Governing groundwater flows for growing cities facing drought risks

GoFlow project: Cape Town Learning Lab 1 Report (Dec 2021)

Introduction

The first in a series of GoFlow Learning Lab events was held in Cape Town on Wednesday 10th and Thursday 11th November (8.30am-3pm) at the Ithaka Island Eco Centre in Century City. This report presents a summary of the presentations, exercises and discussions held during the 2-day workshop focusing on sustainable groundwater flows in the Cape Town 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 with the aim of strengthening the collaborative capacity to adaptively manage groundwater flows in and around growing urban areas under changing climate conditions. The focus is on the Cape Town and Nelson Mandela Bay 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.

[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

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

We designed the first Learning Lab to engage participants on the current state of knowledge and concerns about Cape Town's groundwater systems - spanning the socio-economic, infrastructural, biogeochemical and governance aspects - and reflect on the challenges and significance of bounding the system in light of all these aspects. We collectively mapped who plays what roles and has what stake in and influence over Cape Town's groundwater flows. We showcased and opened up collective thinking on how an analysis of urban water metabolism, exploring various scenarios of climate and land use changes, could 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.

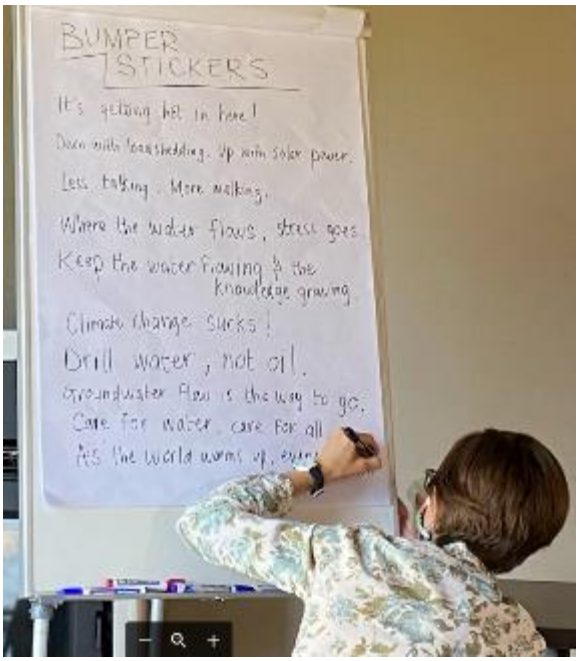
Participation

We invited a range of holders of knowledge relating to groundwater usage, sources, flows, quality, recharge processes and governance arrangements to be part of the first Learning Lab event. The list of invitees included people from the City of Cape Town (specifically the Resilience, Bulk Water, and Catchment and Stormwater Management Units / Branches), the national Department of Water and Sanitation (Western Cape regional office), the Western Cape Economic Development Partnership, GreenCape, Umvoto, Geoss, Delta-H, OneWorld, ICLEI, the WWF South Africa, Environmental Monitoring Group, South African Faith Communities Environmental Initiative, the PHA Food and Farming Campaign, Distell Monis, Peninsula Beverages, and the Universities of the Western Cape, Cape Town and Stellenbosch. 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 two further Learning Lab events planned for April and November 2022. This will hopefully contribute to expanding a Community of Practice in the Cape Town groundwater space, strengthening connections across academia, government, civil society and the private sector between the biogeophysical, engineering and social aspects of groundwater management.

Day 1

Introductions

The first day of the event began with welcoming everyone, a breaking-the-ice exercise and introductions to meet new people in the room and position ourselves in the space. Acknowledging the international COP26 climate negotiations underway in Glasgow, the ice-breaker involved working in groups to come up with a bumper sticker addressing an aspect of climate change, cities and/or groundwater, as shown below.

<u>Bumper stickers</u> It's getting hot in here! Down with load-shedding. Up with solar power. Less talking. More walking. Where the water flows, stress goes. Keep the water flowing and the knowledge growing. Climate change sucks [groundwater] Drill water, not oil. Groundwater flow is the way to go. Care for water, care for all. As the world warms up, every drop counts. I don't have a dream car, I'd rather walk.	

People moved around the room introducing themselves to 2 people they had not met before and discussing why they had decided to join the workshop, what they are passionate about in relation to groundwater, and one thing they hoped to get out of being at the workshop. We did a 'vote with your feet' exercise to get a sense of some characteristics of the participants. Everyone physically positioned themselves in a line across the room representing where they fall along three spectra: (1) where between research and practice their work sits; (2) between physical and social dimensions of water issues; and (3) whether they were more glad or sad that they were out of their home offices now that lockdown is easing up.

Ffion Atkins gave an introduction to the GoFlow project, sharing the ambitions, objectives, modalities and timeline of the project. Explained that this project emerged from responding to a Directed Call from WRC to deal with sub-surface water in growing urban areas. We 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. Proposed focussing 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 there with those in Cape Town. See slides for details: GoFlow LL1_10 Nov 2021_Project overview.pdf

Comments from participants highlighted that the use of groundwater resources is not new. They have been used in Cape Town since the 1980s. And the town of Hermanus has used groundwater for bulk supply for over 10 years. However, the scale of new use is a major consideration. At the national level the focus has traditionally been on regulating surface water. Now groundwater is being integrated, but there are not yet good systems and procedures for managing surface and groundwater together as part of the same hydrological cycle. For example, ecological reserves are derived as separate entities. Water use licence departments look at reserves to determine how much water can be allocated, but there are major gaps in data that limit how accurately this is done. There is a focus on affirmative action in issuing water allocations to historically disadvantaged individuals, but there is a lack of education on water charges and the consequences of getting water licences. There was a challenge to the suggestion that existing rules need to change to better encompass groundwater. The National Water Act wholly applies to groundwater but there is misinterpretation in operationalizing the rules and there are challenges with capacity and budget for implementation and enforcement. The legislation is applied in an oversimplified way and that is what creates problems.

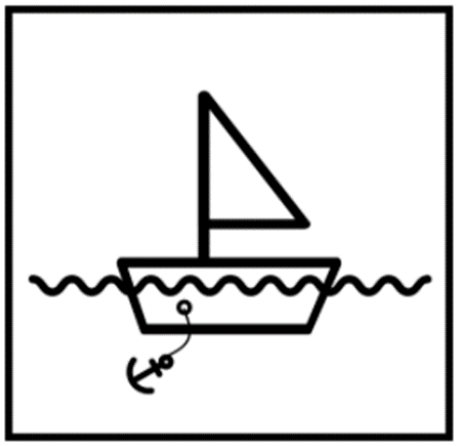
Naming & framing

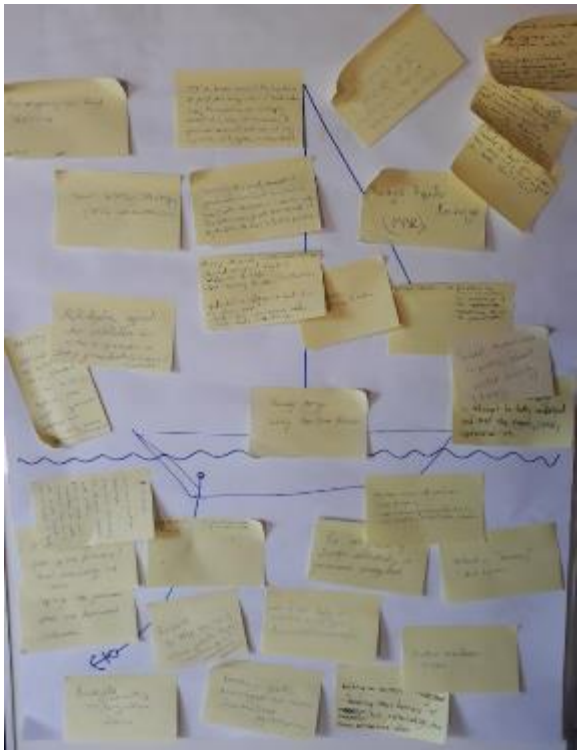
Recognizing the importance and implications of how issues are conceptualised, framed and named (i.e. the terms used to carve out, label and describe an issue or problem), we then moved into a session designed to surface how people see and think about Cape Town's groundwater issues, coming at it from 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 Cape Town'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 Cape Town

- The urgency to find solutions
- CCT has become aware of the importance of groundwater being a form of bulk water supply for conjunctive use and supply diversification, along with implementing groundwater development sustainably and under the NWA (self-regulating to a strong extent)
- Managed Aquifer Recharge
- Greater and growing visibility of groundwater and its importance – no longer just technical concern and interest
- New Water Strategy – Water Sensitive City commitment
- Multi-disciplinary approach where stakeholders have access to information on state of groundwater (both physical and governance)
- Technical expertise of world class standard in the company behind the CCT's groundwater development (not written by someone at Umvoto – promise)

- Knowledge sharing including Open Data Portal(s)
- Technically competent groundwater consultants involved in groundwater development in various water use sectors, who generally self-regulate and try to follow the NWA as best as possible
- Water demand management and re-use of water
- Groundwater monitoring to assess groundwater resources
- Capacity building – providing training at academic institutions
- Day Zero – provided the crisis to address the importance of the appropriate monitoring and use of groundwater
- Raised awareness in public about water scarcity and supply
- Taking the time and energy to attempt to fully understand and map the players, issues, opportunities, etc.
- Integrating groundwater use with surface water use





What is holding us back from sustainable groundwater use in Cape Town

- Water losses, non-revenue water, water leaks, unlawful use
- Public and private sector professionals, scientists etc need to come to consensus
- The gap / silos between management and technical and operational functions when making decisions on sustainability of both stormwater and groundwater use
- Approach for reserve determination needs to be revised – surface water and groundwater should be considered as one entity / resource
- Site specific tools needs to set per water use activity that impacts on both surface water and groundwater
- Defending ‘territories’ and norms
- Unclear mandates and roles
- Regulatory issues with groundwater – lack of capacity leads to under- and over-regulating due to poor understanding of natural systems in question
- Poor integration of scientific understanding in governance arrangements
- Existing water management model of centralized governance
- Pressure to keep engine of urban growth through population growth, investments, expansion

- Lack of data sharing and conversations across group – city – consultants / researchers – public
- Lack of research across disciplines and scales
- Communication challenge in translating groundwater science to decision-makers and public – groundwater is NOT misunderstood or more complex than surface water, we simply have communicated it badly
- Clear opportunity for public-private partnership / shared accountability and action
- Improving cross government sphere and departmental collaboration
- Budgets for implementing long-term vision
- Building on mismatch understanding – breaking barriers of ownership, use, sustainability, how things are currently done

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 Kirsty Carden, based at UCT's Future Water Institute. She told us about the Pathways to Water Resilient Cities (PaWS) project, exploring the integration of green infrastructure into existing infrastructure in Cape Town and Joburg. In Cape Town they are experimenting with building a sandbag bern in a stormwater detention pond near the Philippi Horticultural Area to increase infiltration into the Cape Flats Aquifer. Monitoring flows into and out of the pond, as well as water quality. City has 800-1000 stormwater detention ponds but not designed for infiltration. Also investigating the governance processes and arrangements required to install and maintain green infrastructure, including local level involvement of residence (e.g. school children). Kirsty also shared information about a Water Sensitive City Benchmarking project, assessing Cape Town against 7 goals for transitioning from a water supply city to a water sensitive city using 34 indicators, as a basis for developing an action plan to progress the transition. Disaggregated the assessment to differentiate between formal and informal areas within the city. See slides for further details: GoFlow LL1_10 Nov 2021_Kirsty Carden.pdf

Helen Seyler, Delta-H Water Systems Modelling (Pty) Ltd, presented work from two previous WRC-funded projects focussing on regional scenario planning for Cape Town groundwater supply (completed in 2016) and urban groundwater development and management (completed in 2019). The urban (geo)hydrology modelling suggested bulk abstraction from CFA is feasible and that managed aquifer recharge, by infiltration rather than injection, should only be considered in conjunction with bulk abstraction, within the same area. Scenarios exploring decentralised groundwater abstraction showed groundwater levels lower over a wider area but to a lesser extent than centralised abstraction. Pollution scenarios showed protection zones for bulk abstraction boreholes (5 million m3/a / wellfield) in the CFA to be relatively spatially contained and thereby management of water quality to be feasible if source protection zones were implemented and enforced. Land use scenarios were developed to show areas suitable for increasing infiltration, where the groundwater table is deeper than 5m below land surface and balanced by abstraction. Recommendations included: allow / promote decentralised groundwater use; encourage naturalised infiltration; identify source protection zones for future production boreholes and ecological infrastructure

and reflect these in land use plans and the SDF; share data; and enforce by-laws, including access to private property to monitor groundwater. Helen argued that competition for water use can be managed IF data is shared. She highlighted the problem of proprietary water computational models held by consultants and researchers, and the need for a centralised model owned by DWS that is regularly updated based on new research. This requires capacity and expertise. Currently the onus is on the water use applicant to demonstrate the impact. Not all uses are reflected in the various models held by different consultants. The discussion with participants highlighted the problem of water being managed according to surface water quaternary catchments, which do not match groundwater units. See slides for further details: GoFlow LL1_10 Nov 2021_Helen Seyler.pdf

Next we heard from Hallie Eakin, a visiting Fulbright Fellow from Arizona State University, about water use and groundwater management in the state of Arizona in the USA, an arid state with extensive irrigated agriculture (~72% of water use) and includes the city of Phoenix - the fastest growing city in the US. The state sources 41% of its water from groundwater. In the 1980s a new Groundwater Management Act led to the establishment of 5 Active Management Areas (AMAs) based on aquifer boundaries, put a freeze on the water footprint of agriculture in the AMAs, established a policy of 'safe yield', and requirements for proposed new urban developments to prove 100 years of secure water supply. The Arizona Water Banking Authority was established to administer the trading, gifting and leasing of water credits, including the inter-temporal exchange of surface water for groundwater, making it possible to 'bank' unused allocations for future use[2]. Hallie highlighted the problem that would emerge if in a severe drought - the risk of which is increasing under climate change - everyone wanted to cash in their water credits. She also raised the point that the infrastructure required to flexibly switch between surface water and groundwater is not easy to achieve. Her presentation led to a discussion amongst participants about ownership of water allocations or water use entitlements in South Africa and whether they could be traded or transferred. New law does allow for trading or transferring of water allocations, which requires a memorandum of understanding to be drawn up between the seller and buyer. See slides for further details on the Arizona case: GoFlow LL1_10 Nov 2021_Hallie Eakin.pdf

Tamsin Faragher, who works in the City of Cape Town's Resilience Unit, presented findings from a review of groundwater governance, focussing on the role of local government. She highlighted that the City's Resilience Strategy has a section on community groundwater access. The City put together a set of guidelines on who can do what with groundwater and other alternative water sources. Tamsin highlighted the importance of not talking generically about water and how to manage it but rather to recognize and tailor management mechanisms to different types of water that require different rules, regulations and infrastructures, i.e. greywater, groundwater, surface water, treated industrial effluent, etc. We need a nuanced yet holistic view of water and its uses, which we do not yet have. Instead there is fragmentation between numerous laws, by-laws, policies and strategies. The City has been promoting groundwater use for non-potable uses since 2007. A discussion regarding the need for more compulsory licensing and enforcing compliance ensued.

[2] For more information see: Anita Milman, Cameron Bonnell, Rita Maguire, Kathryn Sorensen, William Blomquist; Groundwater Recharge for Water Security: The Arizona Water Bank, Arizona. Case Studies in the Environment, 5 February 2021; 5 (1): 1113999. Doi: https://doi.org/10.1525/cse.2020.1113999

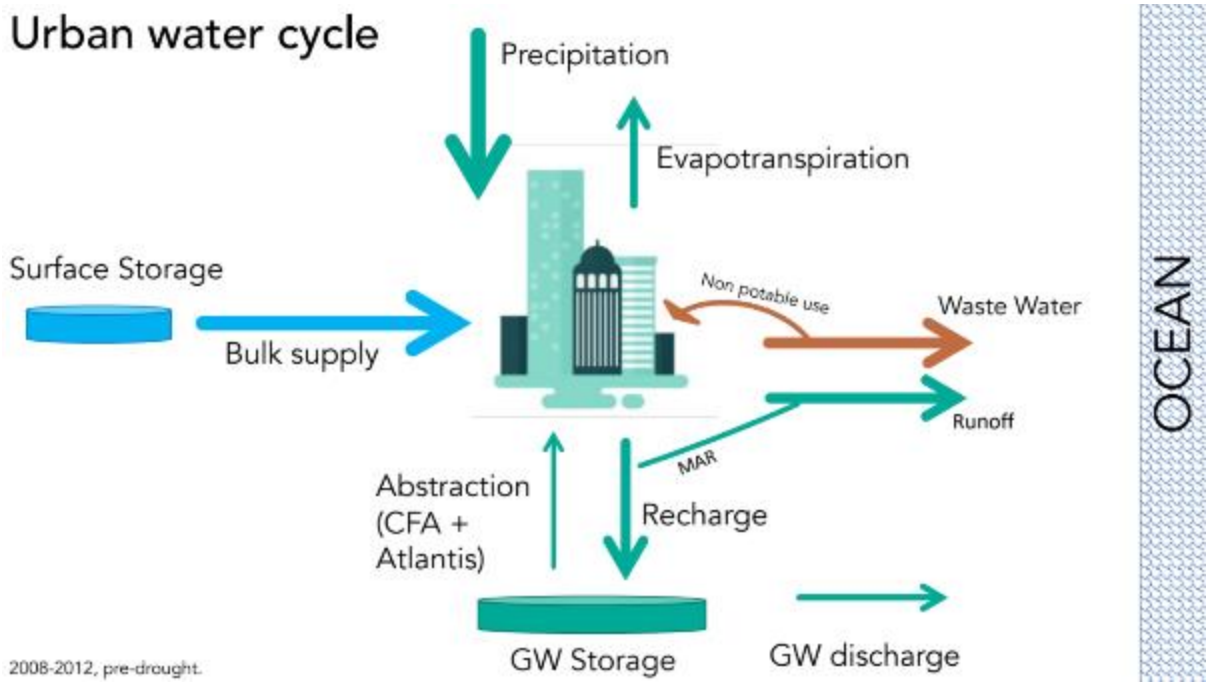
Initial stakeholder mapping

After lunch we moved into a participatory exercise to do some initial mapping of the stakeholder network involved in Cape Town's groundwater scene. Participants were each given a set of blue cards. On the first card they were asked to write the organisation they work for and on the back the key functions the organisation fulfils with regards to groundwater. Specify the department and or branch / unit if it is a large organisation. On the other cards they were asked to write the organisations / departments that they work closely / interact regularly with in the groundwater space. We then laid the cards out on a large sheet into clusters of government entities, consultants, private users, NGOs and advocacy organisations, funders and research organisations, and added linkages between them. Blue lines indicated data sharing, pink lines indicated advice, red lines represented financial flows, green lines indicated authorizations, and black lines showed partnerships, as seen in the images below.

For a spreadsheet capturing the details of the exercise please email anna.taylor@uct.ac.za

Urban Water Metabolism Framework explained

We ended day 1 with a presentation by Ffion Atkins explaining some of the finer details of the Urban Water Metabolism Framework and what it is used for. 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. The urban metabolism framework is increasingly being applied to benchmark and set goals for becoming a more water sensitive city. Cape Town has the goal of transitioning to a water sensitive city in the new Water Strategy. A water sensitive city is characterised by adaptive multi-functional infrastructure and urban design reinforcing water sensitive values and behaviours that result in intergenerational equity and resilience to climate change. The urban water metabolism framework is applied to a city or city region by defining a spatial boundary for the system being analysed and then quantifying the anthropogenic and hydrological flows - bulk water supply, groundwater abstraction, wastewater outflows, precipitation, evapotranspiration, stormwater runoff and groundwater recharge - to establish a water mass balance.



Various scenarios that change the figures of particular flows can then be explored and indicators of the performance of the system under each scenario can be calculated, e.g. urban water efficiency (total external water use per capita per year), water supply internalisation (proportion of total urban water demand met by internally harvested / recycled water) and hydrological performance (ration of post-uranised to pre-urbanised annual stormwater runoff and groundwater recharge). Ffion showed the indicators from an analysis comparing Cape Town's pre-drought situation with scenarios having implemented measures in the Water Strategy. Ffion asked participants to reflect on: what questions can we answer with a water mass balance; are the decisions that we are making moving us towards or away from becoming a more water sensitive city; how granular / at what spatial scale is it useful to

apply the water mass balance analysis? Participants raised questions around how changes in population are accounted for in the model, whether the spatial differences due to the apartheid legacy can be accounted for by applying the model at the suburb scale, and whether variations in microclimate and seasonal variations can be captured. Ffion commented that the availability of data is a constraint as to what can be done and that a transient model was made but not published. It was suggested to consider what the minimum data set is that can still produce a relevant, useful output, especially if this method is to be used in other African cities with severe data scarcity. For further details see slides: GoFlow LL1_10 Nov 2021_Ffion Atkins_UWMF.pdf

Day 2

Day 2 kicked off with a brief reflection on what participant's highlights and take home messages were from day 1. Participants reflected on:

- Enjoying the stakeholder mapping exercise;
- Valuing the contribution from Helen Seyler on groundwater pollution and protection zones;
- The fact that data is NOT flowing and readily accessible - the lack of a centralised, open access data sharing platform is holding us back;
- Hearing from DWS colleagues how water allocation and licensing decisions are made and the varying mandates that departments and levels of government have;
- Useful to hear what is being done on flood retention to increase infiltration;
- Interesting to realise that water losses / unaccounted for water lost through leaks actually contribute to groundwater recharge;
- The importance of understanding land use change and its impacts on groundwater, and what is driving that change - what role do property developers play, where do they fit into the stakeholder map?;
- The ability for the value of water to be better quantified and made explicit through the issuing and trading of water credits - by owning water and being able to transfer it then people more clearly see the value of it;
- The sale or transfer of water rights is covered in the National Water Act but has to be done via DWS, not privately
- The need for water users to be better informed about what the water by-laws are and which government entities to deal with for various applications and transactions;
- There is need to clarify how the National Water Act and Water Services Act interact and can be better aligned to be fit for purpose;
- Groundwater use is not new, there is a lot of existing work to build on, but things are changing fast and that requires new types of joined up thinking - can the urban water metabolism framework add value in this regard?

Exploring city regional hydro-social boundaries

The next session explored various ways of bounding the system and the implications thereof. Ffion Atkins began with a quote from Donella Meadows: "*There are no separate systems. The world is a continuum. Where to draw a boundary around a system depends on the purpose of the discussion"*. Ffion then spoke to the relationship between cities and their environs or hinterlands. As cities grow their resource demands increase and their waste

outflows increase so the boundaries of the regional footprint of the city grows, including where water is sourced from (e.g. Cape Town big six dams and Lesotho Highlands water transfers to Joburg and Tshwane). This can come into competition with other uses, including neighbouring settlements and rural uses. Globalisation and urban agglomeration (cities growing into each other) puts an additional spin on the emergence of city regions as South Africa - like many other countries - pursues regional economic development strategies to increase international competitiveness. The recent Regional Spatial Implementation Framework (RSIF) for the Greater Cape Metropolitan region provides strategic direction for the spatial growth and development of the functional region. City regions are often defined and bounded by economic functions and do not take sufficient account of the more socio-ecological relational dynamics, including the multiple functions (including cultural and identity functions) performed by water over long timeframes. Ffion highlighted that the delineation of a city region's hydrological boundary must be carefully considered in light of the question being addressed by the analysis, the associated data requirements and limitations, and the implications for interpretation. See slides for further details: GoFlow LL1_11 Nov 2021_Ffion Atkins_Boundaries.pdf

Participants noted that in terms of increasing the internalisation of water within the city it is important to ask what actors within the city, including the metro / city government, has control and authority over. There was a question about the role of virtual water in delineating the boundary. This could make the city region very large. Also the issue of time was raised in the sense that as cities grow the exogenous flows end up becoming engulfed by the urban area (i.e. what was previously external becomes internal), however the management functions and processes typically lag behind in addressing these changes. How does future growth of the city potentially change where we draw the boundary? The lack of sufficient data (due to limited monitoring and reporting) is likely to undermine accurate delineation.

Tyrel Flügel drew attention to the different perspectives from which we see, experience and differentiate things, by asking participants to draw a shrub and a tree, a hill and a mountain. He showed how different sources of spatial information can be used and combined to delineate a city's hydrological boundary - such as river catchments, water management areas, municipal and district boundaries, bulk water pipeline networks, land use and vegetation cover maps - but how it always requires judgement calls, in part because of dynamic processes. Boundaries are in flux. Simplification is both an asset and a limitation when drawing boundaries. One has to make pragmatic decisions relevant to the question being addressed, and acknowledge the consequences of those decisions. Precision may not matter too much. In many cases a ball-park figure will suffice or at least provide a useful starting point. See slides for details and maps: GoFlow LL1_11 Nov 2021_Hydro Boundaries_Tyrel Flügel.pdf

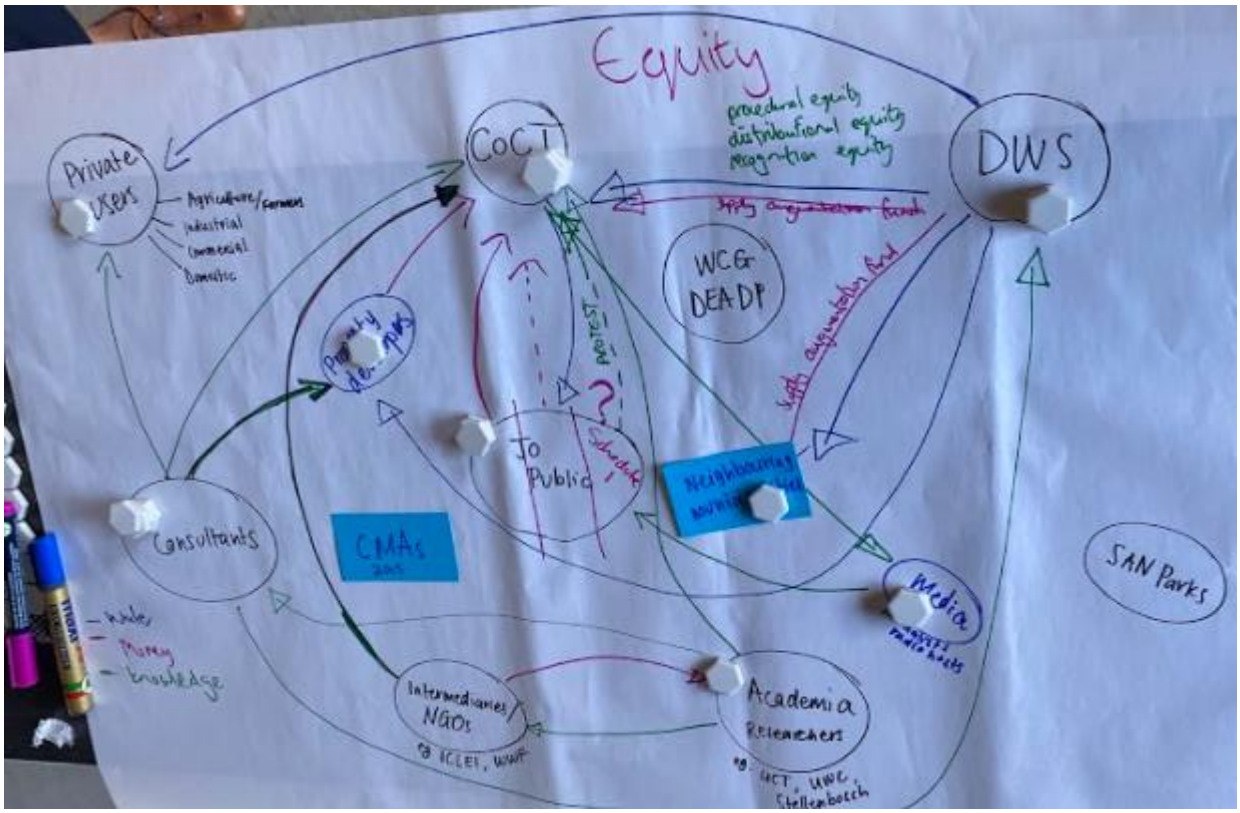
Caron von Zeil presented a rich, layered account of urban resource flows and the importance of understanding the intimate interconnections between urban spaces, people and water. She highlighted the inequalities that persist in Cape Town due to colonial and apartheid spatial planning, infrastructure investment and service provision. Local areas and communities across the Cape Flats, like Brown's Farm and Khayelitsha, suffer considerable health impacts, loss of household assets and limited mobility due to regular flooding and water contamination from poor sanitation and waste management services. She challenged the dominant human settlements logic of one plot, one house that drives urban expansion,

loss of green spaces, damage to sensitive ecosystems and loss of important ecosystem services such as flood retention and water filtration. She suggested that integrated bio-regional hydro-spatial planning and cultivating hydro-citizenship can be a vehicle for remaking the post-apartheid city in a socio-ecologically equitable and sustainable way. Caron suggested that in addition to safety, sustainability, equity, access and integration, celebration should also be a criteria of urban performance. Water plays a key role in cultural and personal identity, ritual and celebration of life. Caron pointed to the example of Bali with regards to the central role that water plays in both the cultural and physical landscape. For further details see slides: GoFlow LL1_11 Nov 2021_Caron von Zeil.pdf

Influence mapping

After these presentations we moved into an interactive group exercise building on the initial stakeholder mapping we had done on Day 1. We divided up into three groups. Each group got a large sheet of paper with a copy of the actors clusters that we had identified in the first round of actor mapping, i.e. private water users (domestic, commercial, industrial, agricultural and public e.g. schools, hospitals, parks), consultants, City of Cape Town, National Department of Water and Sanitation, Western Cape Department of Environmental Affairs and Development Planning, SAN Parks and Cape Nature (and other custodians of large tracts of land), 'Jo public', NGOs / intermediaries, research / academic institutions, and funders. The groups also got a set of counters / tiles to create influence towers to indicate which actors have more or less influence over particular outcomes and performance indicators. One group focussed on water equity, another on water resilience (understood as the diversification, internalisation and efficient use of water resources) and the third group dealt with the ecological health of the city's hydrological cycle. Each group discussed the roles that each actor or type of actor plays and thereby the influence they have in shaping the outcome / performance indicator the group was focussing on, as well as the interactions between the actors. In the process of the exercise a number of additional influential actors were added to the maps, including: neighbouring municipalities; catchment management agencies; media; property developers; land owners; the national Departments of Forestry, Fisheries and Environment, Rural Development and Land Reform, Mineral Resources and Energy (as large water user and as energy provider and regulator); and the Working for Water and Fire programmes.


CoCT
To Public
DWS
SAN Parks


Equity
procedural equity
distributional equity
recognition equity
Private Users
CoCT
DWS
WCG DEADP
To Public
Consultants
CMAs
Media
SAN Parks
Academia
Intermediaries / NGOs

The groups exchanged headline messages that emerged from the influence mapping. The exercise highlighted the central role that the City of Cape Town plays in mediating the performance of the city's hydrological cycle, as a water regulator, water distributor and service provider and a large water user. From a water equity perspective there was mention of the connection between money and influence. Those who can afford water alternatives can install them. For many of the public the only way they can try to exert influence is through protest action. From a water resilience perspective, participants highlighted the tension for the city government between allowing decentralised diversification to increase resilience of the system and the loss of revenue that represents for the City as high-end users, paying more for water in a stepped tariff structure, substitute municipal water for alternative sources and thereby the City revenue generated from the sale of bulk water.

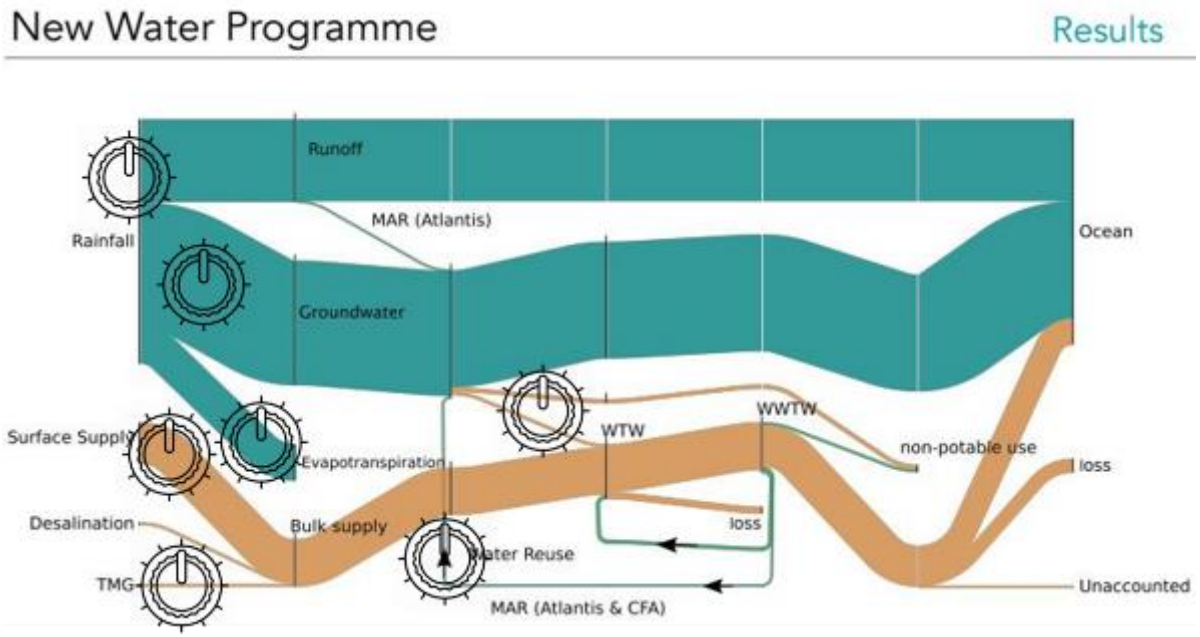
The exercise also suggested the important role that consultants play in the research, planning and applications process. This surfanced an interesting discussion about the extent to which consultants lead or push the transition to urban sustainability, water resilience and water sensitive urban design, or simply reflect the priorities of their clients. A similar discussion was had about the relatively strong influence of funders and the ways in which they shape the agenda locally and nationally. The Greater Cape Town Water Fund was identified as a potentially influential addition to the water governance landscape.

What scenarios to test using the UWMF

The final session of the workshop turned attention to the range of scenarios that could usefully be tested and explored using the application of the urban water metabolism

framework through a water mass balance model. Or asked another way, what dials do we want to turn within the hydrological cycle to see what the implications are? There are dials for rainfall, evaporation, land cover, runoff, recharge, availability of surface supply, water demand, and circularising of water flows (i.e. water recycling, direct and indirect reuse). The model focuses on volumes of various flows and does not deal with water quality. What do we want to know, at what time scale and to what time horizon? Chris Jack highlighted changes in evaporation as a key climate variable to consider, as most models project a drying trend for the region. A 5 to 10 year time period might be most relevant to decision-makers. A 10-year year period that is 25% drier than the current average is an extreme but plausible scenario. Scenario options could include: maximum reuse; weighted land cover change with change of porous aquifers weighted higher; spatially selective rewilding to maximise natural recharge; the conversion of all detention ponds into maximised infiltration ponds.

The city government is planning towards there being 600,000 more households by 2040 based on in-migration and internal population growth. The ambition is for much of this growth to be through densification and not increasing the spatial extent of the city. This would suggest an increase in water demand. What does it mean for changes in land cover, runoff and infiltration? And how realistic is this densification scenario? How effective are constraints of land use change?



The metaphor of dials that can be turned is a useful one to think through how easily each dial turns, whether the dial can go in both directions or once opened it cannot be reversed (e.g. decentralised investments in alternative water supplies that once installed cannot be removed or abandoned when there is surplus bulk water supply), and who is involved in turning which dials. This is a question that we hope to explore further between this and the next Learning Lab event, in order to share findings and discuss further at the next event.

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 in 2022.

Annex 1: Programme

Day	Timing	Session
Weds 10th	8.30-9.00	Arrival & coffee
Weds 10th	9.00-9.20	Welcome & ice breaker
Weds 10th	9.20-9.50	Round of introductions
Weds 10th	9.50-10.05	Intro to GoFlow project & aim of the Learning Lab
Weds 10th	10.05-10.35	Naming & framing groundwater matters of shared concern - different at various scales; where can we add value with this project?
Weds 10th	10.35-11.00	Tea / coffee break
Weds 10th	11.00-12.00	Other work that this project builds on - bring and share - we will hear from Tamsin Faragher (CCT), Kirsty Cardin (UCT Future Water), Helen Seyler (Delta-H), Hallie Eakin (Arizona State University)
Weds 10th	12.00-12.30	Mapping groundwater governance arrangements - part 1
Weds 10th	12.30-13.30	Lunch
Weds 10th	13.30-14.00	Overview of Urban Water Metabolism framework & methodology
Weds 10th	14.00-15.00	Exploring city regional hydro-social boundaries at various scales
Thurs 11th	8.30-9.00	Arrival & coffee
Thurs 11th	9.00-9.20	Welcome, recap of day 1, objectives of day 2
Thurs 11th	9.20-9.50	Mapping groundwater governance arrangements - part 2
Thurs 11th	9.50-10.35	Decision-relevance of Urban Water Metabolism analyses (with a focus on building joint understanding of how groundwater fits into the urban water system, exploring how this could change, and tracking / benchmarking performance)
Thurs 11th	10.35-11.00	Tea / coffee break
Thurs 11th	11.00-12.00	What climate & land-use scenarios to test in an UWM evaluation for Cape Town city region
Thurs 11th	12.00-12.30	Co-develop a Theory of Change - part 1 - situating the project within context of Cape Town's ambitions to be a water resilient and water sensitive city
Thurs 11th	12.30-13.30	Lunch
Thurs 11th	13.30 - 14.00	Co-develop a Theory of Change - part 2 - intended impact, outcomes, outputs, assumptions
Thurs 11th	14.00-14.30	Where to next for the project (linking to other activities)
Thurs 11th	14.30-15.00	Reflections, thanks & closing

Annex 2: Participant list

SH group	Organisation	Name	Role
Private sector	Umvoto	Dylan Blake	Hydrogeologist
Private sector	Umvoto	Tyrel Flugel	Geospatial Analyst
Private sector	Delta-H	Helen Seyler	Hydrogeologist
Civil society	WWF	Marlese Nel	Coordinator of TMG Strategic Water Source Partnership
Private sector	OneWorld	Tasneem Steenkamp	Commissioned by WWF to develop groundwater dashboard
Govt	City of Cape Town	Tamsin Faragher	Principal Resilience Officer
Govt	DWS	Christo John Louw	Scientific Technician for Breede WMA
Govt	DWS	Valli Yantolo	Scientist Candidate for Berg WMA
Intermediary	ICLEI	Lauren Arendse	Water team
Academia	UCT Future Water	Kirsty Carden	Research Director & Project Reference Group
Academia	UCT Future Water	Miriam Arinaitwe	Civil Engineering Masters student
Project team	Reclaim Camissa	Caron von Zeil	Landscape Architect & Water activist
Project team	UCT EGS	Naadiya Hoosen	EGS Masters student
Project team	UCT CSAG	Chris Jack	Climatologist / Data scientist
Project team	UCT ACDI	Ffion Atkins	Oceanography / Data scientist
Project team	UCT ACDI	Anna Taylor	Urban Geographer
Academia	Arizona State University	Hallie Eakin	Visiting Fulbright Fellow
Private sector	Bibliotec	Jamy	Graphic designer