EQUITY DIMENSIONS OF THE NELSON MANDELA BAY WATER CRISIS AND THE IMPLEMENTING CONTEXT AS ENABLER OR BARRIER FOR UPTAKE OF TRANSLATABLE LESSONS FROM THE CAPE TOWN WATER CRISIS

Final Report

To the

Water Research Commission

By

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Abbreviations

ANC – African National Congress

ATTP – Assistance to the Poor

CoGTA – Department of Cooperative Governance and Traditional Affairs

DA – Democratic Alliance

DMA – District Metered Area

DWS – Department of Water and Sanitation

ECSECC – Eastern Cape Socio-Economic Consultative Council

EDAMS – Engineering Design and Management Systems

GDP – Gross Domestic Product

GIS – Geographical Information Services

GMA – Greater Metered Area

GWP – Global Water Partnership

IDP – Integrated Development Plan

IMESA – Institute of Municipal Engineering of Southern Africa

IT – Information Technology

KL/month – Kilolitres per month

KPI – Key performance indicator

LL – Living labs

ML/day – Megalitres per day

NGO – Non-governmental organization

NMB – Nelson Mandela Bay

NMBLL – Nelson Mandela Bay Living labs

NMBM – Nelson Mandela Bay Metro

NRW – Non-revenue water

OECD – Organization for Economic Cooperation and Development

RDP – Reconstruction and Development Programme

SASSA – South African Social Security Agency

SCADA – Supervisor Control and Data Acquisition

SDG – Sustainable Development Goal

SEZ – Special Economic Zone

SI – Social innovation

STEEP-H – Social, Technical, Economic, Environmental, Political, and Historical

UN – United Nations

USD – United States Dollar

WCSS – Western Cape Water Supply System

WRC – Water Research Commission

WSS – Water Supply System

WTWs – Water Treatment Works

WWTWs – Wastewater Treatment Works

Executive Summary

In South Africa, extended droughts are becoming more frequent. Whenever a prolonged drought occurs, it triggers a water crisis. In extreme cases, dams run so low that the overall water security of an entire city is threatened, e.g., the case of the Nelson Mandela Bay Metro, City of Cape Town, and Makhanda. Drought in the Nelson Mandela Bay Metro is not new. Since 1969, the Metro has experienced at least four instances of severe drought, but the 2017 – 2023 drought was the most severe in the history of the Metro. The 2017 – 2023 drought led to the combined water storage levels in reservoirs reaching extreme lows, for example, 11.17% in 2021. This study focused on government-led interventions and the equity dimensions of these. The Nelson Mandela Bay Metro responded to the drought by implementing several measures aimed at: 1) optimising existing water sources and supply systems, 2) diversifying and augmenting water supply sources, and 3) reducing consumption and demand. Regarding optimising existing sources and supply systems, the Metro implemented extensive leak repairs, domestic meter audits, installation of advanced metering systems, backwash water recovery, and refurbishing and upgrading supply sources and systems. In augmenting the municipal water supply, efforts mainly focused on diversifying water sources (e.g., the feasibility of a desalination plant, wastewater reuse in the industrial sector, and groundwater exploitation in the Coegakop Wellfield) and upgrading existing water supply schemes (e.g., the Nooitgedacht low-level water scheme). Regarding managing consumption, as the severity of the water crisis increased, the municipality intensified its efforts to reduce consumption through smart metering, increased restrictions and tariffs, and pressure-control devices. Citizens were engaged through various public and awareness raising media, e.g., radio and social media, but evidence of social learning is lean. What is clear from these interventions is that they are mainly technical, raising questions about i) the place of social innovation, including those related to governance and institutions, and ii) equity dimensions of the measures implemented throughout the city.

Project Aims

The following were the specific aims of the project:

1. To analyse the distributive, procedural and contextual equity dimensions of the municipal response to the drought in the Nelson Mandela Bay Metropolitan Municipality (NMBM).

2. To analyse factors in the implementation environment within the NMBM that may accelerate uptake of translatable lessons, and those that may impede their uptake, given lessons learnt from the well-documented Cape Town drought.
3. To engage existing selected social innovation platforms and programmes such as Living Labs, Nelson Mandela Bay Learning Labs, City Support Programme, etc., as platforms for strengthening transversal and cooperative governance of water and related services within the NMBM.

Project approach and methodology

The study used a case study approach to interrogate the equity dimensions of the municipal responses to the drought, as well as analysing the implementing environment within the metro. We collected both primary and secondary data through surveys, interviews, workshops, living lab engagements, focus group discussions and document analysis. The quantitative data were analysed using descriptive statistics and the qualitative data using thematic analysis.

Project results and discussion

The study revealed that municipal water supply was the primary source of drinking water across the metro. However, as the drought intensified and the municipality responded by implementing a range of measures, the higher income groups were able to procure alternative drinking water sources such as bottled or filtered water, and increasingly became less reliant on municipal supplies. There was also a general perception among low-income households that the municipality tends to fix leaking pipes in affluent suburbs more quickly compared to those in the low-income and informal settlements areas. This may reflect disparities in municipal response times, with residents in better-serviced suburbs receiving faster attention, while others face long delays. Although residents of the low-income and informal settlements indicated a sense of neglect when it comes to fixing leaks, they, however, indicated that these leaks do not seriously impact them, probably because it is in these settlements that water is highly subsidised by the municipality.

In many low-income households, unpaid, excessively high water bills were common, and in most cases, these residents were in no position to clear these bills. Several reasons were provided for the high water bills. These include i) bill inheritance, ii) landlords not paying bills even if tenants have paid their rents, and iii) bill disputes between the municipality and

consumer(s). It was also these residents who indicated that increases in tariffs have affected their ability to pay for other household necessities such as food. This then raises a fundamental question regarding balancing equity, efficiency and sustainability. On the one hand, the municipality must implement efficiency-driven measures such as meter audits (ensuring that meters work correctly), pressure control, stepped tariffs, etc. On the other hand, it must also implement safeguard measures to protect those who are not able to afford the payment for services. In this regard, our study revealed that egalitarian thinking informing municipal response has to be moderated by need-based distributive equity thinking to lessen the burden of these municipal measures on the poor and most vulnerable. Perhaps the best example of this need-based thinking was the implementation of the Assistance to the Poor Programme (ATTP).

The Living Lab engagements indicate communities' deep understanding and the complexity of water security, providing impetus for why it is important to engage communities when attempting to address complex sustainability challenges such as water security. The engagement also indicated that communities used different strategies to build resilience during the drought. However, adaptive capacities among low- and medium-income households were limited. Long-term infrastructure planning, maintenance/repairs, effective communication, education and awareness raising, regular engagement with the communities, as well as equity-sensitive interventions were suggested solutions for building resilience within the metro.

We synthesised 16 lessons based on the analysis of the implementing environment of the metro. These lessons emphasise the importance of building public trust through open, transparent and regular communications via appropriate channels; investing in relationships that foster public confidence and trust; strengthening efficiency and maintaining water infrastructure; investing in data and expertise; securing critical water assets and infrastructure from vandalism, theft and sabotage; ensuring adequate financial resources for water infrastructure and strengthening financial accountability. The lessons also advocate for practising anticipatory governance, setting aside financial resources to support the most vulnerable while implementing systems for efficient collection of water services tariffs and cost recoveries. We also stress the need to continue diversifying water sources, taking a systems approach to planning, while maintaining water sources and ecological infrastructure in good condition. The political environment is critical, and in this regard, the lessons drawn from the research stress the importance of ensuring a politically stable environment, strengthening vertical and horizontal coordination

and cooperation between Directorates, Divisions and units, while fostering multilevel governance, investing in strategic partnerships and mobilising private sector resources.

In terms of translatable lessons from the Cape Town water crisis, several barriers appear to impede the uptake of these lessons. These include political instability, coordination challenges across governance levels, budget constraints and resource allocation, and over-reliance on surface water sources. The false sense of security presented by reliance on surface water could be seen to have slowed down source water diversification efforts before the drought.

Recommendations

Recommendation for operational implementation

Please note that some of these recommendations are already being implemented by the metro. In such cases, they are reinforced through this independent study.

- **Build public trust through open, transparent and regular communication and participatory platforms**. The municipality should strengthen and diversify its communication channels and citizen participatory platforms. Regular ward meetings, house-to-house water campaigns/meetings, neighbourhood water watch committees, and setting up and maintaining community water learning platforms are examples of initiatives and programmes that can assist in trust building and participation. Regular and consistent communication and feedback loops can also strengthen the process of trust building. Feedback loops through participatory platforms provide a mechanism to strengthen a two-way communication between the municipality and the communities it serves. The process of community trust building also implies fostering long-term relationships with a diversity of actors and stakeholders in communities, e.g., community-based organisations (CBOs), environmental activists, community leaders, businesses, ward leaders, and faith-based organisations. These relationships are intended to serve diverse purposes such as information flow and amplification, water education and awareness, and neighbourhood support.

- **Strengthen efficiency and maintain water infrastructure.** There is a need to improve the response time to community complaints regarding leaks, blockages and burst pipes. This can be achieved by developing a community-driven approach that allows rapid

reporting of such leaks and real-time feedback to complainants when the reported incidents have been resolved.

- **Invest in data and expertise**: Expertise in complex data analytics, climate and scenarios modelling, GIS and spatial analysis, machine learning, predictive science, asset management, financial and project management, as well as continuous investment in engineering and hydrological sciences are all critical areas to invest in to strengthen the technical environment within the NMBM. Expertise in foresight and futures thinking methods, such as horizon scanning, Delphi method, causal layered analysis, back casting, vulnerability mapping, participatory foresight modelling, trend analysis, historical analogy, etc are needed to strengthen municipal preparedness for the future. Regular community surveys on perceptions of water service delivery should assist in strengthening service delivery and taking proactive actions based on community feedback.

- **Secure critical water assets and infrastructure to ensure their integrity.** Vandalism and theft remain a major problem within the metro. Investing in a community-driven neighbourhood water infrastructure security programme is urgently needed to curb the incidences of theft and vandalism of critical water assets. The municipality should consider emerging technologies such as drones, which have proved effective elsewhere. The municipal by-laws relating to theft and vandalism of critical municipal assets should be strengthened and strictly enforced for maximum allowable punishment. Community-driven systems and initiatives for rapid reporting of incidents of vandalism and theft should contribute to addressing this perennial problem. Such initiatives should also include a way of documenting evidence for prosecution.

- **Ensure adequate financial resources to diversify the Metro water sources, maintain water infrastructure, and improve demand management**. The water sources diversification efforts (e.g., groundwater sources) of the municipality contributed enormously to addressing the water crisis, and this effort must be sustained. A desalination feasibility study has been carried out and now needs to be implemented, potentially within the framework of a public-private partnership, considering the growing water demand within the Coega industrial development complex. There is enormous potential for effluent re-use within the metro, yet this has not received the attention it deserves, especially for non-portable uses. Financial investment in this

regard is needed. The improvement recorded during the drought on infrastructure maintenance and upgrading across the entire water value chain must be sustained, which requires ongoing sufficient budgetary allocation.

- **Set aside adequate financial resources to support the most vulnerable, while paying attention to those just above the poverty borderline.** A key lesson from the study is that the municipal ATTP plays an important role in alleviating the burden of the water services crisis during the drought. The study has also indicated that the burden fell most on those who were just above the borderline of the ATTP. Setting aside financial resources to support this programme into the future is an important equity matter. Investments should also go into awareness and campaigns to encourage and support qualifying households that have not enrolled to do so.

- **Implement systems for efficient collection of water services tariffs and cost recovery**. The growing unpaid water service bills among household water consumers are a concern. The municipality must maintain a consistent, aggressive posture towards debt and cost recovery, and this must be complemented by regular audits of water meters and customer accounts, ensuring the accuracy of these.

- **Maintain water sources and ecological infrastructure in good condition**. The entire western side depends on water resources within the catchment. The viability of these sources and their potential to support future demands depends on maintaining critical ecological infrastructure in good condition. These include clearing of alien invasive species, maintaining the wetlands and rivers within the metro in good ecological condition, as well as groundwater recharge. Some of these interventions call for multi-level collaboration between the Department of Water and Sanitation and the Metro. These multilevel collaborations should be proactively pursued.

- **Ensure a politically and administratively stable environment and pay attention to vested interests and cognitive biases**. Mechanisms must be put in place to safeguard the political process, and to clearly demarcate political, administrative and technocratic functions of the municipality. Vested interests of incumbents and incentives from legacy systems are sufficient reasons to support a business-as-usual scenario, even if these are not in the public interest. Methods such as design fiction and experiential futures and scenarios should be explored to experiment with transformative water

futures, while being cognisant of cognitive biases that limit thinking about future options.

- **Strengthen horizontal cooperation between Directorates, Divisions and Units within the Metro, and multi-level governance**. Staff recruitment and procurement had direct implications for water services delivery within the Metro. The KPIs of these critical divisions often do not align and speak to each other. The various divisions are often bound by different compliance measures, and in the pursuit of these, they remain in silos. An inter-divisional steering committee for strengthening cooperation and interactions on cross-divisional challenges should be established to strengthen horizontal cooperation within the metro. Regular engagements with DWS and other national government structures during the drought were of great importance. These should be sustained. Strategic partnerships such as those with the Nelson Mandela Bay Business Chamber are vital to sustain, as these play a critical supplementary role in the municipal effort during the drought. Concerning the private sector, the municipality should engage with this sector in support of future water diversification efforts, e.g., the proposed desalination plants. The growing Coega Industrial Complex offers an opportunity in this regard. The private sector can also be encouraged to invest in wastewater reuse, especially for industrial processes that do not require the quality of potable water.

Recommendation for policy interventions

- **Private sector involvement:** There is a need for an urgent policy intervention to get the private sector more involved in the delivery of water services. This could be done in a variety of ways, e.g., through unlocking private sector investments into water services infrastructure, and in return, the government could provide tax credits or other incentives. The more direct approach of the private sector, being Water Services Providers (WSPs), would require careful consideration in light of ongoing national debates and reforms. Service delivery guidelines, the licensing processes and procedures for private sector participation, pricing regimes, and quality assurance mechanisms must be clearly spelled out. The direct involvement of the private sector as WSPs can strengthen the overall resilience of water services delivery in the country.

- **Foresight capability and anticipatory governance**: The response to the drought and the various intervention measures calls for a shift in how water security should be governed in the metro, but more broadly in South Africa. There is an urgent policy imperative to strengthening municipal capabilities in foresight exercises and futures thinking, anticipatory governance and innovations. This would necessitate institutional and structural changes to encourage municipalities in the areas of sense-making about the futures, disruptive, transformative change and innovations, and experimentations, which are not always welcomed in traditional institutional contexts within which municipalities operate.

- **Strategic autonomy for the water service delivery division or units within local governments**. Organisations that are financially and operationally autonomous are usually more agile and are able to circumvent traditional stage-gate processes. An important policy intervention is strategic autonomy for water services delivery divisions within local municipalities. Strategic autonomy should strengthen the agility of WSPs to respond to emergencies, better anticipate and plan for the future, and rapidly deploy resources when needed.

- **Balance efficiency, sustainability and equity in a dynamic fashion**: The study shed light on the intricate, complex relationships between these values. When one single-mindedly pursues any of these values, one ends up being in conflict with the other values. Therefore, policy instruments that seek a dynamic balance between equity, efficiency and sustainability across levels of governance are needed in the water services sector. Guidance must also be given in terms of the operationalisation of these instruments for WSPs.

Future research

The following recommendations are made for future study:

- Critically examine the implications of strategic autonomy for water services units/divisions or institutions within the context of multilevel and polycentric governance systems.

- The current study largely focuses on the equity implications of the municipal response to the drought on households. A similar study should be carried out with a focus on

other sectors such as businesses and agriculture as these have direct implications for job security and socio-economic development within the metro.

- A detailed study is needed to better understand the roles of the private sector in addressing the collective burdens imposed by the drought. This study should also explore the equity implications of these and lessons for future preparedness.

- The role of anticipatory innovation governance in future-proofing water services delivery in the face of uncertainties and a deeply unequal society deserves urgent investigation.

In terms of the comparison between the responses of the City of Cape Town and Nelson Mandela Bay Metro, the tables below summarise these.

Complex interacting elements in both Cape Town and NNMB water services situations during their respective droughts

Elements	**Cape Town Experience**	**Nelson Mandela Bay Experience**
Proactive Risk Planning	Delayed response worsened the crisis; early warning systems were weak.	Facing a prolonged water crisis with late interventions and weak early warning systems.
Clarify Roles and Responsibilities	Poor coordination between city, provincial, and national governments led to inefficiencies.	Fragmented governance between city, provincial, and national government causing delays.
Political Stability and Leadership	Political infighting between the DA-led City and ANC-led National Government undermined response.	Municipal political challenges affect coordination, leading to slow and reactive responses.
Foster Cross-Sector Collaboration	Strong collaboration with universities, businesses, and NGOs helped with response.	Some engagements with businesses and civil society in response planning.

Elements	Cape Town Experience	Nelson Mandela Bay Experience
Public Communication Strategy	"Day Zero" campaign mobilized action but caused panic and economic harm.	No clear messaging strategy: public engagement inconsistent and limited.
Leverage External Expertise	The World Bank and universities provided critical expertise to shift focus to demand management.	DWS and the City Support Programme provide some assistance, but overall limited use of external water governance and climate change expertise.
Aggressive Demand Reduction	Reduced per capita water use from over 1,000ML to below 500ML through restrictions and fines.	Restrictions implemented with noticeable reduction, but public compliance remains challenging.
Behavioural Economics and Social Norming	Publicly displaying household water usage (Green Dot map) encouraged conservation.	No large-scale social norming campaigns to encourage conservation.
Equity in Demand Management	Wealthy areas adapted with boreholes, while poorer communities had fewer options.	Similar inequalities, with wealthier households securing alternative water sources, but ATTP cushion effect on the most vulnerable.
Diversification of Water Sources	Over-reliance on rain-fed dams made the city highly vulnerable to drought.	Also, over-reliant on surface water sources with limited alternative supply planning, e.g., groundwater.
Water Reuse and Alternative Supply	Invested in groundwater, desalination, and stormwater harvesting post-drought.	Invested in groundwater, but investment in desalination is slow.

Elements	Cape Town Experience	Nelson Mandela Bay Experience
Progressive Tariffs to Ensure Equity	Stepped tariff implemented to discourage excessive use while protecting low-income users.	Stepped tariff implemented to discourage excessive use while protecting low-income users.
Climate Change Integration in Planning	Studies showed climate change tripled the likelihood of drought, necessitating planning.	Limited integration of climate change projections in long-term water planning.
Water-Sensitive Urban Design	Emphasis on stormwater harvesting, rainwater reuse, and permeable infrastructure.	Urban planning is still largely detached from water-sensitive infrastructure.
Social and Economic Equity in Water Access	Informal settlements used only 4% of water but were most affected by restrictions.	Low-income communities were less affected due to geographical advantage and ATTP of the municipality.
Community Engagement	Some efforts were made, but many communities mobilized independently.	Some efforts were made, but frustration about limited participation.

Relationships across levels of government and other actors in response to the Cape Town drought versus the Nelson Mandela Bay drought

Category	Cape Town Drought (2015-2018)	Nelson Mandela Bay Drought (2016-Present)
National Government (DWS)	Imposed water restrictions on the Western Cape Water Supply System (WCWSS).	Enforced severe water restrictions on Nelson Mandela Bay's main water sources.
	Provided technical support but was criticized for delayed infrastructure investments.	Provided funding for drought relief but at a slower pace than needed.
	Initially resisted calls for emergency funding and large-scale supply augmentation.	
Provincial Government	The Western Cape Government played a key role in communication and coordination between municipalities.	The Eastern Cape Provincial Government was criticized for a lack of urgency in addressing the crisis.
	Advocated for increased national support and funding.	Less visible leadership compared to Western Cape's approach.
	Assisted in disaster management planning.	
Municipal Government	The City of Cape Town took a leading role in managing the crisis, implementing demand-side measures, restricting usage, and developing alternative water sources.	The Nelson Mandela Bay Municipality play a lead role on the technic side of the water services delivery business but struggled with governance

Category	Cape Town Drought (2015-2018)	Nelson Mandela Bay Drought (2016-Present)
		challenges and delayed implementation of key projects.
	Enforced stringent restrictions and punitive tariffs.	Faced criticism for perceived poor planning and inefficiencies in managing water infrastructure.
	Communicated extensively with residents through the "Day Zero" campaign.	Evident investment in water infrastructure maintenance, upgrade, and refurbishment during the drought.
Inter-Governmental Cooperation	Frequent tension between the City of Cape Town and DWS over responsibilities, funding, and long-term planning.	Less structured inter-governmental cooperation compared to Cape Town.
	Collaboration with national and provincial governments improved over time but remained strained.	After initial delays, evident of collaborations through the declaration of state of disaster and the City Support Programme.
Business Sector	Played an active role in water-saving initiatives and water augmentation investments (e.g., private desalination plants).	Less business-sector involvement compared to Cape Town.

Category	Cape Town Drought (2015-2018)	Nelson Mandela Bay Drought (2016-Present)
	Large industries, such as breweries and tech companies, invested in water recycling.	Some businesses implemented their own water-saving measures but at a smaller scale.
NGOs and Civil Society	NGOs, researchers, and civil society groups were highly active in water awareness campaigns, advocacy, and alternative supply solutions.	Less prominent NGO involvement.
	Significant international attention and donor support.	Some community-based water-saving initiatives but not at the scale seen in Cape Town.
Public Participation	Strong public engagement through mass media, city updates, and behavioural change campaigns.	Public engagement and awareness were evident but not prominent in the media compared to Cape Town.
	Increased levels of compliance with water-saving measures, leading to a reduction in daily water consumption.	Reduction in water consumption achieved but not to the levels expected as frustrations mounts over users compliance.
Infrastructure Investments	Some delays in national-level investments (e.g., delayed augmentation schemes).	Delays in infrastructure investments worsened the crisis.
	The city fast-tracked groundwater projects, desalination, and to some extent wastewater reuse initiatives.	Investment in groundwater exploitation, but limited implementation attention to

Category	Cape Town Drought (2015-2018)	Nelson Mandela Bay Drought (2016-Present)
		wastewater reuse and desalination.

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Chapter 1: Motivation

Prolonged drought is becoming a common feature in South Africa with implications for water security across scales (Mahlalela *et al*., 2020; Petterson, 2021). From 2017 – 2023, the Nelson Mandela Bay Metro was confronted with a severe drought that threatened the overall water security of the Metro (Umejezi & Cheteni, 2026). Drought, resulting in water scarcity, is not new in South Africa, and in particular the Nelson Mandela Bay Metro (NMBM). In fact, the water crisis in the city dates back several years and by August 2018, the dams collectively supplying the Metro water had dropped to 17%. In response to the NMBM water security challenges, the Metro implemented several technical and non-technical measures (Martin, 2021; Umejezi and Cheteni, 2026). These measures are fully discussed elsewhere (e.g., Pietersen, 2021). However, for context, the measures implemented in the city can be categorised into i) reducing water losses, ii) augmenting supply, iii) managing consumption, iv) publicity and engagement. On reducing water losses, the municipality implemented several solutions, including leak repairs, domestic metre audits, and installation of advanced metering systems. On augmenting municipal water supply, efforts were mainly directed at diversifying water sources (e.g., feasibility of a desalination plant, wastewater re-use in the industrial sector and groundwater exploitation in the Coegakop Wellfield) and upgrading existing water supply schemes (e.g., the Nooitgedacht low-level water scheme, etc) (Pietersen, 2021). Regarding managing consumption, as the severity of the water crisis increases, the municipality has intensified its efforts at reducing consumption through measures such as smart metering, increased restrictions and tariffs, and pressure control devices (Martin, 2021). Citizens have also been engaged through various public awareness raising media, e.g., radio and social media, but evidence of social learning is lean (Martin, 2021). What is clear from these interventions is that they are mainly technical, raising the questions about i) the place of social innovation, including governance and institutional innovations, and ii) equity dimensions of these measures.

Lessons from the responses to the Cape Town water crisis suggest that equity is a fundamental value that must be centred when designing and implementing measures during a water crisis. In the NMBM, equity is critical in the context of the water crisis and the municipal response because poverty is a major challenge and is spatially distributed within the metro. For example,

in the towns of Zwide-Uitenhage, more than 60% of households had less than 300 USD as monthly income, compared to households in high-income areas. Among the poorest households within the metro, 84% of persons older than 18 years did not complete secondary education, 96% had no tertiary education and 53% rely on grants from the government (Nelson Mandela Bay Municipality, 2025). Unemployment is rife, creating a state of path-dependency, low adaptive capacity, and resilience to shocks such as water restrictions, increased metering, and tariffs. Therefore, one of the fundamental questions posed in this project relates to the equity implications of the municipal responses to the drought.

A WRC study by Odume *et al*. (2022) on water governance ethics in South Africa shed light on the multidimensionality of the value of equity, and on the need to consider its multiple dimensions in policy and practice within the South African water sector. Equity as a multidimensional concept can be construed as entailing distributive, procedural, contextual and recognitional dimensions (McDermott *et al*., 2013; Loft *et al.,* 2017). Distributive equity focuses on how costs, benefits, risks, and burdens are shared/allocated among people and social groups arising from resource governance, policy, and implementation practices (Leach et al. 2018). In the context of water insecurity in the NMBM, distributive equity enables us to clarify how different social groupings are affected by the benefits, risks and costs arising from the drought on the one hand, and how municipal policy and practice responses have also impacted the different societal groupings. By using a distributive equity analysis lens, we shed light on how the measures taken by the municipality may have implications for the distribution of risk, costs, benefits, and burdens arising from the water security challenges in the Metro (Schloberg, 2007; Fraser, 2009).

Political and governance processes are important considerations in terms of how people participate in and influence decisions in relation to implementation measures for alleviating the ongoing water crisis in the Metro. Although community awareness and publicity are two of the pillars of municipal response, the extent to which different societal groupings' voices effectively influence decisions on how the municipality responds to the ongoing water security challenges remains to be seen (Loft *et al*., 2017). In this regard, procedural equity is fundamental as it pays attention to fairness in how decisions are made, in how people participate in those decision-making processes, as well as fairness in representation of social groups of involved and affected parties (Loft *et al.,* 2017; Leach *et al*., 2018; Odume *et al.,* 2022). Through the procedural dimensions of equity, this project sheds light on issues of power

dynamics, access to information and powerful knowledge, as well as discourses that may result in unequal participation and influence over decision-making processes that determine the allocation/sharing of benefits, costs, risks, and burdens arising from the drought and the municipal response. By analysing the procedural dimension of equity in relation to the NMBM drought and the municipal responses, the project distils water governance measures necessary for inclusivity, participation, and representation for equitable sharing of costs and benefits.

It has been argued that context matters in the pursuit of equity imperatives (Sandel, 1990; Pelletier, 2010). In this regard, pre-existing contextual conditions, e.g., social, technical, economic, environmental, political, and historical (STEEP-H), can impact people's adaptive capacity to absorb and respond to shocks such as unexpected imposition of water restrictions, steeper tariffs, water rationing, etc. The implications are that such externally imposed shocks, e.g., those by the municipality, differentially affect social groupings in ways that may deepen inequity as an unintended consequence. Therefore, contextual equity as a dimension of equity pays attention to contextually sensitive factors that influence the governance processes on the sharing of benefits, costs and risks associated with water and related services (Odume *et al.,* 2022). By using the lens of contextual equity as an analytical frame, the project distils the contextually relevant factors that impact people's ability to effectively participate in and influence the sharing of costs and benefits arising from the drought and the municipal responses within the Metro.

The 2015-2017 Cape Town water crisis is well documented (Brick *et al*., 2017, https://www.drought-response-learning-initiative.org/). In response to the water crisis in Cape Town, the municipality working collaboratively with other government and non-governmental institutions implemented several institutional, technical, and social innovations, which see water consumption reduced drastically at the peak of the water crisis (Brick *et al.,* 2017; Brick and Visser, 2017), for a review of the Cape Town water crisis and measures taken). Ziervogel's (2019) analysis of translatable lessons learnt from the Cape Town drought. Ziervogel's (2019) analysis of lessons focused on: i) the governance lessons, ii) data, expertise, and communication, iii) the importance of a system approach, and iv) building adaptive capacity. For example, some of the translatable lessons on governance include i) the need to strengthen transversal management between municipal departments, ii) building systems and relationships of mutual accountability for effective water management between spheres of government, iii) strengthening leadership and the capacity to enable flexible, adaptive decision making, and iv)

investing in partnerships beyond the local municipality. Translatable lessons were also documented in other areas such as data management, the role of expertise, and effective and proactive communication.

A system approach has been hailed in the literature as appropriate to addressing complex challenges such as water insecurity. Empirical evidence suggests that the City of Cape Town draws on systems thinking in responding to and addressing the water crisis (Brick *et al.*, 2017). Translatable lessons in this regard have been documented, including i) an integrated approach to planning the entire water value chain, ii) a robust and resilient networked system of water supply, and iii) recognising the limitations of the current financial model for water (Ziervogel, 2019). In this project, we asked whether these lessons can be rapidly implemented in the Nelson Mandela Bay Metro. In doing so, we analysed factors within the NMBM implementation environment that may accelerate uptake of translatable lessons, and those that may impede their uptake. For example, a political analysis of the NMBM by Ndletyana (2022) showed a municipality in a political crisis and has the potential of impeding the uptake of lessons. Overall, the project distilled the equity dimensions of the municipal response to the water security challenges that confronted the NMBM between 2017 – 2023. It also analysed the implementation environment for the uptake of translatable lessons.

Project Aims

1. To analyse the distributive, procedural and contextual equity dimensions of the municipal response to the drought in the Nelson Mandela Bay Metropolitan Municipality (NMBM).
2. To analyse factors in the implementation environment within the NMBM that may accelerate uptake of translatable lessons, and those that may impede their uptake, given lessons learnt from the well-documented Cape Town drought.
3. To engage existing selected social innovation platforms and programmes such as Living Labs, Nelson Mandela Bay Learning Labs, City Support Programme, etc., as a platform for strengthening transversal and cooperative governance of water and related services within the NMBM.

Chapter 2: Study Area Description

The Nelson Mandela Bay metro is a Category A municipality with exclusive municipal executive and legislative authority. The municipality occupies an area of about 1 950 km^2 and has a population of about 1.26 million people (COGTA, 2020). It is located on the shores of Algoa Bay on the southern coast of South Africa (Figure 2.1). The city of Gqeberha, and the industrial town of Uitenhage, residential towns of Despatch, Perseverance, Motherwell, Zwide, Bethelsdorp, Bloemendal, Blue Horizon Bay, and KwaNobuhle are some of the major towns and cities within the NMBM (ECSECC, 2017; Odume *et al*., 2014). The municipality boasts two major seaports, Port Elizabeth Harbour and Ngqura, which also contribute to its economy. The Port of Ngqura is the largest deep-water port in South Africa and lies adjacent to a multibillion-dollar industrial development complex known as the Coega Industrial Development Zone (COGTA, 2020).

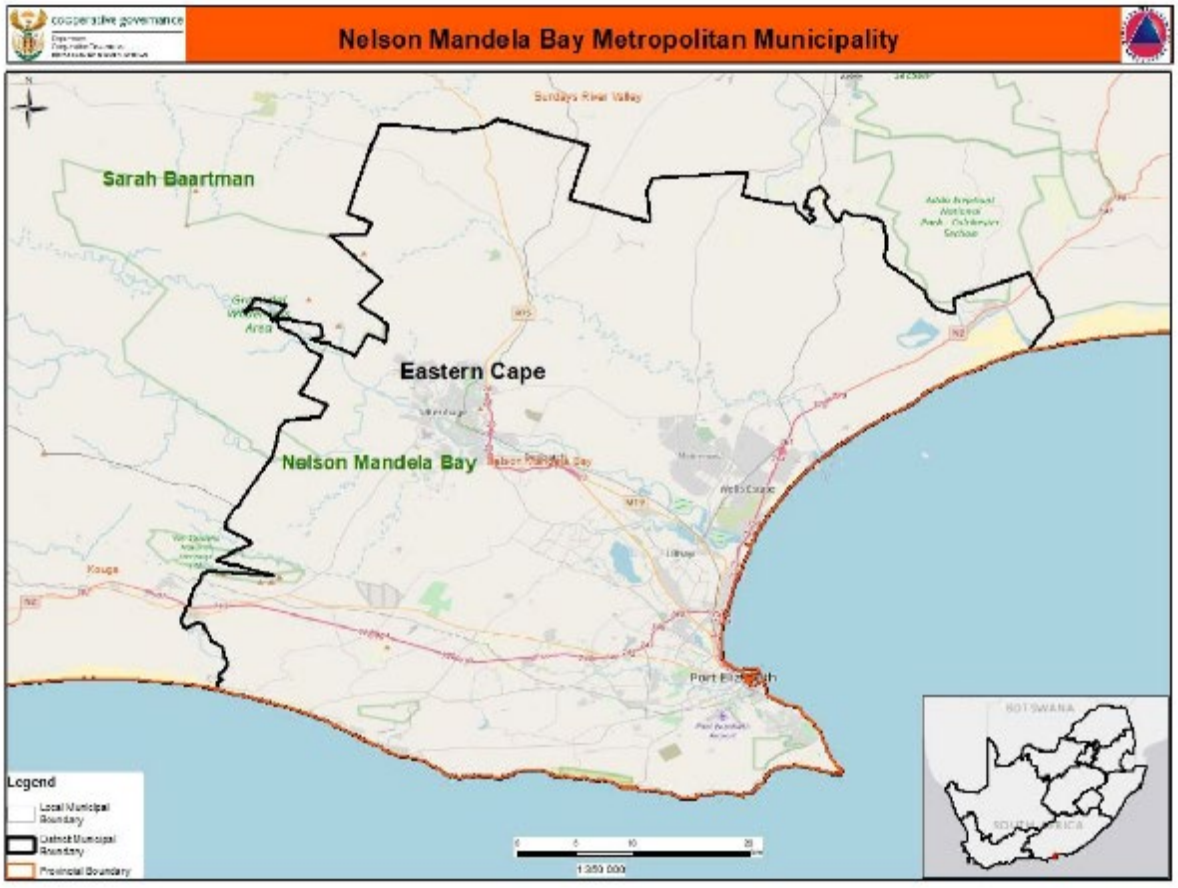


Figure 2.1 1Map Showing the municipal boundary of the Nelson Mandela Bay Municipality (NMBM) (NMBM, 2021).

2.2 Biophysical description

Climate

The NMBM experiences a moderate to warm temperate climate with precipitation all year round. The mean monthly temperature ranges from 14 °C to 22 °C with average daily maximum temperatures of 25.4 °C in late summer months (January and February) and 19.6 °C during the winter months (June – August) and average daily minimum temperature of 17.9 °C and 8.8 °C for the summer and winter months, respectively (NMBM, 2011; Odume, 2014). The mean annual precipitation ranges from 300 mm to 1200 mm, with peak rainfall during the winter and early spring months (June – October) (NMBM, 2011; Odume, 2014). Water losses due to evapotranspiration (1800 mm per annum) far outweigh the rate of precipitation in the Metro (Schael *et al*., 2015). During the last decade, the NMBM experienced extreme seasonal uncertainty in temperature and rainfall patterns, leading to drought and persistent water shortages (NMBM, 2021).

Freshwater systems

The freshwater ecosystems in the NMBM include the Seaview stream, Swartkops, Coega, KwaZungu, Elands, Sand, Brak, Chatty, Bakken, Maitland, Kruis, and Papenkuils Rivers (NMBM, 2011). The Swartkops River (54 km in length), which originates from the confluence of the KwaZungu and Eland Rivers, flows through major industrial towns and settlements before emptying into the Blue Water Bay and then the Indian Ocean. The Brak and Chatty Rivers join the Swartkops River at different points along its length, with the Chatty River contributing to the flow in the Swartkops River estuary. Thus, the Swartkops Rover and its tributaries constitute the freshwater system located in the central region of the NMBM. The Coega River, which is the longest river (62 km) within the NMBM boundaries, is located several kilometers eastward from the Swartkops River, where it drains the catchment from the Groot Winterhoek Mountains to the sea (NMBM, 2011; Nyawo, 2017). The Papenkuils River flows through the industrial areas of North End and Deal Party and carries waste and effluents from urban and industrial activities to sea (NMBM, 2011). Dams located along the major river stretches serve as reservoirs for water treatment works, for domestic water supply and water sources for irrigation purposes. Some of the notable dams include the Groendal Dam in the KwaZungu River, Sandrivier Dam, and Bulkrivier Dam (NMBM, 2011).

2.3 Socioeconomic description

The NMBM is estimated to have a little over 1.25 million people living within its boundaries with an average annual population growth rate of 1.54% (COGTA, 2020). The NMBM constitutes about 18% of the total human population in the Eastern Cape province of South Africa (ECSECC, 2017). The human population density of the Metro is 641 persons per square kilometre. The Municipality has a total of 368 518 households of which 41% are headed by women, with an average size of 3.6 persons per household (COGTA, 2020). The NMBM is occupied by population groups of different races including African, White, Coloured and Asians. The industries within the NMBM makes it a migrant receiving area where people immigrate to in search for job opportunities. Within the metro, 156 informal settlements with 28 174 informal households are spatially distributed within the Metro (NMBM, 2025). Poverty is a major challenge within the Metro with about 27% of households receiving government grants (under the Assistance to the poor programme) as their main source of income (NMBM, 2022).

The NMBM contributed 34.86% and 2.67% to the GDP of the Eastern Cape and South Africa in 2020, respectively (NMBM, 2022). The largest economic sectors in NMBM are community services, manufacturing, transport, finance, and trade (NMBM, 2021). Community services contributed R34.3 billion to the GDP in 2020 followed by the finance and then manufacturing sectors. These sectors create the most employment in the Metro. Nevertheless, the unemployment rate in NMBM in 2020 was about 36%, that is 1.4 times the unemployment rate in the Eastern Cape province (COGTA, 2020).

Service delivery in the Metro appears to be fair considering that 90.8% of the population get their refuse collected by the local authority or private company (COGTA, 2020). Moreover, the lapses in the delivery of sanitation facilities in the NMBM is very low with 94% of the population having access to tap water (COGTA, 2020).

2.4 The Nelson Mandela Bay Water Supply Scheme

The NMBM is supplied by the Algoa Water Supply System (Algoa WSS), which comprises three systems: the western system, the eastern system, and the central system (Figure 2.2).

The western system supplies water from the Churchill, Impofu and Kouga dams. Whereas the Churchill and Impofu dams are on the Kromme River catchment, the Kouga Dam is on the

Kouga River catchment. Only the Churchill Dam is owned by the Metro; the other dams within the western system are owned by the Department of Water and Sanitation (DWS). The supply capacity from these dams is 167 mega litre/day (ML/day) with an assurance of 1 in 50 years (NMBM, 2021a). During drought conditions, the supply is restricted as per DWS directives.

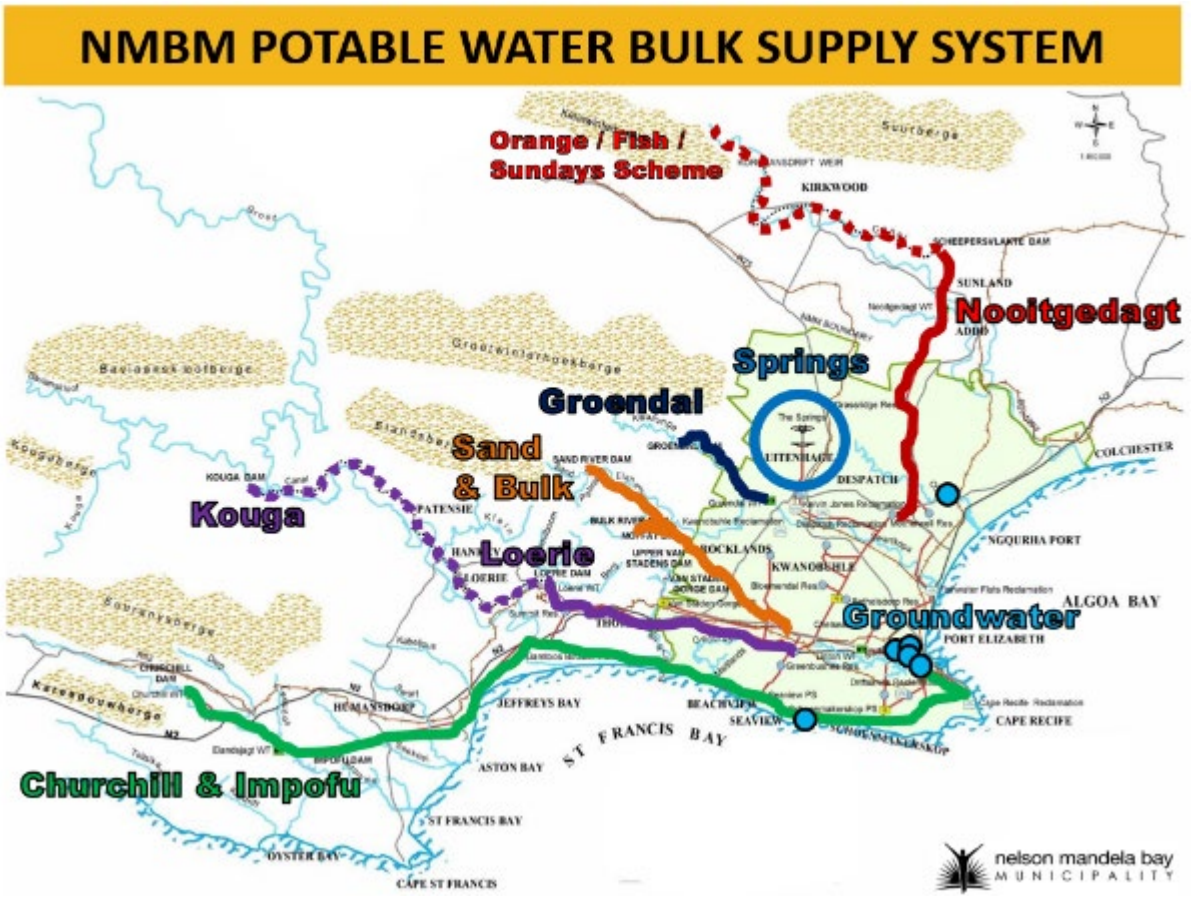


Figure 2.2 Nelson Mandela Bay Municipality (NMBM) water supply system

(Map supplied by Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate, Nelson Mandela Bay Municipality).

The eastern system is a complex one, comprising of an extensive inter-basin transfer scheme – the Orange-Fish-Lower Sundays River transfer system. Water from the Gariep Dam is supplied via the Orange River, to the Great Fish River and then through the Lower Sundays River, from which the Sundays River Water Users' Association supplies a portion of the water to the NMBM for domestic purposes. The eastern system currently supplies the NMBM a total of 210 ML/day.

The central system consists of the Sand, Bulk, Van Staden and Groendal dams as well as the Uitenhage Springs – all of which collectively supply a total of 27 ML/day under unrestricted

conditions. The western, eastern and central systems, their sources of supply as well as licenced abstraction volumes are provided in Table 2.1 below.

Table 2.1: Water supply systems, sources and licence abstraction volume for the NMBM (NMBM, 2022a).

Supply system	Sources of supply	Licenced abstraction volume (ML/day)
Western System	Churchill/Impofu Dams	104.32
	Kouga/Loerie Dams	63.01
Central Supply	Dams on the Sand/Bulk/Van Standen	9.04
	Groendal Dam	12.71
	Springs and Boreholes	5.92
Eastern Supply	Gariep Dam (Inter-basin transfer scheme)	209.73
Total supply volume		404.73

The NMBM currently operates a total of eight Water Treatment Works (WTWs), with a combined treatment capacity of 551.25 ML/day, with the first WTW commissioned in 1940 and the Rocklands WTW being the latest, commissioned in 2006. The combined treatment capacities of these WTWs imply that the NMBM has enough room to receive additional raw water for treatment, when necessary.

2.5 Impact of the drought on dam levels

The prolonged drought within the NMBM had a significant impact on dam levels (Figure 2.3). The western system, consisting of the Churchill/Impofu dams and the Kouga/Loerie dams, was particularly vulnerable. Although the dams were full in 2015, the severity of the drought on the dam levels took hold in 2017, and by April 2022, the water storage in the dams on the western system was only 13.17% of full capacity, declining even further to an all-time low of about 9.98% by 21 July 2021 (NMB Municipality 2022a, 10). The Impofu Dam, which normally serves as a reservoir for overflow from the Churchill Dam, was hardest hit by the drought, only storing water at 10.85% of its full capacity by the end of April 2022. This was followed by the

Kouga Dam at 13.20% capacity, Churchill Dam at 14.45%, Groendal Dam at 23.24% and Loerie Dam at 39.62%.

The impact of the drought on the dams was precarious when the dead storage level was reached. For example, the Churchill Dam dead storage level is 7% and the combined dead storage level for the Churchill/Impofu dams is about 9% and once these are reached, abstraction ceases, although under emergency conditions, the dead storage levels can still be accessed by lowering the barge level and using electrical supply and pumping equipment.

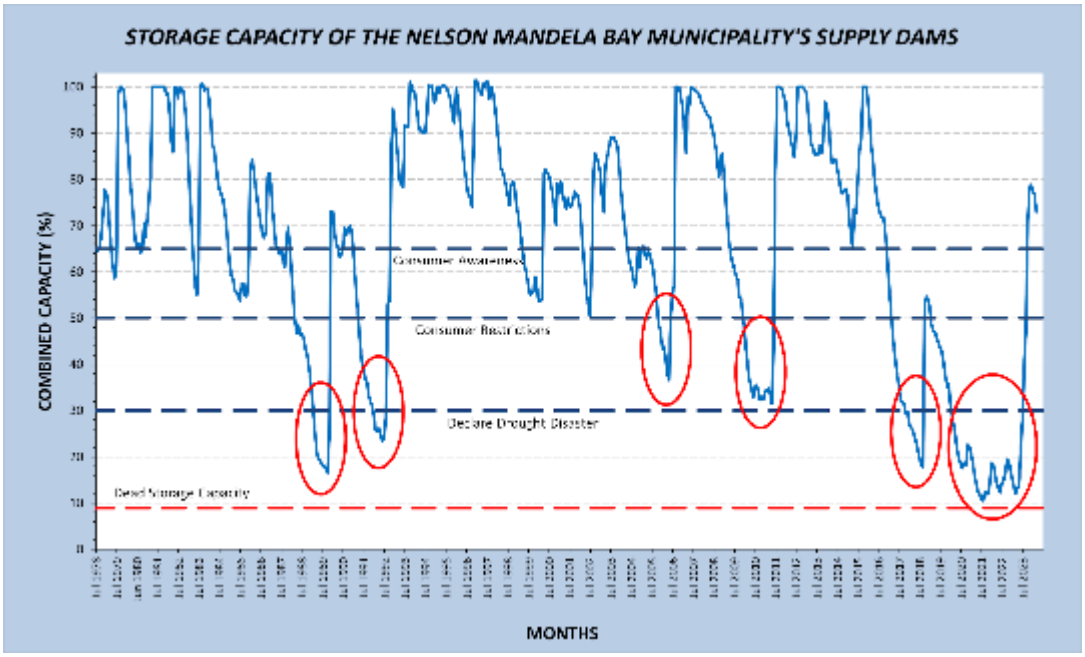


Figure 2.3: Drought impact on the combined storage capacity of dams in the Nelson Mandela Bay Metro

(Figure supplied by Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate, Nelson Mandela Bay Municipality).

To further compound the effect of the drought on the water supply system from the western system, the DWS imposed restrictions on the abstraction volume. These restrictions are, in general, intended to protect the dams. The licence condition allows NMBM to abstract a total volume of 354.73 ML/day under normal conditions, but by April 2022, restrictions imposed by DWS meant that the abstraction volume may not exceed 271.8 ML/day. These restrictions pertain only to the western supply system, which represents a 68% restriction, with the Loerie Dam (85%) and the Groendal Dam (50%) being the most and least affected, respectively (NMB Municipality 2022a).

2.6 Water consumption in the NMBM

Over the years, water demand and consumption have steadily increased in the NMBM (Figure 2.4) mainly due to 1) population growth, 2) increased economic activities, 3) increased service delivery level, particularly access to municipal water and sanitation services, and 4) the municipal effort at converting informal settlements to low-cost formal housing. The population is currently estimated at 1.25 million people, with a projected growth rate of around 1.5% per annum (COGTA, 2020). Between 1969 and 2022, the NMBM population has doubled twice, first between 1950 – 1966 and then 1967 – 1989, and is projected to double again by 2035, just over a decade away. Over the same period, the Metro has witnessed four drought regimes: first between 1988 – 1989, then between 1991 – 1992, and another drought in 2009 – 2011, and finally 2017 – 2023 (Figure 2.4). The municipality is thus faced by a complex challenge, on the one hand, water supply is being physically constrained as a result of recurring drought, and on the other hand, demand and consumption are steadily growing.

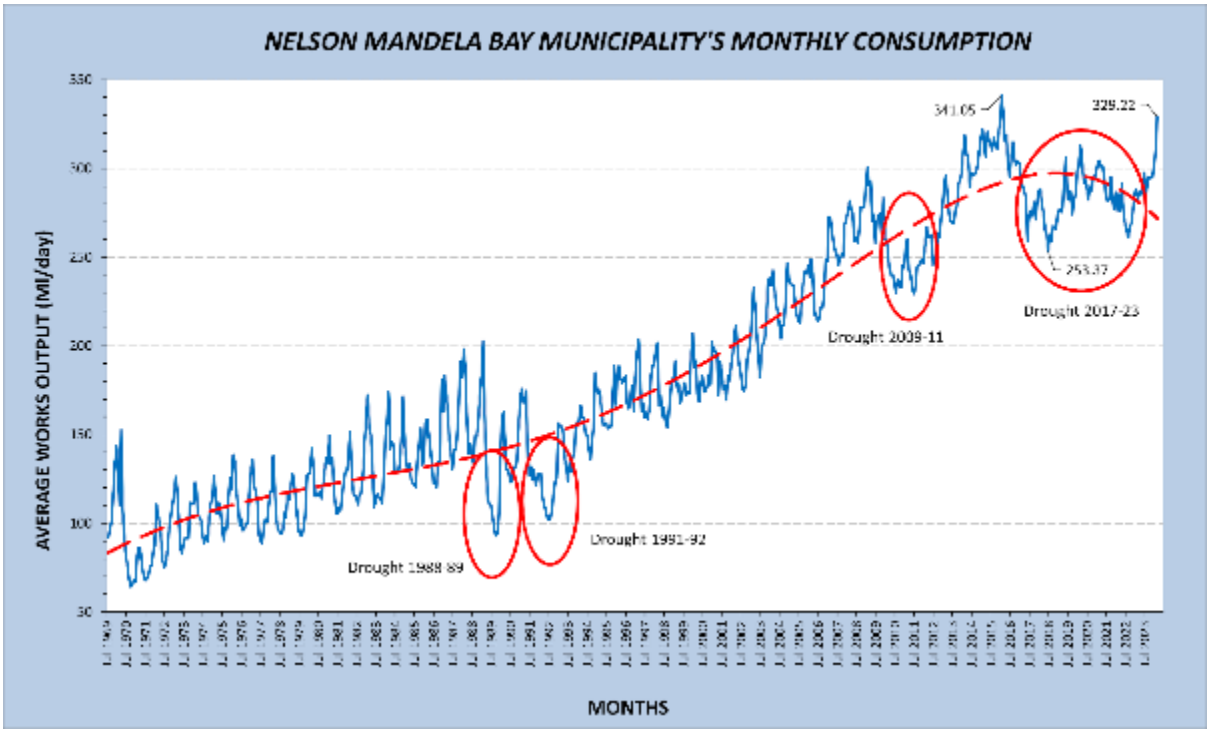


Figure 2.4: Monthly water consumption and droughts in the NMBM (1969 – 2023)

(Figure supplied by Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate, Nelson Mandela Bay Municipality).

The biggest water user sectors in terms of percentage demand within the Metro are the residential sector - single units (59.39%), ATTP- residential (12.94%), commercial (8.32%), Kouga Local Municipality (6.92%), and the industrial sector (5.47%). As can be seen, the residential sector constitutes over half of the total water consumption and demand in the Metro. It is thus important that an equity analysis is centred on this sector.

Chapter 3: Analysing the equity dimensions of the municipal response to the 2017 – 2023 drought in the Nelson Mandela Bay Metro (NMBM)

3.1 Introduction

South Africa is considered a water scarce country, with an average rainfall of 464 mm per annum (Matimolane and Mathivha, 2025). Much of South Africa's drinking water comes from surface water resources, which are extremely vulnerable to physical water scarcity. The implications are that prolonged droughts, which are increasingly becoming a common feature in South Africa, are a major cause for concern across municipalities (Mahlalela *et al*., 2020; Petterson, 2021). The NMBM was under the grip of a severe drought between 2017 and 2023. This led to the combined water storage levels in reservoirs reaching extreme lows, for example, 11.17% in 2021 (DWS, 2024). The drought presents a situation that threatens the water security of the Metro. The NMBM is particularly vulnerable to drought, and since 1969, the Metro has experienced at least four instances of severe drought as a result of extremely low rainfall within its catchment. As the western and central water supply system within the NMBM is entirely dependent on runoff from rainfall (with a very minimal input from springs and boreholes), these instances of severe drought can become extremely threatening. This is particularly true because the western and central system supplies water to over 50% of the population of the Metro (c.f. NMBM, 2021, 2022).

The NMBM has taken considerable steps both at the political and technical levels to address the drought and to mitigate its impact (Aurecon, 2011; NMBM 2006, 2012, 2021, 2022a, 2022b, 2023; Barnard, 2023). For example, the city first declared a state of disaster on 22 May 2017, and then subsequently on 19 May 2018, 21 November 2019, and 04 May 2020. Similar declarations had also been made in response to the drought in the NMBM at the provincial level (NMBM, 2022). The relevance of these declarations is that it allows the freeing up and mobilising of resources to address the drought.

At the technical and operational levels, the NMBM developed a plan to guide the implementation of short-, medium- and long-term measures, categorised broadly into 1) measures aimed at optimising current water sources and supply systems; 2) diversifying and augmenting water supply sources; 3) reducing consumption and demand; 4) public engagement and awareness raising. Regarding optimising supply systems, particularly reducing water

losses, the municipality implemented several measures, including leak repairs, domestic metre audits, installation of advanced metering systems, and pressure management devices. These technical measures have reduced non-revenue water from 46% in 2014/2015 to 43.4% in 2015/2016 (Pietersen, 2021). On augmenting municipal water supply, efforts mainly target diversifying water sources (e.g., feasibility of a desalination plant, wastewater re-use in the industrial sector, in school grounds, and groundwater exploitation have been prioritised (Pietersen, 2021). Regarding managing consumption, as the severity of the water crisis grows, the municipality has intensified its efforts at reducing consumption through measures such as smart metering, increased restrictions, implementation of a stepped tariff system, and pressure control devices. Citizens were engaged through various public engagement and awareness-raising measures (c.f. NMBM, 2021b, 2022a, 2023).

What is clear from these interventions is that there is extensive focus on the technical dimension in responding to the drought, with little attention to how these measures may impact different societal constituencies and their equity implications. This chapter thus aims to analyse the municipal response to the drought and its equity implications.

3.2 The Municipal Response to the Drought

The NMBM developed a plan to guide the implementation of the municipal response. These response measures can be broadly categorised into 1) measures aimed at optimising current water sources and supply systems; 2) diversifying and augmenting water supply sources; 3) reducing consumption and demand; 4) public engagement and awareness raising. These measures were designed to target both the supply and demand aspects of the water system. On the supply side, the main interventions (planned and implemented) are summarised in Table 3.1 below.

Table 3.1: A summary of intervention measures planned, and implemented by the Nelson Mandela Bay Metro (NMBM, 2022a, 2023). Note that some of these interventions were planned as part of the long-term water and sanitation master plan of the municipality, and not necessary in response to the drought per se.

Intervention	Brief description/status
Measures aimed at optimising current water sources and supply systems	
Deployment and upgrading of barges to optimise supply	As a result of the drought, many of the dams' storage capacities were either below or near the dead storage capacity. In order to optimise and efficiently utilise existing water sources even at their dead storage capacity, the municipality commissioned and deployed barges. An example was the deployment and upgrading of barges at the Impofu Dam, which led to an additional abstraction capacity of 33.5 ML/day.
Backwash water recovery	The filters of WTWs using a gravity filtering system are often blocked over time, and this was the case for the Churchill WTW. About 5-25% of abstracted water is lost daily as this volume is used in the backwashing of the filter system. The backwash water is thereafter discharged into the receiving environment. This intervention is thus intended to reuse the backwash water and improve system efficiency.
Refurbishment and upgrading of supply sources and systems	Old infrastructure not being fully utilized has been refurbished to increase its capacities and efficiencies. Examples of such refurbishment were undertaken at the Linton WTW, Lower and Upper Van Stadens Dam supply. These have enabled the municipality to add to the treatment capacity, e.g., increasing the treatment capacity of the Linton WTW from less than 3 ML/day to 7 ML/day and reaching 10 ML/day. The Municipality has also implemented and planned several upgrading interventions for the Nooitgedacht Scheme, including the

	construction of new WTWs, temporary WTWs, installation of new pipelines, etc. These interventions are intended to alleviate the pressure on the western system. Upgrading and refurbishing also took place at the Verwoerd Pump Station to improve operational efficiency. Other locations where refurbishment and repairs have been implemented as short to medium term measures include the repairs to the Chatty reservoir uptake, upgrade of the Motherwell/Bethelsdorp – East to West pipeline, etc. In addition, the NMBM embarked on extensive upgrading and improvement in the telemetry, supervisor control and data acquisition (SCADA) system, leading to improved system integration and interconnectivity and communication.
Diversifying and augmenting water supply sources	
Groundwater exploitation	Potential groundwater sources have also been identified by the NMBM for exploitation. By 2022, seven locations had been identified for groundwater exploitation and in many of these, boreholes drilled. At low yield, these boreholes produce 19.4ML/day, and 30.1 ML/day at medium yield and up to 40.6ML/day at high yield. A sustainable yield of 35 ML/day is projected for these boreholes.
Desalination	The NMBM has also considered desalination as a way of diversifying the water sources within the Metro. Two plants have been penned for further investigation. These are the Coega Special Economic Zone (SEZ) desalination plant, planned to generate 15 ML/day and ultimately 60 ML/day, and the Western Desalination Plant. It needs to be noted that these projects are planned as potential future water sources within the Metro.
Effluent re-use	Effluent re-use represents an important potential source of water within the Metro. At the moment, this source has not been utilised to its full potential. Of the 205.04 current treatment capacity at the peak of the combined

	WWTWs (8 in total) within the NMBM, only about 4%, representing 7.60ML/day of the treated effluent, is being used. Effluent re-use is mainly directed towards school grounds, parks, church grounds and industries. Future re-use options and the necessary infrastructure in this regard would thus need to be fast racked.
Reducing consumption and demand	
Water consumption reduction strategy	On the basis of the stress and consumption levels within the Metro, the municipality developed a water consumption strategy (Figure 3.1). The main intention of the strategy was to achieve 20 - 40% reduction in water consumption in ways that allow lessening of pressure on the system, particularly the western system that is extremely vulnerable to drought. As can be seen in Figure 3.1, the Metro was divided into three zones, Zones 1-3. Zone 1, had a target of 20% reduction in water consumption, Zones 2 and 3 each targeted for 40% reduction in water consumption. It needs to be noted that the chief factor that influenced the decision on how much water must be reduced was mainly physical access to water.
Metering, maintenance of distribution networks, monitoring of the supply system, including remote monitoring	The NMBM implemented wide-ranging initiatives regarding the installation of new smart water meters in the bulk water supply system, audit of existing meters, identification of critical supply points for installation of new meters, and the metering of Greater Metred Area (GMA) and District Metered Area (DMA). These initiatives were aimed at reducing losses through accurate metering, maintaining and monitoring of the bulk water supply system.
Pressure management	Through the implementation of pressure management valves within the bulk water supply system in the GMA and DMA, the municipality achieved water reduction, which peaked at 10ML/day by November 2021. Pressure

	management devices were also installed in homes and facilities of consumers, particularly those identified as high-water consumers. Household flow-limiting disks and meters were installed.
Non-revenue water reduction strategy	Non-revenue water is still quite high within the NMBM, and as part of the drought management strategy, the municipality aims to achieve a target of 36%, motivated by the successes achieved in Cape Town. This target, however, has no set date, and it appears the municipality was pursuing this goal aggressively through the implementation of several measures. Linked to the NRW is a programme to strengthen revenue collection through billing management and consumer database analysis.
Tariffs	The imposition of stepped tariffs has been used as a mechanism to discourage excessive use of water, especially during emergencies as were experienced in the NMBM (Figures 3.2 – 3.4). The metro implemented stepped tariffs, Part A, Part B, Part C and Part D tariffs, with Part D being the most punitive (Figures 3.2 -3.4). On different occasions, the municipality imposed these tariffs to encourage responsible water consumption. It is also important to note that the municipality has an Assistance to the Poor Programme (ATTP), enabling the provision of free basic services to indigents. In the case of water, it is 8 Kilolitres of water per month, and even during the peak of the drought, this was maintained (NMBM, 2023).
Leak repairs, operations and maintenance, metre audits and installation of new meters	In response to the drought, the municipality implemented a metre repair programme, repairing 42 800 leaking pipes/meters, etc., between July 2020 and January 2022. These repairs were implemented throughout the metro with emphasis on residential and school premises. Operational maintenance, metre audits, and replacement of dysfunctional meters were also aggressively carried out as part of the water savings measures.

Public engagement and awareness raising	The Directorate of Communications also embarked on developing different strategies to raise awareness about the water shortages, the restrictions imposed, as well as behavioural change necessary to achieve the needed reduction in water consumption.
Water quality monitoring programme	The municipality also implemented various water quality monitoring programmes and protocols at the operational levels, some of which were routinely done.

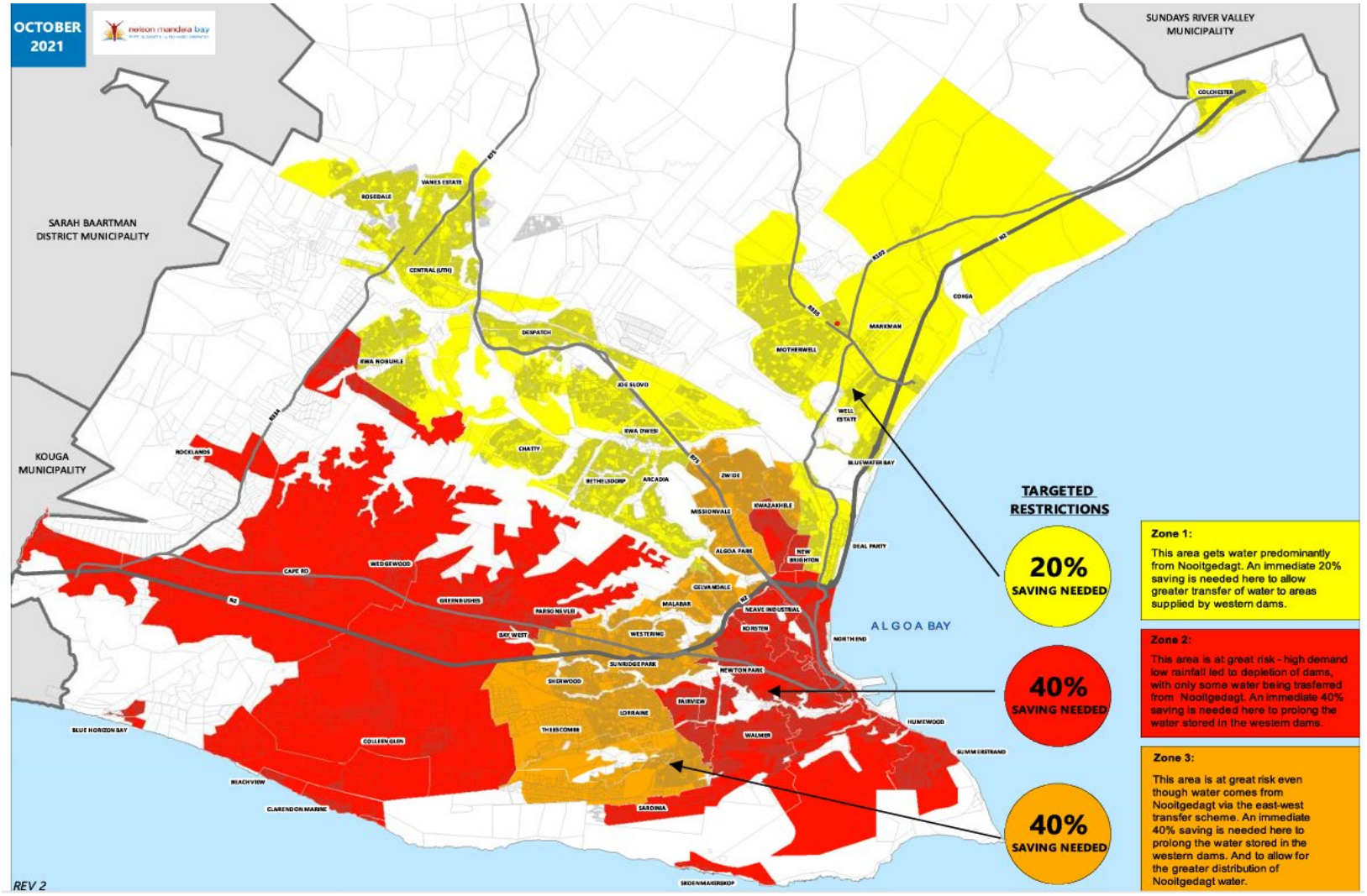


Figure 3.1: Target area-based water reduction strategy within the Nelson Mandela Bay Metro

(Figure supplied by Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate, Nelson Mandela Bay Municipality).

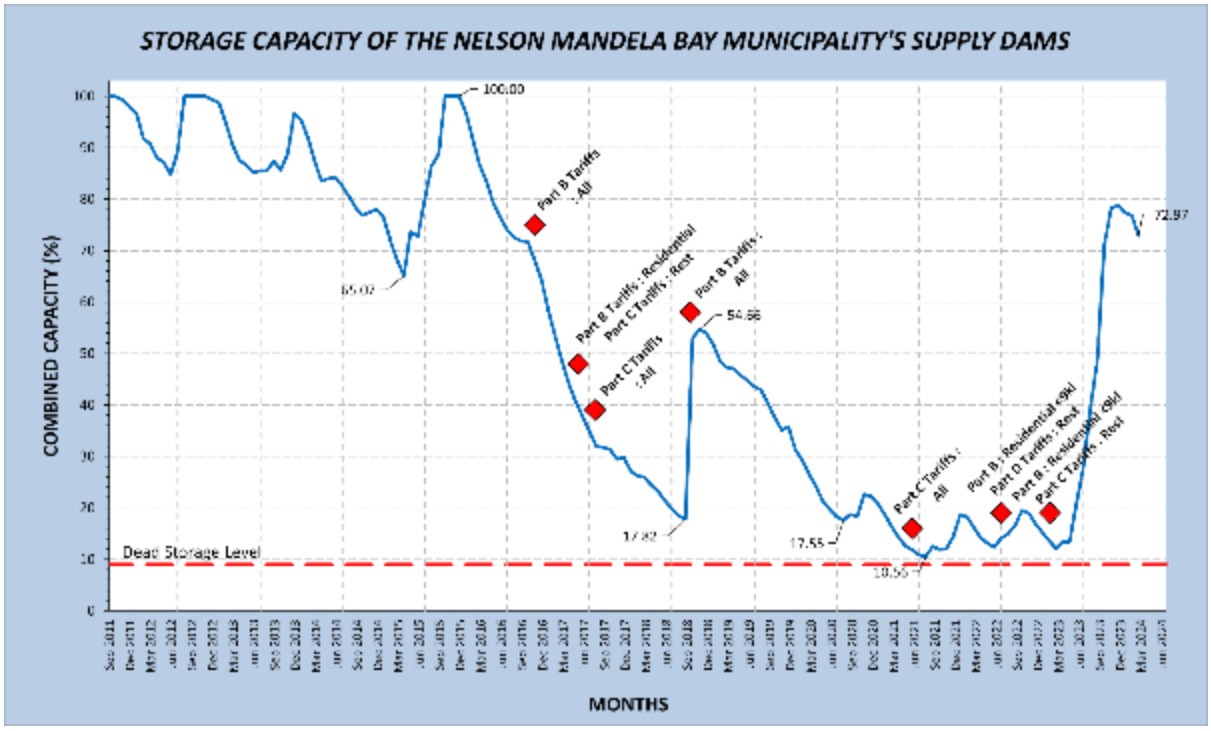


Figure 3.2: Imposition of stepped tariffs as a function of combined storage capacity of dams in the Nelson Mandela Bay Metro

(Figure supplied by Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate, Nelson Mandela Bay Municipality).

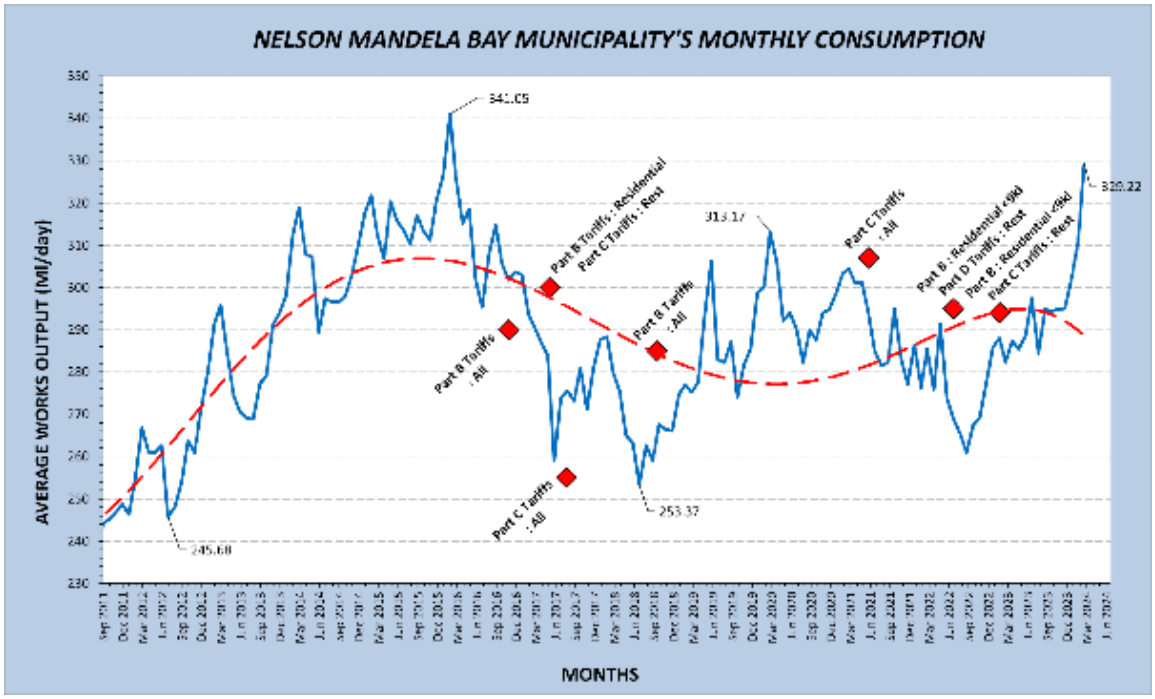


Figure 3.3: Imposition of stepped tariff as a function of average works outputs (consumption) in the Nelson Mandela Bay Metro

(Figure supplied by Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate, Nelson Mandela Bay Municipality).

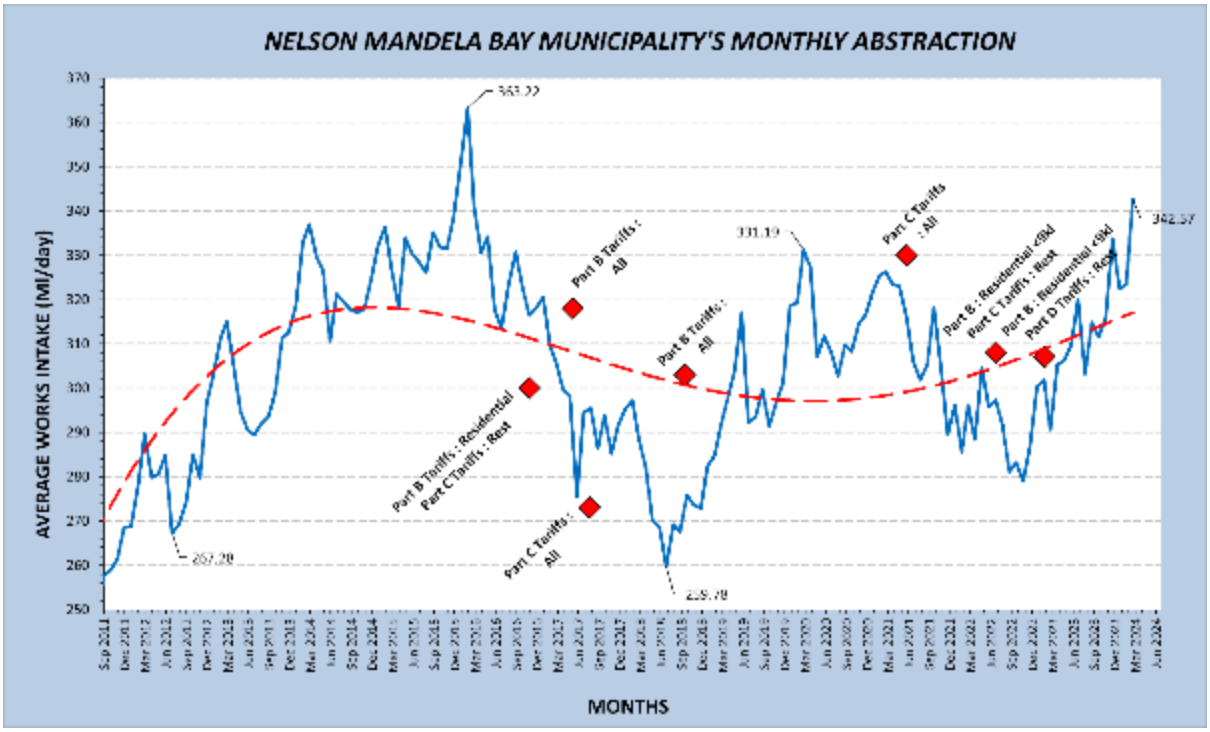


Figure 3.4: Imposition of stepped tariff as a function of average works intake in the Nelson Mandela Bay Metro

(Figure supplied by Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate, Nelson Mandela Bay Municipality).

3.3 Theoretical perspectives on water insecurity

To understand how and why the NMBM took certain actions during the drought, it is important to reflect on important theoretical perspectives that may underpin how water is construed and viewed at the strategic, policy and operational levels. For example, the view that water is a scarce resource may invoke the imposition of an economic approach, rather than a social justice or an ecological justice approach. In this section, we therefore briefly take stock of important theoretical standpoints that one could use to interpret the strategy being pursued by the NMBM.

Malthusian theory

The standpoint put forward by the Malthusian theory is that population growth gets to a point where it puts excessive pressure on natural resources in ways that cause a decline in those resources, thereby creating a scenario of scarcity. Viewed this way, water scarcity is primarily driven by a growing population and associated factors such as migration, low mortality rate, technological improvements that increase lifespan, etc. This theory is rooted in neo-classical

economics and forms the basis of many policies around water, particularly when one begins to consider that a growing population is critical to water availability (Dinar *et al*., 2019).
Policies underpinned by the Malthusian theory often develop strategies targeting population growth and migration. While it is critical to acknowledge that population growth plays a vital role, potentially contributing to water security challenges, systemic governance challenges and other physical factors such as drought are even more important, particularly in the context of South Africa (Ziervogel, 2018) and more specifically in the NMBM. It is also possible to mitigate water security challenges in the face of a growing population through technological and governance innovations (McNeill *et al.,* 2017).

Catastrophe theory

An important theoretical lens that has been used to look at water security challenges is that which posits that water insecurity is an outcome of a catastrophe. The catastrophe theory seeks to explain water insecurity as that which results from sudden transformation and divergence (Zeeman, 1976; Xiao-jun *et al*., 2014). Viewed this way, the severe drought that has led to the state of water insecurity in the NMBM can be seen as a divergence. The imposition of the state of emergencies by the municipality, and that at the provincial level within the Metro meant that the water security challenges were being seen from the catastrophe theoretical standpoint.

Justice theory

The justice theory focuses on justice with particular attention to fairness as a way of looking at water security challenges, and in designing appropriate response mechanisms, strategies and policies. The theory of justice lends itself to equity, and the various dimensions of equity, a critical focus of this project. Concerning equity, it is important to focus on all its dimensions viz: distributive equity, procedural, contextual and recognition. Whereas distributive equity focuses on how costs and benefits are shared between societal groupings, procedural equity pays attention to participation in decision making and the underlying power dynamics between different actors and groupings (Leach *et al*., 2018; Fraser, 2009).

In analysing distributive equity, one might employ the consequence-based and rule-based theories of justice to equity (McDermott *et al*., 2013). With respect to consequence-based theories, utilitarianism and welfare economics are the two dominant forms and are routinely applied in designing policies. Whereas utilitarianism seeks to achieve the greatest good for the

greatest number of people, welfare economics concerns itself with maximising individual utilities as a function of aggregate social welfare (McDermott *et al*., 2013).

Regarding rule-based theories, libertarianism, egalitarianism, merit-based and need-based are often applied to equity analysis. The libertarian rule focuses on equality of rights to opportunities for all members of the society, but less so on the outcomes that flow from the exercise of those rights (McDermott *et al*., 2013). From a libertarian perspective, outcomes, even if different for different members of society, are considered fair and just provided they are accrued from exercises of equality of rights. An egalitarian system emphasizes the equal treatment of people, and in particular, in the distribution of benefits and costs irrespective of the individual's starting point or circumstances (Leach *et al*., 2018). A merit-based rule, on the other hand, emphasises the proportional allocation/sharing of benefits based on the relative contribution of the individual to the productive activity from which the benefits are derived/accrued (Konow, 2003).

Lastly, the need-based system recognises that people's circumstances are different and therefore justice must pay attention to those circumstantial differences, whether these be political, historical, economic, social, or otherwise. In analysing the municipal response to the drought, we sought to understand the justice theory underpinning certain measures, and how these may have contributed to equity-sensitive measures or otherwise. A critical dimension of equity is that which pays attention to the context (Sandel, 1990; Pelletier, 2010).

Contextual equity recognises the need to pay attention to contextual matters that impact on fairness. Such contextual factors may include social, environmental, ecological, political, and historical pre-existing factors. These factors may impact people's capabilities to participate in governance processes, and in their ability to influence fair distribution of costs and risks. Contextual equity thus emphasises the need to pay attention to such contextual factors, and to level the playing field for all.

3.4 Data collection and sampling

To analyse the equity implications of the municipal response to the drought, data were collected using the following methods: 1) document analysis, 2) semi-structured interviews and 3) surveys. We employ document analysis as a systematic technique of reviewing key municipal

documents with the aim of distilling the measures intended and/or implemented to address the drought. The main documents analysed for this report are the drought strategy documents and the water master plans, as well as the integrated development plans (IDP) (c.f. NMBM 2006, 2012, 2018, 2021b, 2022a, 2022c, 2023). We triangulated the document analysis with other sources of data for credibility and validity (Bowen, 2009).

We also conducted semi-structured interviews with different actor groupings within the Nelson Mandela Bay Metro. A total of 110 interviews were concluded, covering 11 actor groups (Table 2.2). Regarding the households, samples were selected across various income groups and geospatial locations across the metro. This was done to ensure diversity and representativeness of the analysed samples. The household and municipal official interviews were structured to elicit data on 1) basic demography, 2) distributive equity, 3) procedural equity, and 4) contextual equity. Drawing on the plural rationality theory, the interviews with the NGOs sector were designed to shed light on egalitarian perspectives regarding the water situation, and how this may impact the so-called fatalists (the voiceless, marginalised groups) (Umejesi *et al*., 2018). A total of seven NGOs and community-based organisations were interviewed.

Table 2.2: Categories of participants interviewed during the study in the Nelson Mandela Bay Metro.

Category	Number
Household interviews	40
Community members dealing with water leaks and water infrastructure theft	10
Community leaders	7
Municipal officials	8
Ward councillors	4
Contractors	4
NGOs and community-based organisations	7
Fishermen	10
Farmers	12
Businesses	6
Experts	2
Total	110

We also conducted a total of 235 household surveys across 12 locations, taking into account low, medium and high-income households, spatially distributed across the metro from central to outlying locations. The survey questions, like the interviews, were designed to elicit data regarding access to water and equity dimensions of the municipal response to the drought. Demographic information was also obtained.

3.5 Analytical framework

To analyse the equity implications of the municipal response, we will use the framework developed by McDermott *et al*. (2013). This framework distinguishes between equity dimensions, target, and scale of equity analysis. Regarding the dimensions of equity, we focus on three dimensions: distributive, procedural and contextual equity. Regarding distributive equity, our analysis was to distil how the costs, benefits and risks arising from the municipal response to the drought impacts on different societal groupings. Such an analysis is useful from an adaptive capacity and resilience perspective because measures that do not centre distributive equity in a country such as South Africa with historical inequality may further deepen inequity.

To distil the distributive dimension of equity in relation to the municipal responses to the drought, we employ both the consequence- and rule-based theories. Consequence theories focus on the outcomes and consequences of the outcomes – it is the ends and not the means that matter. By applying the consequence theory (McDermott *et al*., 2013; Loft *et al.,* 2017) we analyse the policy intent informing the municipal response to the drought. For example, is the municipal response concerned about actions that achieve the greatest good for the greatest number of people, even if a few people become worse off due to the consequences of the actions to ameliorate the drought effect? We apply this analytical perspective to reflect on the documented municipal responses.

Unlike consequence-based theories, rule-based theories are concerned with the fairness of the rules applied to the allocation of costs, benefits, and risk arising from governance actions. Here, it is not the consequence of the action per se that matters, but the rules resulting in the actions and their consequences (Loft *et al*., 2017). In this report, we draw on egalitarian- and need-based distributive equity theories to analyse and reflect on the potential effects of the municipal responses on different societal and institutional groupings within the NMBM. By applying the

egalitarian theory, for example, we were able to analyse whether the benefits and costs arising from governance decisions in response to the drought are distributed equally to individuals/institutions regardless of their starting point (Leach *et al*., 2018). On the other hand, the application of the need-based theory as an analytical lens sheds light on the sensitivity of the municipal responses to the different needs of societal groupings (Rawls, 1971).

Regarding procedural dimensions of the equity analysis, we sought to understand whether, in designing the drought- and post-drought response measures, the municipality sought participatory parity. In this regard, we pay attention to analysing power dynamics, access to information and data, and powerful and influential knowledge in various municipal set-ups. The goal of this analysis was to distil the extent of inclusivity and participation among interested and affected stakeholders within the NMBM. This analysis is critical because it lends itself to unravelling fairness in how decisions are made, which in turn influences the distribution of costs, benefits and risk arising from such decisions (Loft *et al.,* 2017; Leach *et al*., 2018).

Context plays a key role in equity, as pre-existing contextual conditions may create unequal starting blocks for people, and the degree to which their voices can be heard and their influence over decisions that affect them daily (Sandel, 1990; Pelletier, 2010). Therefore, the focus on the contextual equity analysis was to shed light on contextual factors among different societal groupings that may impact their adaptive capacity and resilience to the drought and municipal responses.

3.6 Results

3.6.1 Impact of municipal responses to the drought on households (Distributive equity)

An important strategy implemented by the municipality was the imposition of water restrictions targets. To achieve these targets, the municipality implemented several measures that have distributive equity implications. These measures include 1) installation of meters and carrying out an audit of existing meters, 2) imposition of stepped tariffs, 3) pressure management and flow restrictors, 4) emergency water supply via tanks and 5) repair of leaks.

Regarding reducing water consumption, the municipality aims for a 20 – 40% reduction depending on the target area. It appears the municipal thinking in designing these water targets

was primarily informed by the catastrophe theory, in which the primary consideration was the physical availability of water and the need to optimise available water. Viewed from the consequence-based theory, it also appeared that the implementation of the water restriction targets was equally informed by actions that achieve the greatest good for the greatest number of people, even if a few people become worse off due to the consequences of the actions to ameliorate the drought. For example, in imposing the 15Kl per month per household (NMBM, 2020), the municipality was suggesting that all households that were unable to confine themselves to these targets, irrespective of their individual circumstances, should be punished, except for households registered for ATTP. The 15Kl/per month was based on the assumption that there is a maximum of 10 people living on a property or in a household. Similar restrictions were also extended to industrial and commercial sectors, which demand that these entities reduce their consumption by 20%.

Households' drinking water sources

Municipal water supply is the primary source of drinking water across the various geographical locations surveyed (Figures 3.5 and 3.6). However, in areas like Summerstrand, Bloza Rocklands, and Zweledinga, there was a notable use of bottled water, water tankers, and communal stands, respectively, indicating access to alternative sources. Higher-income and male-headed households were more likely to use bottled or filtered water, while families with lower income (especially those earning less than R3,000 per month) almost exclusively rely on municipal taps (Figure 3.6).

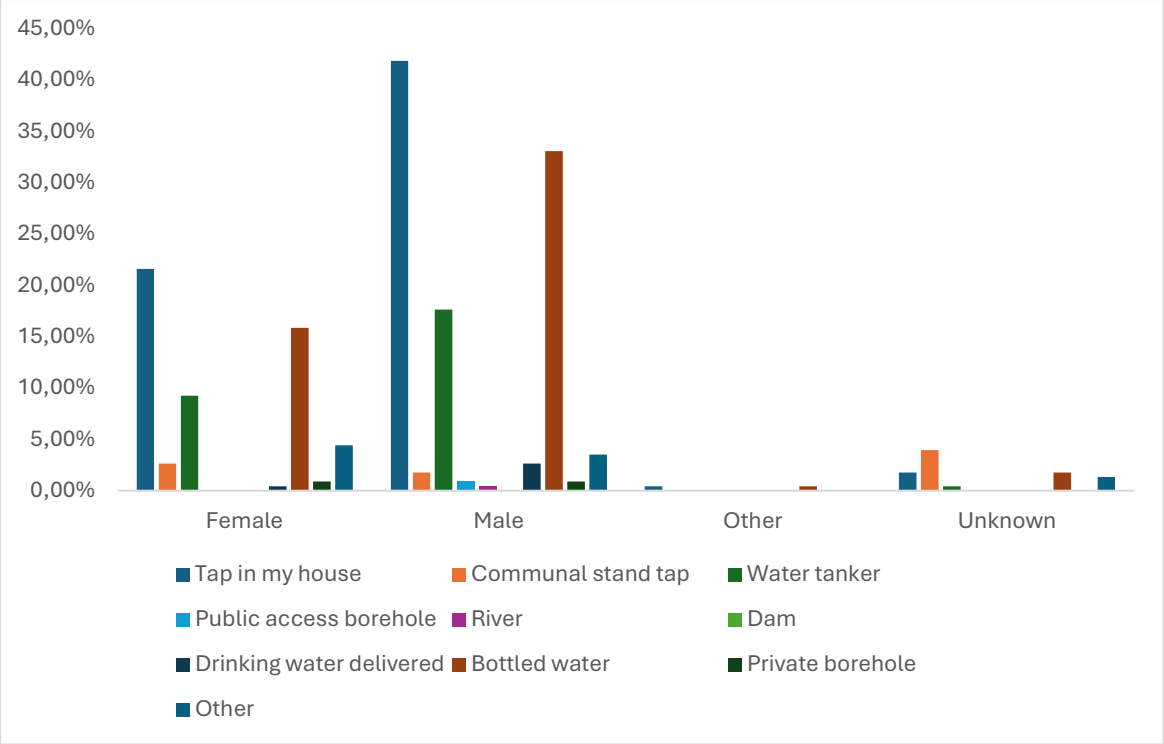


Figure 3.5: Drinking water sources by the sex of household head among the surveyed communities in the Nelson Mandela Bay Metro.

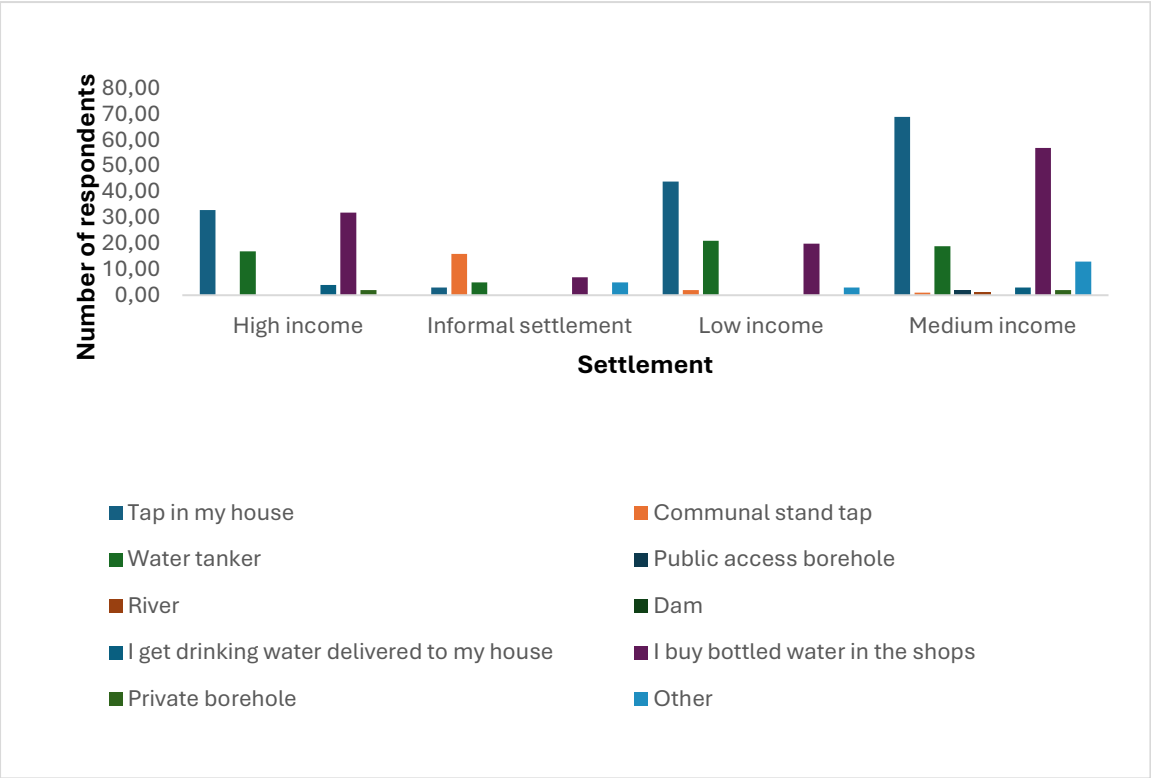


Figure 3.6: Drinking Water Sources by settlements in the Nelson Mandela Bay Metro.

Water leaks and municipal responses

Leaking pipes remain a major challenge within the Nelson Mandela Bay Metro. During the drought, the municipality took several interventions aimed at reducing and addressing water leaks within the Metro. The frequency of leaking pipes varies across different income groups (Figure 3.7). Participants in all income groups indicated high leaking pipe frequency occurring "occasionally", but places like KwaZakhele reported that leaks happen "often". When disaggregated by sex and gender of household head, women and female-headed households are slightly more likely to report frequent leaks occasionally occurring, whereas males indicated high frequency leaks that are very often occurring (Figure 3.8). Households with lower income levels also tend to experience and report more frequent leaks, suggesting a link between infrastructure quality and economic status.

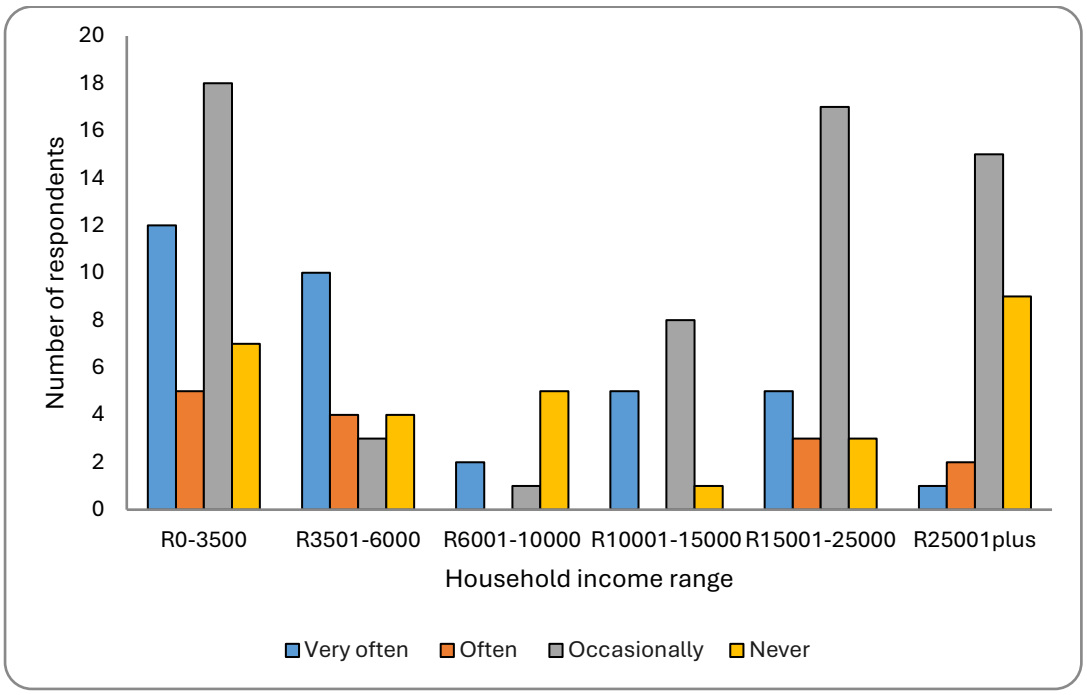


Figure 3.7: Leak frequency by household income categories.

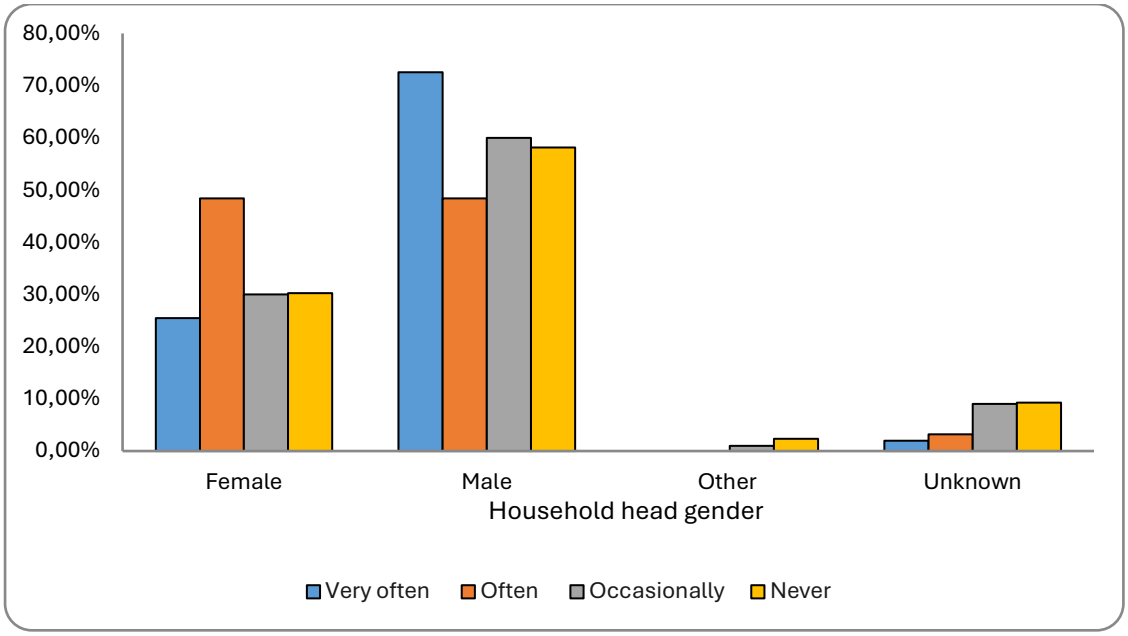


Figure 3.8: Leak frequency by sex of household head.

Regarding the time it takes to fix leaks, the high income stands out for having leaks repaired on the same day or within a few days (Figure 3.9). In informal settlements and low-income areas, many households reported waiting for weeks or that leaks are never fixed. This may reflect disparities in municipal response times, with residents in better-serviced suburbs receiving faster attention, while those in low-income areas experienced long delays before the leaking pipes are fixed.

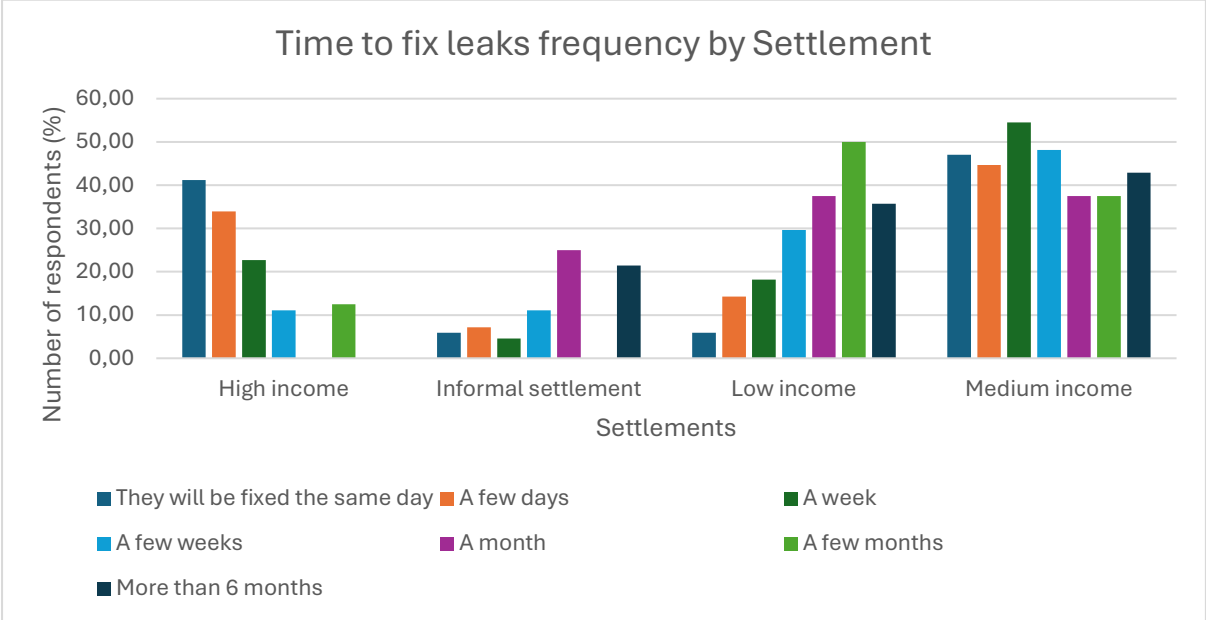


Figure 3.9: Time taken to fix leaks by the municipality as reported by the different settlement groups.

Regarding the seriousness of the impact of the leaking pipes within the various areas surveyed, although the low-income group reported that leaks were often in their areas, they however did not perceive their impacts to be high (Figure 3.10). Interestingly, it is the medium and high-income groups that perceived the impact of leaks in their areas to be either serious or very serious (Figure 3.10).

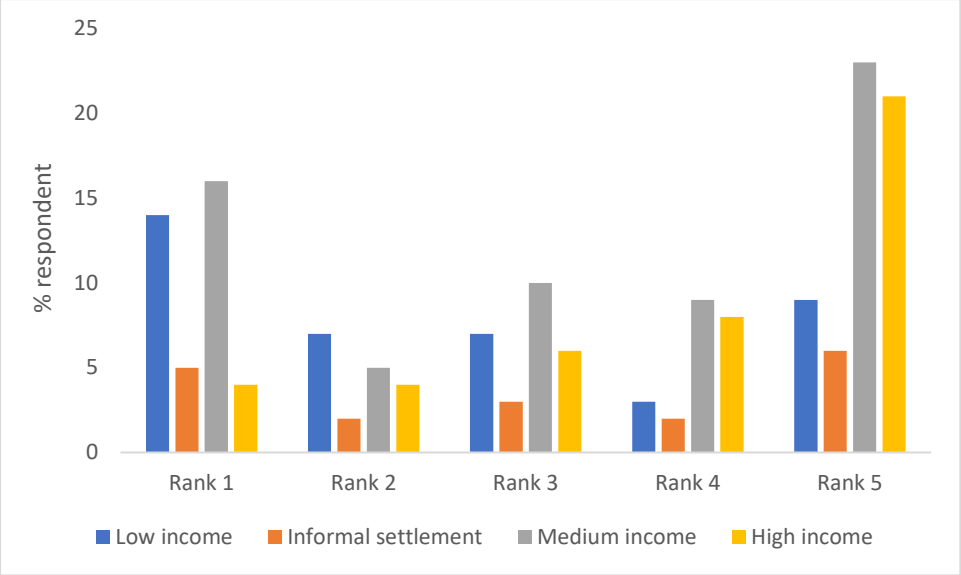


Figure 3.10: Community perception of the impact of leaking pipes among various income groups. Rank 1-5, where 1 being minimal impact, and 5 being a very serious impact from constant leaks.

Impact of water cuts and tariff increases on households

During the drought, the municipality took several measures, including water cuts and the implementation of stepped tariffs to encourage compliance with water restrictions. The impact of the water cuts was diverse, including those related to hygiene, food preparation and gardening (Figure 3.11). Among the high-income group, the main concern was related to not having enough water to bathe as well as cooking food and not having enough water to clean their houses. However, for the medium income group, the main concern related to not having water to bathe, drink and clean houses – critical aspects of basic hygiene. For those in informal settlements and in the low-income settlements, the primary concerns were related to not having water to bathe, collecting water from other sources, cleaning houses and drinking. As the results indicated (Figure 3.11), the water cuts/restrictions affected all income groups, but what was particularly interesting was that the water cuts disproportionately affected the ability of those living in informal settlements and those within low- to medium-income groups to secure drinking water and perform basic hygiene activities.

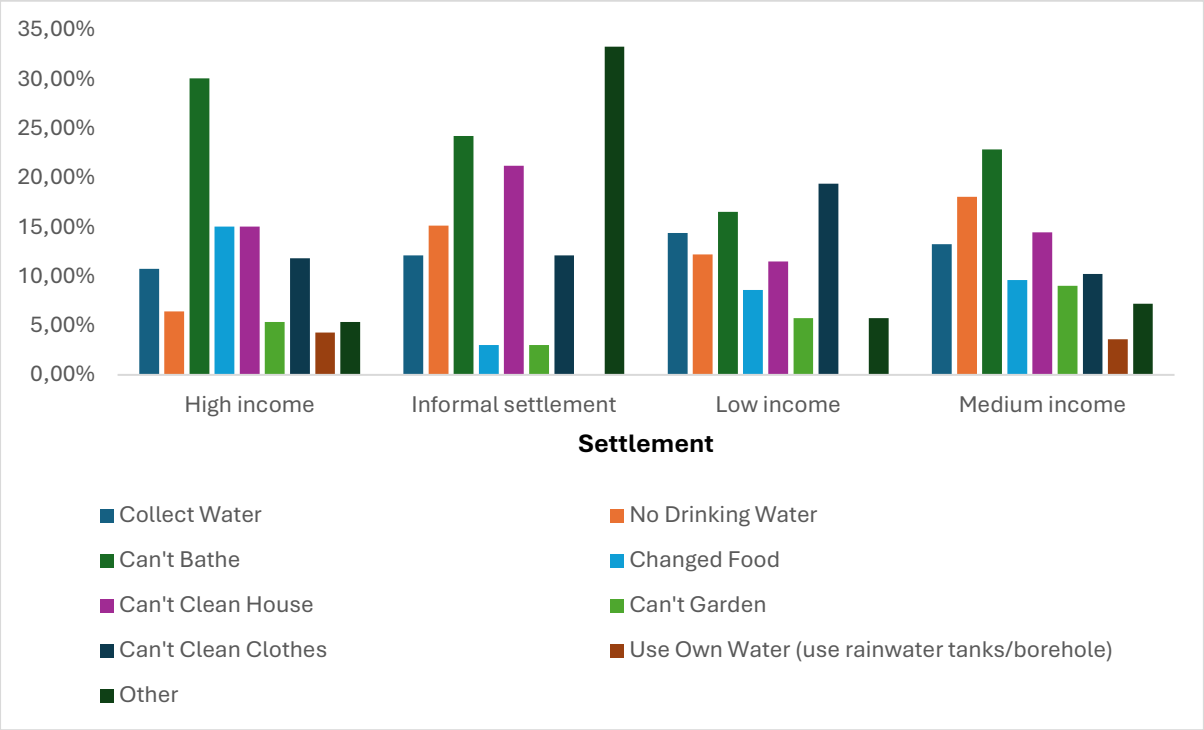


Figure 3.11: Reported impact of water cuts on household basic activities among the surveyed participants

Regarding the increases in water tariffs, a large proportion of participants in the high-income and medium-income settlements indicated that they have reduced the amount of water they consumed on a monthly basis as a result of the increases in tariffs, whereas a considerable number reported that they have not felt any changes due to tariff increases. Interestingly, those in the low- and medium-income settlements indicated that increases in tariffs have affected their ability to pay for other household necessities such as food (Figure 3.12). These results indicate the importance of implementing measures that are equity sensitive, as the municipal responses affected the different groups differently.

Viewed from the rule-based theory of equity, the empirical evidence suggests that the municipal response, particularly those that relate to pressure control and installation of flow meters as well as stepped tariffs, were informed by an egalitarian thinking, to the extent that imposing the same rules implies equal treatment of people. Such an egalitarian thinking largely

ignores the differential adaptive and coping capacities of households to deal with the measures imposed

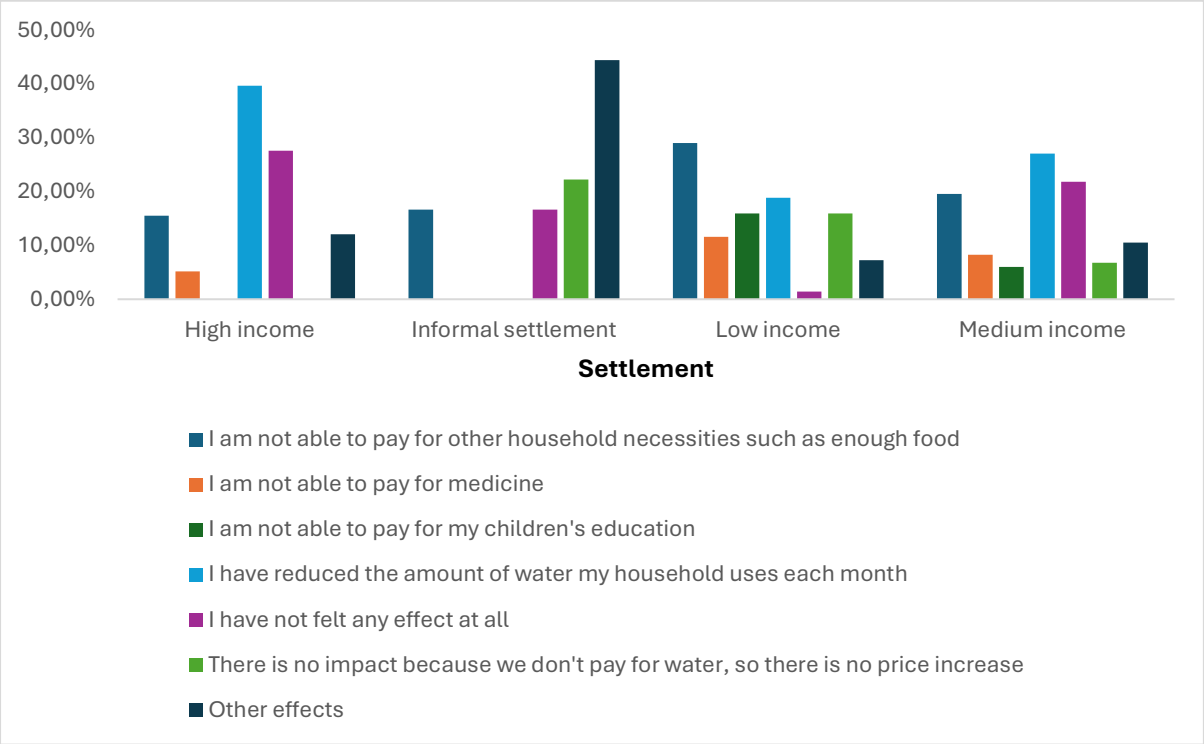


Figure 3.12: Reported impact of water tariff increases on households among the surveyed participants

The egalitarian thinking was moderated by the need-based distributive equity thinking that informs the roll-out and implementation of the Assistance to the Poor Programme (ATTP). In a way, the ATTP sought to moderate the economic burden on the poor, while providing subsidized services (not just water services) to those who may not afford these services. What was particularly interesting is that a considerable proportion of the surveyed households in the low-income households indicated that the water restrictions had no impact on their households because they do not have to pay for water. It remains to be seen whether these households were mainly ATTP participants or not. However, given that the number of people requiring social assistance are on the rise in the Metro, the ATTP is a critical equity intervention. This is exemplified by the fact that a sizable number of households surveyed in the low- and medium-income categories indicated that they were unable to pay for water services.

The use of water tariffs as a mechanism for restricting water consumption is complex. For example, in many of the low-income households, unpaid, excessively high-water bills within

the Metro were common (Figure 3.13). In most cases, the residents are unable to clear these bills for reasons of affordability. Several reasons were indicated by the study participants for the high-water bills, and these include i) bill inheritance, ii) landlords not paying bills even if tenants are paying their rents, and iii) bill dispute between the municipality and consumer(s). As water is a human right, the municipality often takes a cautious approach and in so doing, does not cut off water supply entirely but electricity. This is exemplified in the quote:

"Many living in RDP housing reported astronomical municipal bills, often these were inherited – e.g. from a family member who had passed away/moved. Other times tenants were living in rented houses where the original owner had not paid the bill in years. It was not uncommon to hear of bills for R40 000 – R100 000 or more. There is no hope of realistically ever paying these bills."

"The municipality eventually turns off power to those with high unpaid bills. People tend to live without power for a while – in some cases for years – before eventually finding a way to illegally connect to the power grid, seeing no other option."

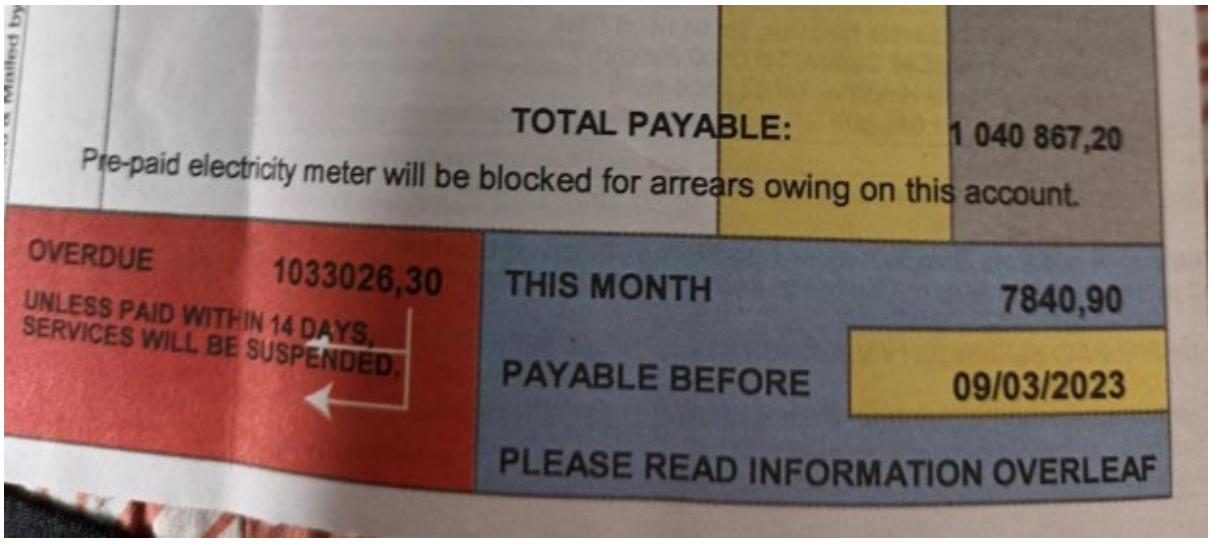


Figure 3.13: Example of municipal bill of over a million Rand in a rented property within a low-income housing area

Emergency water supply via tanks

Regarding water tanks and trucks as emergency intervention measures, it appeared that the municipality employed a combination of egalitarian and need-based thinking. From an egalitarian perspective, the municipality sought to provide emergency water trucks to all

residential consumers irrespective of whether they can afford alternative water sources or not. As one of the research participants puts it:

> *"We provided water tankers at specific locations throughout the Metro and people could access these tankers."*

However, the empirical evidence suggests that the supply of water in trucks in low-income households and those in informal settlements were not sufficient, yet water in trucks in affluent suburbs were not fully utilised:

> *"Those who need access to water and sanitation services the most hold the shortest end of the stick, especially when it comes to visible service delivery - i.e., water trucks being present. The agency and economic power that middle to higher income households have means that water trucks are provided to these areas, (often parked at central locations such as shopping centres) but they are not as heavily used as water trucks supplying lower income and informal settlements. There is some reluctance to divert water trucks to areas of greater need, because higher income residents are more likely to complain if these water alternatives are not visibly provided."*

3.6.2 Procedural equity and the municipal response

Procedural equity stresses participatory parity and pays attention to power dynamics as a critical element of equity. In this regard, access to powerful and influential knowledge, information and data that allow informed decision making across all levels is critical. Inclusivity is thus a critical dimension of procedural equity. The municipality deployed a range of communication and information sharing channels to inform the residents and different water user sectors of water situations within the metro. However, information sharing alone would not necessarily imply fairness from a procedural equity perspective, particularly if communities feel that decisions being made by the municipality do not reflect their voices and do not sufficiently take account of their peculiar contexts. This was particularly evident among the participants surveyed (Figure 3.14) in which the majority of them across income groups indicated that decisions made by the metro did not reflect their voices.

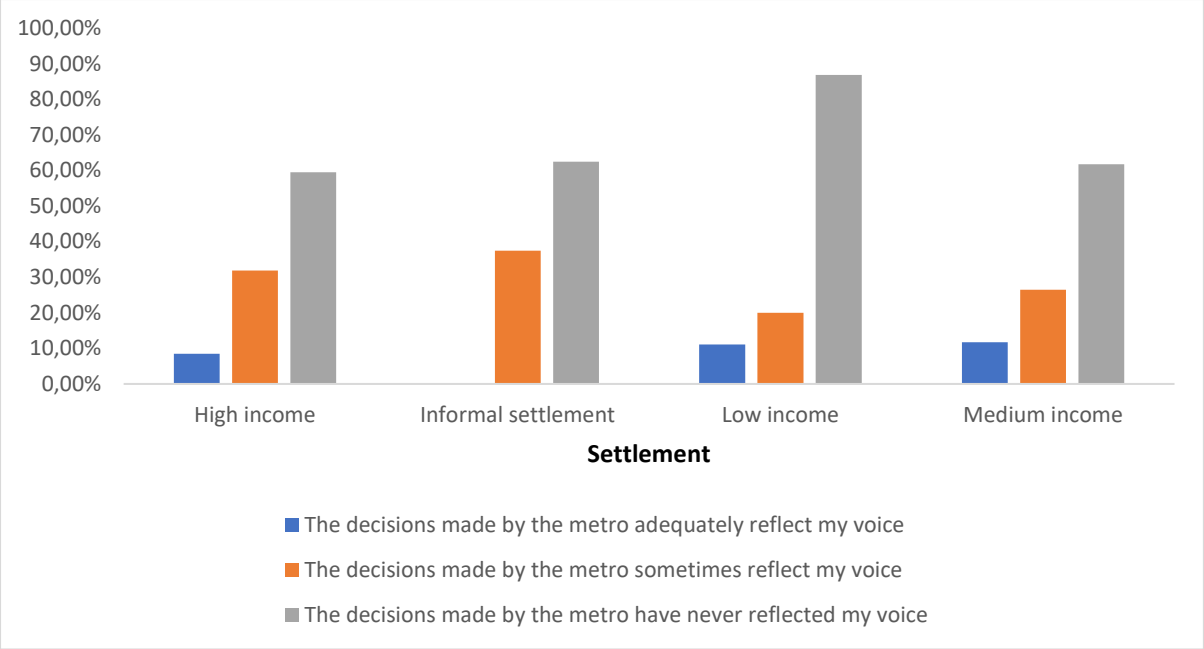


Figure 3.14: Surveyed participant responses regarding whether their voices are reflected in the way the municipality responded to the water challenges in the Metro

The effectiveness of implementing demand-side response measures by the municipality rest largely on consumers' behavioural and practice changes. However, implementing such a change is largely influenced by a sense of fairness regarding information flow, access to decision making, and powerful knowledge. While it is acknowledged that the municipal actions regarding procedural equity were wide-ranging, it appears that residents in the low- and medium-income areas thought otherwise as 62% of the surveyed participants indicated that they do not agree that the municipality inform resident timeously regarding water cuts (Figure 3.15).

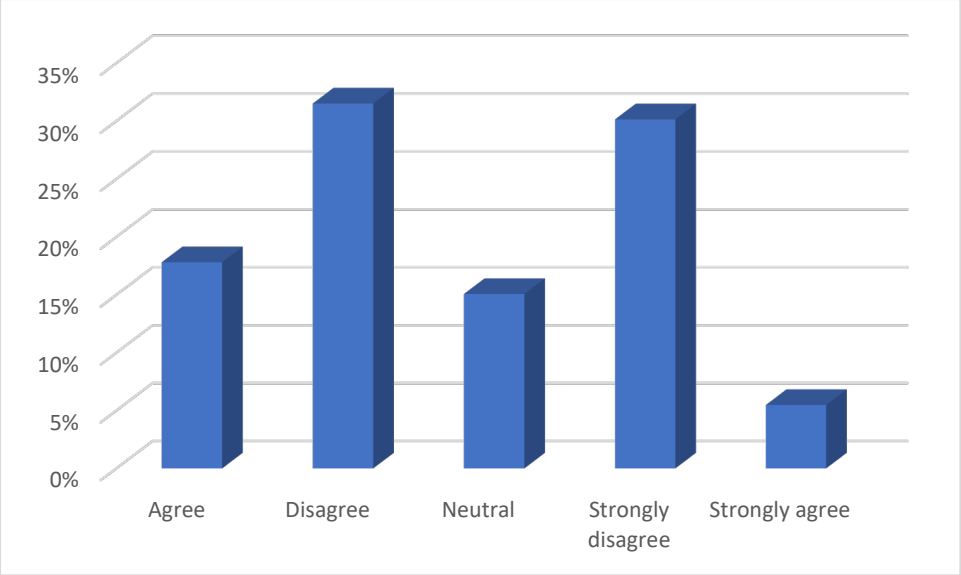


Figure 3.15: Responses of participants in the informal and low-medium income groups on whether they agree that the municipality inform people timeously about impending municipal water cuts.

The concerns regarding the effectiveness of the communication channels between residents and the municipality were echoed by one of the research participants in the low-income bracket as:

> *"There was no alerting. [e.g. telling us] where the trucks would stand and when can we actually find free accessible water. That meant there is no school, no work for other families."*

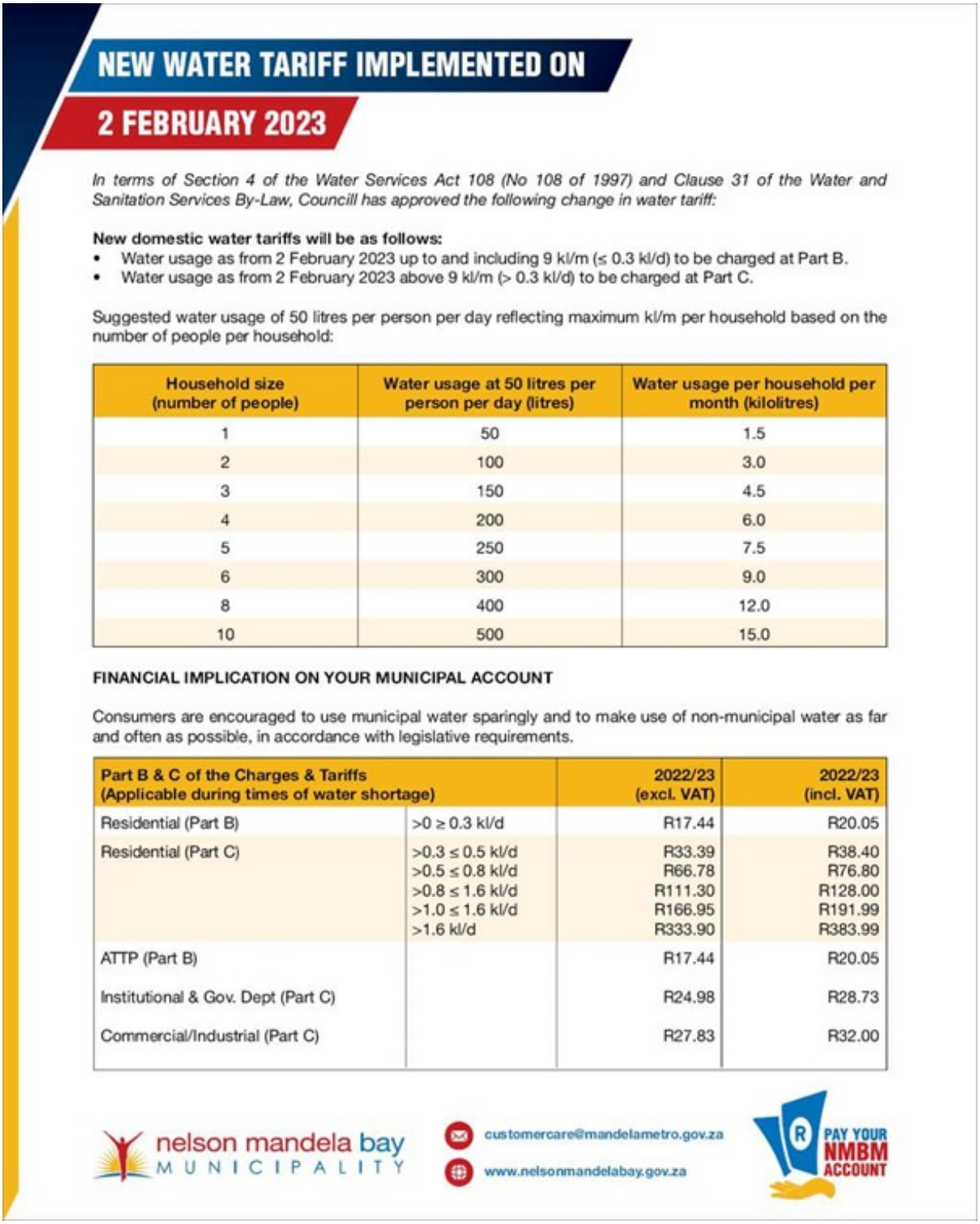
It also appeared that while the municipality was succeeding on the supply side by diversifying water sources and optimising existing infrastructure, the same cannot be said on the demand side, which requires extensive cooperation by the citizens:

> *"The demand exceeds supply. So, we tried to get the message across that if we collectively use a little less water, then our demand would not be 300 [megalitres], it would be 280 [megalitres], and everyone would have water.* ***Where, as the municipality, we [have] failed, is to get everyone to buy-in and use a little less. People have not been willing****." (Boldface for emphasis).*

3.6.3 Contextual equity and the municipal response

Context is an important dimension of equity as it creates unequal conditions for different societal groupings. Contextual equity is particularly important in South Africa given its history of apartheid spatial planning and selective service delivery (c.f. Magidimisha and Chipungu, 2019). Several authors such as Sandel (1990) and Pelletier (2010) have argued that equity must be sensitive to contextual factors that impact on people. In this regard, it is thus important to consider the social, technical, economic, environmental, political, and historical (STEEP-H) aspects of the context that impact on people. Viewed from a contextual equity perspective, the municipal response appeared to be sensitive to a range of contextual factors such as 1) environmental and geospatial conditions, 2) the social-economic conditions, 3) the technical aspects and 4) the political and historical aspects.

In formulating the water reduction strategy across different areas of the Metro for example, the environmental and geospatial conditions were the primary determinants. By the nature of geospatial factors, dams on the western systems were extremely vulnerable to the drought, and since restrictions further constrained abstractions, the municipality considered diverting excess water from the eastern system to augment the western system. The primary factor influencing the municipal decision was the geospatial consideration. The design of the municipal ATTP programme could be said to be primarily informed by political and economic consideration, particularly household income. Figure 3.16 provides a municipal notice on tariff structure showing the various tariff levels and the subsidy to the poor (ATTP).



NEW WATER TARIFF IMPLEMENTED ON 2 FEBRUARY 2023

In terms of Section 4 of the Water Services Act 108 (No 108 of 1997) and Clause 31 of the Water and Sanitation Services By-Law, Councill has approved the following change in water tariff:

New domestic water tariffs will be as follows:

- Water usage as from 2 February 2023 up to and including 9 kl/m (≤ 0.3 kl/d) to be charged at Part B.
- Water usage as from 2 February 2023 above 9 kl/m (> 0.3 kl/d) to be charged at Part C.

Suggested water usage of 50 litres per person per day reflecting maximum kl/m per household based on the number of people per household:

Household size (number of people)	Water usage at 50 litres per person per day (litres)	Water usage per household per month (kilolitres)
1	50	1.5
2	100	3.0
3	150	4.5
4	200	6.0
5	250	7.5
6	300	9.0
8	400	12.0
10	500	15.0

FINANCIAL IMPLICATION ON YOUR MUNICIPAL ACCOUNT

Consumers are encouraged to use municipal water sparingly and to make use of non-municipal water as far and often as possible, in accordance with legislative requirements.

Part B & C of the Charges & Tariffs (Applicable during times of water shortage)		2022/23 (excl. VAT)	2022/23 (incl. VAT)
Residential (Part B)	>0 ≥ 0.3 kl/d	R17.44	R20.05
Residential (Part C)	>0.3 ≤ 0.5 kl/d >0.5 ≤ 0.8 kl/d >0.8 ≤ 1.6 kl/d >1.0 ≤ 1.6 kl/d >1.6 kl/d	R33.39 R66.78 R111.30 R166.95 R333.90	R38.40 R76.80 R128.00 R191.99 R383.99
ATTP (Part B)		R17.44	R20.05
Institutional & Gov. Dept (Part C)		R24.98	R28.73
Commercial/Industrial (Part C)		R27.83	R32.00

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www.nelsonmandelabay.gov.za

PAY YOUR NMBM ACCOUNT

Figure 3.16: Municipal notice showing tariff levels and Assistance to the Poor Programme

Although it can be argued that the Metro considered social-economic factors in implementing its response to the drought. The low- and medium-income residents surveyed in this study were mainly of the view that the Metro did not do enough to ensure that its water related decisions reflect all socio-economic classes or groups living within the NMBM (Figure 3.17).

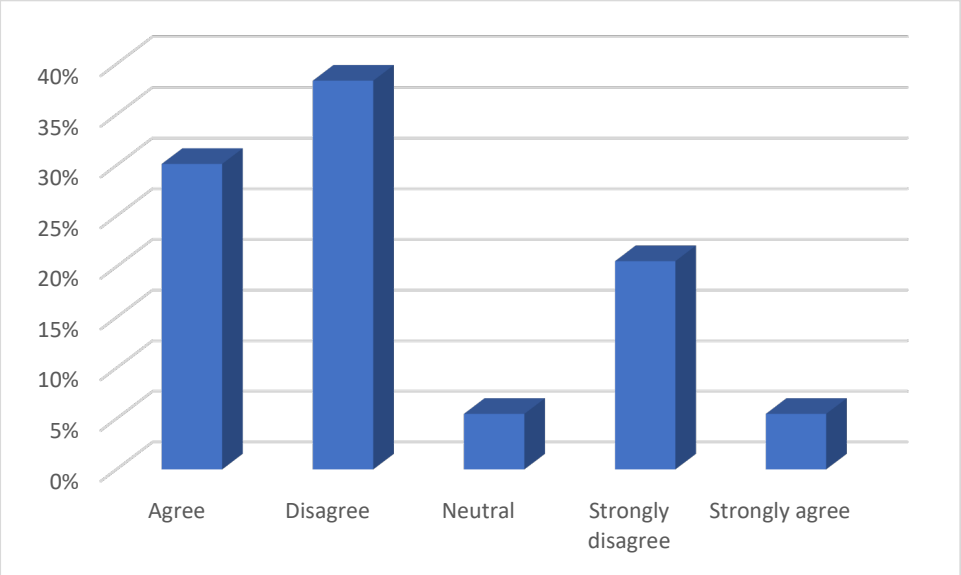

Figure 3.17: Low-medium income resident response on whether they agree or disagree that the Metro decisions reflected all socio-economic classes or groups

3.6.4 Equity, efficiency and sustainability – a critical perspective on the municipal response

Odume *et al*. (2022) developed a framework for analysing interactions between the value of equity, efficiency and sustainability. The framework recognises three interaction zone dynamics: i) mutually enhancing zone dynamic, ii) conflictual zone dynamic, ii) neutral zone dynamics. Whereas the mutually enhancing zone dynamics occur when all three values are co-benefiting, co-supportive, co-enabling and mutually reinforcing, the conflictual zone dynamics refers to a situation in which two or more of the values come into conflict. The conflictual interaction zone usually leads to value trade-off, implying that the pursuit of one value inherently limits the pursuit of another value. When this occurs, the outcome(s) of one value may thus limit, and constrain the outcome of the other value. The third zone of interaction as construed by Odume *et al*. (2022) is the neutral zone. This zone occurs when the pursuit of one value do not have either a negative or positive effect on the outcome of another value.

Drawing on the value interaction zone framework as described by Odume *et al.* (2022) we provide a brief reflection on how the municipal response has in many instances led to the conflictual zone interaction dynamics. For example, to achieve efficiency in the supply and demand system, the municipality implemented a range of measures including restricting supply via a number of mechanisms such as pressure control, flow restrictors as well as stepped tariffs.

These measures together led to system efficiency and optimisation. In response, a number of higher income households partially went off-grid and became self-sufficient. Partially going off-grid and becoming less reliant on municipal water supply also implies less revenue for the municipality as these are the income brackets that were most likely to afford and pay for water services. Less municipal revenue constrains its ability to provide reliable services in the long term, and also its ability to support its ATTP programme. Here, the pursuit of efficiency as a response to the drought come in direct conflict with that of sustainability and equity in the long-term as indicated by one of the municipal staff:

> *"Higher income households have accepted the cost of providing alternatives to municipal water and power. This alleviates some of the pressure on the metro, but there is a danger that higher income earners lose faith in the municipality completely and become as self-sufficient as possible, decreasing the number of paying municipal customers."*

In other instances, a failure to pursue efficiency timeously can be costly, impacting negatively on both sustainability and equity goals. This was particularly evident in the case of water leaks repair. The municipality was battling with many leaks across its very extended pipe networks. While many of these leaks (Figure 3.18) can be attributed to aging infrastructure, a significant number of them are as a result of vandalism.

Figure 3.18: Photos of leaking water pipes taken in NMBM during field work.

Nevertheless, a perception of an inefficient system regarding leak repairs can impact negatively on equity and sustainability as put forward by one of the research participants interviewed in this study:

> *"[Municipal] response time to [repair] leakages [is very delayed]. It cannot take the municipality more than three months to fix a leak. That's clean water that is running down the street, clean water…let me make an example: I've been reporting [a water leak] I think I have about 5 reference numbers right now for one leakage. I've reported it to the Councillor's Office, and they call and they give out the reference number and they say they are coming now… Of course, they do not arrive. This needs to be addressed..."*

Regarding leakage, there is a sense that low-income communities and especially schools in lower income areas, are particularly prone to leakages due to vandalism and related crime, as well as a history of neglect that is common in these areas.

3.7 Conclusion

This Chapter presents an analysis of the equity implications of the municipal response to the water crisis induced by the prolonged drought. As already indicated, the municipal response was wide-ranging, involving both technical and non-technical interventions. These were implemented on the supply and demand sides of the water supply systems. The results presented in this chapter suggest that although these measures affected all residents within the Metro, their effects on different groups, either by sex, settlement, or income group, were diverse. Of particular interest is the need for a considered, balanced approach that considers the short- and long-term implications of the responses, in ways that account for the complex interaction between equity, efficiency and sustainability. The single-minded pursuit of efficiency measures, such as cost recovery through implementation of tariffs or water cuts, may undermine long-term equity goals, unless these are carefully considered from an equity perspective. In the same vein, when equity becomes an overarching goal without careful balancing with efficiency and sustainability, both in the short and long term, again, such measures may run into long-term trouble. Therefore, the results in this chapter provide empirical evidence for measures that reflect not only equity imperatives but also the long-term implications for efficiency and sustainability.

Chapter 4: Living labs as social innovation platforms for strengthening transversal and cooperative water governance

4.1 Introduction

Social innovation (SI) is critical to responding to the water security challenges that confront South Africa. Social innovation can be construed as a process that fosters collaborative exchanges between diverse stakeholder and actors in ways that support new relationships, shift power dynamics and lead to the creation and potential implementation of new solution-oriented outputs and outcomes, and processes that address societal problems, needs and challenges (Rosa *et al*., 2021; Macedo *et al*., 2020; Kok *et al*., 2023; Ansell *et al*., 2022). Social innovations (SI) are seen largely as comprising two important dimensions: 1) the process, and 2) the outcome. The process must be open to bring diverse societal actors and stakeholders together in ways that re-balance power dynamics (Odume *et al*., 2021; Cullen *et al*., 2014; Fugslang *et al*., 2013; Fugslang and Hansen, 2022; Sheik *et al*., 2023; Ebbesson *et al*., 2024). The outcome, on the other hand, should ideally respond to and address societal needs, problems, and challenges (Pahl-Wostl *et al*., 2020; Mildenberger *et al*., 2020; Domanski *et al*., 2020; Caro-González, 2023; Bridi *et al*., 2024). SI is critical because it draws on ideas, concepts, and frames from diverse stakeholders and actor groupings, potentially representing different societal domains. This means that SI can also play a key role in informing transformative sustainable development trajectories and collaborative governance (Joel and Nel-Sanders, 2021; Millard, 2021; Temmerman *et al*., 2021; Millard and Fucci, 2023; Avelino *et al*., 2022).

SI may be incremental or radical (Apostolopoulou *et al*., 2022; Vercher *et al*., 2023; O'Shaughnessy *et al*., 2023). Incremental SI tends to gradually shift existing processes, practices and outcomes in ways that incrementally enhance their social relevance and the solutions they bring to societal needs. Radical innovations, on the other hand, tend to be transformative, potentially leading to the creation of new processes or solutions that are more effective than existing ones (Avelino *et al*., 2019, 2022; De Piere and Teasdale, 2021; Szekely and Strebel, 2013). SI can take the form of ideas, practices, concepts, tools, methodology, or paradigms (Castro-Arce and Vanclay, 2020; Ebbesson et al. 2024, Fugslang et al., 2014, 2022; Barreteau et al., 2023).

Collaborative platforms are necessary for SI. Living Labs (LL) are one of such platforms. As the concept of LL is still evolving, there is no single definition that concretises what Living Labs are and what they do. However, the European Network of Living Labs (ENoLL, 2018), defines Living Labs as "user-centred open innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real-life communities and settings". Though slightly different, this definition is largely in congruence with other definitions including the one given by Leminen *et al.* (2012) in which they argue that LL are "physical regions or virtual realities in which stakeholders form public-private-people partnerships of firms, public agencies, universities, institutes, and users all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts." It is clear from this definition that for a platform to qualify as a LL, it must possess certain desired characteristics: 1) it provides opportunity for collaboration; 2) it is multi-stakeholder, bringing diverse stakeholders and actors together; 3) it is open and people-centred with a network governance mode; 4) it is situated in real-life situations, enabling experimentation, testing, validation, and implementation; and 5) it is solution-oriented, and responding to societal needs.

Living Labs (LLs) as collaborative platforms are useful because they tend to involve societal stakeholders throughout the major processes and stages of the research project. This implies that through the LLs, stakeholders can participate and potentially influence the problems to be researched, identifying priorities, scoping, and testing different concepts and ideas, and proposing and testing pathways needed to address complex sustainability challenges (Cossetta *et al*., 2014; Fuglsang *et al*., 2014, 2022; Rubalcaba *et al*., 2022; Alamanos *et al*., 2022; Beaudoin *et al*., 2022; Bridi *et al*., 2024). In a way, LLs can be construed as a research approach, and in this way, they differ from conventional research approaches, which tend to retrofit stakeholders' contributions. By retrofitting, we imply that the knowledge and ideas of affected people are collected in the form of interviews and or surveys late in the research process, when key aspects such as problem definition, structuring, priority needs and agenda setting have all been done. One critical drawback of such a research process is that results are hardly used by the intended end-users as they may not be contextually sensitive in terms of realities, aspirations, and values of the affected local actors (Cullen *et al*., 2014; Ballon and Schuurman, 2015; Ingram *et al*., 2020; Oliver *et al*., 2012). Therefore, the LL offers an approach that departs from expert-led research to one that is co-led between diverse stakeholders and actors – particularly those affected by the problem being researched.

As social engagement platforms, LLs have substantially contributed to generating nuanced understanding of the complexities and multiple dynamics that characterise human-nature relations (Lupp *et al*., 2020; Ebbeson *et al*., 2024), especially how communities negotiate challenges of water shortages and inequitable supply in times of drought. (Anderson *et al*., 2019; Conallin *et al*., 2017; Kabogo *et al*., 2017; Lave, 2016; Taylor *et al*., 2023; Kliskey *et al*., 2023). In this way, LLs serve as platform where those who are most directly affected can engage with and share their views and explore issues and potential solutions in a culture of knowledge co-creation and co-learning.

The Nelson Mandela Bay Living Lab (NMBLL) was established on 22 July 2022 in Gqeberha. It was established as part of the Belmont Forum funded, SDG pathfinding project, which aimed to develop tools and capacities to support the localisation of the SDG agenda in African countries using participatory bottom-up approaches. The SDG Pathfinding project was a collaborative project between Rhodes University in South Africa, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement in France, and the International Institute for Applied System Analysis (IIASA) in Austria, along with a leading local NGO, Groupe d'Action et d'Initiative pour un développement Alternatif (GAIA) in Senegal. Since its establishment, the NMBLL has generated and tested innovative ideas on the water security challenges, fostering a multi-stakeholder collaboration to promote social learning, mediate power dynamics between different actors, and provide a platform for capacity strengthening of local actors on critical water challenges within the Metro. The LL draws membership from diverse communities and sectors, including community development partners, non-governmental organisations, government departments, industries, advocacy groups and community members. Therefore, this chapter sheds light on communities' perspectives on water security challenges and their equity implications in the NMBM. The social engagement during the reporting period serves multiple purposes: 1) distilling community perspectives on water security and equity; 2) debating feedback from previous findings; 3) co-creating solutions and knowledge based on shared experiences and lived realities among the different actors and stakeholders. Additionally, the LL sheds light on the complexities of participation, unequal power relations and the implication of these for equity and justice.

4.2 Living Labs engagement tools

During the course of the project, several LL sessions were convened. The LL members co-developed, tested and played a water choice game on 21 June 2023, and then on 1 September 2023. The purpose of these games was to assign real-life roles to players and to demonstrate the consequences of their actions on water resources, water service delivery and how these impact on other people and the environment. These games were useful as they demonstrated in real-life, actions that can be taken to improve the water resources within the NMBM. Details of these games are attached in Appendix 1. We also convened another LL session on 5 June 2024 to co-explore the implications of the water security situations in communities within the Metro and to identify bottom-up solutions based on shared experiences. The session had 21 participants in attendance, with apologies from a further 13.

4.2.1 The engagement approach during the Living Lab session on 5 June 2024

To co-explore the water security situation and bottom-up solutions, we employed two methods: 1) participatory community mapping; and 2) focus group discussions. Participatory community mapping allows for stakeholders' visual representation of their experiences, values, perceptions, assessment in a spatially reflective manner. It is particularly useful as a way to incorporate intangible heritage and cultural relationships with water and water spaces (Strang, 2020; Toussaint, 2021; Pillai, 2022). Participatory community mapping ensures active participation of actors and stakeholders, serving as an important tool for collective action (Hossen, 2016; Edizel and Evans, 2017; Reilly *et al*., 2018; Okotto-Okotto, 2021; Stosch *et al*., 2022). Through the participatory mapping exercise maps were created to unlock water-related narratives. Mapping oneself into place and then sharing the stories that emerge from these maps allows participants to tell their own stories, in their own words. Sharing these maps in a group setting allows for discussion around shared or comparative experiences, leading towards finding common ground in a safe and interactive space (Figure 4.1).

The LL participants were provided with materials so that they could map their lived realities as they related to water availability and water-related concerns in their areas. An example was created by the facilitator, explaining that the aim was not to measure mapping accuracy, but to allow everyone a free-flowing method to share their water-related narratives. Given the choice to create either individual maps or collective maps, they chose according to their interests and the stories they wanted to focus their maps around. For example, some who lived close to each other chose to create maps together, others who wished to focus on a particular theme, such as

fishing or farming, chose to create individual maps. Following the participatory community mapping, a total of nine maps were created as follows: 1) Fishing spots along the Swartkops River; 2) Rocklands area; 3) Perseverance and its importance to traditional healers; 4) Wells Estate 1; 5) Wells Estate 2; 6) My house in Wells Estate; 7) Chris Hani Area; 8) Pollution along the Swartkops River; 9) How I save water and harness rainwater at my house (refer to the quote in section 4.3.2).

4.3.2: Co-exploring how communities dealt with the drought and water scarcity in the NMBM

Figure 4.1: NMBM Living Lab participants during the participatory mapping

Focus group discussion

After the participatory community mapping, members of the LL were divided into two groups for a focus group discussion. The focus group discussions were guided by the following questions:

- What does water security mean to you and your community?
- How did your community deal with the drought, how do you deal with water scarcity?
- What are your thoughts on the municipality's various responses to the drought?
- What can be done to improve resilience when it comes to water security?
    - In your community?
    - In NMB as a whole?
- Ranking water-related concerns, what should be the focus in the short, medium and long term?

- What would you say to those responsible for water provision in the metro if you had the chance to do so?

We used focus group discussions as a way of better exploring and understanding the complexities involved in communities' use, values and perceptions of water as well as their perception of the water security challenges in the Metro and potential bottom-up solutions. Focus groups are particularly good when it comes to understanding diverse voices and multiple views and perceptions. By exploring potential issues and avenues in a group setting through interactive discussions, participants can find common ground, help each other unpack the mechanics of common problems, share knowledge and information and build towards shared understanding (Badrul *et al*., 2020; Acocella and Cataldi, 2021; Hoolahan *et al.,* 2018).

4.3 Results and Discussion

4.3.1 Co-exploring the concept of water security

Water security is a multidimensional concept, and its understanding by communities can influence their individual, collective and relational agencies (Pandey, 2021; Bakker and Morinville, 2013; Taylor and Sonnenfeld, 2019; Mishra *et al*., 2021; Allan *et al*., 2023; Zaman and Swaminathan, 2018). A collective, deeper understanding of water security can help guide actions, solidarity and mobilise community practices towards more sustainable and equitable water utilisation (Adams *et al*., 2020; Keemeier, 2000; Basco-Carrera, 2018; Octavianti and Staddon, 2021; Molden *et al*., 2020).

We co-explored the concept of water security with members of the LL by asking: What does water security mean to you and your community? The aim of this exercise was to advance our collective understanding of the concept of water security. What was clear was that water security was viewed by members of the LL as multidimensional, involving **availability or quantity**, which was captured as having enough water for human and animal consumption, recreation, cultural heritage/practices, food security, and ecosystem support. A second dimension that emerged relates to **quality**, captured as having clean water, usable water, and safe water. The participants identified a third dimension of water security as **access,** which for many meant free access to fresh, usable clean water. A dimension related to **assurance of supply** was captured as "*to be notify when there are water cuts, water problems, dirty water"* (Figure 4.2). It also appears that the LL members took cognisance of threats and risks to water

and ecosystems as an important consideration when dealing or operationalising the concept of water security. Examples of such risks/threats include pollution, drought, mismanagement, climate change, wasting water etc.

Figure 4.2: Example illustration by LL members of what the concept of water security means to them

It is critical to note that the concept of water security is an evolving one both in the academic literature and in policy and practice domains, and as such, there are diverse definitions mainly reflecting disciplinary perspectives (Mishra *et al*., 2021; Babel *et al*., 2020; Young *et al*., 2021; Allan *et al.*, 2013; Srinivasan *et al*., 2017). For example, the United Nations Water gave a working definition of water security as "the capacity of a population to safeguard sustainable access to adequate quantities of water with acceptable quality necessary for sustaining livelihoods, human well-being, socio-economic development, ensuring protection against water-related disasters, and for preserving ecosystems in a climate of peace and political stability" (UN Water, 2013). Earlier, the Global Water Partnership (GWP) defined water security as "every person has access to enough safe water at affordable cost to lead a clean,

healthy and productive life, while ensuring the environment is protected and enhanced." (2000). On the other hand, Swaminathan (2001) sees water security as a concept that "involves the availability of water in adequate quantity and quality in perpetuity to meet domestic, agricultural, industrial and ecosystem needs." de Loe¨ *et al*. (2007) define water security as "a multi-dimensional concept that recognises that sufficient good quality water is needed for social, economic and cultural uses while, at the same time, adequate water is required to sustain and enhance important ecosystem functions." It appears that none of the definitions of water security emphasize assurance or reliability of supply, both in terms of quality and quantity, as a dimension of water security, yet assurance can impact both ecosystem function and socio-economic development. Access, as a common theme in the diverse definitions of water security, must be construed as having two important components – physical access and economic access. Whereas the first aspect of access deals with whether one can physically access water services or not, the second deals with the question of affordability by reason of the economic standing of the individual/household. Overall, the LL members appear to not only have a deep understanding of water security as a concept but also seem to extend it. This co-exploration with communities through a platform such as the LL thus provides impetus not only for social innovations but also provides an opportunity to conceptually advance a particular knowledge domain.

4.3.2: Co-exploring how communities dealt with the drought and water scarcity in the NMBM

Community adaptation to water emergencies and crises is critical for resilience at the household level (Howarth and Monasterolo, 2017; Johannessen, Å. and Wamsler, C., 2017; Lebu *et al*., 2024). In fact, adaptive measures may be taken at the individual, household, or community levels (Van Aalst *et al.*, 2008; Ayers and Forsyth, 2009; Grasham *et al*., 2019; Stoler *et al*., 2023). Drawing on the experiences and collective knowledge of members of the LL, we explored how communities dealt with the drought and water scarcity in the NMBM. Such an exploration is critical to identifying lessons and measures that can be scaled up, and those the needed to be improved or enhanced, while also indicating weaknesses and gaps. Based on the discussion in the LL, the measures undertaken by communities can be categorized as: 1) reduction in household water consumption; 2) alternative water sources; 3) reliance on external water donors; and 4) municipal supply and assistance.

Reduction in household water consumption was mainly due to imposed municipal restrictions (NMBM 2023) as well as water re-use - mainly for gardens and to flush toilets, etc. It appears that the reduction in household water consumption was also due to heightened awareness among communities about the water shortages within the Metro. Members of the LL alluded to the fact that households were relying on alternative water sources such as rainwater, and water supplied through trunks and tanks. However, among the low-income communities, this was problematic because of issues of affordability and knowledge regarding water tank installation.

Regarding knowledge, for example, knowing what is required to most successfully set one's house up for rainwater harvesting and greywater re-use was identified as critical. The story below exemplifies the complexities of how communities navigated and adapted to the drought in the NMBM:

> *"This is how I save water at my house. This is my house and I've got two tanks. This one is specially, it's only for watering the garden. It's 2 900 liters [tank], and this one is much smaller than this one [first tank]. I use this one a lot, because I like my gardening. I like gardening a lot, especially with vegetables".*

The mapping and focus group exercises during the LL allowed the unpacking of how water scarcity affected people at the household and individual levels. One participant's map showed that a single communal standpipe was the only source of water for over a hundred people in the area where they lived, and that emergency water provision was limited to a single truck that was not sufficient, leaving times when there was no water available. In most cases, lower-income households have very limited means to access alternative water provision, such as buying water or installing water tanks, which is something more affluent households were doing. Often, the only option is to wait until water is turned on or water trucks are in the area. One of the LL participants puts it this way, as depicted in the drawing in Figure 4.3.

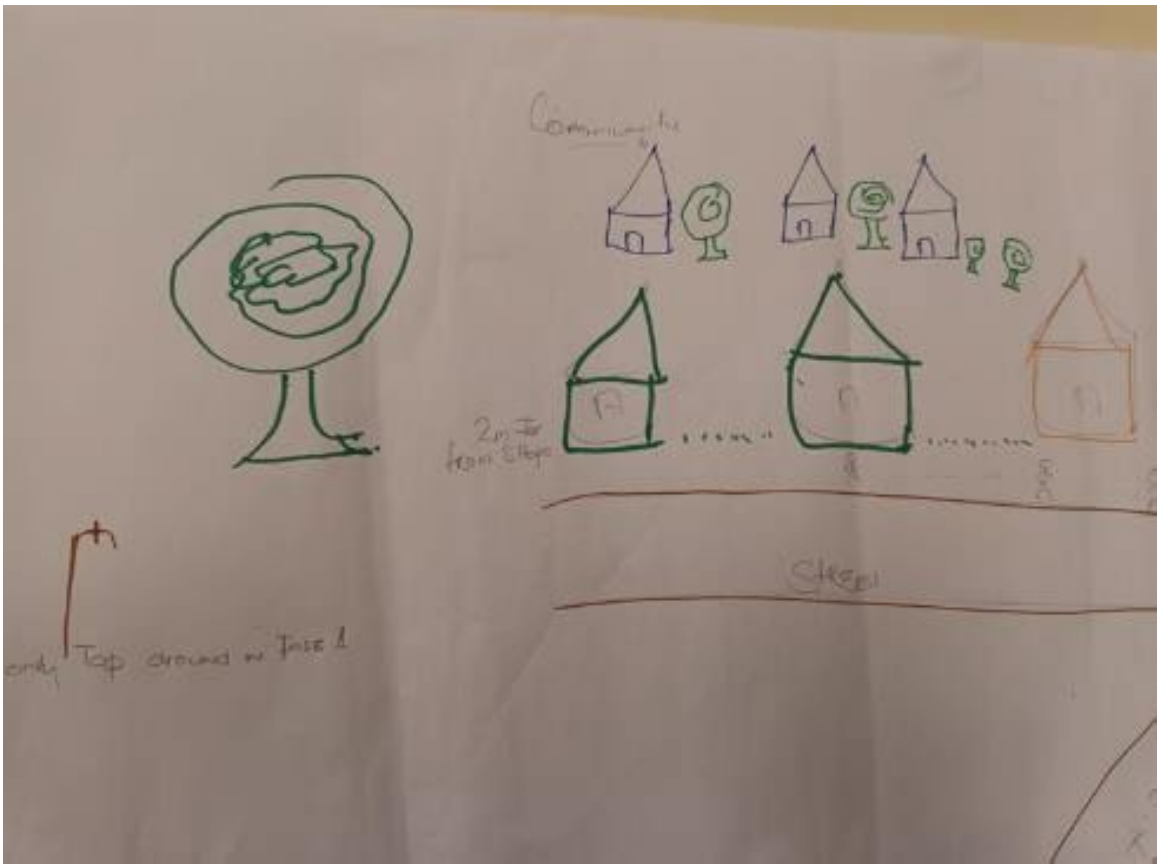

Figure 4.3: An Illustrative drawing by LL members of one communal tap serving an entire community in Wells Estate

4.3.3 Co-exploring perceptions of the municipal response to the drought

Based on the discussion with the LL members, the communities' perception of the municipal response to the drought was not very good. Three main themes emerged regarding how communities perceived the municipal responses. These are 1) inadequate preparation and poor management; 2) challenges related to effective communication, awareness raising and education; and 3) a lack of proactive planning. Regarding the perception that the municipality was not well prepared for the drought, the LL members raised several implications such as inconsistent water supply, and water of poor quality, poorly planned distribution of emergency water supplies, and a lack of policy or strategy on equitable and orderly distribution of emergency water, often leading to conflict between households etc.

> *[I'd like to ask those responsible for water provision]: Why are you taking forever to respond to water leaks when they are reported? And then, why is your call centre line always busy when you're phoning to report the water leaks? Thirdly – why are you charging too much for bills for people that are not using much water, because you get*

old people, pensioners, that have bills running from 1.5 (R1500) to plus minus R50,000- that is an old person surviving only on a SASSA grant, which is 2000 Rand. Why are you guys doing that? Why are you always dragging your feet for everything?

The major concerns relating to poor communication, awareness raising and education were mainly around the timing of water cuts, scheduling of water supplies, municipal bills and fines as well as response time to queries on pipe bursts and leaks. The mapping and focus group discussions at the LL revealed that often residents in lower-income communities feel they are not as included in communications when it comes to water-related issues. One example would be communication regarding emergency water provision. Another would be water-related health hazards, such as fishermen reported to be unknowingly fishing next to sewage leaks. Currently, communication is largely done through the municipality's social media and various related platforms. One demographic that currently lacks access to these platforms is lower-income households, especially elderly residents who may not have regular access to social media platforms. Solutions put forward included spreading awareness via ward committees and various grassroots platforms, holding regular ward/street meetings as well as via local WhatsApp groups:

I would ask those responsible for water service provision: Can you prioritize your upgrading and expansion infrastructure program with immediate effect? And also, not leaving most people behind as you modernize your ways of communication. The best way in our communities is still to have your community meetings, because not all of us are so advanced in today's technologies. Your Gogos (grandmothers) at home don't go to Facebook. They will still rely on you having that community meeting at the street level, so that you are able to reach everyone.

Overall, the LL members were of the general view that the municipality was rather reactive in their planning and intervention approach. The sense of being reactive speaks to the need for drought-proof planning in the water sector for South Africa, given that the country is considered as water-scarce (Botha, 2020; Brühl *et al.,* 2020; Bischoff-Mattson *et al*., 2020; Kaiser 2021a, 2021b; Savelli *et al*., 2021; Pamla *et al*., 2021; Calverley and Walther, 2022).

4.3.4 Towards collective identifications of solutions to the water security challenges

The LL members were asked to indicate what can be done to improve resilience to water security challenges at the level of their communities and the entire NMBM. Table 4.1 provides a summary and the ranking of the potential solution identified by members of the LL.

Table 4.1: A summary of potential solutions as put forward by members of the LL

Short term	Medium term	Long term
Maintenance of water infrastructure and better water distribution – "Make maintenance cool again"	Upgrade water distribution network	Aim: Enough water for a growing population Upgrade and expand water distribution network
Respond to leaks faster		
Water preservation skills and knowledge	Preservation of skills and knowledge	
Education and awareness ● How to save water ● How to use water better ● Waste less and re-use more	Education and awareness	Education and awareness
Better communication structures put in place, especially between the municipality and various communities		
Increase number of boreholes		
Improve waste collection	Improve waste collection	
Reduce dumping – so less waste ends up in waterways	Reduce dumping	
Maximise catchments' potential – teach people how to do this	Engage with research institutions for best solutions	

Plan: for better water resilience, how to best upgrade – e.g., the sewage system	Upgrade sewerage system	Upgrade and expand sewerage system Investigate potential add on projects, such as desalination, to increase water supply in NMB Do we have enough dams? Are more needed? Investigate and implement the best solutions
Water leaks need immediate maintenance	Monitoring and treatment of water	Infrastructure upgrading
Response time to water-related incidents needs to be improved	Increasing capacity	Implementing programmes to increase capacity and improve water-related problems
Look at ways to provide more ways to store water and harvest water	NMB is buying potential tools to aid in this, such as rainwater tanks	Put communal taps at regular intervals in areas where these are needed

Many of the solutions proposed by the communities are not far from those implemented by the municipality. However, there is a sharp emphasis on 1) communication, education and awareness raising both as a short and long-term measure; 2) infrastructure planning for a growing municipal population – including regular maintenance, diversifying water sources as well as installing water sources within communities in ways that pays attention to equity imperatives.

4.3.5 Living Labs as a response to addressing equity and participatory challenges

Living Labs appeared to respond to the general perception that was rift among the low-income groups that the Metro was not adequately taking their views into account when making decisions. Participation in the LL was seen as a way of empowering communities to engage and actively contribute solutions to the water security challenges in the Metro. The sense of

empowerment through the LL allows different perspectives to emerge about the causes, origin and solutions of the water security challenges. The active involvement of the Metro in the LL provides further impetus in this regard as members genuinely sense that their views and voices are now being taken into account. As the LL engagements substantially contributed to generating a nuanced understanding of the complexities and multiple dynamics of the water security crisis, and also empowering communities to engage with these complexities (Lupp *et al*., 2020; Ebberson *et al*., 2024), the LL serves multiple purposes. First, it addresses the procedural equity dimensions by way of providing a platform for engagement and participation. Second, it addresses the distributive dimension of equity as the games make real the implications of actions in relation to water access and associated risks. Third, it appeared to strengthen the government-community relations as the LL brings these actors together, especially in ways that mediate power relations.

4.4 Conclusion

Social innovation platforms such as the NMBLL provide a crucial opportunity for generating bottom-up solutions, while offering critical perspectives on socially relevant sustainability challenges (Mehmood and Parra, 2013; Baker and Mehmood, 2015; Castro-Arce *et al*., 2020; Norström *et al*., 2020; Haskell *et al.,* 2021). The NMBLL has become a unique platform within the Metro, bringing together diverse actors and stakeholders interested in and affected by the water security challenges within the Metro. The NMBLL provides members the opportunity to reflect on the challenges as it relates to them, while collectively identifying possible solutions. The engagement with the actors within the NMBLL suggests that communities have a deeper meaning and interpretation of the concept of water security, often extending its definition and interpretation beyond those in the academic literature. This provides a critical impetus for why it is important to engage communities when attempting to address complex sustainability challenges such as water security. Communities used different strategies to build resilience during the drought, including reducing household water consumption, depending on alternative water sources, relying on external water donors, as well as municipal supplies and assistance. However, many low-income communities relied solely on municipal supplies and assistance, which in most cases was not assured, indicating the need for equity-sensitive interventions and planning in the water sector. Long-term infrastructure planning, maintenance/repairs, effective communication, education and awareness raising, regular engagement with the communities, as well as equity-sensitive interventions are suggested solutions for building resilience within the Metro.

Chapter 5: Implementing Environments, Governance and Translatable Lessons

5.1: Background and context

Prolonged drought is becoming a common feature in South Africa. This has implications for water security for many municipalities (Mahlalela *et al*., 2020; Petterson 2021). The Nelson Mandela Bay Metropolitan Municipality (NMBM) was under a severe drought between 2017 and 2023. This led to the combined water storage levels in reservoirs reaching extreme lows, for example 11.17% in 2021 (NMBM in Daily Maverick, 2021; see also DWS, 2024). The drought presents a situation that threatens the water security of the Metro. The NMBM is particularly vulnerable to drought, and since 1969 has experienced at least four instances of severe drought because of extremely low rainfalls within its catchment. As the western and central water supply system within the NMBM is entirely dependent on runoff from rainfall (with a very minimal input from springs and boreholes), these instances of severe drought can become extremely threatening. This is particularly true because the western and central system supplies water to over 50% of the population of the Metro (NMBM 2021a, 2022a, 2022b).

The NMBM has taken considerable steps both at the political and technical levels to address the drought and to mitigate its impact (Aurecon, 2011; NMBM, 2006, 2012, 2021a, 2021b, 2022a, 2022b, 2023a, 2023b; Barnard, 2023). For example, the city first declared a state of disaster on 22 May 2017, and then subsequently on 19 May 2018, 21 November 2019, and 04 May 2020. Similar declarations had also been made in response to the drought in the NMBM at the provincial level (NMBM, 2022a). The relevance of these declarations is that it allows the freeing up and mobilisation of resources to address the drought.

At the technical and operational levels, the NMBM developed a plan to guide the implementation of short-, medium- and long-term measures, categorised broadly into 1) measures aimed at optimising current water sources and supply systems; 2) diversifying and augmenting water supply sources; 3) reducing consumption and demand; 4) public engagement and awareness raising. Regarding optimising supply systems, particularly reducing water losses, the municipality implemented several measures including leak repairs, domestic meter audits, installation of advanced metering systems, and pressure management devices. These technical measures reduced non-revenue water from 46% in 2014/2015 to 43.4% in 2015/2016 (Pietersen, 2021). On augmenting municipal water supply, efforts aimed mainly at diversifying water sources (e.g., feasibility of a desalination plant, wastewater reuse in the industrial sector,

in school grounds) and groundwater exploitation have been prioritised (Pietersen, 2021). Regarding managing water consumption, as the severity of the water crisis grew, the municipality intensified its efforts at reducing consumption through measures such as smart metering, increased restrictions, implementation of a stepped tariff system, and pressure control devices. Citizens were engaged through various public engagement and awareness raising measures (c.f. NMBM 2021b, 2022a, 2023b).

The NMBM is not the only metro in South Africa to have confronted severe drought in recent history. The 2015-2020 Cape Town water crisis is well documented (Brick *et al*., 2017; OECD, 2021; Millington and Scheba, 2021). The triggers of the Cape Town water crisis are multidimensional but can be attributed mainly to rainfall variability, prolonged drought, population growth, unsustainable water consumption and systemic governance challenges, including weak anticipatory governance (Rodina, 2019; Rodina and Chan, 2019; Enqvist and Ziervogel, 2019). In many ways, the Cape Town water crisis was exacerbated by inter- and intra-party politics, with profound consequences in terms of how the drought was handled (c.f. Rawlins, 2019; Rodina, 2019; Kaiser, 2021).

The Cape Town drought and the associated water crisis have been extensively studied (Enqvist and Ziervogel, 2019; Savelli *et al.,* 2021; Savelli, 2023). Once the crisis became apparent, the City of Cape Town, working collaboratively with other government and non-governmental institutions, actors and stakeholders implemented several institutional, technical, and social innovations, which saw water consumption reduced drastically at the peak of the water crisis in Cape Town (see Brick *et al*., 2017 for a review of the Cape Town water crisis and measures taken).

Translatable lessons are important as they inform future response, saving costs and enhancing efficiency in many ways. Ziervogel (2018, 2019) documented translatable lessons based on her analysis of the Cape Town drought. Her work distilled 13 translatable lessons clustered around four themes: 1) governance, 2) data, expertise, and communication, 3) the importance of a system approach, and 4) building adaptive capacity. For example, some of the translatable lessons on governance include i) the need to strengthen transversal management between municipal departments, ii) building systems and relationships of mutual accountability for effective water management between spheres of government, iii) strengthening leadership and the capacity to enable flexible, adaptive decision making, and iv) investing in partnerships

beyond the local municipality. Translatable lessons were also documented in other areas such as data management, the role of expertise and effective and proactive communication. A systems approach has been hailed in the literature as appropriate to addressing complex challenges such as water insecurity. Empirical evidence suggests that in many ways, the City of Cape Town draws on systems thinking in responding to and addressing the water crisis (Brick *et al*., 2017). Translatable lessons in this regard have been documented, including i) the imperative for an integrated approach to the entire water value chain and all its components, ii) a robust and resilient networked system of water supply, and iii) recognising the limitations of the current financial model for water (Ziervogel, 2019).

The way in which measures are deployed in response to a crisis is largely a function of the implementing environment (Bakker, 2013). A dysfunctional implementing environment, whether in terms of governance, resources, or technical expertise, would likely aggravate the consequences of the crisis and undermine any meaningful effort at resolving the same. For example, a recent political analysis of the NMBM by Ndletyana (2022) showed a municipality in a political crisis. Ndletyana showed how party politics negatively impacted service delivery, including water services in the NMBM (2022. See also Ndletyana 2020). We construed the implementing environment as multidimensional, encompassing the social, technical (including expertise, data, infrastructural), economic (including financial), ecological (including natural capital), political (decision, administration) and historical dimensions. In analysing the implementing environment, the overall aim of this Chapter was to distil factors that may enable or constrain the municipal response to the drought, as well as consider the uptake of translatable lessons. In this Chapter, we distil translatable lessons from the NMBM and evidence of uptake or otherwise from the Cape Town drought.

5.2 Analytical framework

5.2.1 The implementing environment

The implementing environment can be both an enabler and a barrier to drought-related interventions. We construed the implementing environment as multidimensional, encompassing and framed around the STEEP-H framework (Rogers and Luton, 2011; Everard *et al*., 2021). The STEEP-H has been adopted as an appropriate framework because it encompasses multiple contextual factors/dimensions that influence decisions, actions and

performances. These contextual dimensions, as used in our analysis, are briefly described below:

Social environment – This includes the social demographic configuration and related social indicators and parameters within the municipality. It includes the social relations between the people and the municipality. This dimension of the implementing environment assesses the adaptive capacity of society to the drought, and the ability of the municipality to facilitate such societal response through trust building, open, and regular communication and engagement.

Technical environment – This refers to the technical dimension of the implementing environment. It includes infrastructure, data and technical expertise necessary to respond to the drought and to plan and implement measures, including future scenarios.

Economic environment – This relates mainly to financial and other economic resources necessary to respond to the drought. It also includes the capacity to leverage financial and economic resources to build, operate and maintain water system infrastructure and processes.

Ecological environment – This refers to the ecological assets available to the municipality, which it can deploy in response to the drought, and to plan for future measures. In the context of water systems, these ecological assets relate to the quantity and quality as well as assurance of supply of water resources.

Political environment – This relates to administrative, management, institutions and governance systems and processes relating to decision-making and efficiency with regard to responding to the drought, and uptake of translatable lessons.

Historical environment – This is an intersecting aspect that reflects on the historical context that may impact on the way in which the municipality responds to the drought and manages and secures water services.

The approach to analysing the implementation environment takes the broader municipal context (internal and external) into account. By taking such a broader perspective, one is able to identify both internal and external enablers and barriers to measures implemented in response to the drought, as well as uptake of translatable lessons.

5.2.2 Data collection

To analyse the implementing environment and lessons learnt, we collected data through reviewing relevant government documents, semi-structured interviews and secondary data in the form of municipal reports and Excel spreadsheets supplied by the municipality. Municipal financial data were collected from annual reports, including financial reports (NMBM 2018, 2022b, 2023a). Where available, data were collated from various sources for a period of 10 years (to cover the duration of the drought). Data on water leaks, client complaints, infrastructure procurement, and maintenance were supplied by the Water & Sanitation Sub-Directorate, Infrastructure & Engineering Directorate of the Nelson Mandela Bay Municipality. Only spatially aggregated data were supplied. Efforts to get spatially disaggregated data from the municipality proved abortive. The work by Ndletyana (2022) forms the foundation for analysing the political environment.

Data gleaned from the various sources were complemented by surveys and interviews. We concluded 235 surveys and across different locations to gain perspectives from low, medium and higher income households at different locations around the metro. We also concluded 110 interviews (see Table 3.3). As can be seen, the interviews cover a variety of stakeholders, including household level, municipal officials, community leaders, ward councillors, contractors and businesses. The surveys and interview guides are appended (Appendix 2).

5.3 Results

5.3.1 Social environment

The social environment of the NMBM has a direct bearing on its ability to provide water services and the way it responds to the drought. The municipality has a population of over 1.2 million people and a total of 368,520 households (Stats SA, 2022). Of these, 24 032 households are informal, accounting for about 7.2%. In 2022, there were a recognised 124 informal settlements (NMBM, 2022). Municipal officials state that there are now over 150 informal settlements. Unemployment in the metro is around 40.7%. Poverty is high, with about 27.2% of households receiving grants as their main income source.

The social environment of the municipality implies that it has to respond in ways that are particularly sensitive to these social realities. During the drought, the municipality intensified its ATTP programme and sought to increase awareness about the water scarcity and the looming

water crisis. The public awareness campaigns were mainly through media such as radio, community meetings, and social media platforms – with Facebook updates being the main means of communication between the metro and residents. These public awareness campaigns have so far failed to foster deep social learning and behaviour change, especially in vulnerable communities. There was a general sense of a lack of consistent, transparent communication which led to a public trust deficit and frustration in some quarters during the drought. In particular, poor communication with vulnerable communities undermined trust building. While communicating via social media (e.g., Figure 5.1) may have worked quite well in Cape Town, it was felt by some to be a method that failed to reach all residents of the NMB metro, largely due to disparities in access to such channels. Lack of community involvement at the grassroots levels undermined the social buy-in and collaborative spirit that was necessary to collectively address the drought. The main concern was that communicating via Facebook does not reach people who are not on such social media platforms.

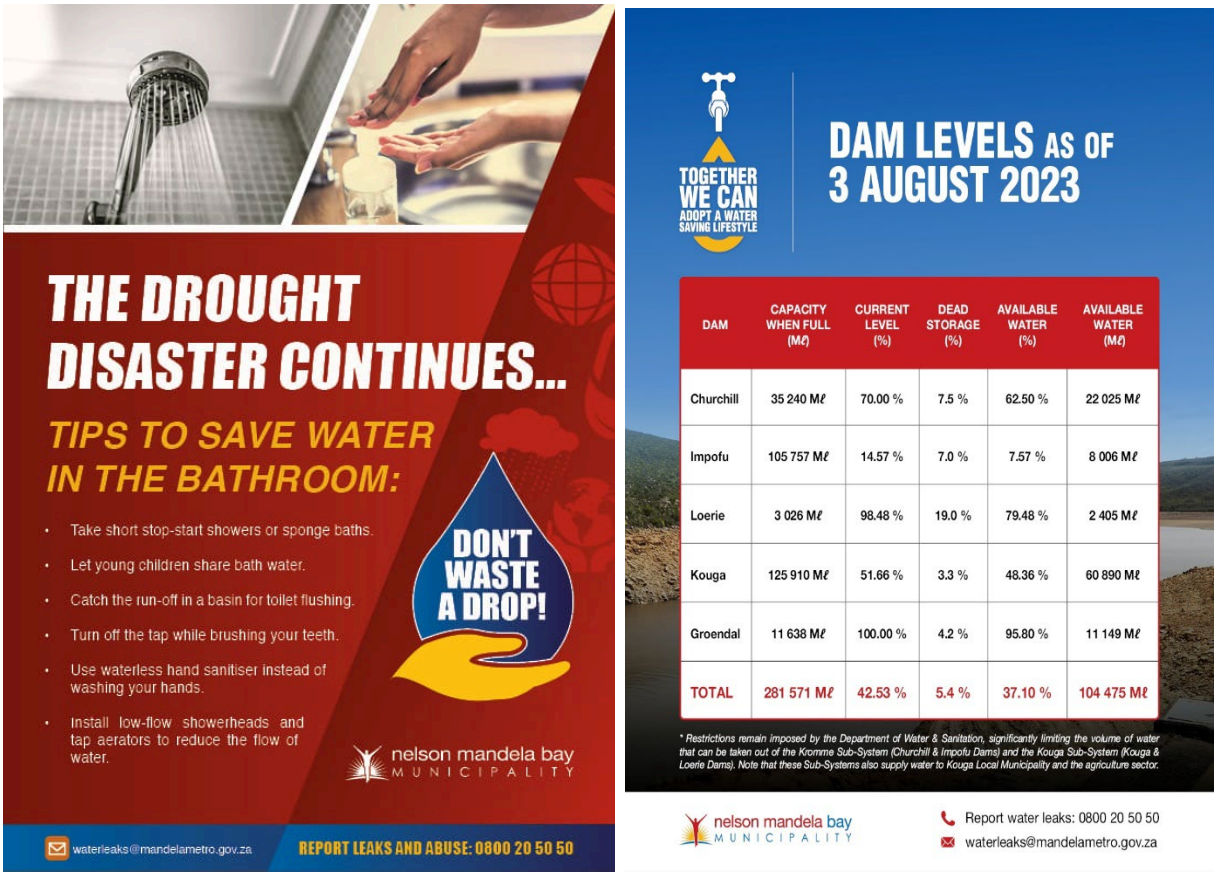

Figure 5.1: Water crisis awareness posters shared via NMB municipality's social media pages

Among some actors and stakeholders, there was a sense of apathy that has been attributed to poor communication during the drought. People in the lower-income areas felt that they were

not often taken seriously, and in some cases, reporting leaks led to investigations that meant smart meters were installed. This was taken as the municipality not trusting the community members who reported the leaks. Regarding apathy and mistrust during the drought, one of the municipal officials remarked:

> *"There is an apathy of reporting in fact, and people have a huge mistrust of the municipality and hence they go to the ward councillors in our affluent areas and then in the historically disadvantaged areas, they just don't think that they get any help from anyone, so there's no point in even reporting a leak."*

The concerns regarding the effectiveness of the communication channels between residents and the municipality were echoed by one of the research participants in the low-income bracket as:

> *"There was no alerting. [e.g., telling us] where the trucks would stand and when we can actually find free accessible water. That means there is no school, no work for other families".*

The apparent lack of trust-deficit between the public, in particular among low-income communities, and the municipality implies that people in these communities were less willing to comply with water savings measures. This is reflected in the sentiments echoed by one of the municipal officials interviewed:

Key lessons:

1. **Build public trust through open, transparent and regular communication and participatory platforms**. The municipality should strengthen and diversify its communication channels and citizen participatory platforms. Regular ward meetings, house-to-house water campaigns/meetings, neighbourhood water watch committees, and setting up and maintaining community water learning platforms are examples of initiatives and programmes that can assist in trust building and participation. Regular and consistent communication and feedback loops can also strengthen the process of trust building. Feedback loops through participatory platforms provide a mechanism to strengthen a two-way communication between the municipality and the communities it serves. The process of community trust building also implies fostering long-term relationships with a diversity of actors and stakeholders in communities, e.g., community-based organisations (CBOs), environmental activists, community leaders, businesses, ward leaders, faith-based organisations, etc. These relationships are

intended to serve diverse purposes such as information flow and amplification, water education and awareness, neighbourhood support etc

5.3.2 Technical environment

The technical environment, which refers to the infrastructure, data, and expertise necessary to respond to the drought and to plan and implement measures, was seen as robust within the NMBM. Of particular interest is the engineering foresight that was deployed during the drought to optimize water use efficiency, to lower water pressure in pipes, and to monitor water consumption. The NMBM has developed a rather robust telemetry system, enabling it to undertake real-time, cost-efficient monitoring of the water distribution system. This effort has been recognised at the 2024 IMESA conference through a paper presented by one of the NMBM engineers. The metro's strategies in this regard become a translatable lesson with applications for other water-scarce cities facing similar circumstances.

A critical element of the technical environment is the integrity of the water supply infrastructure. The engineering design and management systems (EDAMS) proved robust not only as a means of capturing and maintaining assets, but also in tracking progress when complaints are lodged:

> *"We've got two modules on there: we've got operations and maintenance. So, whenever the consumer phones in a call, a complaint of a water leak or sewer leak or anything – that gets logged on the operations and maintenance module and for us to maintain our assets we've got the asset module which is linked to the GIS, the Geographical Information Ssystem. Which we can then attach job cards and costs and depreciation to things, so we can actually proactively say:*
>
> *Yeah, in six months' time, you must go and do the inspection on that reservoir or you must go and service that pressure reducing valve and stuff like that."*

We assessed incidences of water leaks, burst pipes, and municipal water blockages for the drought period 2020-2021. The analysis revealed that municipal pipe blockages were the most frequent, occurring more than three times as often as other reported water-related issues based on end-user complaints. Water leaks followed in frequency, while burst pipes received the fewest complaints (Figure 5.2).

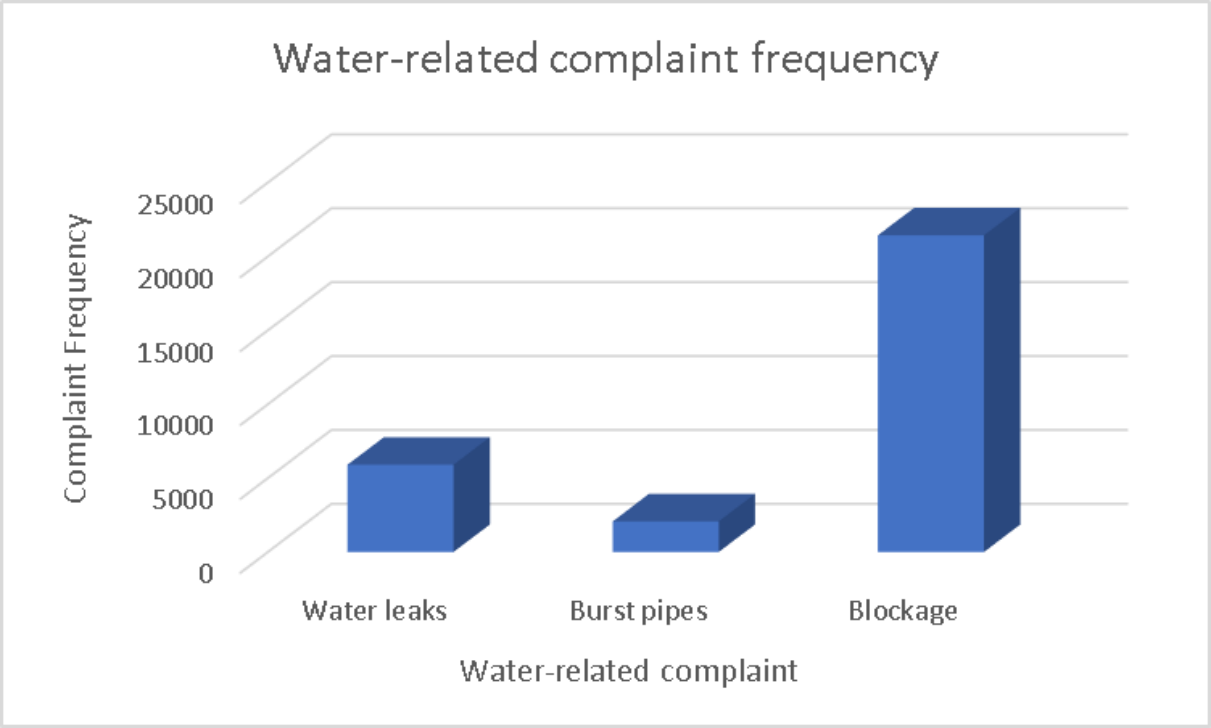

Figure 5.2: Water-related complaint frequency for the drought period 2020-2021

In terms of resolution times, approximately 46% (9,768 complaints) of reported blockages were addressed within one day. However, 6% (1,235 complaints) took over three months to resolve, and 3% (647 complaints) remained unresolved for more than six months (Figure 5.3). It should be noted that based on the data supplied to the project team, a job is considered resolved when the job call log is closed. Due to administrative reasons, jobs resolved were not always closed on the call log, and it was not possible to differentiate these from the rest in the data.

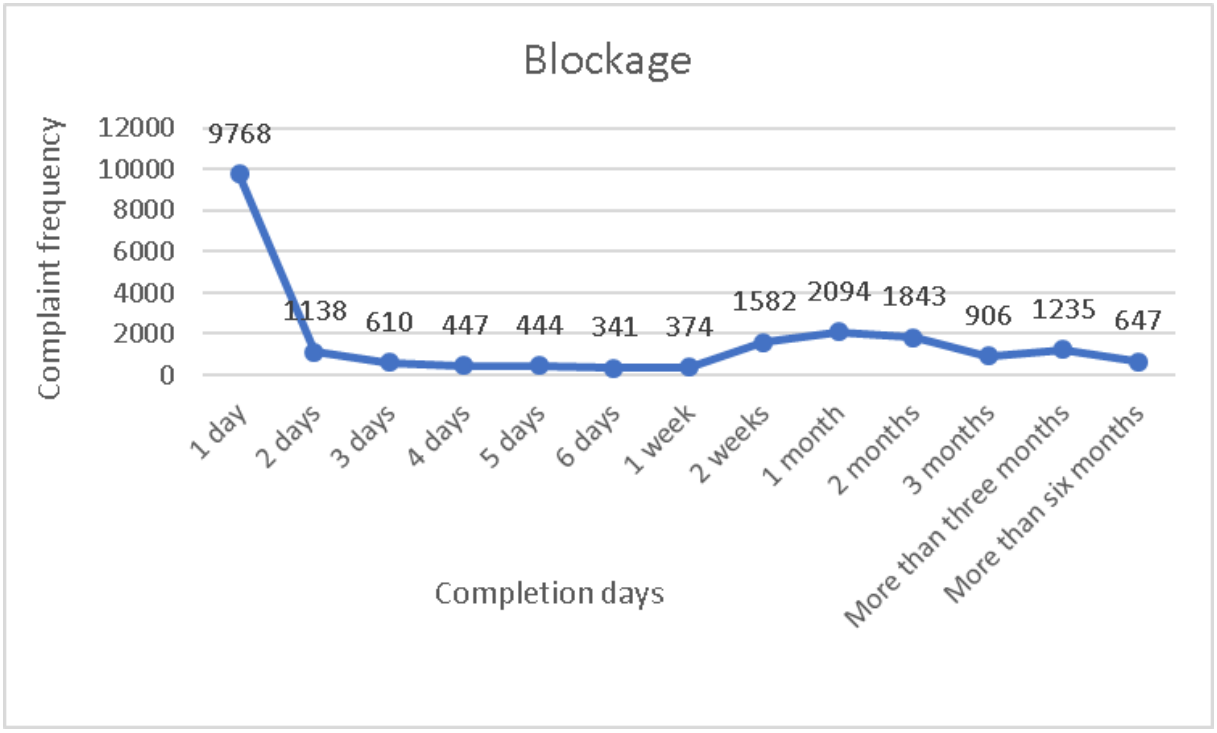

Figure 5.3: Municipal pipe water blockage complaints and resolution times for the year 2020-2021 period.

For water leaks, 7% (424 complaints) were resolved within one day. In contrast, 28% (1,630 complaints) took approximately two months to fix, and 275 cases (about 5%) remained unresolved for more than six months (Figure 5.4).

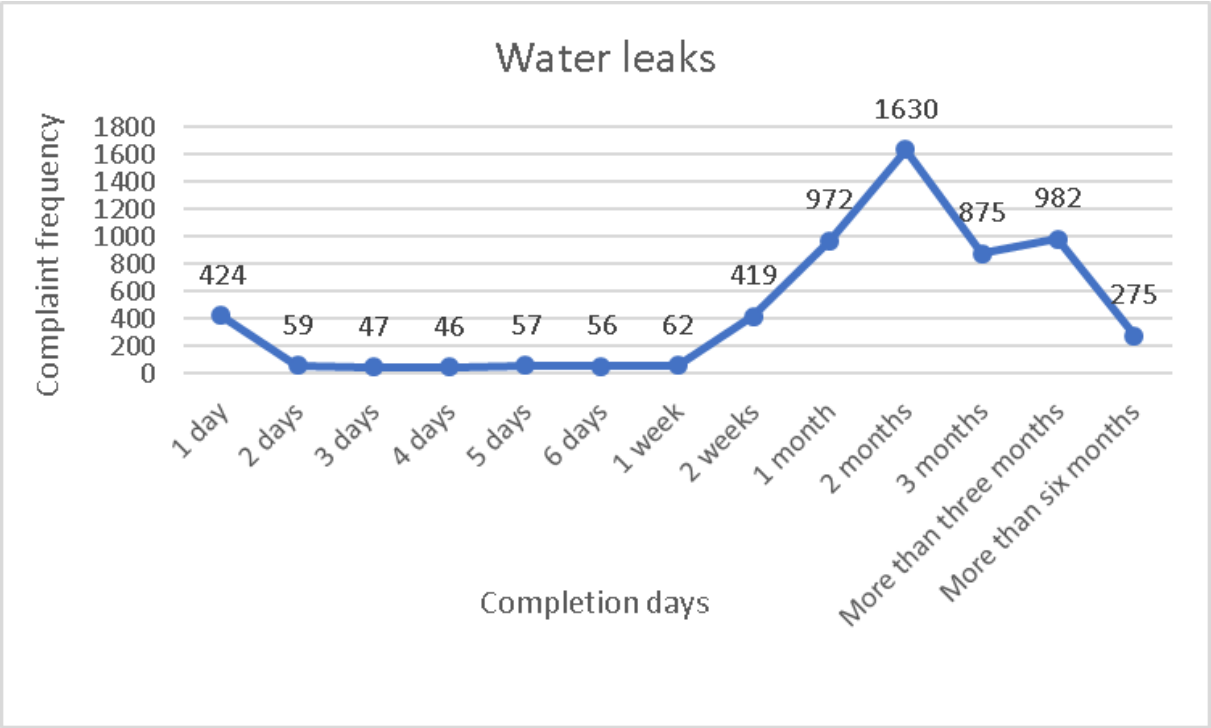

Figure 5.4: Water leaks complaints and resolution times for the year 2020-2021 period

For burst pipes, only 29% of cases were resolved within one day of reporting, while nearly 50% were addressed within one week to three months. However, 256 cases (about 12%) took more than three months to resolve, and 61 cases (about 3%) remained unresolved for over six months (Figure 5.5).

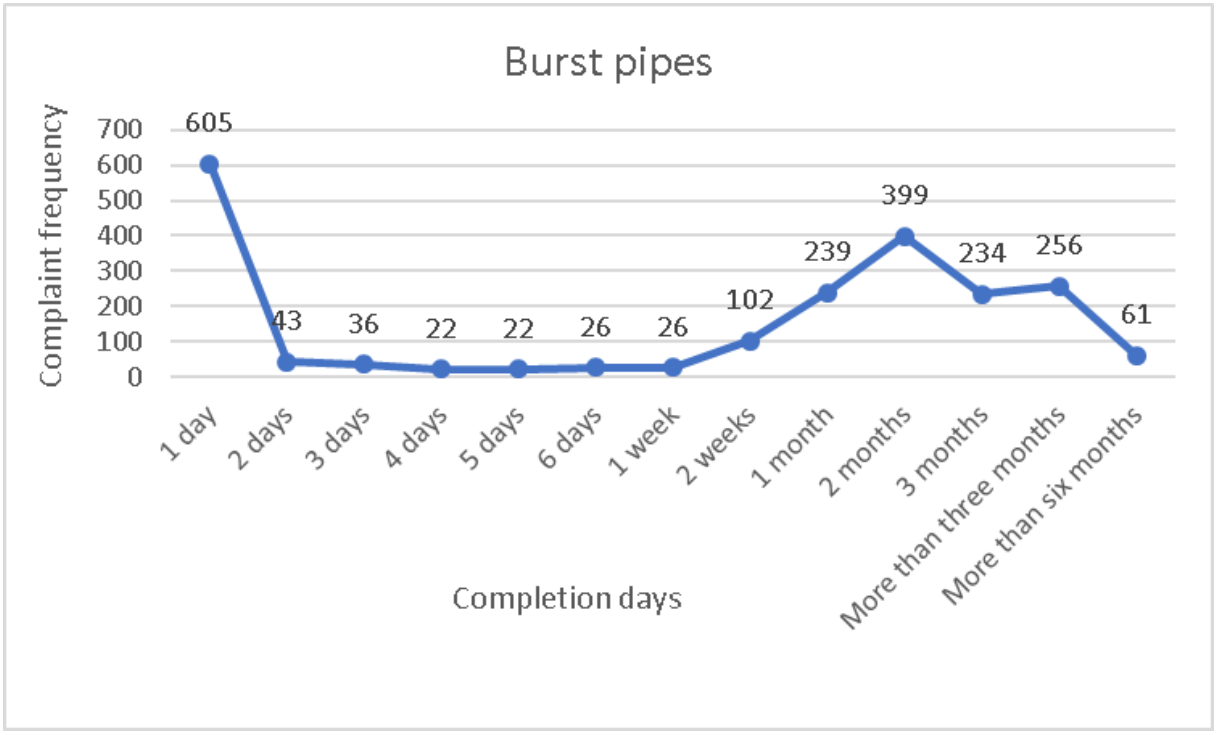

Figure 5.5: Burst pipe complaints and resolution times for the year 2020-2021 period

In summary, municipal pipe blockages had a higher percentage of cases resolved within a day compared to water leaks and burst pipes. However, a larger number of blockages (1,235 complaints) remained unresolved for more than three months, compared to water leaks (982 cases) and burst pipes (256 cases). In percentage terms, unresolved blockages represented just 5.9 % of reported cases during the period, compared to 16.6 % for water leaks and 12.4 % for burst pipes (Figures 5.6 – 5.7).

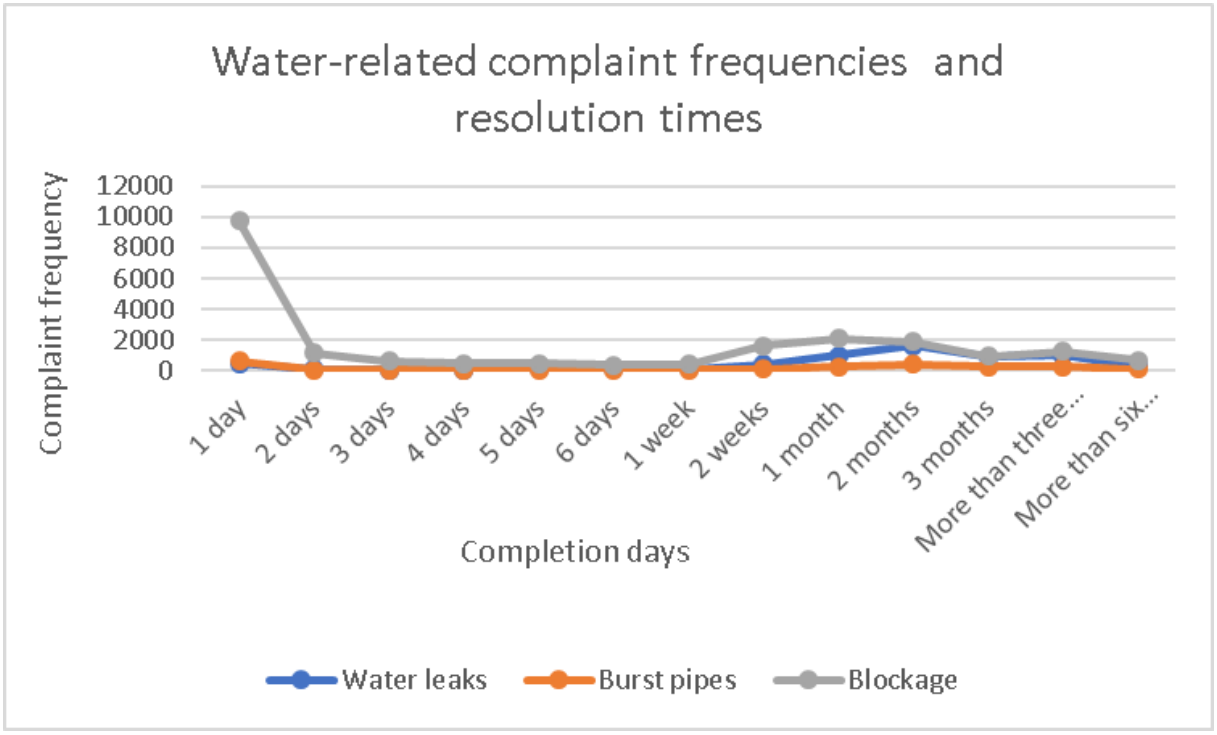

Figure 5.6: Water-related complaints and resolution times for the year 2020-2021 period

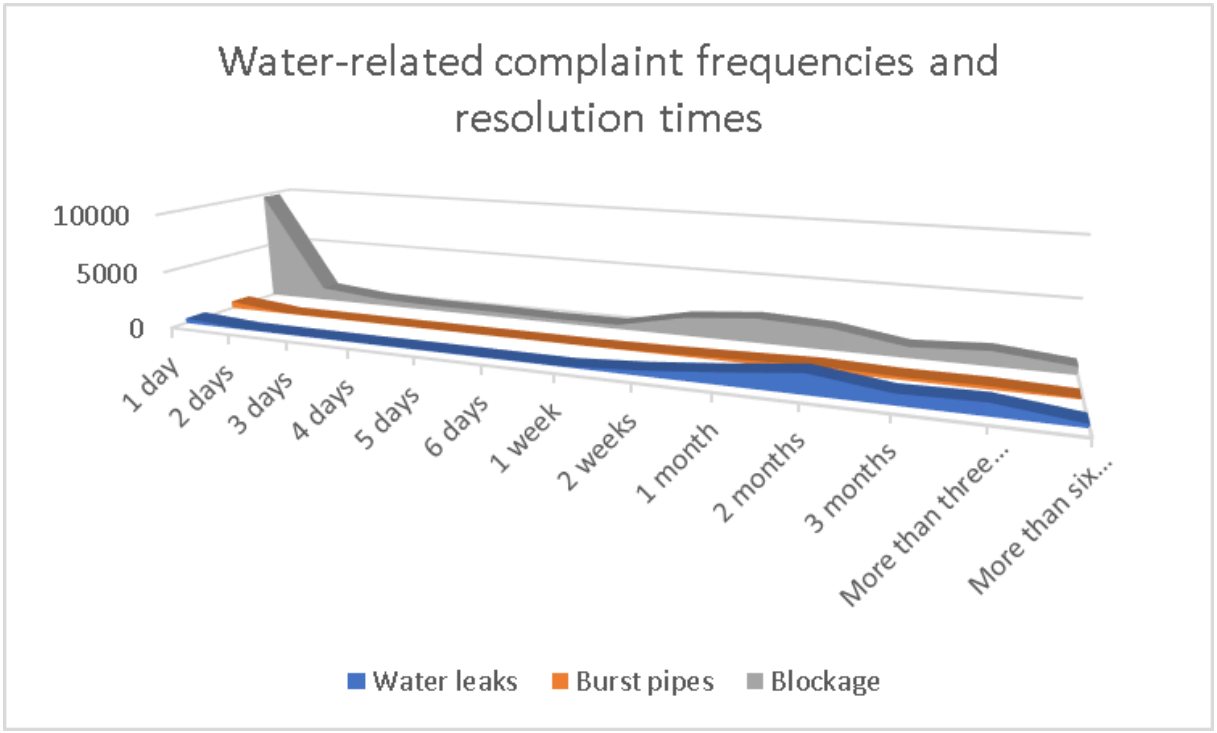

Figure 5.7: Water-related complaints and resolution times for the year 2020-2021 period

The NMBM appears to be operating within an environment with high levels of theft of water and electrical infrastructure and equipment – especially copper and other metal pipes and fittings. Vandalism and theft are common occurrences within the metro, and during the drought, these did not abate:

> *"Theft and vandalism have compromised us a lot. We are spending millions of Rands, especially during the drought, protecting especially our critical water installations, so that we could keep the water going."*

Key lessons:

1. **Strengthen efficiency and maintain water infrastructure**. There is a need to improve the response time to community complaints regarding leaks, blockages and burst pipes. This can be achieved by developing and implementing a community-driven approach that allows rapid reporting of such leaks, etc, and real-time feedback to the complainant when the issue has been resolved.
2. **Invest in data and expertise**: Expertise in complex data analytics, climate and scenarios modelling, GIS and spatial analysis, machine learning, predictive science, asset management, financial and project management, as well as continuous investment in engineering and hydrological sciences are all critical areas to invest in to strengthen the technical environment within the NMBM. Expertise in foresight and futures thinking methods, such as horizon scanning, Delphi method, causal layered analysis, back casting, vulnerability mapping, participatory foresight, modelling, trend analysis, historical analogy, etc are needed to strengthen the municipal preparedness for future water crisis. Regular community surveys on the perceptions of water services delivery can assist in strengthening service delivery and taking proactive actions based on community feedback.
3. **Secure critical water assets and infrastructure to ensure their integrity.** Vandalism and theft remain a major problem within the Metro. Investing in a community-driven neighbourhood water infrastructure security programme is urgently needed to curb the incidences of theft and vandalism of critical water assets. The municipality should consider emerging technologies, such as drones, which have proved effective elsewhere. The municipal bylaws relating to theft and vandalism of critical municipal assets should be strengthened for maximum allowable punishment. Community-driven systems and initiatives for rapid reporting of incidents of vandalism and theft cases can contribute to

addressing this perennial problem. Such an initiative should also include a way of documenting evidence for prosecution.

5.3.3 Economic environment (with an emphasis on financial)

The financial environment plays an important role in the capacity of the NMBM to respond to the drought. The total annual expenditure saw a sharp and sustained increase starting in 2016/2017, coinciding with the onset of the drought, and continuing through 2018/2019 (Figure 5.8). However, in 2019/2020, the expenditure experienced a significant decline, falling to just above its pre-drought levels. Between 2019/2020 and 2025/2026, the capital expenditure remained relatively stable, with only slight increases and decreases observed throughout the period. Notably, the rise in the annual expenditure during the 2016/2017 fiscal year was more than three times higher than the levels in the years preceding the drought.

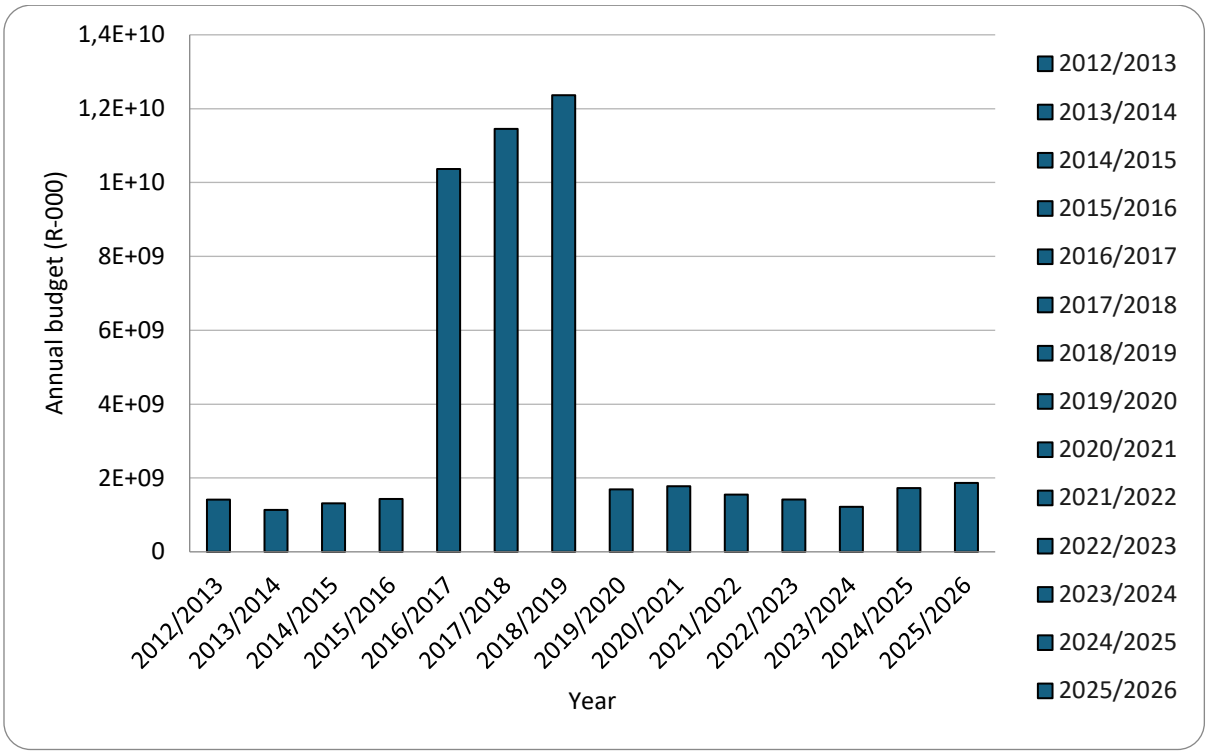

Figure 5.8: Total capital expenditure for the fiscal years 2012/2013-2025/2026

The annual water expenditure experienced a sharp and sustained increase starting in 2016/2017, coinciding with the onset of the drought, and continuing through 2018/2019 (Figure 5.9).

However, in 2019/2020, the expenditure saw a significant decline, dropping to just above its pre-drought levels. From 2019/2020 to 2025/2026, the expenditure fluctuated, with a steady rise in 2020/2021 and 2021/2022, followed by a decrease in 2022/2023 and 2023/2024. In 2024/2025 and 2025/2026, it increased by more than a 100% from the level in 2022/2023 and 2023/2024. Notably, the rise in the annual water expenditure during the 2016/2017 fiscal year was more than three times higher than the levels observed in the years before the drought.

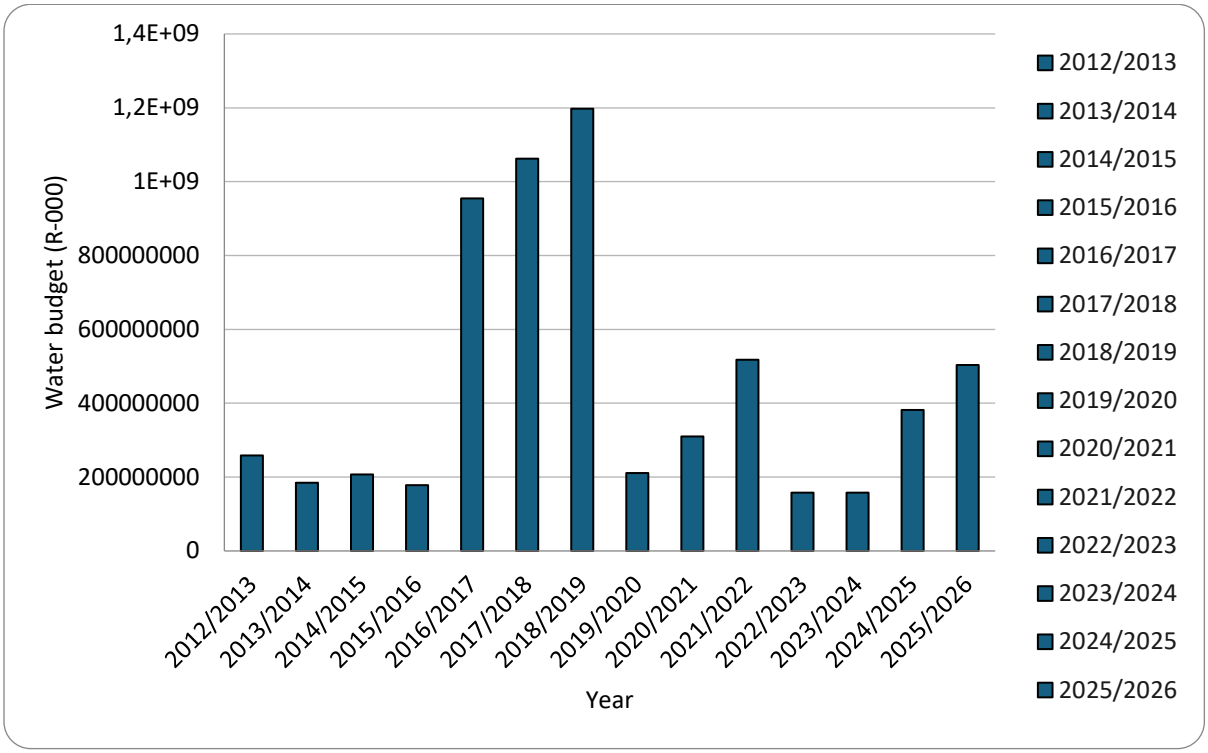

Figure 5.9: Annual water expenditure for the fiscal years 2012/2013-2025/2026

Despite the increase in the overall capital expenditure at the onset of the drought in 2016/2017, there was no corresponding rise in the percentage of water expenditure relative to the total capital expenditure. From 2016/2017 to 2018/2019, the percentage of water expenditure as part of the total capital expenditure was the lowest across all fiscal years from 2012/2013 to 2025/2026 (Figure 5.10).

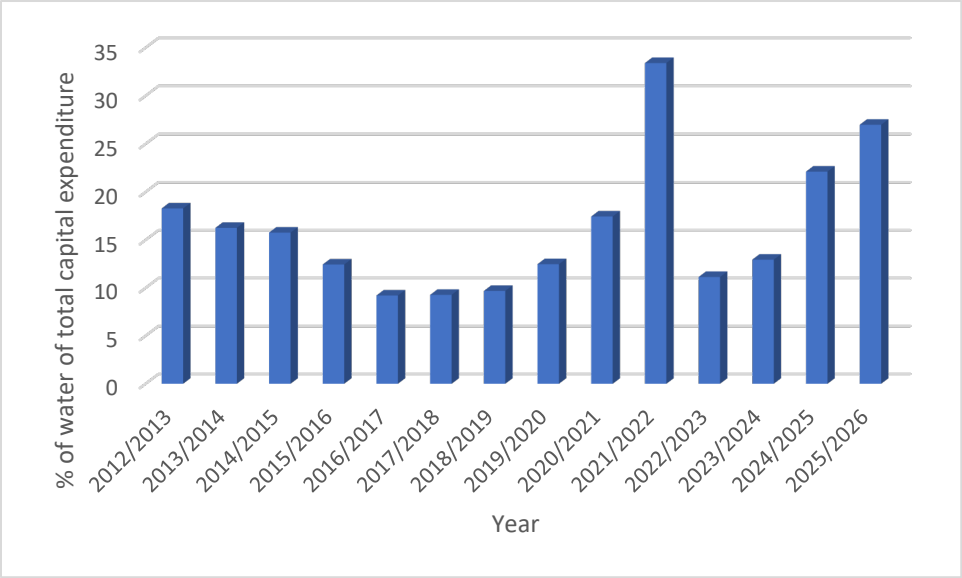

Figure 5.10: Percentage of the annual water expenditure as a percentage of the total capital expenditure for the fiscal years 2012/2013-2025/2026.

Regarding improvements on stormwater infrastructure, expenditure on stormwater infrastructure improvements showed a gradual increase from 2020/2021, peaking in 2022/2023, followed by a steady decline in subsequent years (Figure 5.11). When compared to the annual budget for each year, the percentage spent on infrastructure improvements remained consistently below 0.001% from 2020/2021 to 2025/2026. This percentage was notably lower compared to the years before 2020/2021 (2012/2013 to 2019/2020). The data indicates a reduction in the annual capital expenditure for infrastructure improvements in recent years. More monetary expenditure was made in the 2015/2016 fiscal year for infrastructural improvement, representing more than 7 % of the total annual capital expenditure (Figure 5.12).

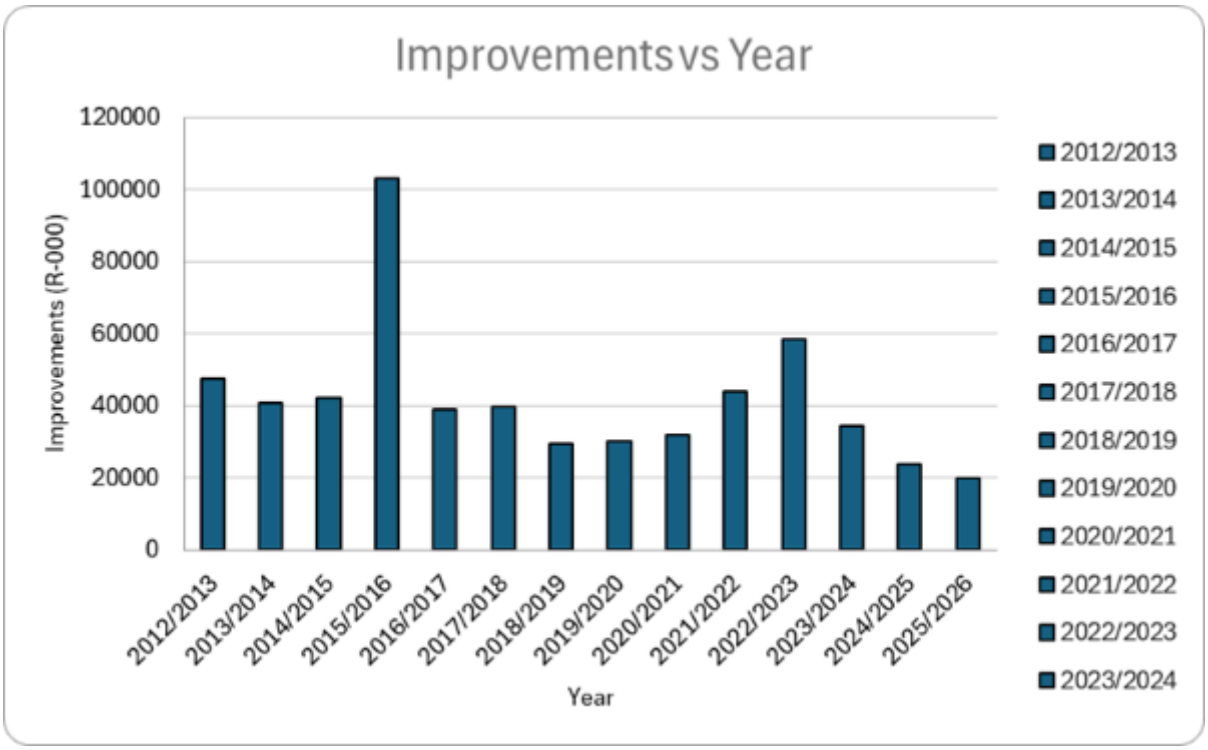

Figure 5.11: Expenditure on the enhancement of Stormwater Infrastructures for fiscal years 2012/2013-2025/2026

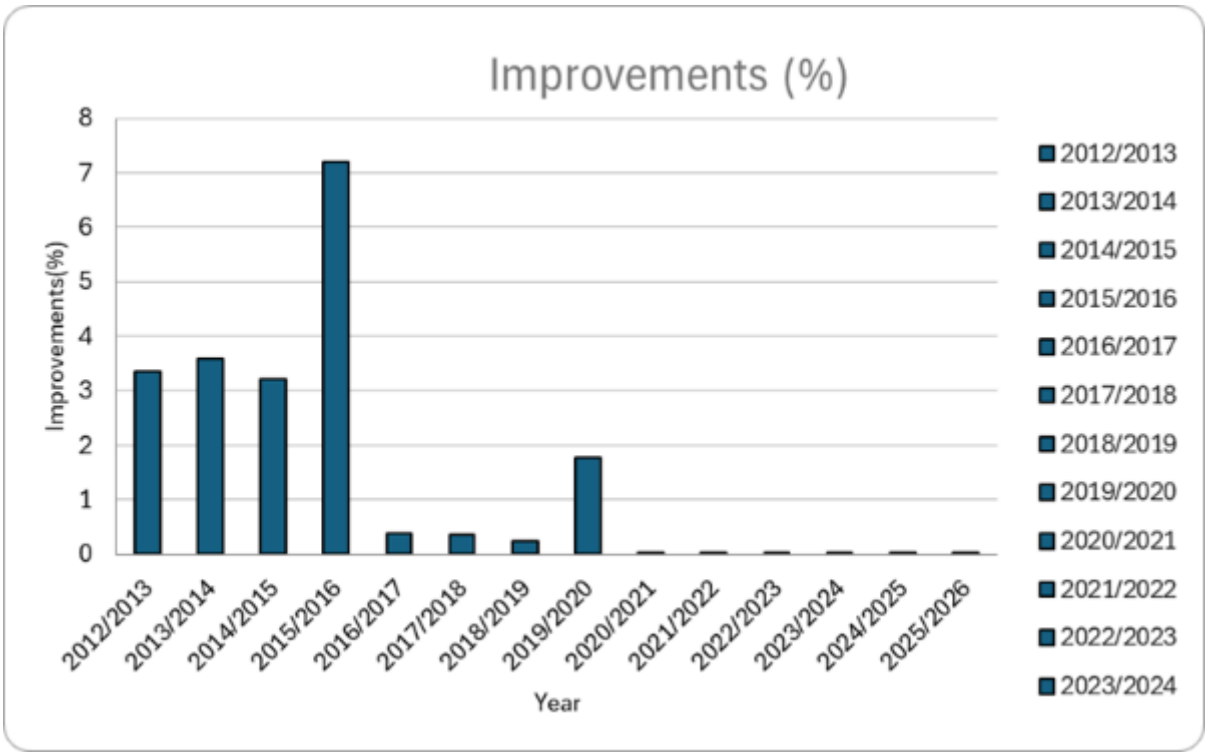

Figure 5.12: Percentage expended on the enhancement of stormwater infrastructures as part of the annual capital expenditure for the fiscal years 2012/2013-2025/2026.

The expenditure on stormwater infrastructure construction for the fiscal years 2012/2013 and 2013/2014 was more than three times greater than that in the subsequent years, indicating a significant decline in the construction of new stormwater infrastructure from 2014/2015 to the present (Figure 5.13). Between 2012 and 2014, there was an urgent need for the metro to strengthen water security by upgrading the aging infrastructure and the failing systems. This action was meant to build resilience against severe weather conditions and drought(NMBM, 2015). Furthermore, the percentage of the annual expenditure on stormwater infrastructure construction has been consistently below 1% from 2014/2015 to 2025/2026, compared to the much higher levels in 2012/2013 and 2013/2014 (Figure 5.14).

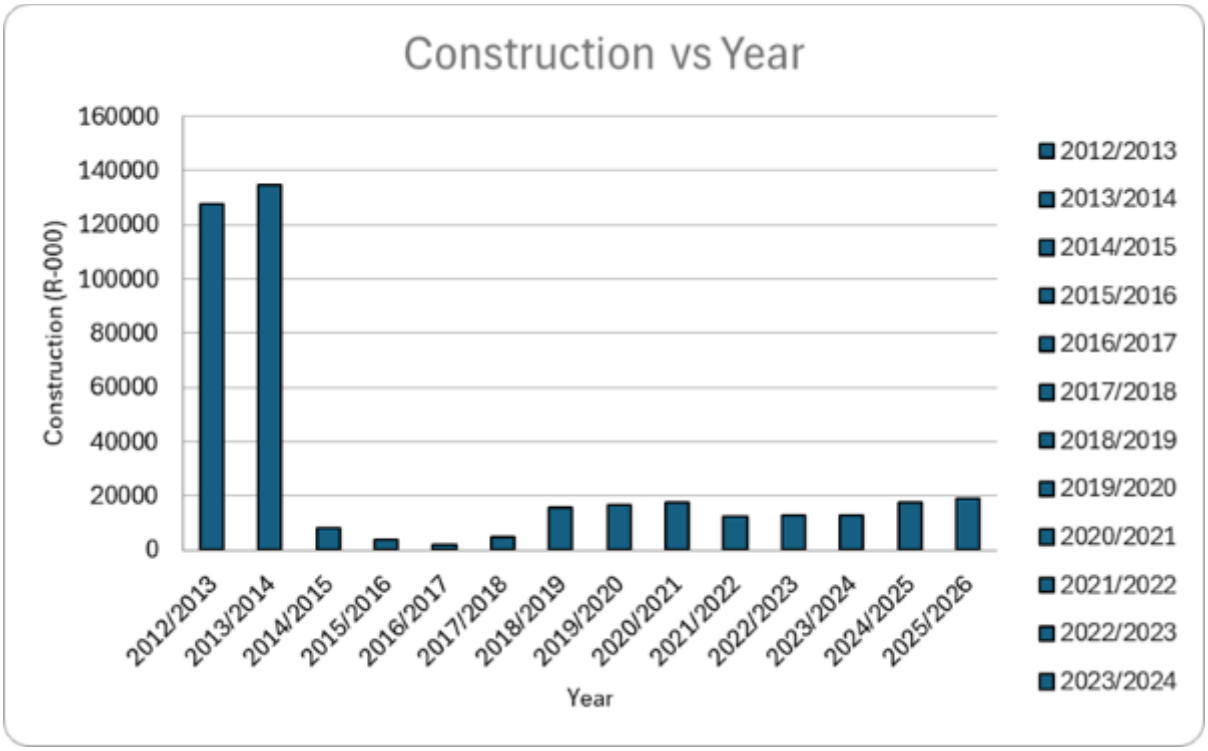

Figure 5.13: Expenditure on the construction of stormwater infrastructures for fiscal years 2012/2013-2025/2026

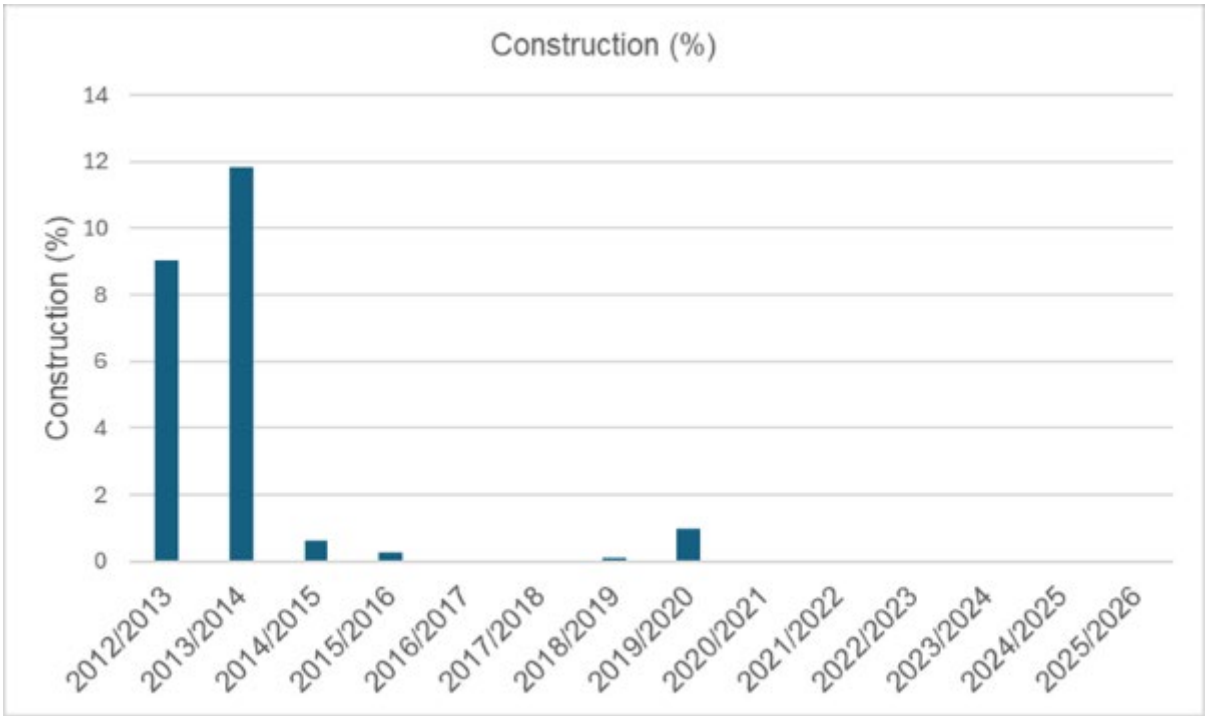

Figure 5.14: Percentage expended on the construction of stormwater infrastructures as part of the annual budget for the fiscal years 2012/2013-2025/2026

Expenditure for the repair and maintenance of water supply infrastructure steadily increased from the 2020/2021 fiscal year through to 2025/2026. The highest expenditure occurred in the 2017/2018 fiscal year, while the lowest amounts were recorded in the 2018/2019 and 2019/2020 fiscal years (Figure 5.15).

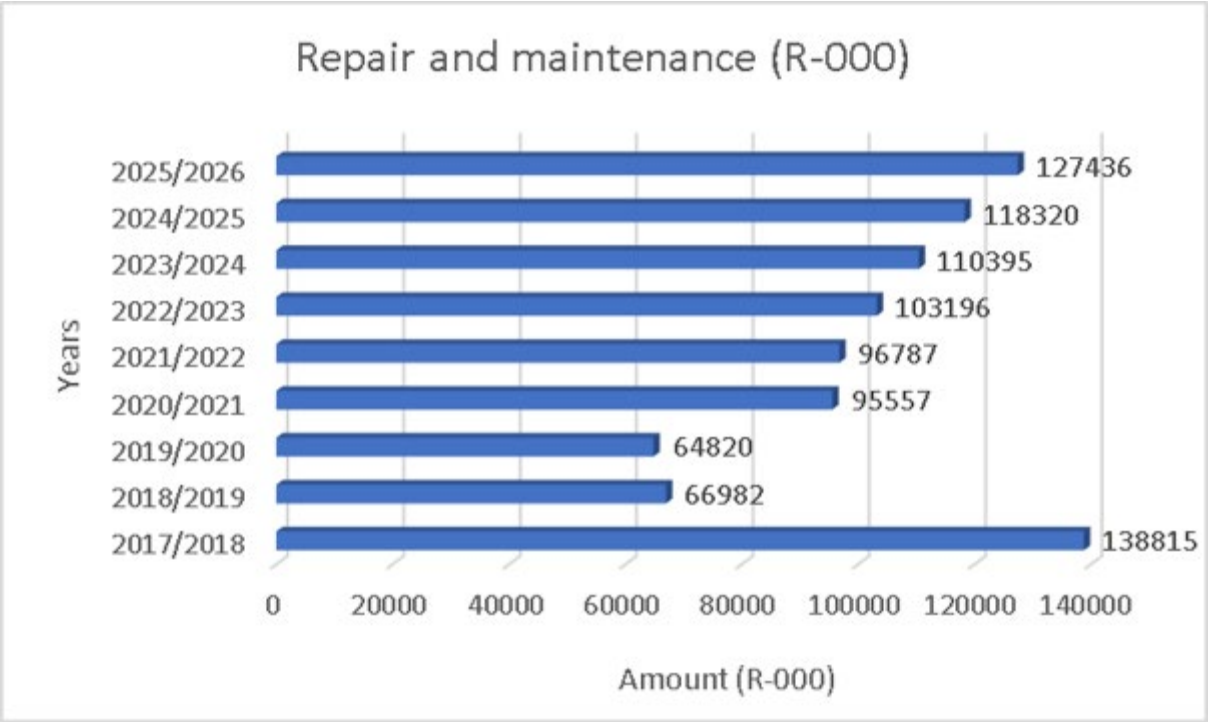

Figure 5.15: Expenditure on the repair and maintenance of water supply infrastructures for fiscal years 2017/2018-2025/2026.

From 2019/2020 to 2025/2026, pump stations and distribution received the highest monetary allocations for repair and maintenance, while dams and weirs, as well as reservoirs, received the lowest allocations during the same period. Both bulk mains and water treatment works had higher monetary allocations compared to dams and weirs, and reservoirs. However, in 2017/2018 and 2018/2019, water treatment works and distribution saw the highest expenditure for repairs and maintenance, surpassing other categories (Figure 5.16). Dams and weirs, along with reservoirs, consistently received the lowest expenditures throughout the entire period under review (2017/2018-2025/2026).

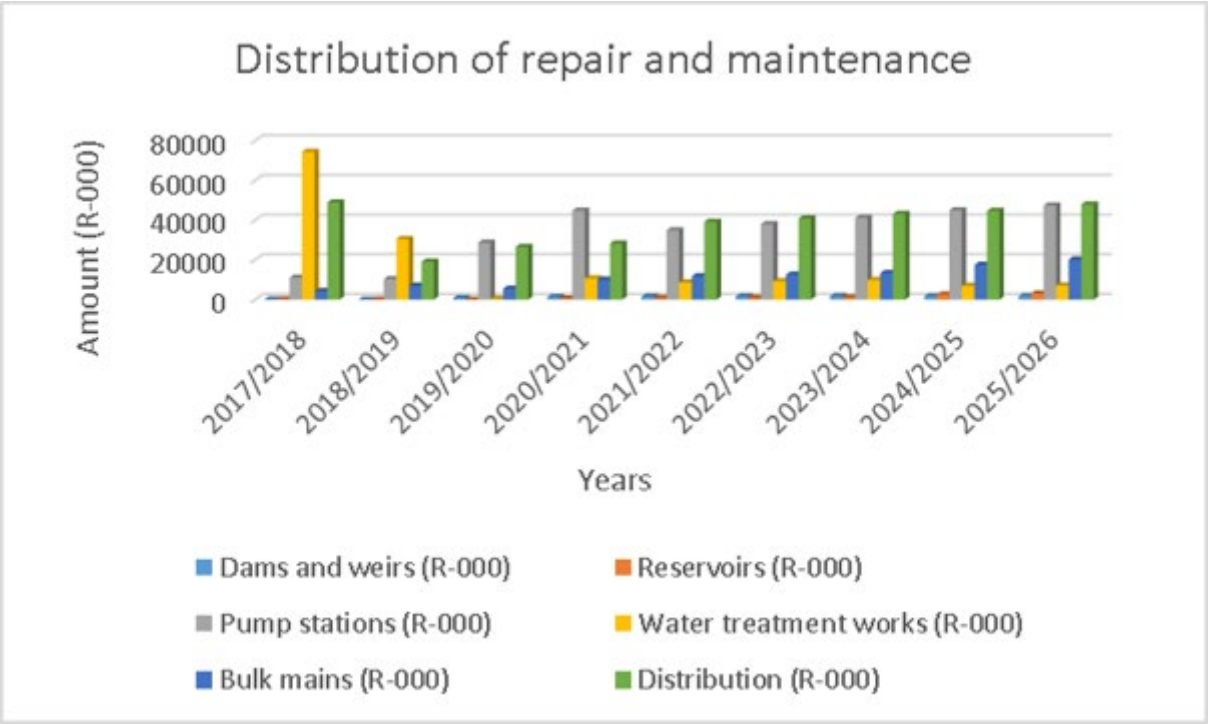

Figure 5.16: Expenditure on the repair and maintenance of water supply infrastructures for the fiscal years 2017/2018 to 2025/2026, broken down by category of infrastructure repaired and maintained.

The amount expended on the repair and maintenance of water supply infrastructure generally accounted for less than 0.5% of the total capital expenditure in most years, with the exception of 2017/2018 and 2019/2020, during which the expenditure percentages exceeded 0.5% of the annual capital expenditure (Figure 5.17).

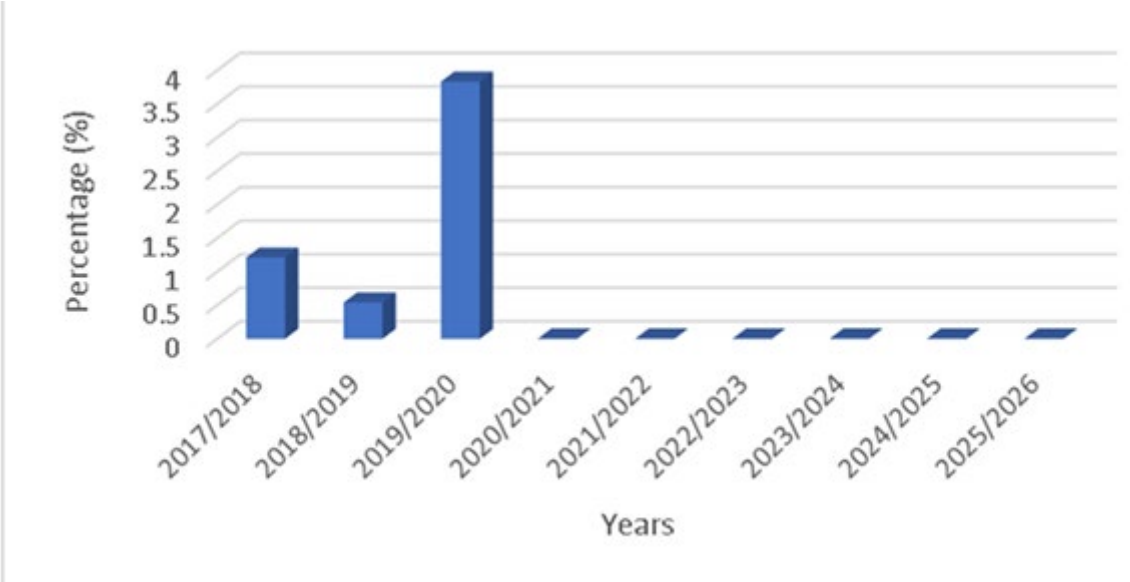

Figure 5.17: Percentage expended on the repair and maintenance of water supply infrastructures as part of the annual capital expenditure for the fiscal years 2017/2018-2025/2026.

Regarding revenue and expenditure, revenues and capital expenditure for wastewater management have remained constrained over the fiscal years under study (Figure 5.18) when compared with the total revenue and total capital expenditure for the same period, which have followed a steady growth trajectory. The anomaly in 2012/2013, with lower total expenditure, highlights a unique fiscal event that deviates from the general trend.

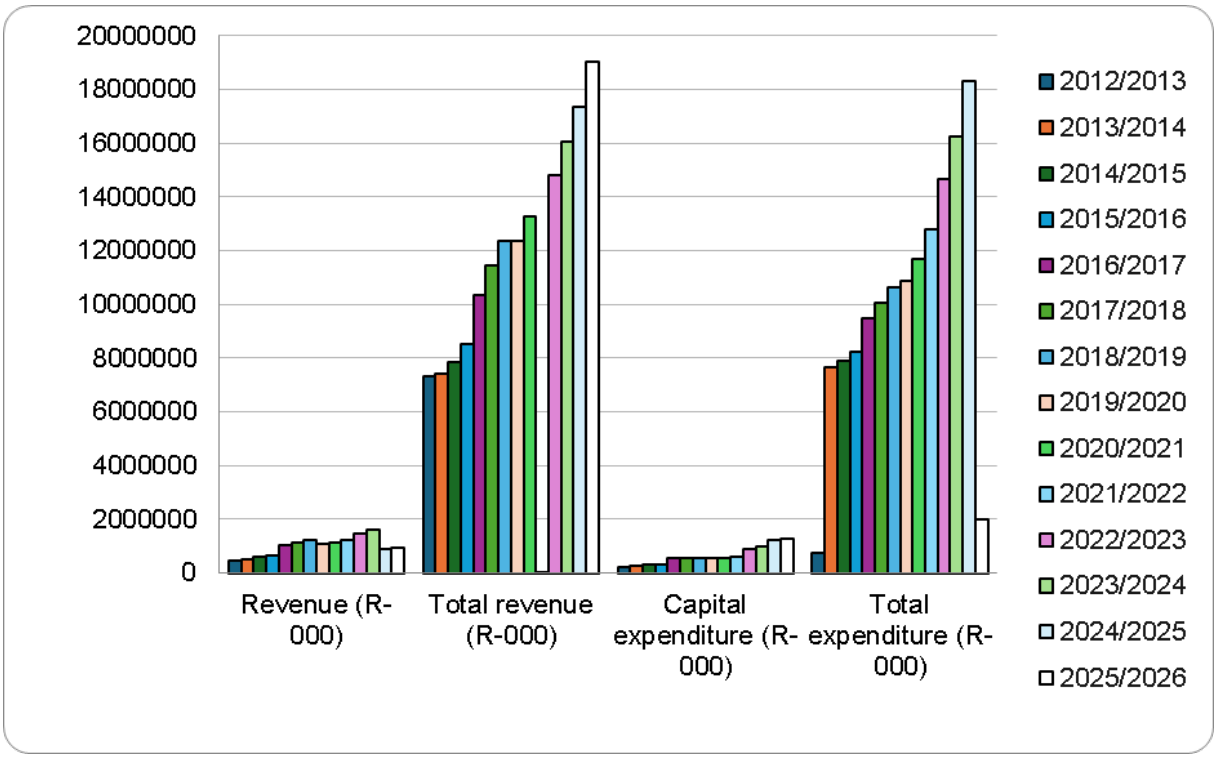

Figure 5.18: Overview of Fiscal Trends in Wastewater Management (Fiscal Years 2012/2013 to 2025/2026).

Debt impairment remained steady from 2012/2013 until 2019/2020, when it experienced a slight increase. This upward trend in debt impairment continued steadily from 2019/2020 through to 2025/2026. In parallel, total expenditure showed a consistent increase from 2012/2013 to 2016/2017, followed by a sharp decline in 2017/2018. However, total expenditure surged dramatically in 2018/2019 and continued to rise steadily from that point until 2025/2026 (Figure 5.19). Notably, the sustained rise in debt impairment from 2019/2020 to 2025/2026 coincided with a corresponding steady increase in total expenditure.

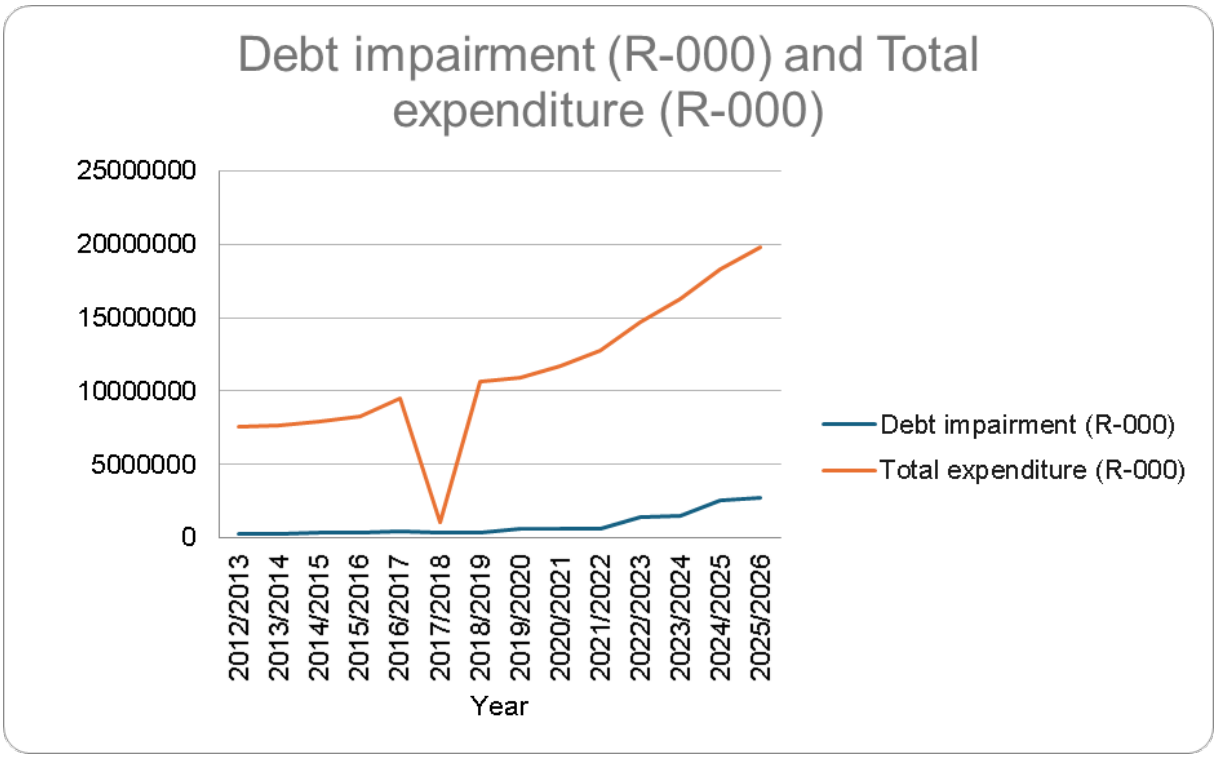

Figure 5.19: Comparison of total expenditure and debt impairment (2012/2013 to 2025/2026 financial year).

The equitable share increased from 2012/2013 to 2025/2026 (Figure 5.20). The increases were particularly pronounced during the drought period, reflecting increased financial commitment to the ATTP of the municipality within this period.

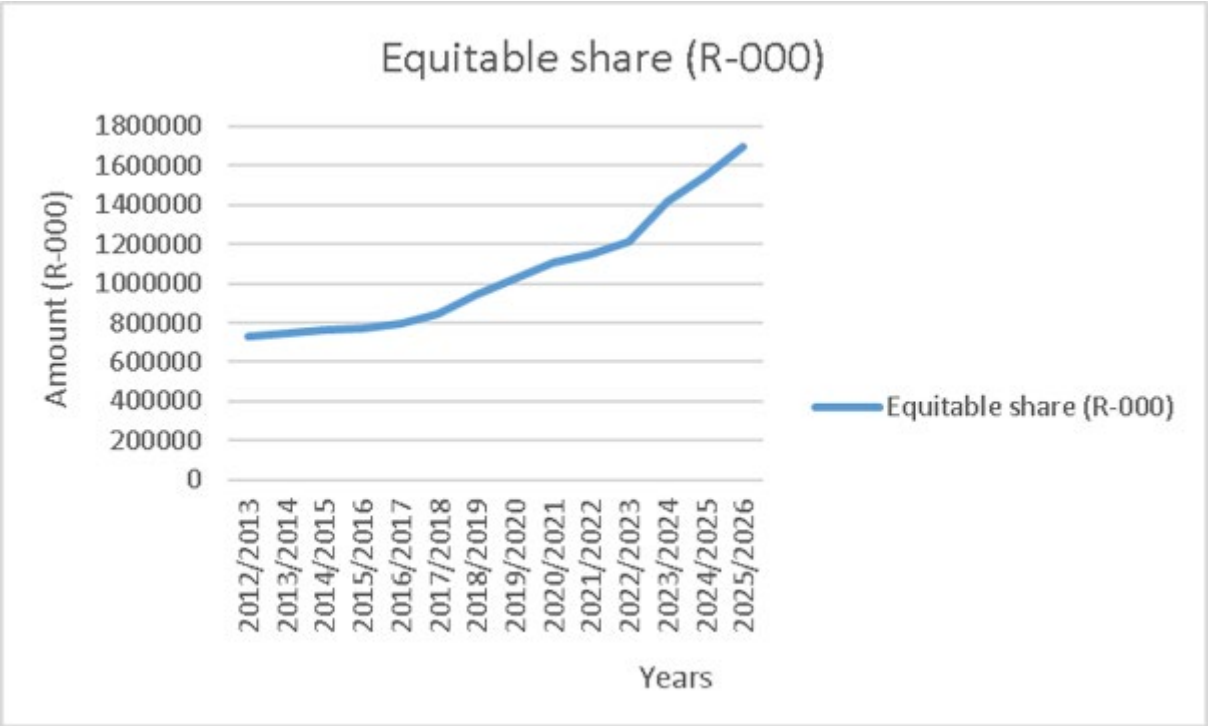

Figure 5.20: Equitable share 2012/2013-2025/2026.

The water sector revenue trends showed that revenues generated saw modest increases between 2012/2013 and 2021/2022. However, the revenue generated in 2022/2023 and 2023/2024 was notably higher than in previous years, though it was only about half of the revenue generated in 2024/2025 and 2025/2026 (Figure 5.21).

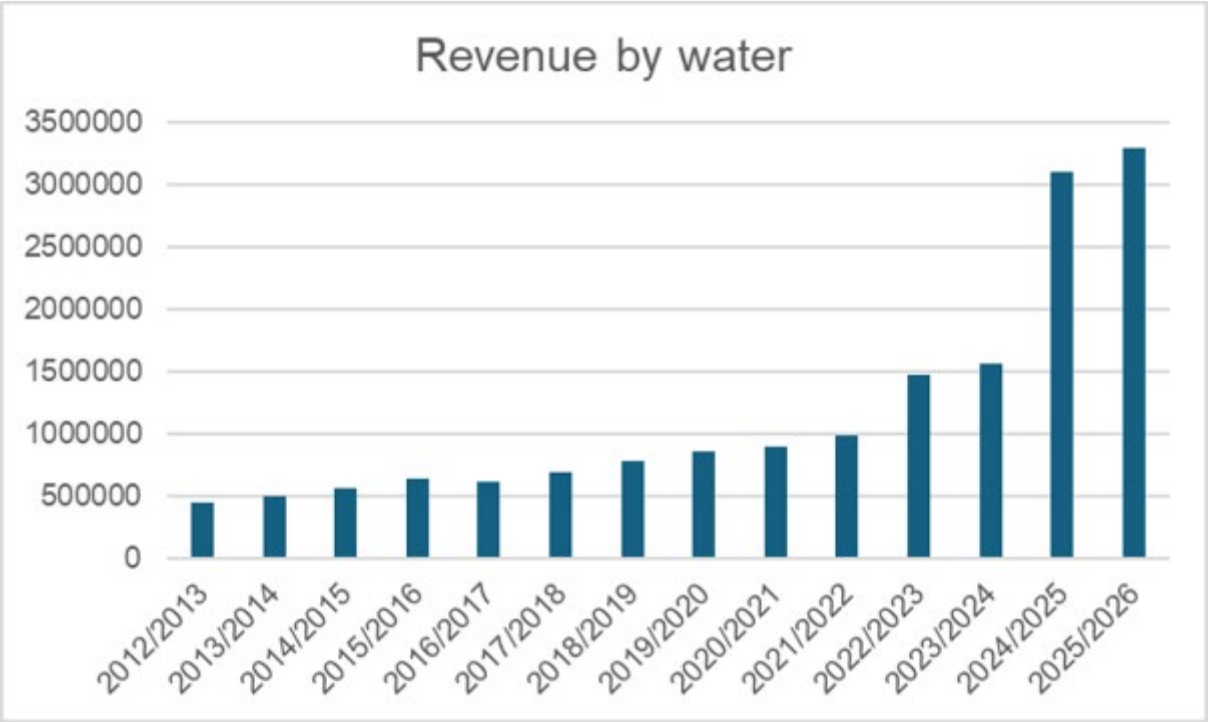

Figure 5.21: Revenue generated by the water sector (2012/2013-2025/2026 financial year).

In contrast to revenues generated by the water sector, total revenues generated within the study period grew steadily on year to year from 2012/2013 to 2025/2026 except in years 2018/2019 and 2019/2020 where the total revenue generated was almost the same (Fig 5.22).

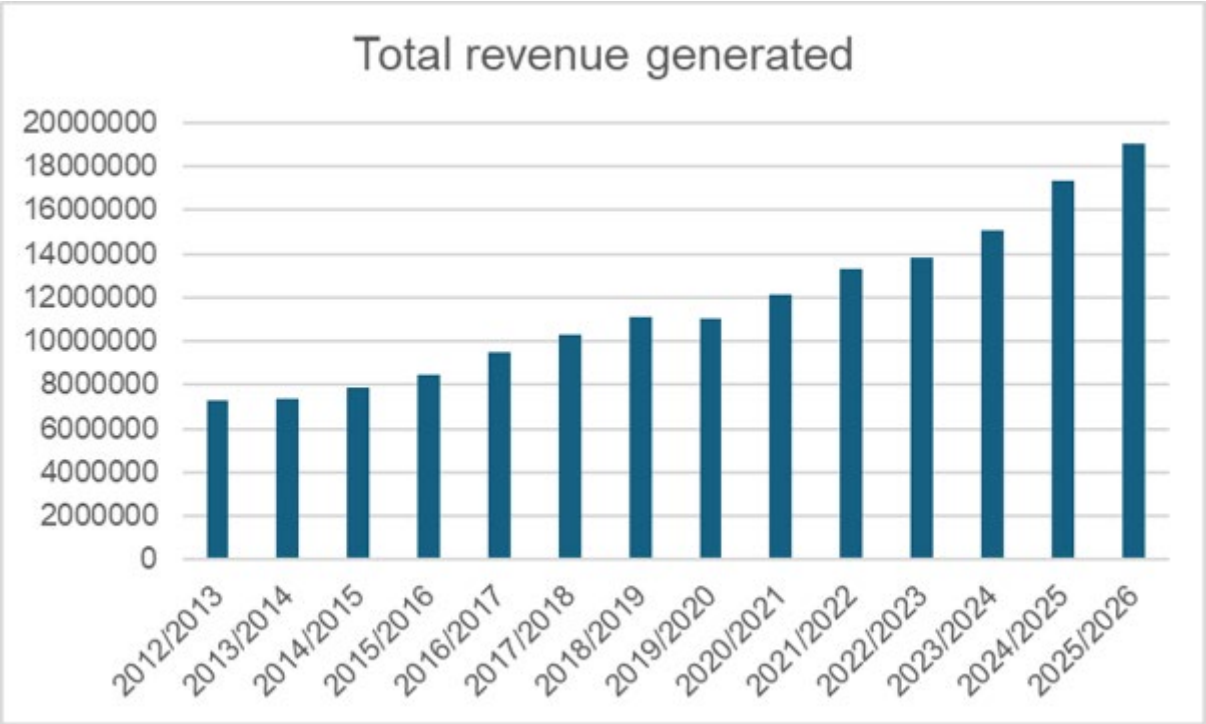

Figure 5.22: Fiscal trends of total revenues generated (2012/2013-2025/2026 financial year).

Comparatively, increases in revenues generated by the water sector influenced total revenue generated. This influence was more visible in 2024/2025 and 2025/2026 (Figure 5.23). Notably, within the Metro, ring fencing of water revenue for water expenditure is lacking with the water sector relying mostly on grants from the National Treasury.

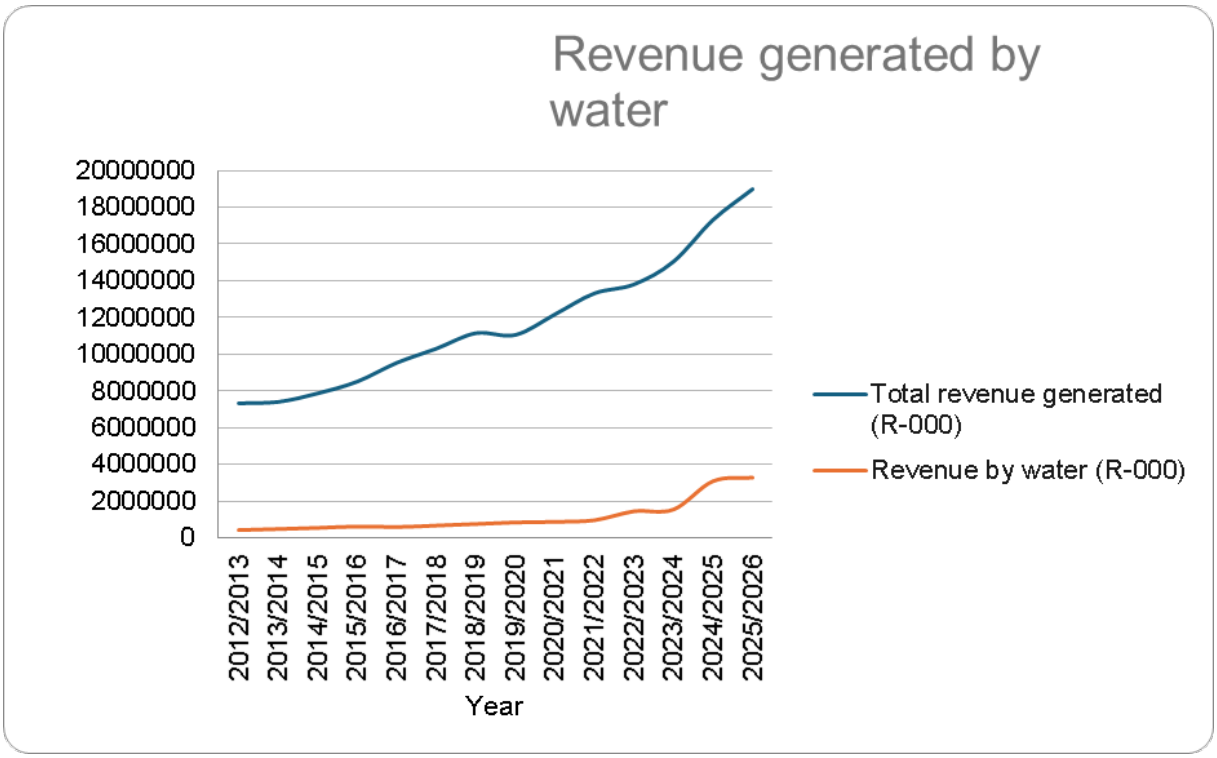

Figure 5.23: Comparisons of fiscal trends in total revenues and revenues generated by the water sector (2012/2013-2025/2026).

An important difference between the NNMB and other similar metros, such as eThekwini and City of Johannesburg, is that the NMBM is both a bulk water services provider and a distributor. In the other cities, there are dedicated bulk water services providers such as Rand Water and Umgeni Water. While these bulk water services providers enjoy financial autonomy, this is not the case for the Directorate that provides both services within the NMBM. There are concerns that not enough financial resources are being allocated to water and sanitation services, despite the tariffs collected in lieu of these services and there were suggestions of a new institution, such as a water board:

> *"Because we are a water service authority in Port Elizabeth and we are also a water services provider, we provide the bulk water and we also provide the distribution and the management, or the maintenance of the distribution system within the city, unlike Durban or Joburg, which has Rand water or Umgeni water, who give the bulk water (to those cities), we do both. The thing that hampers us the most in Nelson Mandela Bay is that we need to be a water board on our own."*

*"If that happened (*being a water board*), that would allow us to have access to our own funding, it would be ring-fenced. At the moment now, whatever we collect from tariffs does not feed directly back into us 100%."*

"We are underfunded every year. So, if we were a water board, that would assist us, then whatever we charge, you pay us and then that's what we have. Then if we had that we could employ our own staff, and run our own programs - as opposed to relying on our human resources department, who don't have staff, and they haven't got practitioners to employ people".

Key lessons:

1. **Ensure adequate financial resources to diversify the Metro water sources, maintain water infrastructure, and improve demand management**. The water source diversification effort (e.g., groundwater sources) of the municipality contributed enormously to addressing the water crisis, and this effort must be sustained. A desalination feasibility study has been carried out; this now needs to be implemented, potentially within the framework of a public-private partnership, considering the growing water demand within the Coega industrial development complex. There is enormous potential for effluent re-use within the Metro, yet this has not received the attention it deserves, especially for non-portable uses. Financial investment in this regard is needed. The improvement recorded during the drought on infrastructure maintenance, upgrading across the entire water value chain, must be sustained and this requires ongoing sufficient budgetary allocation.
2. **Strengthen financial accountability and the procurement system**: A key lesson during the drought is the intersection between the procurement system and technical interventions. In many instances, delays in the procurement system mean that technical interventions had to be put on hold for longer than necessary or anticipated. The procurement system needs to be strengthened to respond more rapidly to technical requests while remaining legally compliant. Strengthening horizontal integration and interactions between divisions should assist in this regard. Financial ring-fencing for water services should provide some degree of autonomy to rapidly respond to emergency situations. Ring-fencing must be accompanied by strengthened accountability measures, such as clearly defining when ring-fenced funds can be used and the authorisation process.

3. **Set aside adequate financial resources to support the most vulnerable, while paying attention to those just above the poverty borderline.** A key lesson from the study is that the municipal ATTP plays an important role in alleviating the burden of the water services crisis during the drought. The study has also indicated that the burden fell most on those who are just above the borderline of the ATTP. Setting aside financial resources to support this programme into the future is an important equity matter. Investments should also go into awareness and campaign to encourage and support qualifying households who have not enrolled to do so.
4. **Implement systems for efficient collection of water services tariffs and cost recovery**. The growing number of unpaid water service bills among household water consumers is a concern. The municipality must maintain a consistent aggressive posture towards debt and cost recovery, and this must be complemented by regular audits of water metres and customer accounts, ensuring the accuracy of these.

5.3.4 Ecological environment

The NMBM operates within an ecological environment where part of its water supply comes from within its catchment and the remainder comes from further afield, through an inter-basin transfer scheme. The western system relies on water from the Churchill, Impofu and Kouga dams. These dams have a combined capacity of 167 ML/day. The eastern system relies on water from the Gariep Dam via the Orange-Great Fish-Lower Sundays River inter-basin transfer scheme. These eastern systems supply 210 ML/day to the NMBM. The central system, a rather small one, supplies 27 ML/day when not restricted, and it consists of the Sand, Bulk, Van Staden and Groendal dams as well as the Uitenhage Springs.

At the peak of the drought in 2021/2022, dam levels were very low, and those on the western side were severely impacted, operating at a capacity of only 13.17%, declining to 9.98% by 21 July 2021. This natural-capital constraint environment influenced some of the measures put in place by the municipality. These measures, which have been discussed extensively earlier in this report, can be summed up as follows: 1) supply efficiency and optimisation (e.g., upgrading barges, backwash water recovery, upgrading of supply sources), 2) diversifying and augmenting supply sources (e.g., groundwater exploitation, desalination and effluent reuse). These measures were largely effective, extending the water supply within the Metro.

During the drought, coordination between the municipality and the Department of Water and Sanitation was critical. Coordination ensures that abstraction restrictions are imposed considering infrastructure sustainability. For example, at the peak of the drought, the DWS imposed further abstraction restrictions on the western supply scheme. For example, under unrestricted conditions, NNBM can abstract 354.73 ML/day, but by April 2022, this was limited to 271.8 ML/day due to restrictions imposed by the DWS. Although municipal officials understand the importance of these restrictions, some were of the view that they were imposed in ways that further compounded the municipal efforts aimed at addressing the drought.

The configuration of the water supply systems in the NMBM is unique from the perspective of equitable share. The eastern supply scheme is located near historically disadvantaged communities – this unique configuration means that these communities are served water first before it gets delivered to the more affluent communities on the western side.

Key lessons:

1. **Diversify water sources and proactively plan**. The eastern supply system and the groundwater supply systems on the western side of the metro water scheme proved critical during the drought. This implies that there is an urgent need to keep diversifying the water sources within the Metro – e.g., through desalination and effluent re-use.
2. **Take a systems approach to physical planning and infrastructure integration**. A key lesson was that a system and integrative approach was fundamental to assuring water security within the Metro. Such an approach ensures that preventive measures are in place across the entire water value chain. This is critical as the Metro plays the role of bulk water services provider, and that of distribution and supply.
3. **Maintain water sources and ecological infrastructure in good condition**. The entire western side depends on water resources within the catchment. The viability of these sources and their potential to support future demands depends on maintaining critical ecological infrastructure in good condition. These include clearing of alien invasive species, maintaining the wetlands and rivers within the metro in good ecological condition as well as groundwater recharge. Some of these interventions call for multi-level collaboration between the Department of Water and Sanitation and the Metro. These multilevel collaborations should be proactively pursued.

5.3.5 Political and governance environment

The political and governance environment is critical during times of emergency as this impact on the efficiency of decision-making. The NMBM was a politically turbulent environment, which was not always favourable to good governance. During the drought, a political analysis carried out by Ndletyana (2022) indicates an environment that impedes systemic and good governance of the drought response. At the heart of Ndletyana's analysis is the controversy surrounding the appointment of a permanent municipal manager, access to state resources and general political instability in the metro. At some point, there were two municipal managers appointed to run the Metro, each owing allegiance to the political faction that had supported their appointment. The coalition government that was in place at the time also did not do well, as the government was generally unstable, impacting critical decisions that had to be made in response to the drought. Such a politically unstable environment does not speak well to service delivery, particularly during the time of a crisis.

At the administrative level, there was evidence of cooperation between various divisions and units within the Metro. However, there were many frustrations about the level of cooperation between various divisions, which in some cases did not exist. These frustrations were particularly manifest through a general feeling of delays in procurement, patterns of staff recruitment, etc., which impact maintenance turnaround time. There was also a general sense of a lack of appreciation for a systems thinking approach, as many departments were being silo-minded, making cooperation in practice challenging. With regard to recruitment, it appears that there are non-alignments with key performance indicators between HR and technical divisions, and these do not appear to support one another.

> *"So, for example, if we want to employ labourers to assist a plumber, the Human Resource Department, they have got targets to meet in terms of youth, disability, women. (But) young black female professionals, like engineers or technologists, those girls don't exist (in the numbers they've stipulated). Now, we can't recruit because of these, which also affect our ability to meet our KPIs".*

Not only does poor horizontal and vertical collaboration affect water services delivery, but it also impacts repairs, maintenance, procurement and implementation:

> *"(there's a) grant that we received last year for non-revenue water for two big projects whereby the National Treasury pays that money into our account at Nelson Mandela Bay.*

We have to pay that over to an implementing agent. We prepared (everything) and then we got told by an accountant that it's wrong and they don't want to do it and they refuse to pay so yeah, it's frustrating" ...

Engaging with the DWS and other regulatory entities was critical during the drought. Regular meetings were held between municipal staff and DWS. These meetings were used to take stock of progress, identify challenges and to develop new strategies and programmes. For example, during the drought, NMB had to negotiate with the DWS to exceed extraction limits beyond the recommended limits, except for maintaining sufficient ecological flow. Municipal engineers shared their experiences of having to request this, as demand exceeded the supply. For several years during the drought, the municipality was overabstracting water beyond DWS limits. Before the drought, NMB was using 340 ML a day. During the drought, the target of 280 ML was not met, despite various technical improvements and extensive water saving campaigns; water abstraction remained around 300 ML a day. The DWS had to let the Metro continue overabstraction due to the severity of the water crisis.

The private sector, particularly through the NMBM Business Chamber, played a pivotal role during the drought. The Chamber collaborated with the Metro to assist with leak repairs. The chamber adopted schools and assisted with leak repairs via the Adopt A Leak and Adopt A School Initiative (Daily Maverick, 6 June 2022). The Chamber has set a goal to save one million litres of water, and they are close to achieving this goal. The partnership between the Chamber and the municipality is an example of a success story of private-public sector collaboration.

Key Lessons

1. **Ensure a politically and administratively stable environment and pay attention to vested interests and cognitive biases**. Mechanisms must be put in place to safeguard the political process, and to clearly demarcate political, administrative and technocratic functions of the municipality. Vested interests of incumbents and incentives from legacy systems are sufficient reasons to support business-as-usual scenarios even if these are not in the public interest. Methods such as design fiction and experiential futures and scenarios should be explored to experiment with transformative water futures, while being cognisant of cognitive biases that limit thinking about future options.
2. **Strengthen horizontal cooperation between Directorates, Divisions and Units within the Metro, and multi-level governance**. Staff recruitment and procurement had

direct implications for water services delivery within the Metro. The KPIs of these critical divisions often do not align and speak to each other. The various divisions are often bound by different compliance measures and in the pursuit of these, they remain in silos. An inter-divisional steering committee for strengthening cooperation and interactions on cross-divisional challenges should be established to strengthen horizontal cooperation within the metro. Regular engagements with DWS and other national government structures during the drought were of great importance. These should be sustained, especially as the Metro relies heavily on the inter-basin transfer scheme. Strategic partnerships such as those with Nelson Mandela Bay Business Chamber are vital to sustain, as these play a critical supplementary role in the municipal effort during the drought. With regard to the private sector, the municipality should engage with this sector in support of future water diversification efforts, e.g., the proposed desalination plants. The growing Coega Industrial Complex offers an opportunity in this regard. Private sectors can also be encouraged to invest in wastewater reuse, especially for industrial processes that do not require the quality of potable water.

5.4 Reflection on Cape Town and the Nelson Mandela Bay Metro water crises

In many ways, the Cape Town water situation bears similarities to those of Nelson Mandela Bay, but the differences were also pronounced. Drawing mainly from Ziervogel (2019), Taylor *et al* (2023), and our own research, Table 5.1 below provides a summary of these complex interacting elements that play out in different ways in both cases.

Table 5.1: Complex interacting elements in both Cape Town and NNMB water services situations during their respective droughts

Elements	Cape Town Experience	Nelson Mandela Bay Experience
Proactive Risk Planning	Delayed response worsened the crisis; early warning systems were weak.	Facing a prolonged water crisis with late interventions and weak early warning systems.
Clarify Roles and Responsibilities	Poor coordination between city, provincial, and national governments led to inefficiencies.	Fragmented governance between city, provincial, and national government causing delays.

Political Stability and Leadership	Political infighting between the DA-led City and ANC-led National Government undermined the response.	Municipal political challenges affect coordination, leading to slow and reactive responses.
Foster Cross-Sector Collaboration	Strong collaboration with universities, businesses, and NGOs helped with the response.	Some engagements with businesses and civil society in response planning.
Public Communication Strategy	"Day Zero" campaign mobilized action but caused panic and economic harm.	No clear messaging strategy: public engagement inconsistent and limited.
Leverage External Expertise	The World Bank and universities provided critical expertise to shift focus to demand management.	DWS and the City Support Programme provide some assistance, but overall limited use of external water governance and climate change expertise.
Aggressive Demand Reduction	Reduced per capita water use from over 1,000ML to below 500ML through restrictions and fines.	Restrictions implemented with noticeable reduction, but public compliance remains challenging.
Behavioural Economics and Social Norming	Publicly displaying household water usage (Green Dot map) encouraged conservation.	No large-scale social norming campaigns to encourage conservation.
Equity in Demand Management	Wealthy areas adapted with boreholes, while poorer communities had fewer options.	Similar inequalities, with wealthier households securing alternative water sources, but the ATTP cushion effect on the most vulnerable.
Diversification of Water Sources	Over-reliance on rain-fed dams made the city highly vulnerable to drought.	Also, over-reliant on surface water sources with limited alternative supply planning e.g., groundwater.

Water Reuse and Alternative Supply	Invested in groundwater, desalination, and stormwater harvesting post-drought.	Invested in groundwater, but investment in desalination is slow.
Progressive Tariffs to Ensure Equity	Stepped tariff implemented to discourage excessive use while protecting low-income users.	Stepped tariff implemented to discourage excessive use while protecting low-income users.
Climate Change Integration in Planning	Studies showed climate change tripled the likelihood of drought, necessitating planning.	Limited integration of climate change projections in long-term water planning.
Water-Sensitive Urban Design	Emphasis on stormwater harvesting, rainwater reuse, and permeable infrastructure.	Urban planning is still largely detached from water-sensitive infrastructure.
Social and Economic Equity in Water Access	Informal settlements used only 4% of water but were most affected by restrictions.	Low-income communities were less affected due to the geographical advantage and ATTP of the municipality.
Community Engagement	Some efforts were made, but many communities mobilized independently.	Some efforts were made, but frustration about limited participation.

Multilevel governance also plays out in different ways between the two cases as summarised in Table 5.2 below:

Table 5.2: Relationships across levels of government and other actors in response to the Cape Town drought versus the Nelson Mandela Bay drought

Category	Cape Town Drought (2015-2018)	Nelson Mandela Bay Drought (2016-Present)
National Government (DWS)	Imposed water restrictions on the Western Cape Water Supply System (WCWSS).	Enforced severe water restrictions on Nelson Mandela Bay's main water sources.
	Provided technical support but was criticized for delayed infrastructure investments.	Provided funding for drought relief, but at a slower pace than needed.

	Initially resisted calls for emergency funding and large-scale supply augmentation.	
Provincial Government	The Western Cape Government played a key role in communication and coordination between municipalities.	The Eastern Cape Provincial Government was criticized for a lack of urgency in addressing the crisis.
	Advocated for increased national support and funding.	Less visible leadership compared to the Western Cape's approach.
	Assisted in disaster management planning.	
Municipal Government	The City of Cape Town took a leading role in managing the crisis, implementing demand-side measures, restricting usage, and developing alternative water sources.	The Nelson Mandela Bay Municipality plays a leading role on the technical side of the water services delivery business, but struggles with governance challenges and delayed implementation of key projects.
	Enforced stringent restrictions and punitive tariffs.	Faced criticism for perceived poor planning and inefficiencies in managing water infrastructure.
	Communicated extensively with residents through the "Day Zero" campaign.	Evident investment in water infrastructure maintenance, upgrade, and refurbishment during the drought.
Inter-Governmental Cooperation	Frequent tension between the City of Cape Town and DWS over responsibilities, funding, and long-term planning.	Less structured inter-governmental cooperation compared to Cape Town.

	Collaboration with national and provincial governments improved over time but remained strained.	After initial delays, evident of collaborations through the declaration of state of disaster and the City Support Programme.
Business Sector	Played an active role in water-saving initiatives and water augmentation investments (e.g., private desalination plants).	Less business-sector involvement compared to Cape Town.
	Large industries, such as breweries and tech companies, invested in water recycling.	Some businesses implemented their own water-saving measures but at a smaller scale.
NGOs and Civil Society	NGOs, researchers, and civil society groups were highly active in water awareness campaigns, advocacy, and alternative supply solutions.	Less prominent NGO involvement.
	Significant international attention and donor support.	Some community-based water-saving initiatives but not at the scale seen in Cape Town.
Public Participation	Strong public engagement through mass media, city updates, and behavioural change campaigns.	Public engagement and awareness were evident but not prominent in the media compared to Cape Town.
	Increased levels of compliance with water-saving measures, leading to a reduction in daily water consumption.	Reduction in water consumption achieved but not to the levels expected as frustrations mounts over users compliance.
Infrastructure Investments	Some delays in national-level investments (e.g., delayed augmentation schemes).	Delays in infrastructure investments worsened the crisis.

	The city fast-tracked groundwater projects, desalination, and, to some extent, wastewater reuse initiatives.	Investment in groundwater exploitation, but limited implementation attention to wastewater reuse and desalination.

5.5 Barriers to the Uptake of Translatable Lessons

NMBM has applied some of Cape Town's successful strategies to avert water supply collapse, and they have also come up with their own strategies to improve water security and water delivery in the metro. When comparing the two metros, however, it is apparent that there are several barriers in NMBM's local context that have hindered the translation and uptake of lessons that assisted in Cape Town. These barriers can be broadly categorised across governance, financial, technical, social, and environmental dimensions.

Governance and Political Barriers

Effective drought response requires stable leadership and coordinated governance. NMBM's political and administrative environment has instead been fraught with challenges that hampered decisive action:

- **Political Instability and Governance Inefficiencies**: NMBM has experienced chronic political turbulence and leadership vacuums. During the drought, the metro had turmoil over its municipal management – at one point, two different municipal managers were simultaneously appointed, each backed by opposing political factions. A fragile coalition government led to frequent instability, undermining consistent policy direction. Such upheaval impeded "systemic and good governance" of the drought response, diverting focus from service delivery in a time of crisis.
- **Coordination Challenges Across Government Levels**: There were difficulties aligning municipal, provincial, and national efforts in NMBM's drought response. Fragmented governance and unclear roles contributed to delays and inefficiencies. For example, while the national Department of Water and Sanitation (DWS) imposed necessary water use restrictions on NMBM's supply dams, local officials felt these mandates sometimes came in ways that compounded municipal efforts. The Eastern

Cape provincial government was also criticized for a slow and less visible response compared to the proactive stance the Western Cape took during Cape Town's crisis.

- **Political Infighting and Decision-Making Paralysis**: Internal political conflicts in NMBM directly affected drought management decisions. Fierce contestation over access to municipal resources and key positions (like the city manager) fostered an environment of infighting. This infighting often stalled critical decisions or led to policy reversals. Leaders were more focused on power struggles than on implementing water-saving measures. Consequently, NMBM's crisis response was often reactive rather than proactive. In NMBM, unstable governance eroded accountability and made it difficult to sustain the tough decisions needed during the drought.

Financial and Economic Barriers

Adequate funding and sound financial management are essential to implement drought interventions (such as infrastructure upgrades, conservation programs, and emergency supplies). NMBM faced several economic constraints that limited its capacity to act.

- **Budget Constraints and Resource Allocation**: NMBM struggled with a constrained fiscal environment and competing priorities. Although there was more financial investment in water-related infrastructure during the drought, this was deemed inadequate given the scale of the crisis.
- **Challenges in Securing Funding for Infrastructure**: NMBM relied heavily on external grants and emergency funds, which often arrived more slowly or in smaller amounts than needed. The national government did provide some drought relief funding, but "at a slower pace than needed," according to assessments. Internally, bureaucratic hurdles also hindered accessing funds. Municipal officials noted that even when they secured grants (e.g., from National Treasury), actually unlocking and using those funds was difficult due to red tape and siloed municipal departments. One official lamented that the water services directorate was "underfunded on a yearly basis" and could not directly reinvest all water tariff revenue back into water services. Unlike cities such as Johannesburg or Durban, which have independent water boards that manage their own finances, NMBM's water department lacked financial autonomy. This structural funding model made it hard to dedicate sustained funds to drought mitigation projects.

- **Cost Recovery Issues and Revenue Shortfalls**: The economic profile of NMBM (with 40% unemployment and many low-income households) led to low revenue collection and debt impairment.

Technical and Infrastructure Barriers

The condition of water infrastructure and the adoption of technical measures are decisive in a drought response. NMBM's infrastructure challenges and certain technical gaps made it difficult to implement Cape Town's more aggressive water-saving tactics:

- **Aging Infrastructure and Limited Capacity**: NMBM's water supply infrastructure has shown signs of strain and disrepair, resulting in frequent leaks, pipe bursts, and blockages during the drought period. An analysis of customer complaints in 2020–2021 found that pipe blockages were the most common issue – occurring three times more often than other water faults – followed by leaks and then bursts. Many of these problems were not resolved quickly. For instance, about 6% of reported blockages took over three months to fix, and a subset remained unresolved for more than six months. Similarly, nearly 5% of water leaks persisted longer than six months. This slow maintenance turnaround is partly due to capacity constraints (limited repair teams, procurement delays for parts, etc.) and bureaucratic holdups. Aging pipelines and inadequate maintenance budgets (as noted earlier) created a backlog of infrastructure issues.
- **Challenges Implementing Advanced Water Technologies**: While Cape Town invested in new water sources and technologies (fast-tracking groundwater drilling, temporary desalination plants, and water reuse projects), NMBM has struggled to do the same. The municipality did explore desalination and groundwater development, but implementation has been slow and limited. Large-scale augmentation projects have faced delays, whether from funding shortfalls or administrative inertia. Even on the demand side, rolling out high-tech conservation tools met obstacles. NMBM engineers deployed some innovative solutions – for example, a telemetry system for real-time monitoring of the water network, which was recognized at a 2024 IMESA engineering conference. This system helped optimise water pressure and detect usage in real time. However, not all these technologies were in place early enough or at sufficient scale during the crisis.

Social and Public Engagement Barriers

Public cooperation and equitable measures are key to managing a water crisis. In NMBM, social factors – from public trust to inequality – created barriers to adopting Cape Town's more robust demand-side interventions:

- **Public Trust Deficit and Communication Gaps**: A major hurdle in NMBM was the lack of public trust in the municipality's handling of the water crisis. Communication with residents was viewed as inconsistent and not sufficiently transparent, which eroded credibility. The city ran awareness campaigns via radio, community meetings, and especially social media (Facebook updates), aiming to educate people about the water scarcity. However, these efforts failed to foster deep behaviour change in many communities. One issue was the medium of communication: heavy reliance on online messages meant many citizens – particularly in poorer or rural areas without reliable internet – were left out. Some residents only realised the severity of the drought when they experienced water outages, rather than through proactive municipal alerts. The absence of a clear, unified message (akin to Cape Town's stark "Day Zero" framing) meant that the public's response in NMBM was more muted. Moreover, missteps in engagement bred scepticism. For example, residents in lower-income neighbourhoods felt their reports of leaks were not taken seriously; in some cases, reporting a leak led to the installation of a smart meter (to limit usage), which they interpreted as punishment rather than help. Such experiences created an atmosphere of apathy and mistrust, where people saw little point in cooperating or reporting issues since they doubted the municipality's responsiveness. As one official observed, many in disadvantaged areas stopped reporting leaks entirely, believing they "won't get any help from anyone" . This breakdown in communication and trust made it difficult for NMBM to galvanise the kind of collective conservation effort that Cape Town managed to achieve.
- **Inequities in Water Access and Impacts**: Social inequalities in NMBM exacerbated the drought's effects and complicated the response. The metro has over 150 informal settlements (about 7% of all households) and very high poverty – roughly 27% of households rely on social grants as their main income. These communities have minimal resources to cushion against water shortages. During the drought, wealthier residents and businesses could drill private boreholes or purchase water storage tanks, while poorer communities had to rely on municipal water deliveries or standpipe water provision. This mirrors Cape Town's experience, where wealthy areas adapted with

alternative sources and poorer areas had fewer options. In NMBM, low-income neighbourhoods ultimately faced the greatest hardships when water became scarce. Many informal settlement residents already used very little water, yet they were disproportionately affected by service interruptions. Though NMBM's distribution network is uniquely configured so that some disadvantaged areas are supplied first from the major Nooitgedacht pipeline, these communities still suffered when overall supply ran low. Women and children bore the burden of collecting water from tanker trucks when taps ran dry. The inequitable impacts bred resentment – some felt that certain suburbs were protected while townships went without. This social context made it politically and ethically challenging for NMBM to enforce drastic demand reductions. The city had to balance crisis measures with the reality that many residents were already at bare-minimum water use. Ensuring fairness in restrictions (so that the poor were not unduly penalized) proved difficult, and NMBM did not effectively use differentiated messaging or support to address these inequities.

- **Challenges in Fostering Behavioural Change**: Changing water-use behaviour is a social challenge that NMBM struggled with. Despite awareness campaigns, many residents did not significantly cut consumption until the situation was dire. Part of the issue was the trust deficit – people were less willing to sacrifice or follow water restrictions when they lacked faith in the authorities or felt they were not being heard. Enforcement of water restrictions in NMBM was also relatively weak: while regulations and fines existed on paper, in practice, there was limited capacity to monitor and penalise misuse across the city. This contrasts with Cape Town, where high-profile enforcement and social pressure (such as the "Water Map" that publicly showed who was saving water) nudged behaviour change. NMBM did not deploy such large-scale social norming campaigns. Some community-led initiatives for saving water did emerge, but there was not a Metro-wide culture of conservation. Additionally, initial mixed messages may have confused the public – for example, NMBM's early optimism about its inter-basin supply (from Gariep Dam) created a false sense of security that the city "would never run out of water". This perception lingered and made people slower to cut back. In sum, NMBM found it challenging to encourage widespread water-saving habits fast enough, especially without the strong, trust-based communication and enforcement that underpinned Cape Town's demand management success.

Environmental and Climate Barriers

Local environmental conditions and water sources fundamentally shaped NMBM's drought response options:

- **Dependency on Surface Water Sources**: Like Cape Town, NMBM has been heavily reliant on surface runoff stored in dams, making it vulnerable to rainfall variability. The metro's western and central water supply system is *entirely* dependent on rain-fed dams and springs. This is problematic in a semi-arid climate where droughts are recurrent. NMBM does have one critical back-up: an inter-basin transfer bringing water from the Gariep Dam (Orange River system) to its eastern supply zone. This imported supply (via the Nooitgedacht scheme) provides a significant portion of the city's water (over 200 ML/day) and was a lifeline during the drought. However, over-reliance on this external source introduced complacency. In reality, the Nooitgedacht supply alone could not meet all of the Metro's needs, especially as local dams emptied. When Cape Town faced its drought, it lacked any large external water import and thus had to aggressively pursue new sources (groundwater, reuse, desalination). NMBM's partial dependence on the inter-basin transfer may have delayed equally urgent diversification. In essence, NMBM did not diversify its water sources sufficiently before the crisis – initiatives like drilling additional boreholes or recycling wastewater were slow. This lack of source diversity is a major environmental vulnerability.
- **Climate Variability and Drought Frequency**: The Eastern Cape region is prone to cycles of drought, a trend likely exacerbated by climate change. Historical records show NMBM has suffered at least four severe droughts since 1969 due to extremely low rainfall in its catchments. The 2017–2022 event was especially prolonged. Climate projections indicate such droughts may become more frequent or intense. In Cape Town's case, studies found that human-induced climate change made the 2015–2017 drought about three times more likely, prompting the city to integrate climate risk into its planning. Before the crisis, NMBM's water planning seemingly did not account for the worst-case scenario of multiple dry years in a row – evidenced by delayed action until reservoirs were nearly empty.
- **Ecological and Systemic Constraints**: NMBM had to balance human water needs with ecological requirements and infrastructure limits. For example, during the height of the drought, the national DWS imposed strict abstraction reductions on NMBM's western supply dams to avoid the complete ecological collapse of those water sources. By April

2022, NMBM was only allowed to draw 272 ML/day total, down from an unrestricted 355 ML/day, to conserve the dwindling reservoirs. While necessary, these restrictions meant the city had to enforce painful water cuts. Additionally, NMBM's water system design (with the eastern pipeline pump-fed and western areas gravity-fed) created distribution challenges when supply was low. Pumping schemes require electricity and are vulnerable to power outages, adding another risk factor. Ecologically, the region's rainfall patterns differ from Cape Town's: rain in NMBM can be even more sporadic, and its main rainfall season does not always align with demand peaks. All these environmental nuances meant that Cape Town's exact approaches (e.g., relying on winter rains, using managed aquifer recharge) could not be directly replicated. NMBM had to tailor solutions to its context – such as exploiting the Nooitgedacht scheme more – but even those were stretched to the limit by the prolonged drought.

5.6 Conclusion

The implementing environment of the NMBM is rather complex, with several interacting components that impact the way the metro responded to the water crisis. Some of these complex elements were not very helpful during the drought, e.g., the political instability, trust-deficit between the municipality and the wider communities, theft, and vandalism, as well as poor inter-divisional, inter-departmental cooperation and collaboration. However, there were aspects that aided the response to the drought, e.g., the declaration of a state of emergency, which led to the freeing up of resources, highly competent and well-experienced technical staff, and the implementation of technical measures on the supply side. In many ways, the environment in the NMBM was like that of Cape Town, but there were very pronounced differences. We distilled 16 lessons, and many of these are like those synthesised by Ziervogel (2019) for the Cape Town water crisis and the recommendations by Pietersen (2021), who did earlier work on the NMBM.

Overcoming the barriers and limitations above will be crucial for NMBM (and other municipalities) to translate water security lessons into effective action. In essence, technical fixes need to be supported by good governance, sustainable financing, community trust, and proactive planning in the face of climatic uncertainty. Only by addressing these underlying barriers will the metro be able to strengthen its resilience and ensure that the hard-won lessons

learnt during the city's water crisis truly inform and improve water service delivery and management in the future.

Chapter 6: Conclusion and recommendations

6.1: Synthesis and conclusion

Drought is increasingly becoming a recurrent feature in the South African water sector. Whenever a prolonged drought occurs, it triggers a water crisis, and in extreme cases, dams run dry, such as in the case of the city of Cape Town, Makhanda, and Nelson Mandela Bay Metro. In an attempt to address such drought-induced water crisis, the responsible local authority implements a range of measures, including technical and non-technical, and they often span the supply and demand side of the water value chain. The current study sought to address fundamental questions related to the equity implications of municipal responses to the drought-induced water crisis in the Nelson Mandela Bay Metro.

The Nelson Mandela Bay Metro, in responding to the drought, implemented several measures, which we categorised as 1) measures aimed at optimising existing water sources and supply systems, 2) those aimed at diversifying and augmenting water supply sources, and 3) measures aimed at reducing consumption and demand. The premise of the first two measures is efficiency and sustainability on the supply side. Efficiency was the primary motivation for optimising existing water sources and supply systems. And in so doing, the municipality implemented measures such as upgrading of barges to optimize supply, implementing backwash water recovery, and refurbishing and upgrading supply sources and systems. The second set of measures could be said to be driven by efficiency and sustainability of the water supply system over the short and long-term for water supply assurance. Examples of these measures, which were implemented in Nelson Mandela Bay, include groundwater exploitation, proposals for desalination and effluent re-use. Of these three measures, the most successful was groundwater, as both desalination and effluent re-use contribute very minimally to the water mix of the Metro. It appears that for long-term sustainability of the supply sources, the Metro would need to invest in effluent re-use and desalination, as both options hold immense potential.

Regarding the consumption and demand side, it appears that the Municipality was driven by the value of efficiency and sustainability, and occasionally by that of equity. In so doing, it implemented several measures such as developing a water reduction strategy, extensive metering, maintenance of the distribution networks, monitoring of the supply system, pressure management, strategies aimed at reducing non-revenue water, introducing stepped tariffs, extensive leak repairs, metre audits, publicity and media, as well as water quality testing. These

measures intersect efficiency, sustainability and equity. The latter being the primary focus of this study.

The study revealed that municipal water supply was the primary source of drinking water across the metro. However, as the drought intensified and the municipality responded by implementing a range of measures, the higher income groups were able to procure alternative drinking water sources such as bottled or filtered water, and increasingly became less reliant on municipal supplies. This is an important finding that has equity implications as income level influences the adaptive and coping mechanisms of households. Another finding that has bearing on equity in terms of the measures implemented by the municipality relates to the time it takes to fix leaks. The study revealed a perceived feeling that the municipality tends to fix leaking pipes in affluent suburbs more quickly compared to those in the low-income and informal settlements areas. This may reflect disparities in municipal response times, with residents in better-serviced suburbs receiving faster attention, while others face long delays or neglect. Although residents of the low- and informal settlements indicated a sense of neglect when it comes to fixing leaks, they however, indicated that these leaks do not seriously impact on them, probably because it is in these settlements that water is highly subsidized by the municipality.

Implementation of stepped tariffs was an important measure aimed at reducing water consumption. The study revealed that the use of a water tariff is a complex instrument that may have unintended consequences. For example, in many of the low-income households, unpaid, excessively high water bills within the Metro were common, and in most cases, these residents were in no position to clear these bills. It was also these residents who indicated that increases in tariffs have affected their ability to pay for other household necessities such as food. This then raises a fundamental question regarding balancing equity, efficiency and sustainability, which also intersect with metre audits and pressure control management. In this regard, our study revealed that egalitarian thinking informing municipal response has to be moderated by the need-based distributive equity thinking to lessen the burden of these municipal measures on the poor and most vulnerable. Perhaps the best example of this need-based thinking was the implementation of the Assistance to the Poor Programme (ATTP).

Drawing on Odume et al (2022) framework for analysing interactions between the value of equity, efficiency and sustainability, it appears that in many instances the municipal responses led to the conflictual zone interaction dynamics. For example, in the pursuit of efficiency, the municipality implemented measures such as restricting supply via a number of mechanisms,

such as pressure control, flow restrictors as well as stepped tariffs. These measures contributed to a reduction in non-revenue water, system efficiency and optimisation but also led to a number of higher-income households partially moving off-grid, as well as lower- and medium households' ability to pay for other necessities being affected. Partially going off-grid and becoming less reliant on the municipal water supply also implies less revenue to the municipality, which can undermine its long-term sustainability. A stepped tariff impacting households' ability to purchase other necessities raises equity questions. It therefore appears that the value of equity, efficiency and sustainability were in conflict, raising questions about careful negotiation and navigation of the three foundational values in the water sector.

We explored the concept of Living Labs as a social innovation (SI) platform for fostering collaborative exchanges between diverse stakeholders and actors in ways that support new relationships, shift power dynamics, and lead to the creation and potential implementation of new solution-oriented initiatives in Nelson Mandela Bay. We see Living Lab as critical because it draws on ideas, concepts, and frames from diverse stakeholders and actors' groupings, potentially representing different societal domains. The Living Lab engagements indicate communities' deep understanding and the complexity of water security, providing impetus for why it is important to engage communities when attempting to address complex sustainability challenges such as water security. The engagement also indicated that communities used different strategies to build resilience during the drought. However, adaptive capacities among low- and medium-income households were limited. Long-term infrastructure planning, maintenance/repairs, effective communication, education and awareness raising, regular engagement with the communities as well as equity-sensitive interventions were suggested solutions for building resilience within the Metro.

The implementing environment or context is critical when implementing drought-related response measures. Using the STEEP-H (social, technical, economic, ecological, political and historical) as dimensions of the implementing environment, we analysed the Nelson Mandela Bay metro and its responses to the water security challenges. Following the STEEP-H framework, we synthesized 16 lessons. These lessons emphasise the importance of building public trust through open, transparent and regular communications via appropriate channels; investing in relationships that foster public confidence and trust; strengthening efficiency and maintaining water infrastructure; investing in data and expertise; securing critical water assets and infrastructure as well as ensuring adequate financial resources for water infrastructure, and strengthening financial accountability. The lessons also advocate for practicing anticipatory

governance, setting aside financial resources to support the most vulnerable while implementing systems for efficient collection of water services tariffs and cost recoveries. We also stressed the need to diversify water sources, taking a systems approach to planning, while maintaining water sources and ecological infrastructure in good condition. The political environment is critical, and in this regard, the lessons drawn from the research stressed the importance of ensuring a politically stable environment, strengthening vertical and horizontal coordination and cooperation between Directorates, Divisions and units, while fostering multilevel governance, investing in strategic partnerships and mobilising private sector resources.

The comparison between the City of Cape Town and Nelson Mandela Bay Metro in terms of how they responded to the droughts appeared to be complex. This complexity plays out in various ways, e.g., in proactive risk planning, leadership across scale, fostering cross-sector collaboration, implementation of both technical and non-technical measures, as well as multi-level governance. In terms of translatable lessons from the Cape Town water crisis, several barriers appear to impede the uptake of these lessons. These include political instability, coordination challenges across governance levels, budget constraint and resource allocation, climate related issues and over-reliance on surface water sources.

6.2 Recommendations

6.2.1 Policy and implementation

Recommendation for operational implementation

- **Build public trust through open, transparent and regular communication and participatory platforms**. The municipality should strengthen and diversify its communication channels and citizen participatory platforms. Regular ward meetings, house-to-house water campaigns/meetings, neighbourhood water watch committees, and setting up and maintaining community water learning platforms are examples of initiatives and programmes that can assist in trust building and participation. Regular and consistent communication and feedback loops can also strengthen the process of trust building. Feedback loops through participatory platforms provide a mechanism to strengthen a two-way communication between the municipality and the communities it serves. The process of community trust building also implies fostering long-term relationships with a diversity of actors and stakeholders in communities, e.g., community-based organisations (CBOs), environmental activists, community leaders,

businesses, ward leaders, faith-based organisations, etc. These relationships are intended to serve diverse purposes such as information flow and amplification, water education and awareness, neighbourhood support, etc.

- **Strengthen efficiency and maintain water infrastructure.** There is a need to improve the response time to community complaints regarding leaks, blockages and burst pipes. This can be achieved by developing a community-driven system that allows rapid reporting of such leaks, etc, and real-time feedback to the complainant when the report incidence has been resolved.
- **Invest in data and expertise**: Expertise in complex data analytics, climate and scenarios modelling, GIS and spatial analysis, machine learning, predictive science, asset management, financial and project management as well as continuous investment in engineering and hydrological sciences are all critical areas to invest to strengthen the technical environment within the NMBM. Expertise in foresight and futures thinking methods, such as horizon scanning, Delphi method, causal layered analysis, back casting, vulnerability mapping, participatory foresight, modelling, trend analysis, historical analogy, etc are needed to strengthen the municipal preparedness for future water crisis. Regular community surveys on the perceptions of water services delivery can assist in strengthening service delivery and taking proactive actions based on community feedback.
- **Secure critical water assets and infrastructure to ensure their integrity.** Vandalism and theft remain a major problem within the Metro. Investing in a community-driven neighbourhood water infrastructure security programme is urgently needed to curb the incidences of theft and vandalism of critical water assets. The municipality should consider emerging technologies such as drones, which have proved effective elsewhere. The municipal bylaws relating to theft and vandalism of critical municipal assets should be strengthened for maximum allowable punishment. Community-driven systems and initiatives for rapid reporting of incidents of vandalism and theft cases can contribute to addressing this perennial problem. Such an initiative should also include a way of documenting evidence for prosecution.
- **Ensure adequate financial resources to diversify the Metro water sources, maintain water infrastructure, and improve demand management**. The water source diversification effort (e.g., groundwater sources) of the municipality contributed enormously to addressing the water crisis, and this effort must be sustained. A

desalination feasibility study has been carried out; this now needs to be implemented, potentially within the framework of a public-private partnership, considering the growing water demand within the Coega industrial development complex. There is enormous potential for effluent re-use within the Metro, yet this has not received the attention it deserves, especially for non-portable uses. Financial investment in this regard is needed. The improvement recorded during the drought on infrastructure maintenance, upgrading across the entire water value chain must be sustained and this requires ongoing sufficient budgetary allocation.

- **Set aside adequate financial resources to support the most vulnerable, while paying attention to those just above the poverty borderline.** A key lesson from the study is that the municipal ATTP plays an important role in alleviating the burden of the water services crisis during the drought. The study has also indicated that the burden fell most on those who are just above the borderline of the ATTP. Setting aside financial resources to support this programme into the future is an important equity matter. Investments should also go into awareness and campaign to encourage and support qualifying households who have not enrolled to do so.
- **Implement systems for efficient collection of water services tariffs and cost recovery**. The growing unpaid water service bills among household water consumers are a concern. The municipality must maintain a consistent aggressive posture towards debt and cost recovery and this must be complemented by regular audits of water metres and customer accounts, ensuring the accuracy of these.
- **Maintain water sources and ecological infrastructure in good condition**. The entire western side depends on water resources within the catchment. The viability of these sources and their potential to support future demands depends on maintaining critical ecological infrastructure in good condition. These include clearing of alien invasive species, maintaining the wetlands and rivers within the metro in good ecological condition, as well as groundwater recharge. Some of these interventions call for multi-level collaboration between the Department of Water and Sanitation and the Metro. These multilevel collaborations should be proactively pursued.
- **Ensure a politically and administratively stable environment and pay attention to vested interests and cognitive biases**. Mechanisms must be put in place to safeguard the political process, and to clearly demarcate political, administrative and technocratic functions of the municipality. Vested interests of incumbents and incentives from legacy

systems are sufficient reasons to support a business-as-usual scenario, even if these are not in the public interest. Methods such as design fiction and experiential futures and scenarios should be explored to experiment with transformative water futures, while being cognisant of cognitive biases that limit future options.

- **Strengthen horizontal cooperation between Directorates, Divisions and Units within the Metro, and multi-level governance**. Staff recruitment and procurement had direct implications for water services delivery within the Metro. The KPIs of these critical divisions often do not align and speak to each other. The various divisions are often bound by different compliance measures, and in the pursuit of these, they remain in silos. An inter-divisional steering committee for strengthening cooperation and interactions on cross-divisional challenges should be established to strengthen horizontal cooperation within the metro. Regular engagements with DWS and other national government structures during the drought were of great importance. These should be sustained. Strategic partnerships such as those with Nelson Mandela Bay Business Chamber are vital to sustain, as these play a critical supplementary role in the municipal effort during the drought. With regard to the private sector, the municipality should engage with this sector in support of future water diversification efforts, e.g., the proposed desalination plants. The growing Coega Industrial Complex offers an opportunity in this regard. Private sectors can also be encouraged to invest in wastewater reuse, especially for industrial processes that do not require the quality of potable water.

Recommendation for policy interventions

- **Private sector involvement:** There is an urgent policy intervention to get the private sector more involved in the delivery of water services. This could be done in a variety of ways, e.g., through unlocking private sector investments into water services infrastructure, and in return, the government could provide tax credits or other incentives. The more direct approach of the private sector, being Water Services Providers (WSPs), would require careful consideration in light of ongoing national debates and reforms. Service delivery guidelines, the licensing processes and procedures for private sector participation, pricing regimes, and quality assurance mechanisms must be clearly spelled out. The direct involvement of the private sector as WSP can strengthen the overall resilience of water services delivery in the country.
- **Foresight capability and anticipatory governance**: The response to the drought and the various intervention measures calls for a shift in how water security should be

governed in the Metro, but more broadly in South Africa. There is an urgent policy imperative to strengthening municipal capability in foresight exercise and futures thinking, anticipatory governance and innovation. This would necessitate institutional and structural changes to encourage municipalities in the areas of sense-making about the futures, disruptive, transformative change and innovations, and experimentations, which are not always welcome in traditional institutional contexts.

- **Strategic autonomy for the water service delivery division or units within local governments**. Organisations that are financially and operationally autonomous are usually more agile and are to circumvent traditional stage-gate processes. An important policy intervention is strategic autonomy for water services delivery Divisions within local municipalities. Strategic autonomy should strengthen the agility of WSPs to respond to emergency situations, better anticipate and plan for the future, and to rapidly deploy resources when needed.
- **Balance efficiency, sustainability and equity in a dynamic fashion**: The study shed light on the intricate, complex relationships between these values. When one single minded pursue any of these values, one ends up being in conflict with the other values. Therefore, policy instruments that sought the dynamic balance between equity, efficiency and sustainability across levels of governance are needed in the water services sector. Guidance must also be given in terms of the operationalisation of these instruments for WSPs.

6.2.2 Future research

The following recommendations are made for future study:

- Critically examine the implications of strategic autonomy for water services unit/division or institutions within the context of multilevel and polycentric governance systems.
- The current study largely focuses on the equity implications of the municipal response to the drought on households. A similar study should be carried out with a focus on other sectors such as business and agriculture, as these have direct implications for job security and socio-economic development within the Metro.

- A detailed study is needed to better understand the roles of the private sector in addressing the collective burdens imposed by the drought. This study should also explore the equity implications of these and lessons for future preparedness.
- The role of anticipatory innovation governance in future-proofing water services delivery in the face of uncertainties and a deeply unequal society deserves urgent investigation.

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APPENDICES

Appendix 1: Serious game simulation with Swartkops Living Lab

Sept 1st 2023, Gqeberha

This document reports on the experience with developing a serious game with Swartkops Living Lab. As explained in the Living Lab session on June 21st, a serious game is a participatory tool used by stakeholders to simulate, by means of playing, activities that occur within an environment. Serious Games vary in design and purpose, and each one of them is environment-specific and portrays the existing local conditions. The NMB WatEqS (NMB Wate Equity and Security) game, adapted to the Nelson Mandela Bay (NMB) was developed using the Crea-WAG method, to help participants simulate, in a real-life like situation, how the water scarcity and equity challenges of the drought-stricken NMB metro affect their lives. This method is structured by the identification of resources, actors and activities and their relations and evolutions, as well as a game board to represent these processes in space. Ultimately, the NMB WatEqS game will allow participants to explore issues of water access, equity, and governance as they affect the metropole's respective communities.

Focus selection and objective of the game

The NMB WatEqS game is part of the development of tools and methods in the SDG pathfinding project in order to explore possible local pathways towards sustainable goals. As such the first objective of using this game is then to explore such pathways within locally set living labs. It has to fit expectations of people gathered in this Living Lab and provide them with a tool to enable collaborative exploration possible futures. Here the game is designed in the frame of the Swartkops Living Lab.

Serious games are meant to focus on a specific issue to be addressed collectively, while Living labs, even more when they are dedicated to SDGs, are institutions meant to address the development issues coming from their members, including in this case several SDGs. In this context, serious games can only be part of the tools used. They are recognized to be tools used in agile processes, focusing on an agreed common issue and enabling the reconfiguration of this issue into a new one (Barnaud et al. 2006).

This initial game was then focused on water equity and security because it was one of the key dimensions identified by the Living lab and met concerns of key partners in situation to provide support (Rhodes University, DWS, WRC…). As a consequence, the objective of this game has been settled to explore pathways to face water scarcity collectively and the consequences on water equity.

In order to track whether game session is meeting this objective, we developed a decision sheet and an observation sheet to be filled by players along the game and we conducted a short debriefing at the end of the session, as requested when using serious games.

Connection with system analysis process

SDG Pathfinding associates several tools, including policy simulation, system analysis and serious games. From the point of view of LL members these tools are meant to be complementary and adjusted in their use to fit one the other. As any models, serious games may result from various types of design process, participatory as within the CreaWAG method used in the sister Living Lab Fimela in Senegal, or on the basis of suitable existing knowledge.

In Swartkops, the LL has held a session in November 2022 for system analysis of the Swartkops social ecological systems and its main challenges towards Sustainable goals. In a participatory workshop, it has elaborated causal loop diagrams to represent challenges related to water security, poverty and (un)employment, ecosystem health, food security. It could identify the connections between them and listed items to be included into an action plan. Regarding water security it ended up with the causal loop diagram in figure 1.

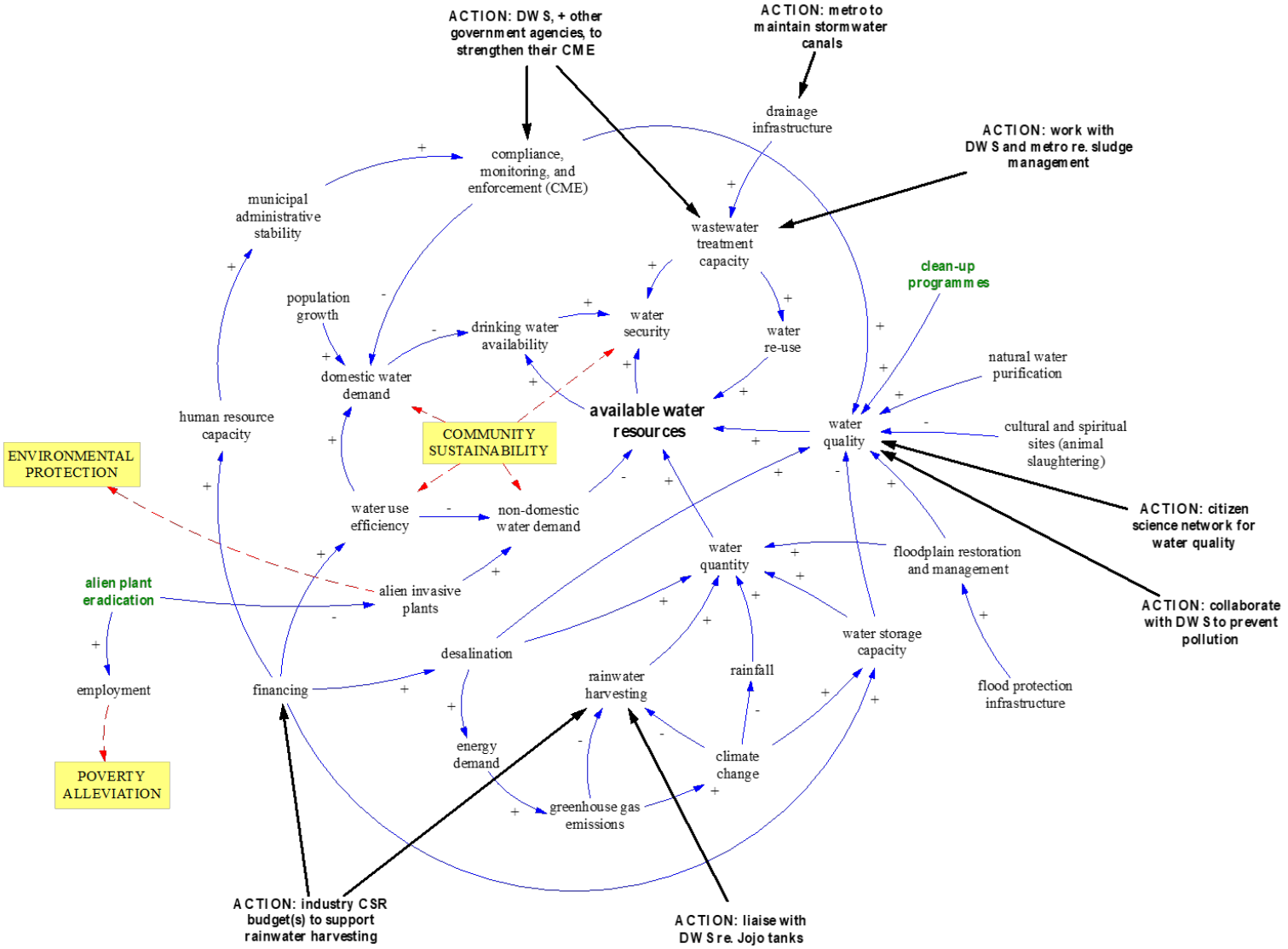

Figure 5: Causal Loop Diagram with actions (from Swartkops Living Lab November '22 session)

That being said, a participatory design of a serious game to explore through simulation pathways towards water security and equity would have been redundant. The design of a game indeed starts with the identification of actors, activities, and resources and their interactions. These could be elicited through a re-analysis of the material that came out of the system analysis workshop, with the filter of water security and equity issues.

For that purpose, we went through the diagrams and list of activities as summarized in Figure 1 in the November'22 LL session to elaborate the game.

Game design

The game design has been a process based on several versions and revisions, with tests with colleagues and students at Rhodes University (IWR and ISER). It has gone with a preliminary version tested on June 21st 2023, with Living Lab members in Gqeberha and then a revised version tested on September 1st, 2023 with an increased number of Living Lab members in Gqeberha as well. We described here both preliminary and revised versions and how they were received.

Preliminary version

The preliminary version was tested on June 21st, 2023 with 13 Living Lab members in the B&E conference centre in Gqeberha, with the presence of 7 people from the project team, including one facilitating the game and one in support with the dynamic spreadsheet model.

This preliminary version features nine roles in connection with water use or regulation in the Swartkops catchment. The roles are listed in Table 1 below.

Table 3: roles in the NMB WatEqS game

	Role	activities	objectives	Characteristics
P1	Upstream small scale commercial farmer	Farming Domestic water use	Feed family Expand production Secure water access	Farming a major source of income Water tank

P2	Formally employed midstream	Domestic water use farming	Feed family Expand production Secure water access	Farming as a secondary source of income Water tank Half efficient waste water connection
P3	Informally employed midstream	Domestic water use farming	Feed family Expand production Secure water access	Farming as a secondary source of income No water tank Half efficient waste water connection
P4	Unemployed midstream	Domestic water use	Feed family Temporary jobs acquisition	No litter collection No waste water connection
P5	Formally employed downstream environmentally minded	Domestic water use gardening	Feed family Ecosystem conservation advocacy	Affluent Water tank
P6	Formally employed downstream business minded	Domestic water use Income generating businesses	Feed family Expand business	Affluent Water tank High water demand for leisure and business
P7	Industry	Industrial water use Alternative technology investment	Profit generation	

		Invest in corporate social responsibility		
P8	NMB Municipality	Pump water from the river into dam Manage dams and interbasin scheme Regulate water tariff Allocate water	Water equity Domestic and industrial water supply	
P9	D9	Allocate river water resource Employ teams to remove solid waste Employ teams to clear alien plants	Ecosystem health	

Three resources flow in the system: money, river water and domestic water. Each activity has a cost and may provide income, measured in Rands. Farming and municipality may pump into the river if water is available and according to the water allocation set by the DWS. Municipality transforms this raw water into municipal water that might be used for domestic or industrial purposes, and then allocates to players P1 to P7 according to their demand, water availability and water allocation rules. Municipal water might be substituted by rainwater collected by water tanks, either provided at initialisation or following dedicated investments. Activities also generate waste, either solid (litter) or liquid (wastewater). According to the level of public services quality in various neighbourhoods, all, half, or none of these end up in the river. The ecosystem health is then computed according to the quantity of water and its ratio of clean VS waste water at the level of the estuary. This involved several computations and is supported by a spreadsheet. One facilitator collects the decision of action from players, types them in the spreadsheet and gives back to players their information of interest (quantity of money for all, and in addition, estuary quality for P9). Although an indicator of well-being was included in the role descriptions, this was not played.

Even though this version is characterized by strong realism made easy thanks to the use of dynamic spreadsheet support, some work of calibration has been necessary to cope with the selection of some components of the social ecological system (and hence the absence of others).

Calibration has been made on the basis of data available at state or metropolitan level. As each role is representing the whole population of households of this type, calibration has taken in account existing censuses (StatsSA, 2019), water consumption figures for agriculture (Bate et al., 2004) and domestic use (NMB 2023) allowed to estimate levels of water use for each activity in a low, medium or high intensivity mode. The Ecological Water Requirement (EWR) has been set to official figures in the Swartkops basin (EFA, 2009; EFA, 2011).

Each of the nine roles was played by one or two Living Lab members. The participant endorsing a role as a single player had more difficulties to play. Participants chose the role they preferred after an extensive presentation of the game. The play was often interrupted to get explanations. As a consequence, only two rounds could be played, interrupted by the lunch break. The communication between players' choices, the spreadsheet model and back to the players with the consequences of their choices cut the fluidity of the play, leading several players to focus on other issues than the game. In addition, as the game was mainly based on accounting money and water, some participants get lost with these numbers. In the debriefing, two different regards came on that regard. Some mentioning they could not get in the game because of its numerical complexity, others mentioning rather that after a difficult start they could understand and hence learn from the game. However, these regretted that the use of the spreadsheet support made opaque the computation and hence hid some aspects of the social ecological system dynamics. Despite these drawbacks due to the game format, the participants enjoyed the representation in which they recognized some situations they have to face. The time during which they were not active due to the communication with the spreadsheet model, was used by some of them to share their experience with water access on the follow up of the game situation. This experience sharing enabled by the game was much appreciated

Main critiques were then (1) the difficulty to play for some of the participants because of the many big numbers and (2) the black box aspect induced by the use of a dynamic spreadsheet model meant to support the computer. Even though computer support is known to handicap the unfolding of a game session because the computer would capture players' attention (Becu 2021), recent experience has shown that when it is handled as a mere computing support not central to the game dynamics it might be positive (Barreteau et al. 2023). Here the concern with this computer support has rather been a black box effect than an attention capture. In addition, the components of the model were confirmed, to the exception of the need to add groundwater as a possible solution to deal with water scarcity.

Revised version

On September 1st 2023 a revised version has been tested with 26 members of the LL in the same conference centre in Gqeberha as the preliminary version. The project team was here with 7 people to facilitate and observe the game.

Main changes compared to preliminary version to take in account feedbacks from the 1st test have been to move from a computerized to a haptic game (1) in completely stopping the use of a computer and dynamic spreadsheet model, and (2) replacing the use of big numbers with meaningful units into the use of handy artifacts such as coloured pebbles and fake notes. These handy artifacts were taken from the WAG toolkit (Abrami et al. 2012), which framed in this way the game design. In addition, we added possibility to create borehole. In this fully analogical version, we had thus to make sure the quantity of artifacts manipulated by a player to be handable. For that reason, we could not remain with classical units and had to figure out what was the quantity of water represented by one pebble. As a side effect, we had to represent water in the river and pumped from the river in a different colour than water distributed by the municipality. This is interesting because it helps to make visible that water in the river and the fields cannot be substituted with water in the Municipality distribution network. There is an effect of scale and the quality (and hence the cost) is not the same. We then also attributed another colour to wastewater. The costs associated to each type of water are then more difficult to align and a dedicated comparative work was necessary, with fine tuning thanks to tests with colleagues and students. This fine tuning with colleagues and students has also allowed to improve the fluidity of the game play, with a focus on lay out of the game board and use of analogic elements to make game dynamics more visible. While feedbacks from test of preliminary version with Living Lab members brought pebbles to represent water, fine tuning added pebbles to represent alien plants dynamic.

This revised version keeps the same structure, with the same roles as in table 1. Table 2 below describes representations of water and table 3 the list of possible activities, with their inputs and outputs.

Table 4: resource representation in NMB WatEqS game

Resource	**Representation**	**Scale of representation**
River Water (for farming and municipal withdrawal)	Purple pebbles.	1 pebble = 1 000 ML of water
Municipal Water (treated for domestic and industrial consumption)	Blue pebbles	1 pebble = 400 ML of water
Rainwater (harvested and used to supplement municipal water)	Blue pebbles	1 pebble = 400 ML of water
Money	WAG Notes, R10 to R10 000	Rand value printed on paper
Water Tank	Drawing, purple pebbles placed on top of tank to indicate its capacity	1 pebble = 400 ML of water
Wastewater	Yellow pebbles	1 pebble = 400 ML of water
Litter	Stoney pebbles	1 pebble = 5 tonnes of litter
Wellbeing	Provision of Public Services	1 to 3, depending on applicable ratio
Alien Plants	Green Pebbles	1 pebble = 25 hectares of alien plants invasion

Table 5: activities simulated in NMB WatEqS

Action	**Needs (Input)**	**Produces (Output)**	**Constraints**
Farming	cash, raw water	cash	Arable land, cash and irrigation water are all available in limited quantities

Sewage Collection and treatment	Cash, Infrastructure (pipe network and treatment plant)	Raw water	This activity is not fully efficient. Only a fraction of waste water collected is transformed in raw water. Remaining wastewater goes into the river as well
Industrial technology investment	Cash	New Technology	Only three available investment choices, opening the way to substitute labour to water.
Domestic water use	Municipal Water, Harvested rainwater	Wastewater, Wellbeing	Only municipal water. No option to use groundwater and river water for household consumption
Industrial Production	Municipal Water, Harvested rainwater; Labour	Wastewater, Income	May use desalinated water as well as source of municipal water.
Corporate Social Responsibility investment	Cash	Support to DWS or P4	For households can be only as rainwater tanks
Municipal water production	Cash, Dams, raw water, Schemes, Desalination plant	Municipal Water	Constrained by the maximum capacity of infrastructures to produce from all the water sources, and water availability in river.
Increase dam capacity	Cash	Storage Capacity	Available budget
Investment in desalination	Cash	Municipal Water	Only for industrial use due to location close to the sea
Investment in sewage network	Cash	Efficiency (Sewage Network)	Available budget

Temporary employment acquisition		Income	Determined by temporary employment provided by Household 5, Household 6 and the DWS.
Alien plants removal	Cash, Labour		Available budget. Alien plants consume river water. Their removal increases water availability in the catchment
Gardening	cash, Municipal Water	Wellbeing	Only one of the two land use options available: either plant vegetables or flowers,

This version has marginally revised the game board in order to have it printed out in a cleaner way and mainly with all the possible routes for the different types of water represented. Figure 2 features this revised game board

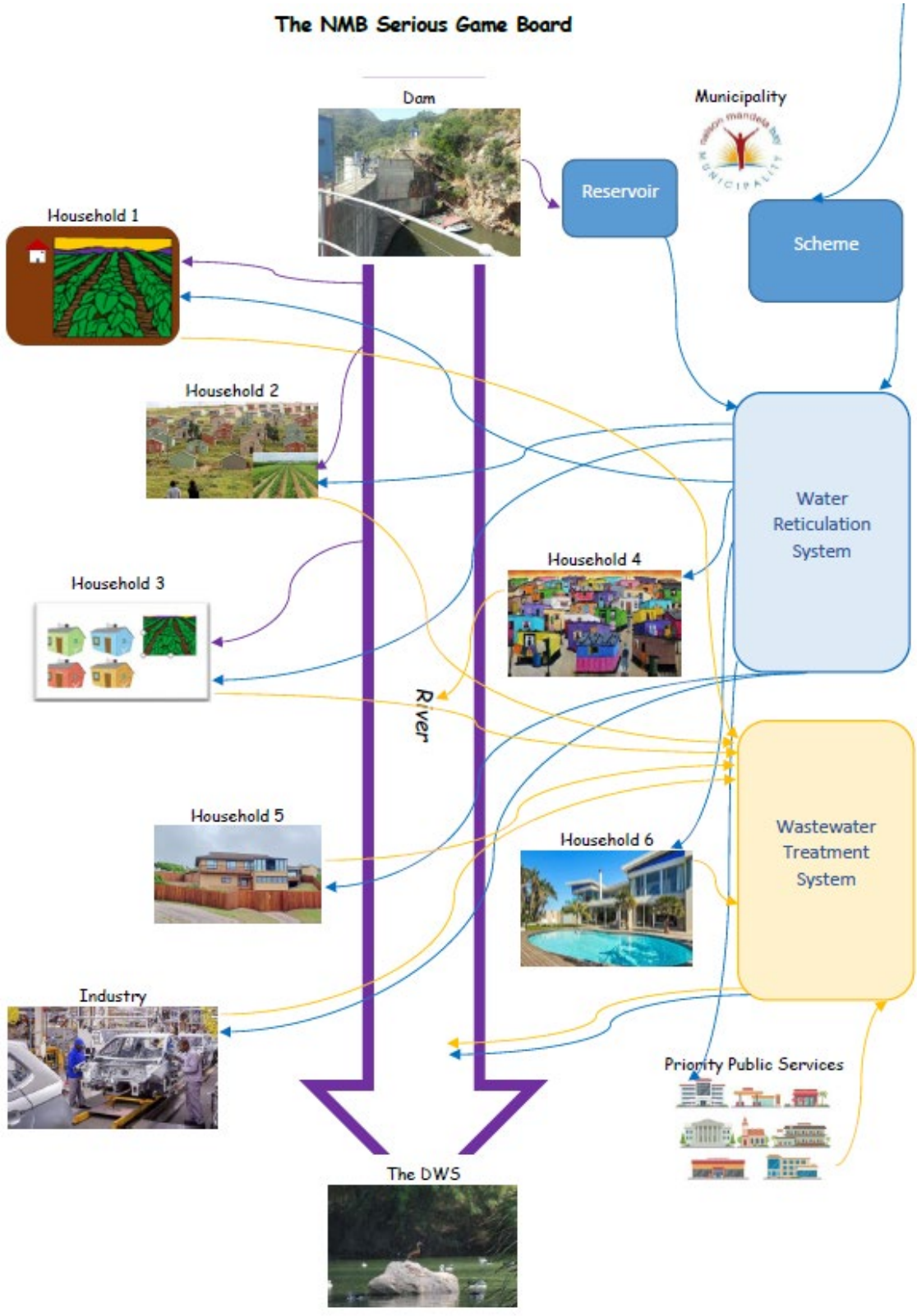

Figure 6: the NMB WatEqS game board

Calibration of this revised version is built on the same basis as the preliminary one, with corrections due to the shift to rounded figures and translation into pebbles, to simplify the use

in a fully haptic version and take into account some simplifications, such as the integration of inefficiencies of appliances. The last version of the role description is provided in the appendices

This revised version has been played by 26 participants, leading to the participants being grouped into units of 3 for each role. This was too much and made it difficult for the movements of players and led some to stay out of the collective dynamics. The best number to play this game is then 18 (2 per role). During the play, they were asked to fill out a decision sheet and observation sheet (one for each role). This was a way to involve all members of each group. However, the players did not pay enough attention to these sheets and some of them remained almost empty. Some more systematic guidance in game facilitation is needed to ensure this is correctly done and hence providing data to analyse.

This version of the game has been well received by players and hence we consider it to be validated as a correct representation of the Swartkops catchment social ecological system. The first indicator of this positive reception is the engagement of participants during the play, with far less use of smartphones by participants during the game session. From the game transcription, we observed that 11 players out of 26 were very active in the discussions during the game, representing all of the 9 roles. It appears that each role had one spokesperson. However, that does not mean that other members of each group endorsing a role were out as they were often the ones seeking explanations. The second indicator is the oral feedback in the final debriefing. Participants mentioned it was realistic. Municipality representative underlined that it captured the main issues that the municipality has to face in water management and planning. This is corroborated by the fact that other players reported in their observation sheet that they learned about the complexity of planning tasks for the municipality.

Link to objectives

Capacity to explore future pathways

This objective has not been fully tested. However, the session with the revised version has shown the capacity of the group of players to simulate the evolution of the catchment social ecological system as it is represented across several years with emergence of a drought. During the debriefing, all voices went into the direction of an easier artefact, hence more dynamic to explore future pathways. First, players mentioned that handy artefacts, like fake banks notes,

provided direct, visible and easy to understand feedbacks. This enables the generation of quicker answers and then to explore over a longer time horizon. Second, the game design provided the right handles to simulate the roles' behaviours. For example, the Municipality had to first pay attention to interactions with DWS and the lowest income roles, which were considered relevant. This increased the capacity of players to play along meaningful pathways. Third, players reported they could learn about system behaviour, such as the various water flows and then include this new knowledge in their own play in the game to explore pathways in a meaningful way. In addition, this learning can be included for their thinking beyond the game itself. This learning has been significantly increased in this session as the Municipality player was playing purposefully in a very transparent way. Transparency is necessarily increased in serious games due to the uniqueness of place and time, that make information shared by default. Players can see most of the others' situations and actions. In addition, the municipality player has voiced out all his choices all along the game to ensure that information reaches all players, who could then react accordingly in a meaningful possible pathway. Fourth, the use of groups of players for each role has pushed them to rely on partners to make decisions and justify them beyond too little elaborated beliefs.

However, one participant mentioned the lack of information on the origin of water, and rain in particular, making it more difficult to endorse the DWS role, which is more concerned with drought and mitigation, while the game is more focused on adaptation and sharing. Other (longer) sessions with a longer debriefing are needed to confirm this capacity of participants to engage in forward thinking and explore a diversity of pathways, and check if this limit or others prevent a thorough exploration of future pathways.

Equity dimension

The game has been tailored to handle equity in the following ways:

- Municipality and DWS players have to distribute water, which is intentionally less than potentially needed by water users
- Water users may invest to secure their water resources. The more they invest, the less they need to get water from a common source. However, they still benefit from public services attached to wastewater treatment and contribute less to its financing
- Solidarity may come variously: some roles may invest so that water is more available for others, either through setting water tanks at their own level or at the level of least

privileged who can afford these investments; some investments (borehole) are too expensive for a single player to invest but might be shared among several roles; in very dry year water users with higher financial means may get more expansive water (desal) and leave the rest to others.

Even though the game parameterization was somewhat generous with each role so that none was fully stuck due to lack of money (so that all players could play all along the simulation), the observation of the game could then provide information on how equity is handled as the resource is scarce. The municipality went through two strategies. First, it pushed for prioritising the least affluent households, as the most vulnerable, and the industry to ensure job and local revenues. However, in a second time with a less scarce situation, the municipality came up with a second, more egalitarian view on equity, alternating who would be considered first according to the previous round's priority choices. The solution of increasing capacity through investment, either in desalination or an increased interconnection scheme, which would have led to a fee increase, was not chosen or even discussed.

We could observe much less play on the DWS role side, with a more careful stance regarding budget and hence hardly any investment to limit water scarcity. The water sharing in the drought round was then rough due to increased water scarcity, leading all to lack water. There was still a clear priority on the domestic water supply side compared to farmers. This DWS stance opened the way for more controversies among players of who should be prioritized and why. The game has also been informative on the place of argumentation in discourses according to roles. Farmers mentioning specific higher-level rights to water coming from the dam close to their fields, referred to as a "Groendal law" and the need for food for all households that is met by their production, while the municipality called on the higher-level characteristic of domestic water: better being hungry than thirsty and dirty. When these controversies occurred, they made private interests come first, leading DWS players not to listen to the water demands.

Beyond the two dominant roles of Municipality and DWS, solidarity has occurred among other roles, with industry paying for water tanks to player 4 for example. Collaborative action from bottom remained at a low level though. Most players perceived that boreholes were too expensive for themselves, but none suggested a joint investment.

Reactions on the equity dimension in the situation of heavy drought revealed that participants have in mind that water is not managed in an isolated way. Player 1 (commercial farmer upstream) asked for a relief fund as soon as he could identify the prospect of major losses due to water shortage.

Perception of equity is another issue that the game informed. While six roles feature households with a whole range of water needs and affluence, the comparison in the debriefing was on the extremes to claim for inequity.

Beyond the equity issue, this game session was informative on other aspects of each role's conditions. The municipality could put forward its need to generate revenues and have a balanced budget. However, the most striking aspect that came out was the role of transparency that was intentionally performed by the municipality player, but also well analysed during the debriefing. Transparency could generate empathy, less heavy criticisms, and enable explaining limitations.

The game also informed on power relations and how they are demonstrated by who comes to whom. These power relations are a complex set of relations about money and water allocation. Hence, the municipality appears as the most powerful agent constraining the municipality on water, itself constraining DWS on money. DWS could have had a dominant position to municipality, but it did not materialise.

Further steps

As the game has been appreciated, opportunities to have it played within communities emerge.

Beyond appreciation during or right after the game session, a follow-up in the field would be meaningful. For example, in this session, the issue of transparency came through very strongly. The translation into a real situation is not that easy, though. The municipality representative who was attending explained he was trying to achieve this transparency through the publication of all similar information online. The impacts of online information sharing are still to be compared to those in the game.

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Appendix 2: Surveys and interview guides

HOUSEHOLD INTERVIEW

1. What is the name of this area?

(area, ward name/number)

2. When did the water crisis start?

(Do you remember a time when there was enough water? How long ago was that? When did water issues begin?)

3. What do you think is the main cause of the water crisis?

4. Where do you get your drinking water?

5. Where do you get the rest of the water you need?

6. Where is the nearest body of water to your home- dam/river/pond?

7. Do you access this? If so, for what? If not, why not?

8. Do you access water via any social networks?

(E.g., getting drinking water from a friend/family's rainwater tank/from a public place?) If so describe where from and how often.

9. Are there any subsistence/livelihood activities you have had to stop or cut down on because of a lack of water?

Distributive Equity

10. How would you describe the effect of the water crisis on your household?

11. What measures is the municipality implementing to manage the water crisis in your area (e.g., water cuts, hiking water tariffs, smart meters, etc.)?

12. Do you have a smart meter? Does it cut off water if you use over a certain amount?

13. How are these measures affecting you and your household?

14. How have you and your household responded to water restriction measures?

(e.g., if the prices went up do you pay these bills?)

15. Do you receive bills from the municipality for water use? How do these bills come?

16. Do you think the billing system is fair/not? Why?

17. How often are water cuts in this area, and how long do they generally last?

18. Where do you get water from when the municipality implements a water cut event/when taps are running dry?

19. Does the municipality provide an alternative water supply when taps are running dry, and if so, how does it do so?

20. Is there enough alternative water supplied during water cuts? Are these alternatives accessible to everyone? (Are there people who cannot access them?)

21. Have you ever made a water-related complaint to the municipality? If so, how did they respond? (e.g., reporting leaks, reporting faulty meters)

22. Have water restrictions affected your income, sanitation and/or general welfare?

(If yes, how?)

23. Does the municipality implement its intervention measures across all the various areas within the metro in the same way? Are some groups/areas more privileged? If so, why is that?

24. Do you think the municipality is dealing with the water situation within the Metro well/not well?

25. Has the municipality implemented any socio-economic measures to assist you in overcoming the water challenges?

26. Does the water crisis impact vulnerable groups more? (Such as the elderly, children, or those with limited resources?)

27. Do you think your community received adequate support during the drought?

28. Have you been actively involved in decision-making processes related to drought response and water management? If so, how? Do you feel your participation contributed to the choices/plans made when it came to dealing with water management?

Procedural Equity

29. Do you know which unit/division/institutions make decisions about water supply in the metro?

30. Do you think your needs are represented in water-related decision-making processes?

31. Does the municipality consult you regarding the various measures it has implemented to deal with the water situation? If so, how?

32. If there was consultation, how engaged/effective was it?

33. Do you think all socio-economic classes or groups are represented in the decisions that are made that relate to water? Are there some groups that are more privileged/listened to? Why?

34. How safe do you feel talking about water issues in a public setting? If you feel unsafe, why is this?

35. Does the municipality keep you and your household informed about the various intervention measures it is implementing? (e.g., water restrictions and rises in water tariffs). How?

Prompt: Do you get a letter in the mail, community meeting announcements, or a loud hailer speaker announcements informing you of changes to water access?

Contextual Equity

36. What do you think is the main factor that affects the way your household is able to cope with the water crisis?

37. Do you think municipality takes into account the economic conditions of households when it comes to water security? (Would you say there are measures put in place to assist more vulnerable households?) If so what?

(Do you think the various water security measures implemented by the municipality speak to the lived realities of households in the Metro?)

38. How does the availability of alternative water sources, such as boreholes or rainwater

harvesting, vary across different areas of the metro. Are there alternatives you would like to access that would help improve the resilience of your household during droughts? What is the main reason they remain inaccessible?

Implementing Environment

39. Does the political environment in the Metro affect water services delivery? If so, how?

40. Do you think the municipality has the technical capacity to deliver water and sanitation services?

41. How would you describe the state of water infrastructure and maintenance in the metro? Does this affect the municipality's ability to deliver on water and sanitation services?

42. What would you say about how the legacies of apartheid have affected water and sanitation services delivery in the Metro?

(e.g., Do you think problems with water service delivery is still a result of the legacy of apartheid, or is it that NMB now has more people than there is water available, or is it that the municipality is not maintaining/fixing water infrastructure?)

43. What needs to be done to prevent a water crisis in the future?

44. How can the municipality improve water security in your area?

MUNICIPAL OFFICIAL INTERVIEW

1. When and how did the water crisis start?

2. What do you think is the main cause of the water crisis?

3. Which intervention strategies has the municipality implemented to manage the water crisis?

4. What policy and strategy documents has the municipality developed regarding the water situation?

Procedural Equity

5. Which institutions make decisions about how the metro manages the water crisis?

6. Which stakeholders does the municipality involve when making decisions about management of the water crisis?

7. Please explain the nature of this involvement?

8. Which platforms of communication does the municipality use when engaging with stakeholders (e.g., community meetings, radio, social media, loud hailing speakers etc).

9. How does the municipality ensure that everyone feels that their views are respected and taken into account during decision-making?

10. How does the municipality consider all inputs from different stakeholder groupings?

11. What mechanisms exist to protect stakeholders who may not hold the same view as municipal officials and other people in authority?

12. How does the municipality inform people within the Metro about the different measures that it has implemented regarding the drought?

13. How are households in the different suburbs, businesses, and farmers responding to the water situation in the Metro?

14. How would you describe how households, businesses, and farmers responded to the implementation of the municipal intervention strategies regarding the water situation?

15. How does the municipality gather feedback from households, businesses, farmers and other water sector users about how they experience different municipal drought management strategies?

16. How would you describe the efficiency and regularity of payment of water bills by the different households, businesses, farmers and other sectors?

17. What challenges, if any, have you experienced with the implementation of the municipal response measures regarding the water situation?

Distributive Equity

18. How does the municipality implement water cuts, pressure regulation, and tariff changes across the different suburbs/locations/townships among businesses and other water users groups?

19. What has been your experience in terms of how the municipal intervention strategies affect households in the different suburbs/locations/townships within the Metro?

20. When designing the various intervention measures, how does the municipality account for the social, economic, political and historical differences among different households within the Metro?

21. Are there particular suburbs/locations/townships within the municipality where water bills are not regularly paid, and if so, what might be the reasons?

22. In cases where water bills are not paid, what steps does the municipality take to address the problem?

23. Are there particular suburbs/locations/townships within the municipality where water leaks are most reported, and if so, what might be the reasons?

24. How would you describe water consumption among the various suburbs/locations/townships within the metro?

25. What targeted interventions exist in suburbs/locations/townships where water consumption is very high?

Contextual Equity

26. Do you think there are certain classes of people who are affected by the drought more than others, and if so, what is the municipality doing to respond to this?

27. Does the municipality implement the same drought management strategies (e.g. water cuts, raising water tariffs, etc.) across all settlements (informal settlements, affluent suburbs, farmers, businesses, schools, hospitals)?

28. On average, for how long does a water cut event last, and how many times a week do you implement water cuts?

29. Does the municipality provide an alternative water supply during a water cut event (e.g., water trucks), and if so, do you do it to all settlements?

30. How does the municipality work out what alternative water sources to supply to which areas? (e.g., how many water trucks, where, how often?)

31. How are the socio-economic conditions of the Metro affecting its ability to adequately respond to the water situation?

32: How would you describe the water infrastructure maintenance culture of the municipality?

33: What challenges exist regarding water infrastructure maintenance within the municipality?

34: How would you describe the budgetary allocation to water and sanitation-related matters within the Metro?

35. How would you describe the current political and administrative arrangements within the Metro and its impact on water services delivery?

36. How would you describe the legacies of apartheid planning and water service management within the Metro, and the impact this has on water services delivery?

37. How would you describe the technical capacity within the Metro to equitably, efficiently and sustainably deliver water and sanitation services?

38. Can you describe how the geographical locations of the Metro may have contributed to the water security situation within the Metro?

39. How does the municipality's water infrastructure maintenance affect its ability to effectively and equitably respond to the water crisis?

40. The 2017 Cape Town drought experience produced a lot of lessons on how to manage a water crisis event. How would you say some of these lessons apply to the NMBMM?

41. What do you think must be done in order to enable the NMBMM to implement some of the lessons learned from Cape Town's drought management strategies?

42. What do you think the municipality needs to do in order to mitigate the effects of drought

events in future?

NGO INTERVIEW

1. When and how did the water crisis start?

2. What do you think is the main cause of the water crisis?

3. How has the crisis impacted households of different socioeconomic classes and businesses?

4. What steps are you taking to help businesses and households most acutely affected by the crisis?

5. How are stakeholders (including residents, the municipality and businesses) responding to the steps that have been taken to abate the crisis?

6. Are you getting sufficient support from the government to help respond to the water crisis?

7. Are your drought intervention strategies aligning with those of the municipality?

8. Do your support strategies to respond to the crisis take into consideration varying household and business needs?

Prompt: Have you tailored support based on income and need?

9. What needs to be done to prevent a water crisis in the future?

10. Do you work in collaboration with other organisations in your efforts to mitigate the impacts of the drought, which ones are they?

11. Do you think the municipality is considering equity (e.g., involving the voices of stakeholders in decision-making, distributing help according to need, and considering the reality that people have different social, economic, historical and political backgrounds which affect their vulnerability to the effects of the drought?

12. What do you think the municipality needs to do in order to be able to respond effectively and equitably to the water crisis?

Survey Questionnaire

Demographic Section

1. How many people live in your household? _____

2. How many people are working in your household? _____

3. What is the name of the area (location, township/suburb/) you reside?

4. What is your sex ?
   a. Male
   b. Female
   c. Prefer not to say
   d. Other

5. What is your monthly household income?
   a. R 1-3,500
   b. R 3,501-6,000
   c. R 6,001-10,000
   d. R 10,001-15,000
   e. R 15,001-25,000
   f. Above R 25,001

6. What is your main source of income?
   a. formal employment
   b. self-employment (select if say farming), please specify
   c. informal employment, please specify
   d. social grants
   e. remittances
   f. other, please specify

7. What is the gender of the head of your household?

8. What is the age of your head of household?

9. What is the highest educational level of your head of household?

10. Does your head of household live with a disability or not?

11. What is the category of your settlement (informal, low-income RDP but formal, affluent suburb)

12. How often do you see leaking municipal pipes in your community?
    a) Very often
    b) Often
    c) Occasionally
    d) Never

Access to Water Section

13. Where do you get **drinking water** from (you can choose more than one answer)?
    a. Tap in my house
    b. Communal stand tap
    c. Tanker
    d. Rainwater
    e. River
    f. Bottled Water
    g. Other, please specify _____

14. Where do you get your water from for other uses besides drinking? (check all that apply or do we want their main source of water?)
    a. Tap in my house
    b. Communal stand tap
    c. Tanker
    d. Rainwater
    e. River
    f. Bottled Water
    g. Other, please specify _____

15. Besides water for domestic use (cooking and drinking), what else do you use water for?
    a. Irrigation of backyard gardens
    b. Car washing
    c. Irrigate lawn
    d. Swimming pool
    e. Flushing of toilets
    f. Other, please specify ___

16. Has the municipality raised water tariffs in your settlement?

17. If so, the increase is from how much money per liter to how much now?

18. How confident are you in the municipality's ability to manage the water crisis effectively?
    a. Not at all confident.
    b. Not confident.
    c. Neutral.
    d. Somewhat confident.
    e. Very confident.

19. Do you participate in community meetings about water issues?
    a. Yes
    b. No
    c. Cannot say

20. Do you agree with the following statement? All people are informed in time about impending municipal water restrictions.
    a. Strongly disagree
    b. Disagree
    c. Neutral

d. Agree
e. Strongly agree

21. Do you agree with the following statement? The municipality has done a good job managing the water crisis.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

22. What is the primary cause behind the water access in the Nelson Mandela Bay municipality?
    a. climate change
    b. Normal drought cycle
    c. There is not enough and well-maintained water infrastructure to deliver water to our households.
    d. Water is there but it's not treated, so it's not suitable for human use.
    e. Water is there, but it is too expensive
    f. The fault of the municipal government.
    g. There are not enough qualify technical people
    h. There is not enough budgetary allocation to water and sanitation services
    i. Political instability in the municipality
    j. Other, please specify _____

Procedural Equity

23. I do not participate in community meetings about water issues because:
    a. I do not have time
    b. I feel shy to speak in meetings
    c. I am scared of being victimized if I speak against the authorities
    d. I do not know when they take place
    e. I do not think my participation will result in any changes
    f. I do not think I know enough to meaningfully participate
    g. Other, please specify

24. If at all, how would you describe how the municipality consults household in its water related decision?
    a. Regularly consult
    b. Occasionally they consult
    c. Rarely consult
    d. Do not consult at all

25. How do you feel your voice is represented in how the municipality is responding to the water challenges in the Metro?
    a. The decisions made by the metro adequately reflect my voice
    b. The decisions made by the metro occasionally reflect my voice
    c. The decision made by the metro has never reflected my voice

26. Do you agree or disagree with the following statement: The metro tries hard to ensure that its decision is a reflection of all social-economic classes or groups living within the Metro
    a. Agree

b. Strongly Agree
c. Disagree
d. Strongly disagree

27. Please tell us more about your response to the question above.

Distributive Equity

28. Where do you get water from when the municipality implements a water cut event/taps are running dry?
    a. Borehole
    b. Rainwater
    c. River
    d. municipal water tanker
    e. Water tanker from other organisations like NGOs
    f. Grocery store (e.g. Pick n Pay, Checkers)
    g. Neighbours and relatives
    h. Wait until the municipal water is back
    i. Other, please specify _____

29. What has been the impact of the increase in water tariffs on your household? (check all that apply) (ask if respond yes to related question)
    a. I am not able to pay for other household necessities such as enough food.
    b. I am not able to pay for medicine.
    c. I am not able to pay for my children's education
    d. I have reduced the amount of water my household uses per month
    e. I have not felt any effect at all
    f. Other effects, please specify

30. What have been the impacts of water restrictions on your household? (check all that apply)
    a. I spend a large portion of my day collecting water and do not have time for other things.
    b. I do not have access to enough drinking water.
    c. I am not able to bathe as much as I need to.
    d. I have had to change the foods I eat because I do not have enough water to cook.
    e. I am unable to clean my house as I normally would because of the lack of water.
    f. I am unable to garden.
    g. I am unable to clean my clothes as frequently as I might otherwise because I do not have enough water.
    h. Other, please specify _____

31. Do you agree or disagree with the following statement? I am able to pay for water services.
    a. Strongly disagree
    b. Disagree
    c. Neutral
    d. Agree
    e. Strongly agree

32. On a scale of 1-5, where 1 is the least serious and 5 is the most serious, rank the following municipal actions in terms of their impacts on your households

Municipal actions	Scale 1 - 5
Increased water tariff as a response to the drought	
Water cuts and water rationing	
Awareness raising and education	
Municipal water billing system	
Fixing of leaking pipes	
Restriction of pressure in the tap	

33. On a scale of 1 – 5, where 1 is the least effective and 5 most effective, rate the effectiveness of the following municipal measures in response to the water situation. Rate 0 if you do not have enough information to inform your decision.

Municipal measures	Scale: 0 -5
Use of underground water sources	
Bringing in additional water through the inter-basin transfer scheme	
Repairs of water infrastructure	
Fixing of leaking pipes	
Water cuts and rationing	
Education and awareness	
Raising of water tariffs	
Restricting the flow pressure	

34. How would you rate the quality of the municipal water that comes to your household?
    a. The water is always clean, and we can drink it
    b. The water is sometime clean, and we can drink it when it is clean'
    c. The water is smelly, and we do drink it
    d. The water is always looking bad and we do not drink it

35. In response to the question above, please tell us more about the quality of the municipal water.

36. How reliable is the supply of water to your households during the drought?
    a) The water supply is very reliable and whenever there is a cut, the municipality tells us
    b) The water supply is reliable but whenever there is a cut, the municipality does not tell us
    c) the water supply is not reliable, and we cannot predict when the water will be supplied or not.

37. Whenever there are water cuts, tell us how you deal with such water cuts.

Contextual Equity

38. How would you describe the current political arrangement in the metro viz-a-viz water supply and sanitation services?
    a. The political environment is conducive and favourable to water supply and sanitation services
    b. The political environment is unstable and no adequate attention is given to water supply and sanitation services
    c. The political environment is unstable and has negatively impacted the supply of water and sanitation services.
    d. Do not know.

39. Which of the following has the greatest impact on your ability to deal with the water crisis in your household. Rate them on a scale of 1- 5, where 1 is the one that has the least impact and 5 the one that has the most impact

Item	1. 5
Household income	
Legacies of apartheid	
The number of people in my households	
Technical knowledge on water	
The place I reside	
Others, please specify	
Not being part of the decision on how water is managed by the municipality	

40. Please tell us what you think the municipality must do to alleviate the water situation.

41. Please tell us what you are doing to alleviate the impact of the water situation. How?