No. 1 - 2023

Newsletter

Pathways to water resilient South African cities (PaWS) project

STORMWATER PONDS FOR A WATER RESILIENT CAPE TOWN: OVERFLOWING WITH POTENTIAL?

Jessica Fell

Multifunctional infrastructure is a way to make cities more resilient and water sensitive. However, it is not always feasible to develop new multifunctional infrastructure in rapidly urbanising cities with competition for space and constrained budgets. In such instances, existing infrastructure or open green spaces can be transformed to provide multiple benefits.

The PaWS project has focused in part on transforming stormwater ponds to provide multifunctional benefits. Stormwater ponds are largely considered as monofunctional, that is providing the single function of stormwater management. PaWS has developed a site level case study transforming a stormwater pond for multifunctionality.

This issue

About the project

The ‘Pathways to water resilient South African cities (PaWS)’ project is a collaboration between UCT's Future Water Institute, and the University of Copenhagen, funded by Danida MFA. Drawing on physical experiments and governance and social processes, it explores the potential for existing flood attenuation infrastructure to be adapted towards water resilient cities (read more here).

Contact: Kirsty.carden@uct.ac.za

Pathways to water resilient South African cities
University of Cape Town
FUTURE WATER
UNIVERSITY OF COPENHAGEN
Ministry of Foreign Affairs of Denmark
DANIDA | INTERNATIONAL DEVELOPMENT COOPERATION

With this site level case study in mind, another part of the project has evaluated the potential for Cape Town's existing stormwater ponds to provide multifunctional benefits. The research used a Multi-criteria Analysis (MCA) paired with GIS for the evaluation. MCA consists of various methods, techniques and procedures for structuring planning and decision problems. This first volume of our PaWS newsletter describes the research, taking you through the steps of a MCA.

Evaluating the multi-functional potential of Cape Town's stormwater ponds

There are approximately 850 stormwater ponds of different shapes and sizes in Cape Town. These seemingly unremarkable pieces of infrastructure look like empty, dusty, grassy or wet depressions, but they are an important part of the city's stormwater drainage system as they protect people, property and the environment from flooding impacts. During rainfall, stormwater enters the pond through an engineered inlet and is then slowly released through an outlet into the environment or to receiving waterways.

From a stormwater management perspective, stormwater ponds address increased surface runoff from urban surfaces and reduce flooding risks. They can be characterised into detention ponds and retention ponds. Detention ponds temporarily store runoff for short periods of time, typically for 24 to 72 hours, and are usually dry for the majority of the time. In general, they are grassed or vegetation lined but some are concrete lined. Retention ponds have a permanent pool of water and are designed to provide a water quality improvement benefit alongside flood risk mitigation. The maximum storage capacity of retention ponds is larger than the permanent pool of water which also allows for the attenuation of runoff from storm events.

The pictures below show examples from Cape Town of the two types of ponds (left – retention; right – detention).

A MCA was used to evaluate the potential for the 850 stormwater ponds to provide multifunctional benefits. MCA establishes preferences between options by reference to an explicit set of objectives that the decision-making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved. MCAs vary from highly elaborate and mathematically complex to relatively simple. This research used the widely applied and easy to use simple additive weighting model with the following steps: (1) Identification of objectives and options, (2) Development of the options or alternatives to be assessed, (3) Scoring to assess the performance of each option against the criteria, (4) Weighting of criteria, (5) Combination of scores and weights and, (6) Providing planning support with the MCA results.

1. *Identification of objectives and associated criteria against which to test options*

For the research, seven benefits were identified and used as criteria, shown in the table below.

Benefit	Criterion	Explanation
Enhancing cultural and heritage associations with water systems	Proximity to culture and heritage resources	Intersection with national, provincial and local heritage resources indicates potential for the pond to contribute to conserving the heritage resource
Increasing water re-use	Managed Aquifer Recharge (MAR) potential (four indicators of Surficial geology, Aquifer, Soil permeability and Transmissivity)	Suitable conditions for MAR via surface infiltration are required
Reducing the Urban Heat Island effect	Urban Heat Islands Intensity risk (land cover classes, daily normalised, irradiation and windspeed)	The higher the UHI risk, the greater the need for cooling
Enhancing community services connection with water systems	Proximity to schools, community centres and religious institutions	The closer to schools, community centres and religious institutions, the more community services reach and ownership and stewardship potential
Increasing access to blue-green space	Recreation potential (two indicators of park presence and mean population density in 500m pond radius)	The presence of a park indicates a low recreation potential The higher the population density, the higher the level of potential recreational use by people living in close proximity
Incorporating stormwater quality limitations	Proximity to Potential Contaminating Activities (PCA) (informal settlement, industrial, roads, landfill, wastewater treatment works)	The further away from a PCA, the lower the likelihood for poor stormwater quality impacts to limit other potential functionalities
Enhancing biodiversity	Aquatic biodiversity category	Biodiversity significance

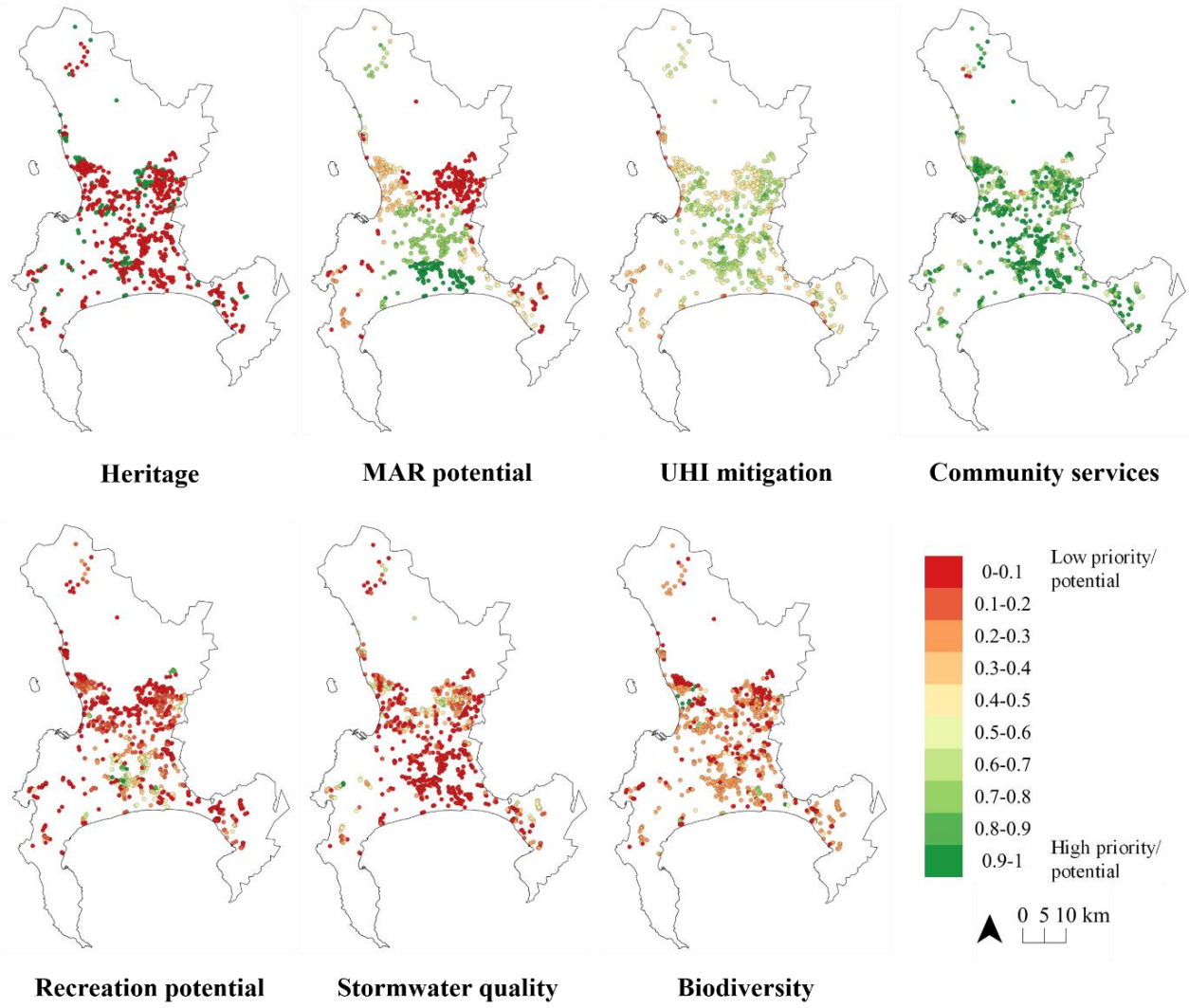
2. *Development of the options or alternatives to be assessed*

The existing stormwater ponds in Cape Town served as the options.

3. *Scoring to assess the performance of each option against the criteria*

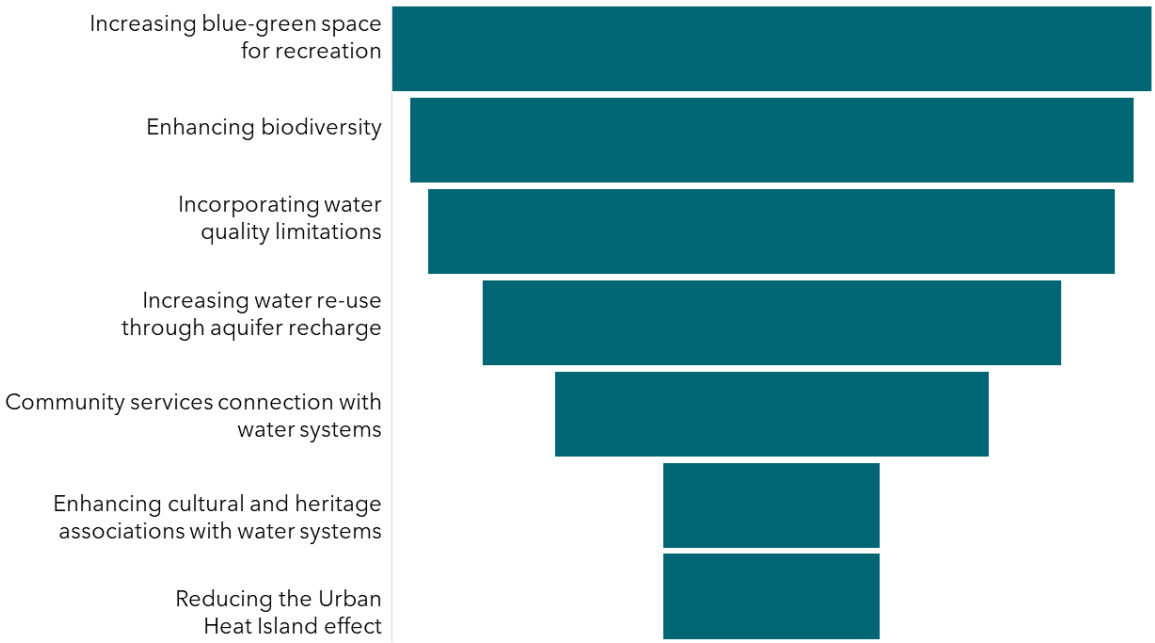
Each of the seven criteria had a matching dataset/s, which was used as a way to score each stormwater pond's potential to provide the benefits. The scores were put on a standard scale to make them comparable. This scoring is called performance scoring and is the mathematical representation of human judgement and knowledge.

Performance scores represent pure numbers with no units. A colour-coded scale from 0 (low potential/priority) to 1 (high potential/priority) was used. The seven maps show the potential benefit provision and scoring spatially. Darker green ponds (with higher criterion scores) show a higher potential for the benefit to be provided.



4. Weighting of criteria

Local stakeholders rated the relative importance of the seven benefits for creating a resilient and Water Sensitive City at a workshop. This enhanced the participatory component of the MCA by incorporating the interests and values of different groups. The weightings are showed below.

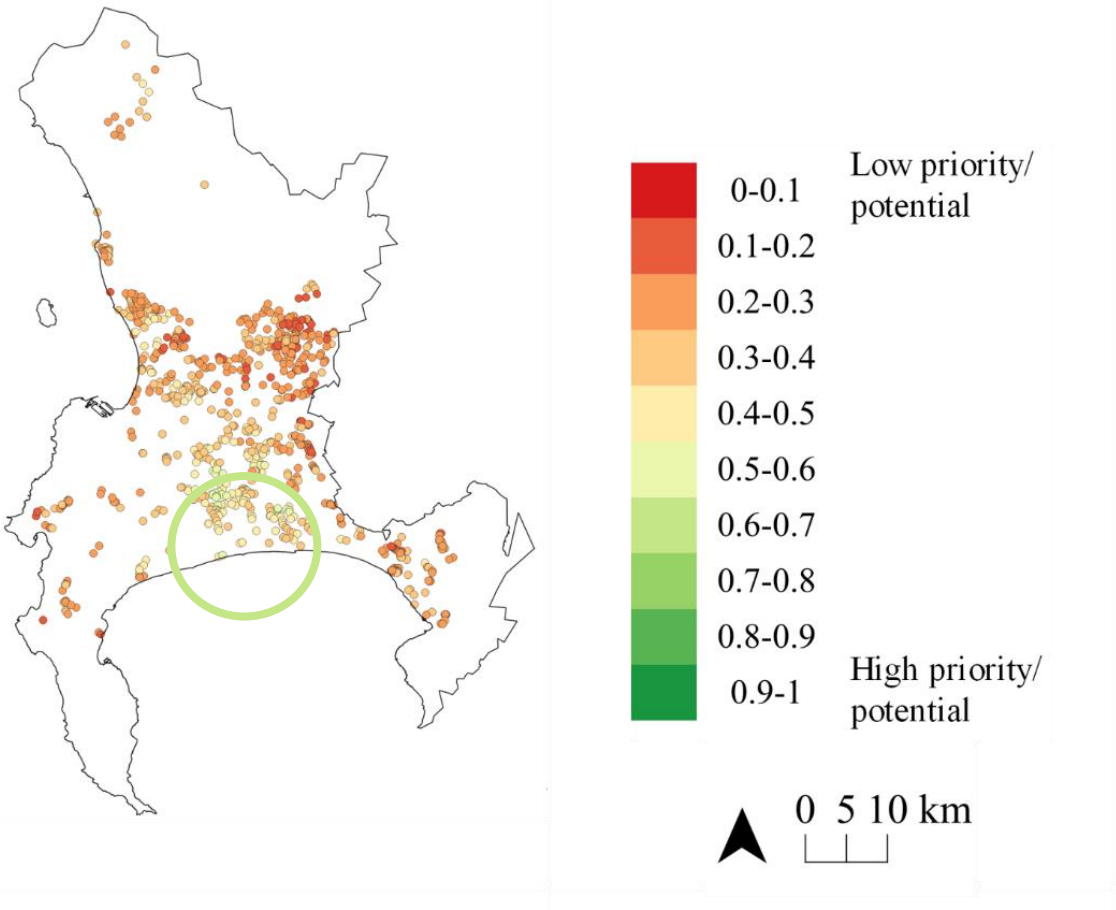


5. *Combination of scores and weights*
6. *Providing planning support with the MCA results.*

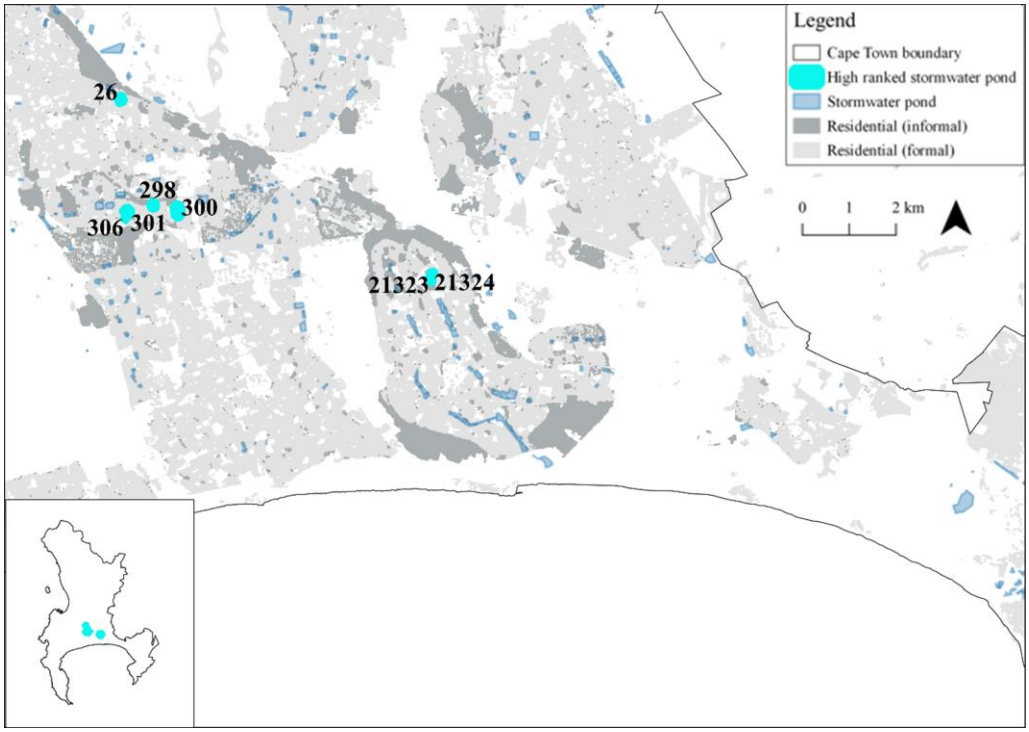
The benefit scores for each map were combined and weighted with the local expert stakeholder weights to produce a ranking of the ponds. This ranking showed the ponds' relative potential to provide a combination of the seven benefits; that is, the pond's potential for multifunctionality.

On the map on the next page, the darker green stormwater ponds (with higher scores) show a higher potential to provide a combination of the seven benefits. They are thus higher priority for multifunctional transformation to create a resilient and Water Sensitive City. There is a cluster of the highest scoring potential ponds in the southern central part of the city, with the top seven ponds located in two clusters in the south-eastern central part of the city.

The MCA approach developed is strategic, flexible, participatory and transferrable. It can incorporate different benefits through criteria and be applied to other infrastructure and cities to evaluate the potential for multi-functionality. You can see an interactive version of the research and maps at this link: https://arcg.is/XuGHD.



The ponds' relative potential to provide a combination of the seven benefits, showing a hotspot of the highest potential ponds in the study area



The top seven ranked ponds clustered in the SE central part of Cape Town

Until the next edition…….

Helpful resources for MCA projects

Dodgson, J., Spackman, M., Pearman, A., & Phillips, L. (2009). Multi-criteria analysis: a manual. http://eprints.lse.ac.uk/12761/1/Multi-criteria_Analysis.pdf

Dean, M. (2022). A Practical Guide to Multi-Criteria Analysis. https://www.researchgate.net/profile/Marco-Dean/publication/358131153_A_Practical_Guide_to_Multi-Criteria_Analysis/links/61f198a98d338833e398624c/A-Practical-Guide-to-Multi-Criteria-Analysis.pdf

Pathways to water resilient South African cities
FUTURE WATER
UNIVERSITY OF COPENHAGEN
MINISTRY OF FOREIGN AFFAIRS OF DENMARK
DANIDA | INTERNATIONAL DEVELOPMENT COOPERATION