Pathways to water resilient South African cities (PaWS)

Rethinking stormwater management - harnessing multifunctional stormwater ponds for water resilience

A pilot project by the Universities of Cape Town and Copenhagen has found that retrofitted stormwater ponds present an exciting yet untapped opportunity for building water resilience through nature-based approaches in the City of Cape Town

Introduction: Why stormwater ponds?

How can we make our cities more resilient to water-related climate pressures such as the 2015-2018 drought in Cape Town?

Many South African cities make use of stormwater retention/detention ponds to manage excess storm flows. In Cape Town over 800 such ponds exist, about 290 of which overlay the Cape Flats Aquifer, where this research has taken place. The project seeks to establish whether ponds that were initially established as mono-functional green spaces aimed at preventing flooding can be retrofitted into hubs with multiple functions. Using nature-based methods to enhance infiltration into the aquifer, these stormwater ponds can help the City and its residents build resilience towards climate change impacts and recurring droughts, while supporting human wellbeing and improving the overall liveability of neighbourhoods – the core focus of the Danida-funded 'Pathways to water resilient South African cities' (PaWS) project.

The project is a transdisciplinary collaboration between researchers from the University of Cape Town (UCT), University of Copenhagen (UCPH), local residents of the area around the stormwater pond (corner Lords Ave and Fulham Road in Rondevlei, Mitchells Plain) and the City of Cape Town. The aim is to identify opportunities for integrating nature-based approaches into the urban landscape through collaborative retrofitting of an existing stormwater pond. The retrofit has widened the Pond's functionality to include improving the quality of stormwater, infiltration to recharge the city's groundwater, as well as enhancing amenity and biodiversity in the local environment. The PaWS project contends that retrofitted multifunctional stormwater ponds present one nature-based pathway in the transition towards water resilient South African cities via the use of existing green infrastructure like this retention pond. This policy brief presents a view into the possibilities of activating water resilient landscapes using the biophysical experimentation and social observations and explorations gathered during our efforts to introduce multifunctionality through retrofitting one existing stormwater pond in Cape Town. We suggest that such efforts in other spaces would garner similar benefits and considerations.

Background: Stormwater retention pond on Fulham Road, Mitchell's Plain

As Rondevlei has developed over the past two decades, the Pond has long been a central, defining feature for the community close to it. The Pond is bound by Fulham Road, Liverpool Road and the Leadership Academy school, with residents of all three representing key community interests. As part of the City of Cape town's flood protection infrastructure, the Pond is owned and maintained by the City through contractors. Whilst the Pond has been well protected from the threats of informal invasion and criminal activities by the community, perceptions of the Pond by community members range from seeing the space as a barren, unremarkable with no clear function, yet in need of constant surveillance to keep out crime and invasion, to residents using it to walk/curb their dogs. The PaWS team chose the site in early 2020 and arranged start-up meetings with the community leaders and adjacent school to gain permission and generate buy-in for experimenting with retrofitting the space.

Image 1: Pond space before the retrofit

FUTURE WATER

Public information session

Tuesday, 10th of March at 6-7pm
We will meet at the bus-stop adjoining the open space, next to the Leadership College Hyde Park

Researchers from the Future Water research institute (University of Cape Town) and the University of Copenhagen are collaborating with the City of Cape Town on a project entitled 'Pathways to water resilient South African cities'. One of the aims of this project is to look for opportunities to repurpose the open space located adjacent to the Leadership College Hyde Park site in consultation with the school and the surrounding community.
Tonight, we would like to start a conversation about your thoughts on the open space and to discuss possible ideas for future uses. This exercise forms part of a Masters research project being undertaken by Bettina Käppeli (University of Copenhagen) which involves developing a design proposal for the open space using a landscape architecture approach.
Thank you for participating and for giving us the opportunity to learn from you as experts in your neighborhood.

Agenda

A. **Introduction and presentation of the team**
B. **Talk and discussion about wishes, needs, and issues by answering 5 leading questions**
   1. Do you know this area? Do you use it, and if yes, how do you use it?
   2. What do you think this open space does? Who do you think created this space?
   3. What does this open space mean to you? What do you think about it?
   4. To create a vision; If you would be in charge of this open space, what would it look like and which activities would happen here?
   5. What are the main needs of the neighborhood?
C. **Summing up and thank you for today!**

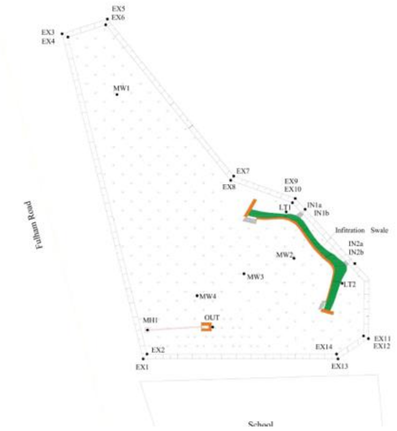
Contact information
To learn more about the project in general feel free to contact Kirsty Carden kirsty.carden@uct.ac.za

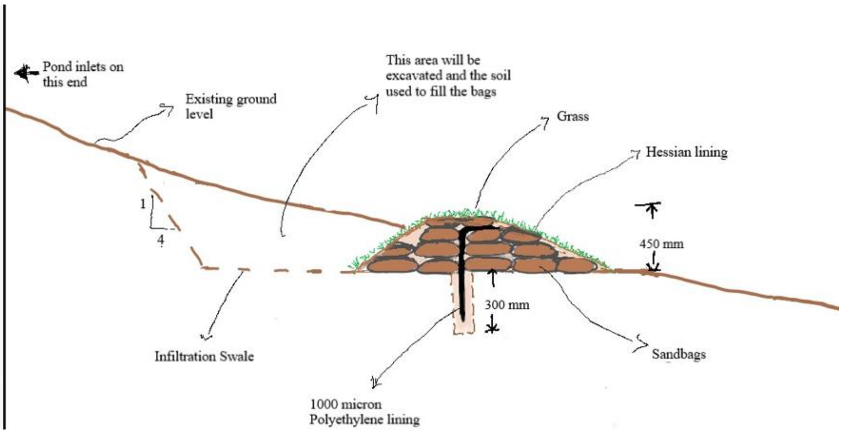
To participate or to discuss further topics in frame of the master thesis research please contact Bettina Käppeli bdc849@alumni.ku.dk / WhatsApp +4179 739 58 26 / Calls +2779 909 18 33

Images 2 and 3: Outreach invitation; First public outreach session with researchers and local residents

What did we do? Biophysical experiment

The pond is an excavated open area connected to a stormwater system with two inlets and an outlet. Runoff from rainfall is directed to the pond via the piped stormwater network, where it is retained for a limited time (usually 24 - 48 hours) and then slowly released to the main, and often larger, stormwater pipe system, leaving the pond to dry. Stormwater detention mitigates flooding by confining large volumes of stormwater in a 'safe' area and then slowly discharging it out of the pond, thus reducing pipe and culvert overflows and urban flooding. The aim was to redesign the pond to create infiltration areas to promote Managed Aquifer Recharge (MAR) – a process wherein groundwater is replenished by purposefully infiltrating or pumping water into an aquifer below – and then incorporate some landscaping to extend the pond's amenity functions. This design intended to improve the stormwater quality and maximise the groundwater recharging volume while guaranteeing that the pond achieves its core function of handling rainwater during storms from the local drainage network. The complexity of the technical interventions was kept low so that local companies, or even residents, could take responsibility after a short training program. Likewise, the costs in terms of materials were limited to that which the local community could afford themselves. The design of the retrofit also had to ensure that the pond would be able to fulfil its intended purpose, i.e., flood attenuation while enhancing infiltration.





Images 4 and 5: CAD drawing of the retrofit design showing berm and monitoring well positions; Sandbag berm sketch

The technical design considered 4 critical components: a) energy dissipaters in the form of stone riprap; b) litter traps fashioned as rock check dams; c) an infiltration swale; d) sandbag berm to detain stormwater with overflow weirs. The ripraps were designed using first principal hydraulics and design to ensure stormwater energy dissipation, and reduce the inflow velocity to <0.3 m/s - to settle sediment. Rock check dams using the same aggregates were constructed flush with the trench edge and berm. The guiding principles behind the sandbag design were:

- Retained water should not be higher than 300 mm to prevent human, and vegetation drowning, with overflow weirs at defined points.
- The bottom of the infiltration swale created by installing the wall should be at a topographical level at least 0.6 m above the winter water table.
- Detention time within the swale should not be longer than 48 hrs to counter mosquito breeding.
- Sand should be obtained from the pond to avoid transporting from other areas (zero net cut / fill).

A berm line was identified by digging trial pits to establish the water table depth after an above-average hydrological year (the 880 mm rainfall depth received in 2021 has a recurrence interval of 18 years). Once the desired position was identified, a topographical survey was conducted to establish the positions that had the same level as the desired point, which would mark out the berm wall. The berm was constructed along the contour line in front of the pond inlets. A 300 mm deep trench was dug along the berm line. A waterproof PVC barrier was placed in the trench after which the trench was backfilled. Grass sods on the land adjacent to the trench were carefully removed from the swale section and later used to cover the berm (Images 6 & 7).

The area was excavated to a depth of 450 mm at the steeper end to create a terrace/infiltration swale whose width varied with the contours. The resultant infiltration swale differs from the standard in that no external filter material (modified sand and gravel) was used. The infiltration performance is thus dependent on the existing soil's infiltration capacity. Excavated soil was used to fill the sandbags for the berm (Image 8). An overflow weir was installed at the outlet to measure outflow discharge. Several experiments are being conducted on and at the site, chiefly:

1. A model developed to evaluate the short and long-term hydrogeological performance of the pond.
2. Stormwater and groundwater quality are being monitored to assess the treatment performance of the pond and the stormwater-groundwater interaction (stormwater water quality is analysed from grab samples taken during rain events, while groundwater is sampled at least once a month from nine monitoring wells installed in the pond).

Image 6: Residents positioning the PVC sheet

Image 7: Assembling the sandbag berm

Image 8: Completed retrofit

Images 9 and 10: Left) A full infiltration trench after a storm b) Pond inlet and forebay after a storm

Image 11: Pond site with workers and teams during planting day

Image 12: Collage of biodiversity on site

How did we do it? Collaboration to produce the multifunctional stormwater pond with local residents and other stakeholders

In mid-2021, after a 15-month COVID 'pause', the research team re-consulted local residents and leaders on how best to begin the biophysical experimentation in a way that would build trust between the community and researchers, allowing for collaboration around the multifunctional pond. Researchers and an NGO specialising in sand-bag construction collaborated with a team of local residents to build litter traps, sandbag walls, and dig trenches. This two-month process provided teams of residents with paid work and opportunities for learning new skills such as sandbag construction; as well as allowing for the mutual transfer of socio-ecological knowledge.

In August 2021, after the construction activities, school children from the adjoining primary school, The Leadership College, engaged in a planting activity with plants sponsored by a local garden centre and facilitated by a local environmental community activist and researcher affiliated with Princess Vlei, a nearby conservation area. One emergent question has been the ongoing maintenance of this space, including the provision that municipal open space maintenance teams ensure not to mow the key central, water-logged areas that are thriving and have become of interest as biodiversity learning spaces. A field trip to the Edith Stevens Nature Reserve in early 2022 with local residents gave inspiration for indigenous plants (including fynbos and other endemic species) that the community can plant. Finally, the researcher team and the community have worked together with local Cape Town artists to paint a mural on some of the boundary walls of properties facing the Pond. The mural serves a three-fold function: (i) as a placemaking instrument further defining the multifunctional Pond's amenity and renewed biodiversity, (ii) as an educational tool depicting the expanded hydro-ecological functions of the pond, and (iii) as a visual reminder of the water resilient futures the community continues to envision for their locale.

Remaining/emergent questions and challenges

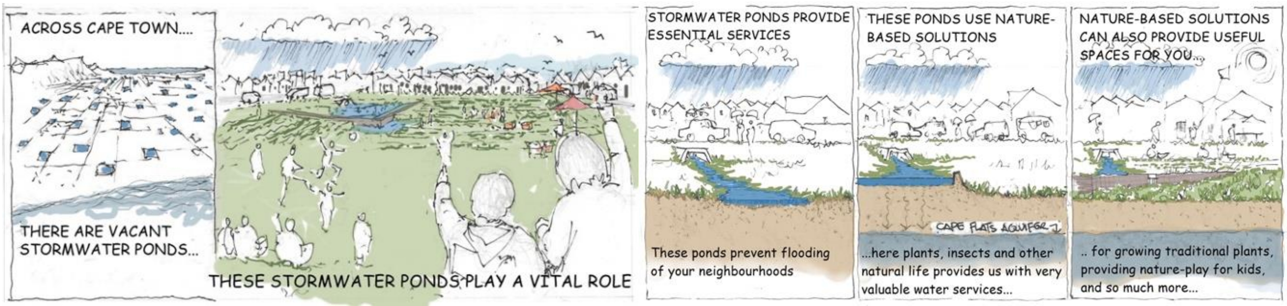
- Maintenance and roles – Who is doing what and how can we make use of local residents?
- Local community mistrust of CoCT - how to improve communication?
- Management plan in place for these types of systems?
- Maintenance tasks: filling in mole holes; looking after planted vegetation; rubbish clearing; etc. Can the CoCT support local residents in engaging with these efforts?
- How can key stakeholders like local communities, NGOs and city officials/contractors collaborate so that these sites can develop into recreational sites and be maintained in the years to come?
- Can a NPO 'Friends of' or similar group be used as a vehicle for the mutual collaboration between the City, local community, and other interested parties in stewarding nature-based efforts such as those at the Pond? How?

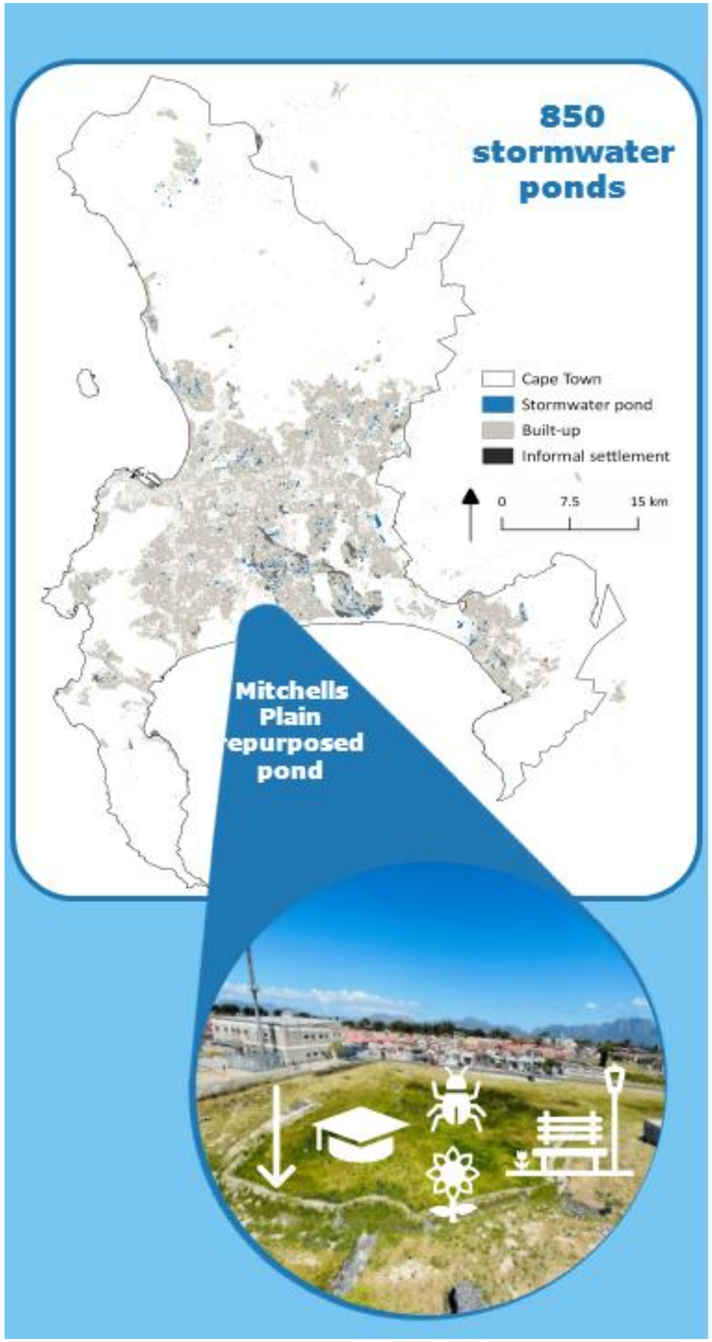
Key lessons learned in efforts towards coproducing multifunctional stormwater ponds in Cape Town

- The space allows for wetland creation; higher grass and different forms of vegetation / biodiversity, frogs, toads and butterflies.
- Local residents expressing that they are more aware of the ecosystem and its importance.
- A broad representation of both old and young, women, men, schoolchildren involved.
- With hands-on engagement comes ownership and stewardship; needs to be formalised with CoCT.
- Mistrust and conflicts in these places of difference between and across local residents and different departments within CoCT.
- Getting to know each other – finding the 'local community' (the councillor as well as many other key stakeholders) school, neighbourhood watch, local youths etc.
- Unemployment and livelihood creation on top of residents' list of concerns.
- Use locally-based organisations and services, encourage local agency in the provision of these.
- Hands in the soil – better understanding of water issue and starting to see biodiversity. Connections to schools and local curricula.
- Visits to other site, such as Edith Stevens visit serves as inspiration.
- Transitions in post-colonial cities entail humbler visions and aspirations than those found in the developed world. The meaningful inclusion of marginalised groups is a key impact in and of itself.
- Acknowledge that sometimes places like the Pond represent unacknowledged dilemmas for parties involved, i.e., the City, communities etc. As indeterminate spaces of potential violence, spaces of resistance to the urban regime, spaces signifying benign neglect, whilst being spaces 'owned' by the community and worthy of protection against invasion etc.
- The approach is not a one-size-fits all, it is more useful if seen as a frame within which to work out the different interests, dimensions and actions likely to be found in the retrofitting of the urban landscape for building water resilience.

Recommendations – How can the City take this forward as an exemplar for other ponds?

- Empower citizens to create local organizations to support and promote the multifunctionality of these green spaces.
- Encourage the use of these green spaces by supporting citizen organizations doing the maintenance and providing tools, plants, facilities, funding (?) in this regard.
- Allowance within Parks and Recreation budgets for ongoing maintenance of these ponds. Handbooks for local resident groups and small stipends to assist in developing similar retrofitting would be useful.
- Enabling environment for feedback on green spaces – and an awareness that a one size fits all approach will not work, so some flexibility in process and procedures.





Pathways to water resilient South African cities

"to identify opportunities for the physical and institutional integration of hybrid, decentralised Blue-Green Infrastructure into the urban water cycle to accelerate a transition towards water resilience"

A Water Sensitive City with Blue-Green Infrastructure can enhance liveability, resilience and sustainability.

An established stormwater detention pond in Mitchell's Plain has been modified as a case study to enhance the benefits of Managed Aquifer Recharge via surface infiltration, enhanced biodiversity, amenity and liveability and an education services connection with the neighbouring school.

There are 850 existing detention and retention ponds in Cape Town that offer potential opportunities for repurposing to provide multi-functional benefits such as

Increasing water re-use	Enhancing cultural and heritage associations with water systems	Reducing the Urban Heat Island effect
Increasing equity	Increasing access to blue-green space	Managing water quality
Enhancing biodiversity	Community services connection with water systems	Flood control

Kirsty.carden@uct.ac.za