmental and pro-climate attitudes correlate negatively with support for nuclear power (Bohdanowicz et al., 2023) and that this effect is stronger in Germany. Ironically, attempts to move away from nuclear power and fossil fuels resulted in dirtier and more expensive energy, with less energy security (Csizmazia, 2023).

As with COVID-19, even experts disagree strongly on how to act on the major environmental questions of our time. Amid

15 Originally published in 1945 by Routledge. Numerous reprints and several new editions followed.

this uncertainty, people like me have to make up our minds personally and professionally. Being aware of the possibility that the actions done in pursuit of a particular ideal can lead to its exact opposite makes this more difficult because it shifts the question away from intentions to future outcomes. Escandón et al. (2021) investigated six false dichotomies (either–or questions) that have been subject to oversimplification during the COVID-19 pandemic. In their analysis, *false dichotomies are pervasive and attractive* because *they offer an escape from the unsettling complexity and enduring uncertainty* (2021, p. 4). In conclusion, they called for *a nuanced understanding of the science,* and they cautioned *against black-or-white messaging, all-or-nothing guidance, and one-size-fits-all approaches.* This advice seems apt also for actions in response to environmental issues. An interesting duel that played out on Twitter is documented in the Institute for Strategic Dialogue's report on climate mis- and disinformation at COP27 – the 27th Conference of the Parties – between the hashtags #ClimateScam and #ClimateEmergency (King, 2023, p. 6).[16] A duel between #ClimateScam and #ClimateEmergency seems to me precisely the *black-or-white, all-or-nothing* thinking that Escandón et al. warn against. I am no supporter of anything that could be labelled #ClimateScam, but I do fear that once #ClimateEmergency wins, the remaining part, namely the *one-size-fits-all* solution, will not be far off.

Another lesson I learned from the pandemic experience is that authoritarian behaviour undermines trust and is frequently counter-productive. Escandón et al. conclude that *conveying uncertainty does not harm public trust* (2021, p. 4), but in my experience, the opposite is also true: simplified messaging about complex issues (i.e., talking to adults as if they were children) creates animosity and mistrust. In the same way, finding out a certain view has been censored makes some people (me, at least) more inclined to believe it – especially if you already have doubts about the censor.

16 The authors of the report seem to suggest that this is somehow orchestrated in favour of #ClimateScam: "The term appears to be trending despite data that shows more activity and engagement on other hashtags such as #ClimateCrisis and #ClimateEmergency".

Some of the knowledge that has emerged after the pandemic came about because of guarantees of civil liberties, such as laws promoting access to information (for example, the analysis by Michels et al., see their discussion on page 975).

Rights such as the right to access information held by the state enable individuals in democracies, at least in principle, to influence, moderate or counter the actions of the state and large corporations or to hold them responsible after the fact. The theme of this book, *Development in the Anthropocene,* should be a joint search for a solution or a joint grand project, something like solving a puzzle or building a house. However, it could also be a battleground between opposing interest groups who compete to deny the other the opportunity to speak. The victory of a specific point of view over another by silencing it would be the worst possible outcome because the ideologically self-assured are particularly prone to acts of folly.

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Part Five

The golden thread

Chapter 15

Drawing the strings together

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1. Introduction

The chapters of our book were written as separate contributions to scholarship. However, there is an underlying unity – a broad picture. This chapter aims to highlight such unity without denying noticeable differences between the respective chapters. The book aligns with the aphorism with an interesting history: *Think globally, act locally* (Dubos, 1998 [1969]).[17] It is, in fact, an extended case study of how a not-for-profit company can think globally and act locally.

2. Think globally

The global perspective is the theme in the first two chapters (PART ONE) called *Philosophical Considerations*. In Chapter 1, the reader is invited to focus on the concept of *development*

17 Patrick Geddes (1854–1932), a Scottish town planner, originally used the idea. His occupation is interesting as the book includes references to town planning in Chapters 9 and 11.

from a qualitative perspective encompassing the globe. Our view is directed towards planetary well-being through a new presentation of the *Sustainable Development Goals* of the United Nations as *Planetary Well-being Goals*. It is argued that there was an evolution in the understanding of the concept of human development in the last century, whereby the emergence of new insights leads to qualitative improvements, without abandoning the insights of previous phases. Therefore, *planetary well-being*, which includes human well-being and the well-being of living non-human beings within the integrated Earth system, is a more appropriate ultimate development goal in the time of the Anthropocene than sustainable development. Thus, in Chapter 1, development is interpreted as *transitioning to a qualitatively better state*. This is a more inclusive take on development than the traditional interpretation of the word, where development mostly refers to the development of low-income persons. Although all the book chapters deal with development in one way or another, not all the chapters share the interpretation of development as described in Chapter 1. Development as a concept unfolds in different ways throughout the book. It is central as is signalled by the title. The title of the book acknowledges that low-income households and communities remain a development priority since there are aspects of well-being that are much more difficult to achieve in low-income contexts. Although there might be different interpretations of *development* in various chapters, all would agree that the goal of development cannot be economic growth only, or the mere accumulation of wealth as money. Furthermore, all authors would agree that there are no easy solutions or quick fixes in progressing towards sustainable development, enhanced quality of life, and ultimately, planetary well-being. It is a tough task to work together towards these goals, especially in the low-income African context.

Even the globe might be too limited a context for thinking *globally*. Chapter 2 forces us to think of the whole creation. Chapter 1 emphasises the integrity of the Earth system in the time of the Anthropocene. The focus is on how human activity impacts the Earth system, rather than describing all factors that

influence the Earth system; for example, the impact of solar cycles on climate change. Chapter 2 makes the point that God created Earth and Heaven. This is a radically alternative meta-narrative to, for example, deep ecology or climate as a religious object. The chapter also signals the topic of technology, which is important throughout the book. When we act locally, we must act with technology, but always as a means and not an end. When thinking globally and recognising Heaven, as Chapter 2 encourages us to do, technology finds its proper place. It is an important place, as most chapters show. The interventions discussed in PART TWO of the book are intertwined with technology, without technology becoming autonomous or an aim in itself.

3. Act locally

In PART TWO, consisting of 5 chapters, several in situ projects conducted by the Nova Institute are described in the form of scholarly contributions to the applicable literature against the background of existing scientific and technical writings: air quality interventions, sustainable energy interventions, waste management projects, an early childhood development project, and sanitation solutions. The last-mentioned chapter on non-sewered sanitation practices has a decided philosophical import, aligning it with PART ONE.

The local action described in this book is intertwined with technology. Technical details, including chemical symbols, can be found throughout – even in a chapter dealing with government policy (Chapter 10). In dealing with, for example, air quality, technical solutions must be found, but they must be managed and mediated with the low-income families at the local level. Mediation is essential for the success of interventions, especially in the short term, as is emphasised in Chapter 6.

Efficient and effective management is also technology. Nova, the organisation that works together with households and network partners to improve the quality of life of low-income families, emphasises the right kind of step-by-step

management of its projects. Projects are grounded in scientific evidence where possible, but at least in facts. In this sense, Nova works scientifically; and science is respect for the facts or evidence. Much effort is invested in the development of robust tools to gather information and monitor and evaluate results. We hope that development agencies in other contexts will benefit from this approach and join in a scholarly conversation. Since, with this book, Nova also works with the output side of science to share findings and insights with the scholarly world. So, the book is not neo-Luddite and is broadly technology-friendly. It includes a chapter on the possible benefits of the Fourth Industrial Revolution which includes artificial intelligence for low-income households.

Acting locally obviously means taking wider contexts and ways of thinking in addition to global frameworks into consideration. This is shown in PART THREE. It deals with transversal issues that remain important in local interventions: the Fourth Industrial Revolution, the question of whether policy can be based on science, measuring the impacts of interventions on the quality of life, consultation versus collaboration and spatial justice. Each of these is intertwined with the projects of a development agent.

4. Working together in the local environment

The main aspect of the unity of the book is the global and local environment in which low-income households live. This environment is part of the Earth system in the Anthropocene, in the main experienced locally. Nova meets these households in their local environment and works with them towards improved quality of life and well-being. This *working together* can be described as a trans-disciplinary search for solutions with households and networks to develop a qualitatively better situation whereby the quality of life of households improves without compromising the integrity of the environment. A golden thread that runs through all the chapters is that this ongoing trans-disciplinary research, development, implementation, and monitoring and evaluation is a tough task. Several stakeholders participate in this endeavour, including

government and large industries. Look at the chapters making up the bulk of PART TWO. Every one of these aspects discussed in PART TWO impacts the health and well-being of low-income persons. Every one of them represents a task of government, specifically at the local level. Every one of them is the object of government policy and legislation. This comes out when one looks at the discussion of air quality and waste in Chapter 10 and compares it with PART TWO. Thus, Chapter 12 also addresses the measurement of the outcomes of interventions described in Chapter 4, and Chapter 11 deals with inequalities and service delivery that fails to put these inequalities right in the fields discussed in PART TWO.

5. Conclusion

In summary, the book starts by *thinking globally* about what an appropriate ultimate development goal in the time of the Anthropocene could be. An important insight to consider is that development could be interpreted as *qualitative growth into something better*, and not only *quantitative monetary growth*. That means that if humankind wants to grow into something qualitatively better, we need to consider that we are part of the Earth system. Furthermore, it serves as well to remember that the Earth system was not created by humankind. Interpreting ourselves as part of the larger creation means that the value of the Earth system cannot be derived only from our own evaluation of species and individuals. There is a greater meta-narrative to consider than only linking development to human and even Earth system prosperity. The drive to make a positive contribution towards planetary well-being in a local context is grounded and originates in the meaning that the actors, who participate in such initiatives, give to their actions. One of the most responsible ways to approach development in a local context is to take a trans-disciplinary approach. Such an approach values the participation of low-income households themselves as agents of their own development. Including households in the research and development process, where possible, is of great importance. Furthermore, trans-disciplinarity means applying rigorous scientific methods.

A scientific approach is valuable since it gathers evidence to determine the impact of interventions. When potential solutions are developed, these solutions must be tested with the end users to ensure that they work in their lifeworld. Trans-disciplinarity often also entails working with several stakeholders, which may include government, universities, local authorities, industries, churches, NGOs and other relevant role players depending on the specific task at hand.

And lastly, what we, the authors of this book, have learned from experience is that even if one has a noble goal and follows a responsible approach, it can still be a tough task to accomplish what one sets out to do. We have a huge development task still ahead of us, namely, to grow into something qualitatively better. This includes the responsibility to think globally and act locally towards finding ways with low-income households and networks to improve their quality of life, where they live locally, but also within the greater Earth system. It is a tough task to work towards planetary well-being, and we know that we will not succeed in every endeavour. But are we not called to grow into something qualitatively better?

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The pith of this book is interventions to collaboratively improve the lives of low-income households with their development on a local scale. These interventions are co-created with communities by the Nova Institute, a not-for-profit company based in South Africa. Successful interventions to provide more efficient and less polluting energy, treatment of waste, and sanitation are discussed. Access to water is also discussed. They all contribute to planetary well-being in their small way. These are not the only developmental topics: early childhood development (ECD), artificial intelligence (AI), policymaking, urban planning, intervention models, and research tools are also on the table.

The book starts by thinking globally about what an appropriate ultimate development goal in the time of the **Anthropocene**[1] could be. An important insight to consider is that development could be interpreted as qualitative growth into something better, and not only quantitative monetary growth. A golden thread that runs through all the chapters is that this ongoing trans-disciplinary research, development, implementation, and monitoring and evaluation of interventions to improve the quality of life and well-being of low-income communities is a tough task.

The book is scholarly and practical. It takes scientific literature in several fields as well as situations on the ground in South Africa into account. The 29 contributing authors comprise scientific researchers at universities, full-time research consultants, fieldworkers, and philosophers. Seven universities are represented.

[1] *The **Anthropocene** is a proposed geological epoch characterised by significant human impact on Earth's geology and ecosystems.*

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