Governing groundwater flows for growing cities facing drought risks

GoFlow project: Nelson Mandela Bay Learning Lab 1 Report
March 2022

Introduction

The first GoFlow Learning Lab event in Gqebera (Port Elizabeth) was held on Wednesday 10th and Thursday 11th March 2022 at the Summerstrand Guest House conference centre. This report shares a summary of the presentations, exercises and discussions held during the 2-day workshop focusing on sustainable groundwater flows in the Nelson Mandela Bay city region.

The *Governing groundwater flows for growing cities facing drought risks* (GoFlow) project is designed to integrate natural and social science aspects of sustainable groundwater management. It does so to strengthen collaborative capacity to adaptively manage groundwater flows in and around growing urban areas under changing climate conditions. The focus is on the Nelson Mandela Bay (NMB) and Cape Town city regions as 'learning laboratories' for developing knowledge that could be applied in other urban contexts. The GoFlow project is implemented by the University of Cape Town and funded by the Water Research Commission. The project runs from April 2021 to March 2023.

The GoFlow project entails:

1. Conducting an urban water metabolism analysis for the Cape Town and Nelson Mandela Bay city regions by quantifying all anthropogenic (bulk supply, consumption, wastewater) and hydrological (precipitation, evapotranspiration, runoff, recharge) components of the urban water cycle and highlighting knowledge/data gaps. The Cape Town analysis builds on the work already done by F. Atkins, T. Flügel, and R. Hugman (2021)[1].
2. Using the urban water metabolism analysis, exploring urban recharge processes under a range of likely hydrological shifts (long-term trends) and extremes (magnitude and frequency of drought) and urban spatial planning / land cover scenarios (with a focus on imperviousness) for 2040-2060.
3. Analysing current institutional arrangements for groundwater governance at the city regional scale to explore the actors involved, what role they play, the relations between

[1] For details see Atkins, F., Flügel T. and Hugman, R. 2021. The urban water metabolism of Cape Town: Towards becoming a water sensitive city. South African Journal of Science. 117, 5/6 (May 2021). DOI:https://doi.org/10.17159/sajs.2021/8630

them, and the varying levels of influence they have over the sustainability and resilience of groundwater flows.
4. Facilitating multi-stakeholder Learning Lab engagements around the applicability of the urban water metabolism analysis and scenarios to improve understanding of groundwater as part of the larger urban water cycle and strengthen participation in making, implementing and modifying the rules of the groundwater resource regime to adapt to changing hydrological and urban conditions.

The UCT GoFlow team consists of Dr Anna Taylor, Dr Ffion Atkins, Dr Christopher Jack and Naadiya Hoosen. The project is guided by a Reference Group chaired by Mr Yazeed van Wyk (WRC) consisting of Dr Kirsty Carden (FutureWater Institute, UCT), Dr Kornelius Riemann (Umvoto Africa) and Dr Kevin Pietersen (UWC).

Drawing on the design and learning from the first Cape Town Learning Lab held in November 2021, we designed this first NMB Learning Lab to engage participants on the current state of knowledge and concerns about Nelson Mandela Bay's groundwater systems - spanning the socio-economic, infrastructural, biogeochemical and governance aspects. We collectively mapped who plays various roles and has what stake in and influence over Nelson Mandela Bay's groundwater flows. We showcased and opened up collective thinking on how an analysis of urban water metabolism could potentially be useful within groundwater planning, management and regulation processes. The next section briefly introduces who was involved, before moving on to the details of what was covered in days 1 and 2 of the event.

Participation

A range of knowledge holders relating to groundwater use, sources, flows, quality, recharge processes and governance arrangements and processes were invited to attend and contribute to the first NMB Learning Lab event. The list of invitees included experts from Nelson Mandela Bay Municipality, Department of Water and Sanitation (DWS), Zutari, World Resource Institute (WRI), Nelson Mandela University, Nelson Mandela Bay Business Chamber, and Coega Development Corporation.

See Annex 2 for the list of those who participated in the event. Many thanks for sharing your time with us. We hope that others will be able to join us at the two further Learning Lab events planned for August and November. This will hopefully contribute to growing a groundwater Community of Practice in Nelson Mandela Bay, strengthening connections across academia, government, civil society and the private sector.

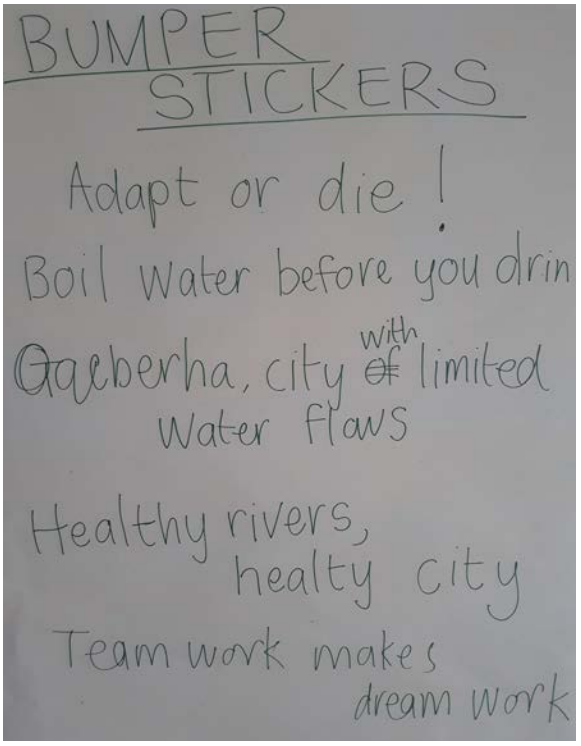
Day 1

Introductions

The first day of the event began with welcoming everyone and outlining the goals of the workshop. Ffion Atkins gave an introduction to the GoFlow project, sharing the ambitions, objectives, modalities and timeline of the project. She explained that this project emerged from responding to a Directed Call from WRC to deal with sub-surface water in growing urban areas.

The UCT team proposed to explore how application of the Urban Water Metabolism Framework (UWMF) could be useful to support decision-making around the use, regulation and monitoring of groundwater at the city regional scale. This exploration would focus on Cape Town and Nelson Mandela Bay as two cities that have or are experiencing severe water stress. Water metabolism analysis has already begun for Cape Town that could be built on and expanded, with a focus on the potential value and utility of the information to various actors. Nelson Mandela Bay provides a case to test the UWMF applicability and utility in a more data scarce environment, and compare and contrast the governance arrangements (between public, private and civil society actors) shaping decision-making with those in Cape Town. See slides for details: GoFlow_Project overview NMB.pdf

This was followed by an exercise to 'break the ice' and a round of introductions. Acknowledging the drought and acute water crisis that the city is grappling with, the ice-breaker involved working in groups (see photo below) to come up with a bumper sticker addressing an aspect of climate change, cities and/or groundwater, as shown below.

Bumper stickers ● Adapt or die ● Boil water before you drink ● Gqebera, city with limited water flows ● Healthy rivers, healthy city ● Team work makes the dream work	

People then moved around the room introducing themselves to someone they had not met before and discussing what their role is in the water sector, one thing they hoped to contribute to the workshop and one thing they hoped to get out of being at the workshop. Afterwards participants introduced the person they met to the rest of the participants.

Photo: Workshop participants discussing their ideas for bumper stickers

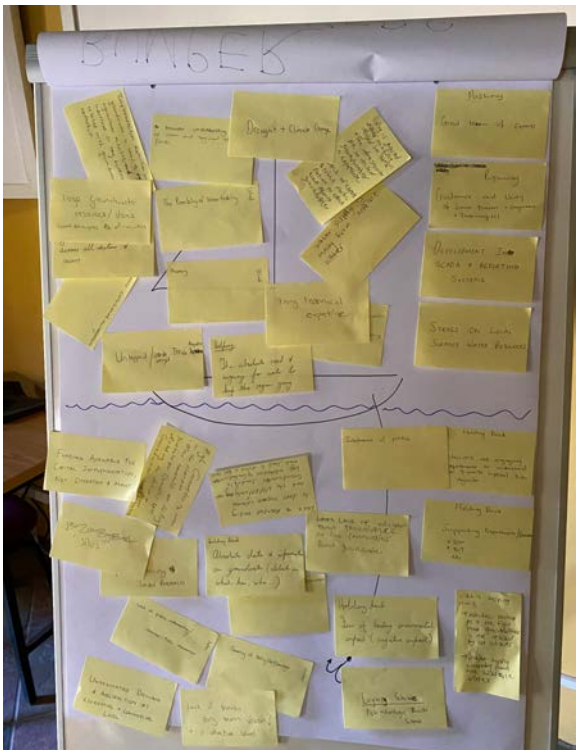
Naming & framing

Recognizing the importance and implications of how issues are conceptualised, framed and named (i.e. the terms used to carve out, label and describe an issue or problem), we then moved into a session designed to surface how people see and think about NMB's groundwater issues, coming at it from both positive and negative perspectives. Using the metaphor of a sailboat, we asked workshop participants to jot down on post-it notes what in their view is (1) moving us forward in terms of sustainably bringing groundwater use into NMB's urban water cycle (i.e. the wind on our boat's sail) and (2) what is holding us back from doing so (i.e. anchoring the boat).

What is helping us move forward towards sustainable groundwater use in NMB?

- Large groundwater resources / stores
- Good examples of conjunctive use
- General interest and activity across all sectors and users
- A broad understanding of urban and regional water flows
- Necessity
- The absolute need and urgency for water to keep the region going
- The possibility of water security
- Groundwater is an underutilised resource and naturally recharged
- Drought and climate change is prompting action
- Stress on local water resources
- Adequate catchment management
- Potential of the untapped resource particularly the TMG aquifer
- Strong technical expertise
- Guidance and unity of senior director, engineers and technologists
- Development in SCADA and reporting systems
- Integrated planning for water between city, agriculture, regional and national govt
- The need and necessity to find solutions to the current water crisis

- Excellent monitoring and reporting systems capacity
- The growing general awareness of groundwater resources as a viable measure to augment supply
- Restrictions on surface levels flows galvanising an interest in groundwater



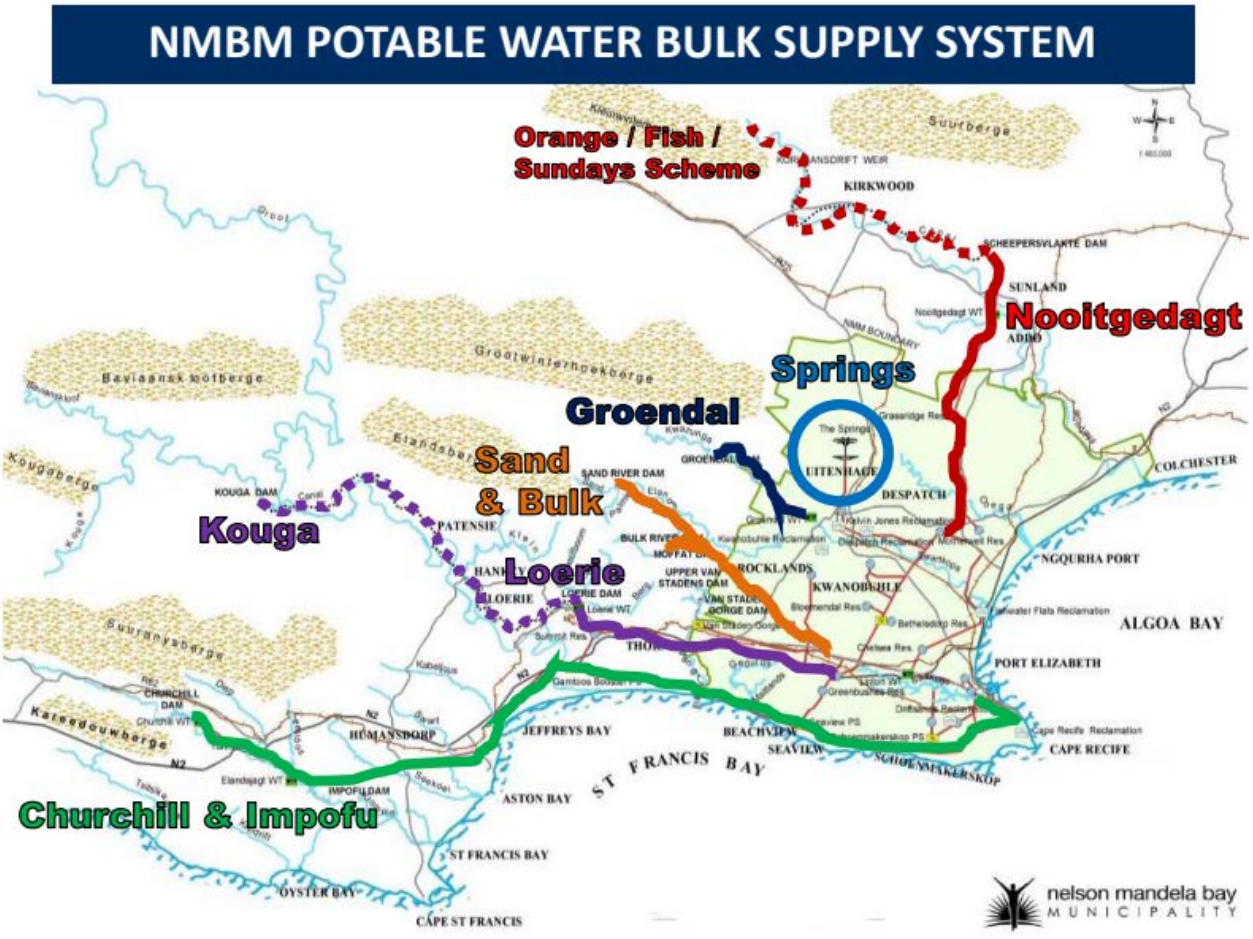
What is holding us back from sustainable groundwater use in Nelson Mandela Bay?

- High per capita consumption level
- Funding available for capital expenditure on infrastructure but not sufficient funding for operations and maintenance
- Historical investment into surface water
- Misaligned political interests
- Interference of politics
- Politicians not engaging with departments to understand the system and instead pushing own agenda
- Working in silos
- Lack of coordinated planning and transversal management
- Lack of support from key corporate services departments/divisions, notably supply chain management and budgets and treasury
- Retarded development of groundwater resource due to legacy of Orange-Fish-Sundays transfer scheme
- Lack of monitoring of groundwater usage and consumption
- Insufficient accurate data and information on groundwater resources
- Low political will
- Lack of a long-term holistic vision at the collective level
- Insufficient amount of technical knowledge, skills and expertise in groundwater sector
- Low public awareness and understanding of how to manage groundwater resources
- Lack of education amongst communities about groundwater
- Poor public communication and participation
- Fear of causing permanent environmental damage
- Unregulated drilling and groundwater abstraction in domestic and commercial sectors leading to decline in water levels

Building on related work

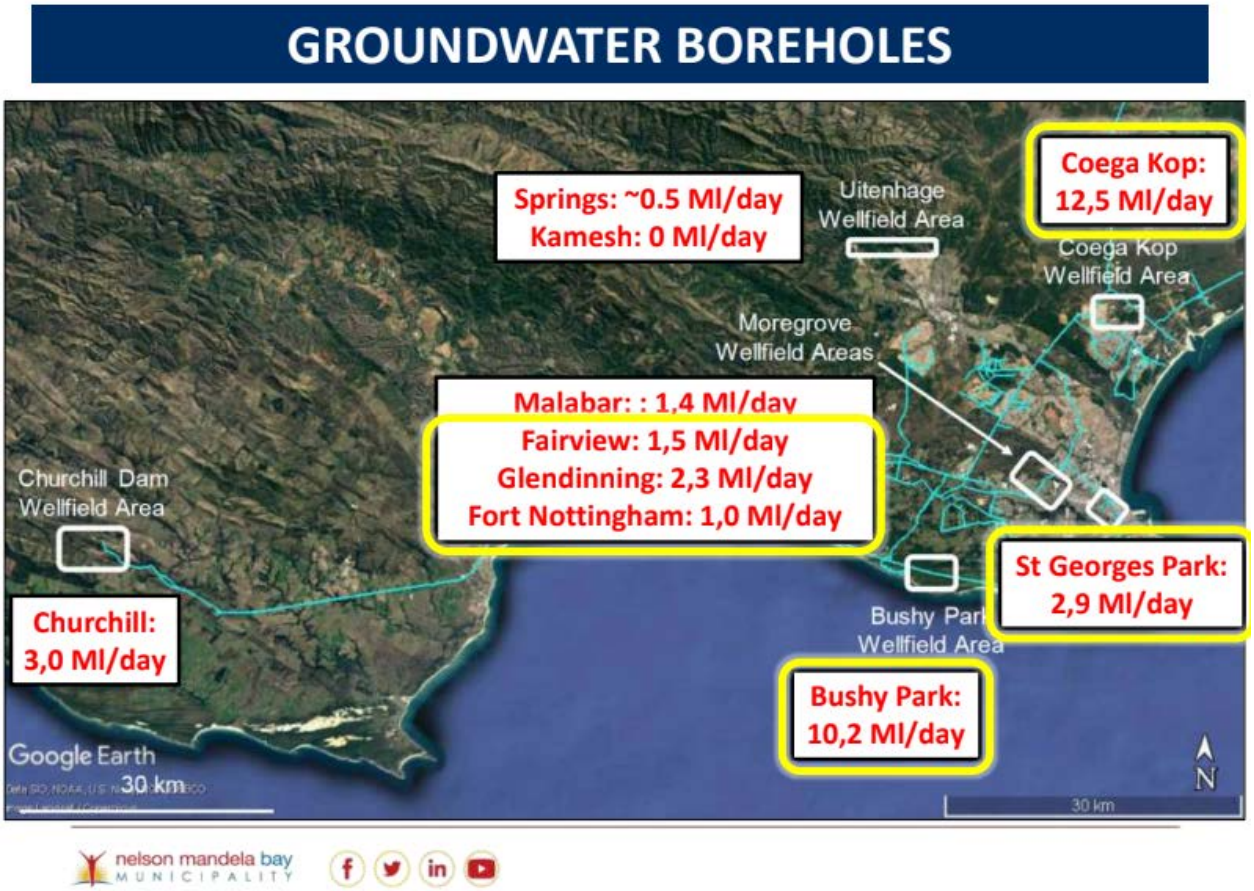
To situate this project within the landscape of related work, we had a series of presentations on related groundwater and water resilience work to learn what others are / have been doing.

We first heard from Matthew Hills, civil engineer from the Research and Planning Directorate of the Water and Sanitation sub-directorate in the Nelson Mandela Bay municipality. He provided an extensive overview of the NMBM water supply system, the drought response and the plans for increasing groundwater supply. He started off by discussing the Orange river as the lifeblood of South Africa, which has been crucial for NMBM water supply. Water is transferred to NMBM via the Orange/Fish river transfer scheme and the lower Sundays River water scheme. NMBM potable water bulk supply system comprises several dams and supply systems: Churchill and Impofu, Kouga and Loerie, Sand and Bulk, Groendal, Uitenhage Springs and Nooitgedact which supplies the water from the Orange/Fish/Sundays scheme (as shown in the map below).



Matthew shared that dams are severely stressed, with capacity currently sitting at 15.68% of total capacity, with most recent rain falling at the coast with no significant events in the catchments. For any change to dam levels to occur, a minimum of 50mm of rain needs to fall within a 24 hour period to create sufficient runoff. Moreover, there have been restrictions imposed by DWS on NMBM reducing the amounts of water the city is allowed to extract from the dams, another challenge the city must contend with. Current water consumption is at 285.44 Ml/day, but it has been estimated that there is a need to reduce NMBM water consumption to 230 Ml/day. Matthew provided an overview of the groundwater plans and projects being

implemented as part of the drought mitigation plan, indicating the most viable wellfields are: Moregrove; Bushy Park and St. George's Park and Coega Kop (as shown below).

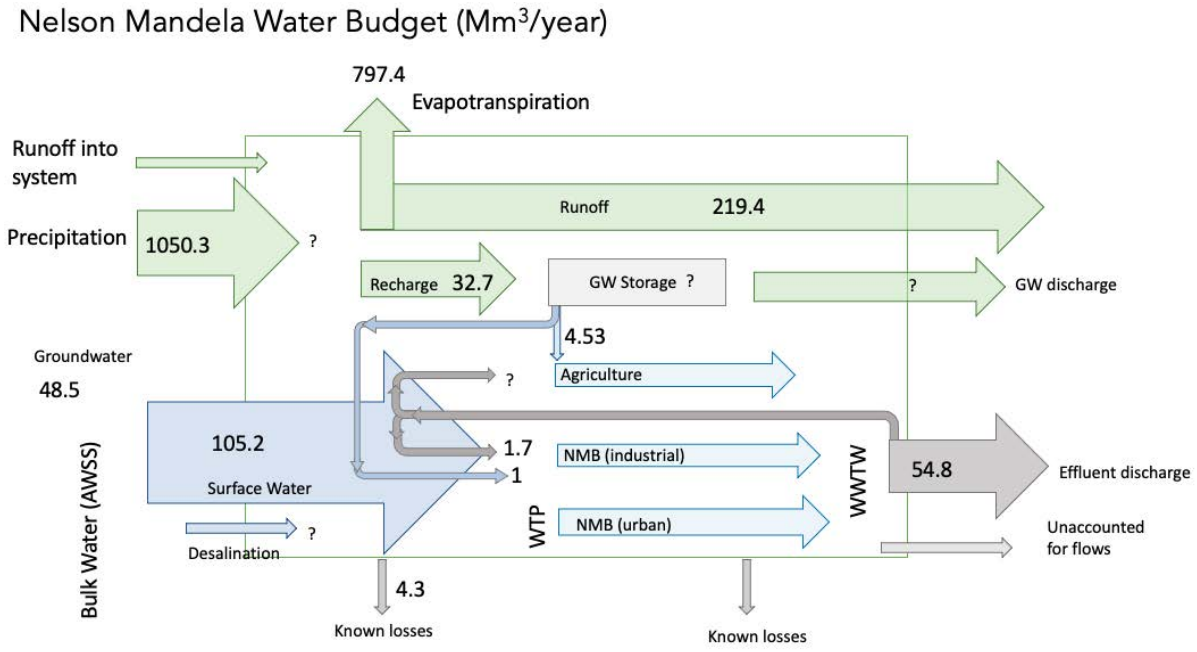


The water treatment plant for Coega Kop borehole is 76% complete and could be supplying water by September. In total, groundwater is estimated to supply up to 12% of total water supply to NMBM. For further details see the presentation:

Mathew Hills NMBM Groundwater Governance Workshop - 2022.03.10.pdf

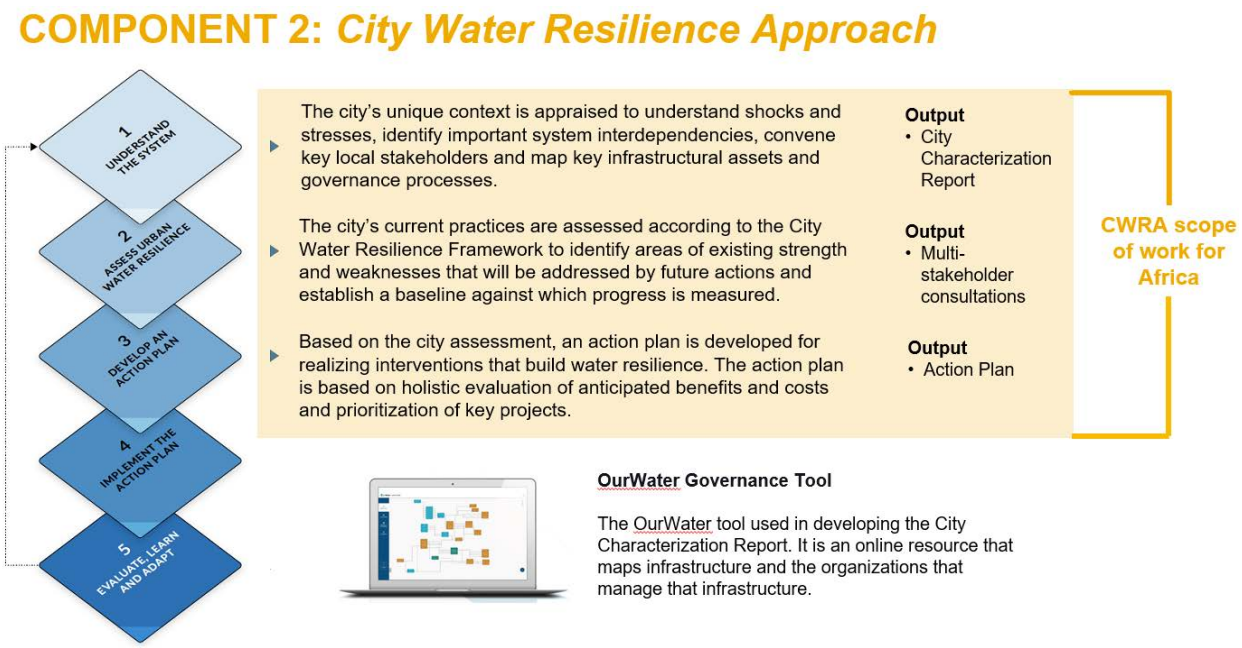
Next, Ffion presented the current progress made with the urban water metabolism analysis for NMBM. She started by giving an overview of urban water metabolism in the Australian context, having been developed at the Cooperative Research Centre for Water Sensitive Cities. Urban metabolism is a conceptual framework that, considering the city as a system, describes and quantifies the flows of water, energy and other materials that enter a city, are used or stored, and leave the city. It draws attention to how to increase the efficiency with which materials and resources are used and reused in a city and wastage reduced, in order to reduce the footprint and ecological impacts of the city. Previous work of the urban water metabolism of Cape Town was presented. This work applied the urban water metabolism framework to the City of Cape Town and assessed how water sensitive it is, under baseline 'pre-drought' conditions, and under the scenario of bringing in alternative water supplies as stipulated in the New Water Programme. The first iteration of the UWMF analysis for NMBM was presented, involving firstly a conceptual illustration of the current water cycle - an integration of both hydrologic (rainfall, evaporation, runoff and recharge) and anthropogenic flows (bulk water supply, demand, treated effluent, losses, reuse, agricultural and industrial use). Details of the data, sources and methods for the hydrologic and anthropogenic flows of water of the NMBM were given, as well as the spatial estimates of the hydrologic flows. Flows of water into, within and out of the system boundary

(NMB metropolitan boundary) were presented as preliminary results of the UWMF. There remain several questions surrounding the portion of water supplied which goes to agricultural and industrial uses, and how much groundwater is actually abstracted for such purposes. After the discussions that occurred on Day 2, the system boundary will be extended to include the municipalities that also form part of the Algoa Water Supply System.



Further details can be found in the presentation, available here:
Ffion Atkins NMB_UWMF.pdf

Following this, Amanda Gcanga introduced the World Resource Institute's (WRI) work on Urban Water Resilience in Africa. This programme aims to help cities navigate water challenges in the context of growing urban populations, watershed degradation and increasing water demand and water stress by strengthening governance interlinkages and shifting to a broader more integrated approach. The programme provides technical support to enhance capacity, centering around a partnership with the cities to improve enabling environments for collective action. They hope to mainstream the urban water resilience lens. The programme utilises a benchmarking framework to characterise the city, looking at the various shocks and stresses that apply. Key stakeholders are enlisted to assess the city's water resilience to better focus the city's actions to address any weakness. With this information action plans are developed that address areas of weakness showing how cities can build resilience against shocks. Finally, partnerships that can facilitate the implementation of these plans are identified. Amanda also introduced the city characterization work being done via desktop with the help of Zutari, building on similar work done in Cape Town and Joburg.



The Our Water tool to visualise stakeholders and the water cycle including infrastructure in a city's water system was showcased as one of the ways WRI is providing technical support to researchers, practitioners, government organisations to facilitate a resilience shift. For more information please read the WRI report entitled 'Water Resilience in a Changing Urban Context: Framing Africa's Challenge and Pathways for Action'.

Introduction to influence mapping exercise

Prior to lunch, Anna introduced some concepts for the mapping of groundwater governance arrangements exercise that will be undertaken on day 2. She asked participants to think about the various roles and activities that stakeholders could be performing in the groundwater sector, based on the definition of groundwater governance provided by Foster and Garduño (2013) as the exercising of political, economic and administrative authority to shape the course of decisions and actions taken to allocate, utilise and protect groundwater resources. These activities and roles include monitoring, researching, enforcing, licensing, financing, installing, maintaining, impact assessing, protecting and communicating. Activities such as rehabilitating and conserving ecological health, politicking (i.e. activity undertaken for political reasons or ends), advocating, and reproducing social norms were added as suggestions by participants (as shown below).

Day 2

Groundwater governance influence mapping

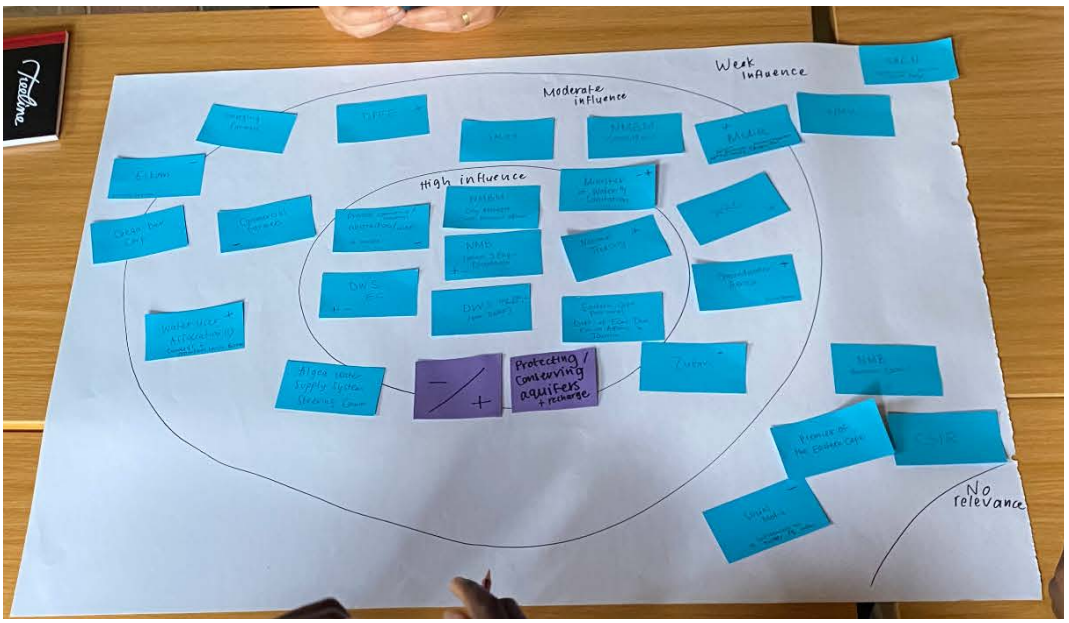
Day 2 kicked off with a recap of day 1 and an overview of day 2's goals and intentions. This was followed by an interactive group exercise building on the introduction to activities and processes performed by various actors in the groundwater space that was done on day 1. Participants first helped validate and clarify which organisations are present in the groundwater space.

Information about the presence of water user organisations such as the Sunday's River Irrigation Board and the Lower Sundays River Water User Association was revealed. Participants confirmed that in the case of NMB private schools and private hospitals were installing boreholes for self-supply, not public schools and hospitals as in the case of Cape Town with the support of Western Cape Departments of Health and Education. Comments from participants also highlighted the presence of industrial groundwater users such as Coca-Cola, Aspen & Volkswagen (VW) as being key players.

To begin the groundwater influence mapping exercise we split into two groups. Each group was supplied with a large sheet of paper and small cards with the various actors and actor clusters working in the groundwater space (including some which had just been identified and validated). These included private water users (domestic, commercial, industrial, agricultural and public e.g. schools, hospitals, parks), consultants, various Divisions and Departments of the Nelson Mandela Bay Municipality, other local municipalities, various Divisions of the National Department of Water and Sanitation, Eskom, NGOs / intermediaries, research / academic institutions, and funders.

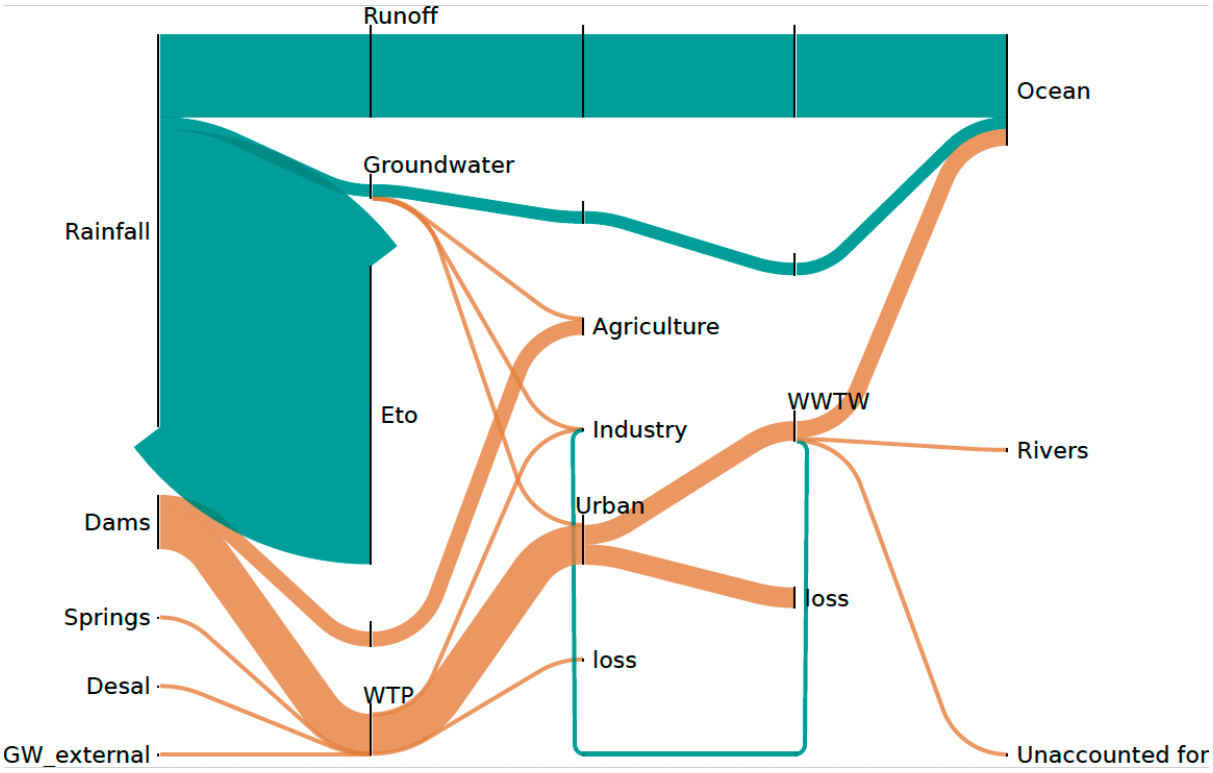
Groups had to then determine the level of influence (high, medium and low) each of these actors had over groundwater governance and place them on the chart accordingly (as shown below). The participants also had to determine if the influence that these actors possessed was positive or negative i.e. facilitating the sustainable use of groundwater or hindering it. Group 1 dealt with actors that were enforcing groundwater laws and usage, while group 2 dealt with actors that were protecting or conserving aquifers and/or recharge. In the process of ranking these actors group 1 identified the metro police as being an important entity for enforcing municipal groundwater by-laws even though it is acknowledged that this is less of a priority for their department. They also highlighted the important role that drilling contractors play in the system. Currently they do not assist or support compliance efforts, but maybe they could.

The groups exchanged headline messages that emerged from the influence mapping. Group 1 highlighted that when it comes to enforcement there was a disconnect from actors that created the laws and those that were in charge of the land as it was the later group that often had the greatest control of whether the rules were going to be adhered to. There is a great opportunity for these actors to contribute positively to enforcement through self-regulation. Group 2 spoke about the different forms of influence actors are able to exert on the process of conserving. When it came to technical influence such as that emanating from DWS was relatively easy to place on the map but other forms of influence were harder to reach consensus on.



How can the UWMF provide useful information for NMB?

Next Ffion turned us back to the UWMF to ascertain what use a framework of this type could provide to participants in relation to their role as practitioners, researchers or planners. Participants were asked to spend a few minutes examining the current iteration of NMBM's UWM and writing down any questions of interest that could potentially be answered by this framework.



After the tea break participants had the opportunity to pose their questions and post them on a section of the Sankey diagram that pertained to the question.

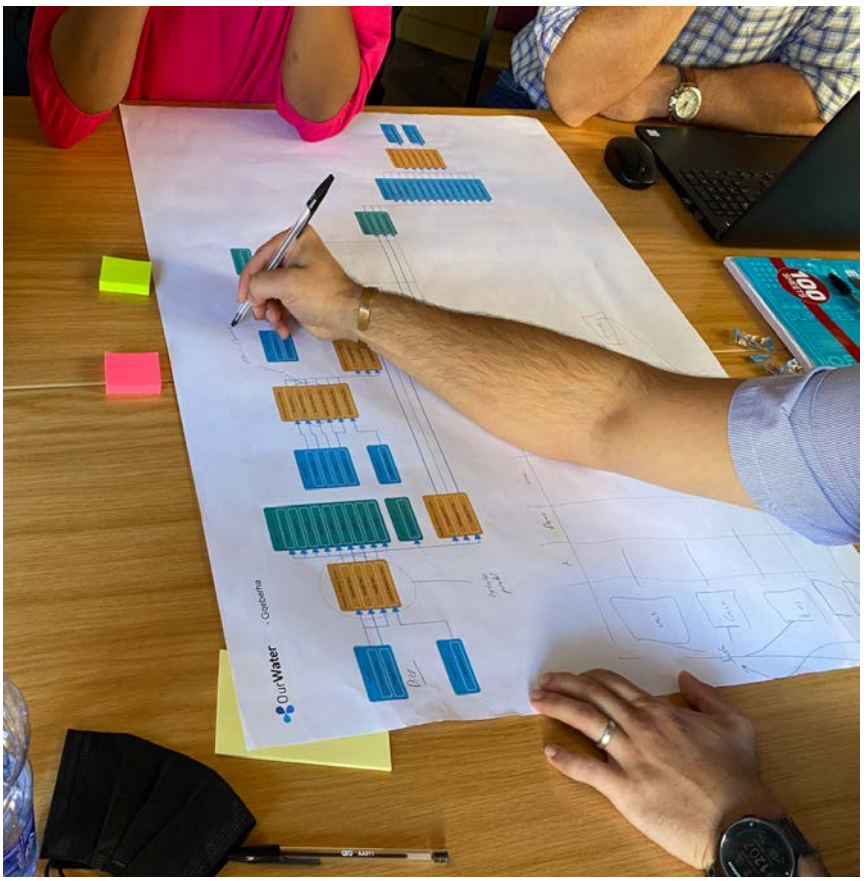
Questions brought forward were:

1. How would the Sankey diagram look if urban management objectives were achieved?
2. Why do we have groundwater arrow not going to industries?
3. Can we increase GW recharge?
4. What could be done to increase recharge, to make use of runoff that ends up in the ocean
5. How would this Sankey diagram look if we achieve our urban water management goals and objectives
6. How does the picture change with climate change? How does it change with planned initiatives? What is the desired state?
7. Runoff and ecological reserves? How much is left for ecological reserves?
8. How will 2deg warming change the natural flows?
9. How can we reduce the GW and runoff flowing to the ocean, and instead to agriculture, industry and urbans?
10. What about untreated flow, pollution from industry and city.
11. Difference between loss and unaccounted for? Why don't we redirect this loss?
12. Where is my potential to increase supply or reduce inefficiencies/wastage
13. How will you ensure that GW is used efficiently by the City?
14. How will you measure that recharge is not influenced negatively?
15. What is affecting recharge into the groundwater resource?

OurWater tool

The final session of the workshop was headed by Dan Abraham of Zutari who presented the OurWater tool for the city of Gqberha. This tool can be used to understand the city's water system through a visual and conceptual mapping of the urban cycle. It includes shocks and stresses and looks at them through a resilience lens. Stakeholders and their interrelations and functions are also captured and represented within the tool, enabling users to interrogate the governance network. As a publicly available tool it can allow various users to have an overview of the water cycle to build on improving the state of data availability for cities like Gqberha. It was emphasised that the tool encompasses a multi-disciplinary approach that attempts to break silos, connecting various departments.

This session concluded with an exercise to interrogate the actors and assets currently captured in the tool for Gqeberha and to add missing items. Participants split into two groups once more and on printed posters of the water cycle diagram and governance table were asked to examine which actors fit into the various roles and positions and which assets were missing or needed to be better represented in the water cycle diagram (as shown in the photo below).



Workshop reflections

The last half hour of the workshop was spent gathering participants' reflections on what they enjoyed about the workshop and what they would like to suggest could be done better or differently at the next workshop, as captured below.

Enjoyed	Do better / differently next time
• Friendly, collegial atmosphere • Engaging and participatory format • Lots of new information and knowledge gained • Showing the NMBM does know about and is doing work on groundwater • No wrong or right answers, participants felt free to voice their thoughts, opinions and questions • Meeting everyone and feeling inspired • Value of youthful energy in the room, no 'holy cows' that could not be talked about or challenged • Help with how to approach Honours research • Understanding municipal water system	• Include an outing into the practical environment, like a visit to the springs and Coega Kop • Invite more people / stakeholders to join, e.g. water user associations and more from the municipality • Share some presentations and content beforehand • Ensure continuity with participants from this first Learning Lab • Deal more with groundwater regulations and enforcement to understand better how it works and what is not working well (Vuyiseka to suggest a presenter) • Get more on the state of groundwater resources and impacts of

● Diversity of the people participating in the workshop and the knowledge they bring ● Mix of presentations and exercises	over-abstraction and unregulated abstraction (e.g. from Ricky Murray, Marc Goedhart, a driller, Paul Chilton or Fanus Foerie at DWS, Gordon McClear) ● More on the historical aspects of groundwater (offered by Graham Taylor) and how people value groundwater through storytelling

Closing

Thanks to all participants for sharing their time, insights and questions. We hope to continue the engagement at the next two Learning Lab events.

Annex 1: Programme

Day	Timing	Duration	Session
Thurs 10th	8.30-8.45	15	Arrival & coffee
Thurs 10th	8.45-9.00	15	Welcome & ice breaker
Thurs 10th	9.00-9.30	30	Round of introductions
Thurs 10th	9.30-9.45	15	Intro to GoFlow project & aim of the Learning Lab
Thurs 10th	9.45-10.10	25	Naming & framing groundwater matters of shared concern - where can we add value with this project?
Thurs 10th	10.10-10.30	20	NMB groundwater projects - Matthew Hills NMBM
Thurs 10th	10.30-11.00	30	Tea / coffee break
Thurs 10th	11.00-11.45	45	Mapping groundwater governance arrangements - part 1
Thurs 10th	11.45-12.30	45	Overview of Urban Water Metabolism framework & methodology
Thurs 10th	12.30-13.00	30	WRI-Zutari work on City Water Resilience benchmarking & introduce to OurWater tool - Dan Abraham & Amanda Gcanga
Thurs 10th	13.00-14.00	60	Lunch
Fri 11th	8.30-8.45	15	Arrival & coffee
Fri 11th	8.45-9.00	15	Welcome, recap of day 1, objectives of day 2
Fri 11th	9.00-9.45	45	Mapping groundwater governance arrangements - part 2
Fri 11th	9.45-10.30	45	Decision-relevance of Urban Water Metabolism analyses (how groundwater fits into the urban water system, exploring how this could change, and tracking / benchmarking performance)
Fri 11th	10.30-11.00	25	Tea / coffee break
Fri 11th	11.00-12.00	60	Filling in OurWater tool posters
Fri 11th	12.00-12.30	30	Data requirements & sources
Fri 11th	12.30 - 13.00	30	Reflections, thanks & closing
Fri 11th	13.00 - 14.00	60	Lunch

Annex 2: Participant list

SH group	Organisation	Name	Role
Academia	NMU	Dr Andre Hefer	Sustainability Engineer
Govt	Nelson Mandela Metro	Matthew Hills	Civil Engineer: Planning & Research Division, Water& Sanitation Sub-Directorate
Govt	Nelson Mandela Metro	Amanda Magugwana	Water Division
Private sector	Zutari	Dan Abraham	Working with WRI on Water Resilience Programme
Govt	DWS EC Office	Fhatuwani Aron Magonono	Scientist
Govt	DWS EC Office	Lufuno Munzhelele	Candidate Technician Scientists, Groundwater Section
Govt	DWS EC Office	Sivuyisiwe Mbange	
Govt	DWS EC Office	Vuyiseka Jack	Production Scientist
NPO	WRI	Amanda Gcanga	WRI Urban Water lead in RSA
Intermediary	Coega Development Corp	Graham Taylor	Trade Facilitation Manager - Operations
Govt	NMB Business Chamber	Prince Matonsi	Operations
Academia	NMU	Tristin O'Connell	Masters candidate
Project Team	UCT	Ffion Atkins	Post Doctoral Researcher
Project Team	UCT	Naadiya Hoosen	Masters candidate
Project Team	UCT	Anna Taylor	Research Fellow