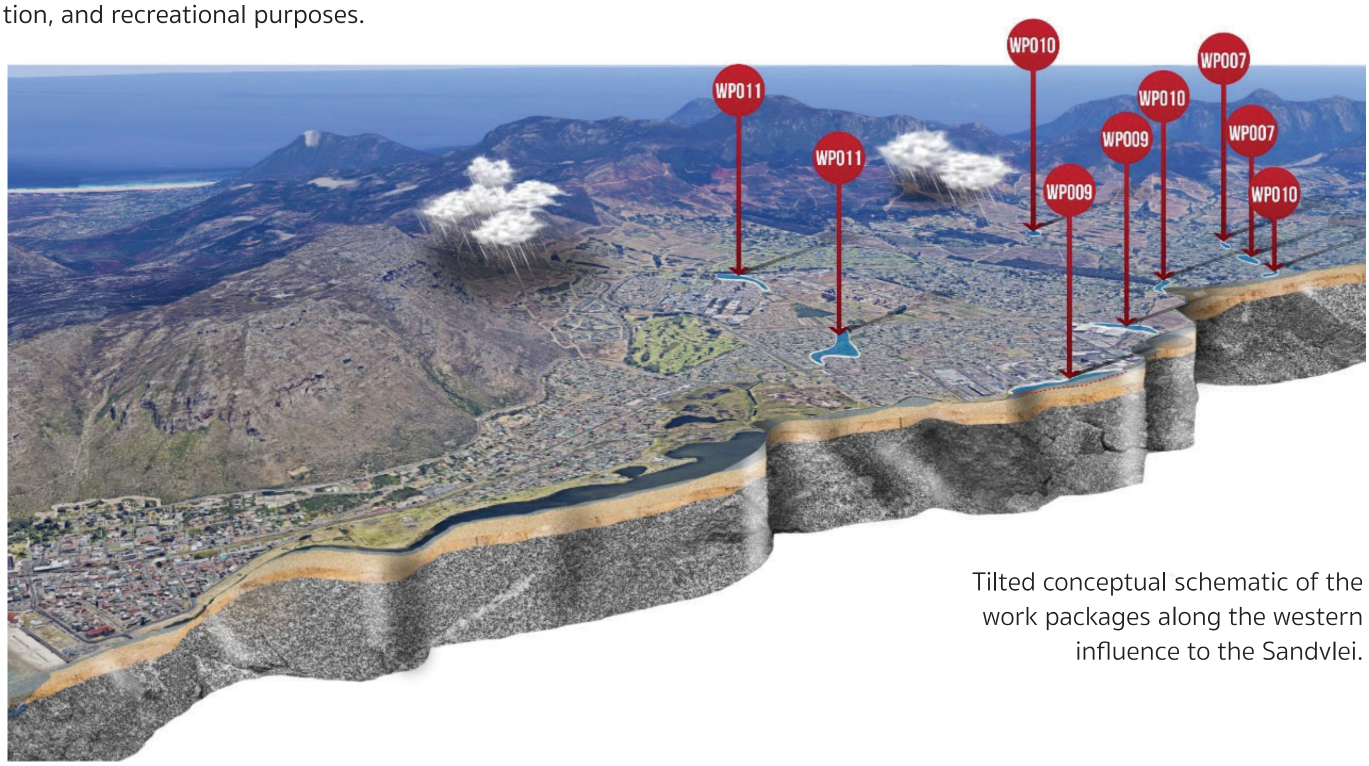
Livable Urban Waterways Project – Hydrogeological Characterisation of the Sand River Catchment

The issue of water scarcity in Cape Town brought attention to the challenges posed by an increasingly unpredictable climate. The growing demand for water services due to urbanization and population growth exacerbates the problem, leading to scarcity and potential conflicts in social, economic, and environmental aspects.

However, water serves a broader purpose beyond meeting supply and demand. It plays a significant role in shaping the identity of a city, providing amenities, ecosystem services, and contributing to urban revitalization. Moreover, water enhances property value, improves neighbourhood appeal, and fosters liveability, community health, and well-being. Cities worldwide are exploring how their waterways can serve as conduits for building greater resilience and act as critical habitats, social spaces, commercial hubs, and transportation corridors (Kaner, 2019).

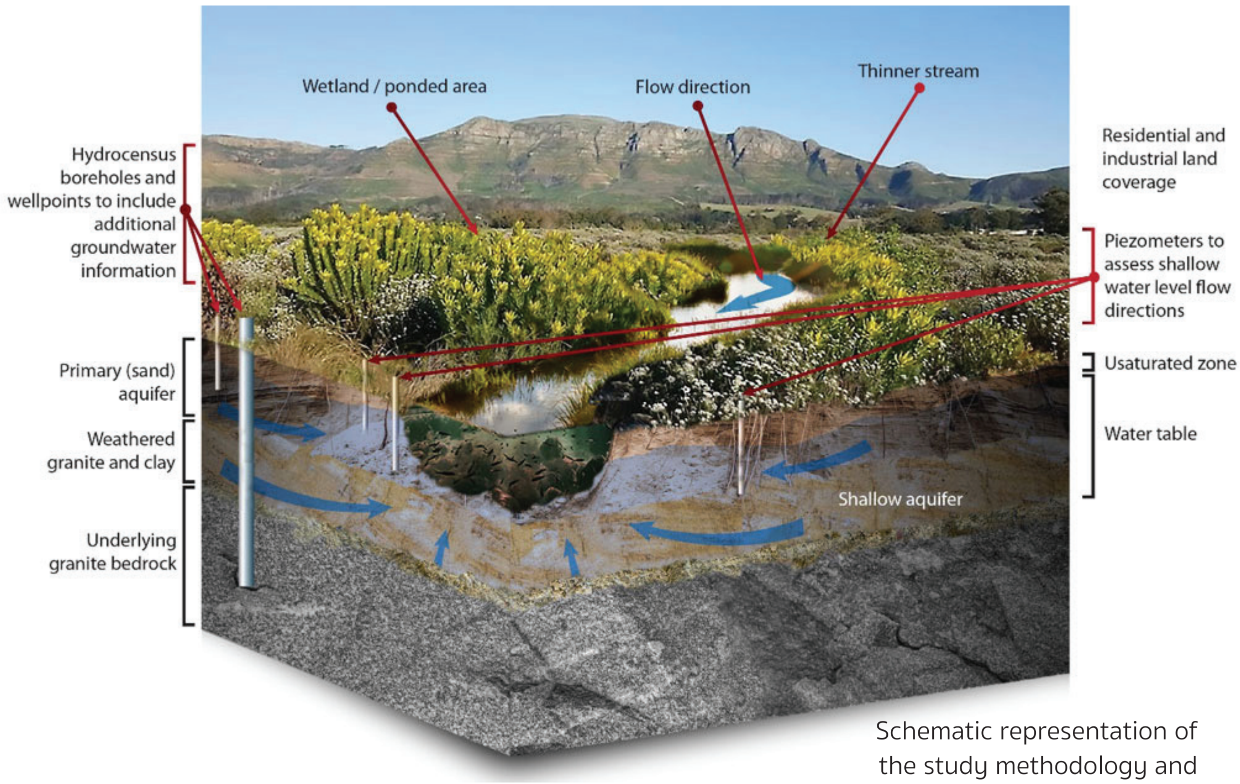
The City of Cape Town envisions a water-sensitive city that celebrates the interconnectedness of people, nature, and water, with a deliberate focus on design. In its Water Strategy (2019), the City has committed to transitioning to a water-sensitive city by 2040. This approach integrates the urban water cycle, enhances resilience, and protects the sensitive natural ecosystems of Cape Town. It optimizes the use of stormwater and urban waterways for flood control, aquifer recharge, water reuse, conservation, and recreational purposes.



Tilted conceptual schematic of the work packages along the western influence to the Sandvlei.

While many of Cape Town's waterways are currently in poor condition (City of Cape Town, 2021), there are some waterways that exhibit elements of liveability. The City of Cape Town have developed and define the concept of Livable Urban Waterways, a concept that has parallel references and conceptual framings to sponge cities and water sensitive cities (World Future Council, 2016).

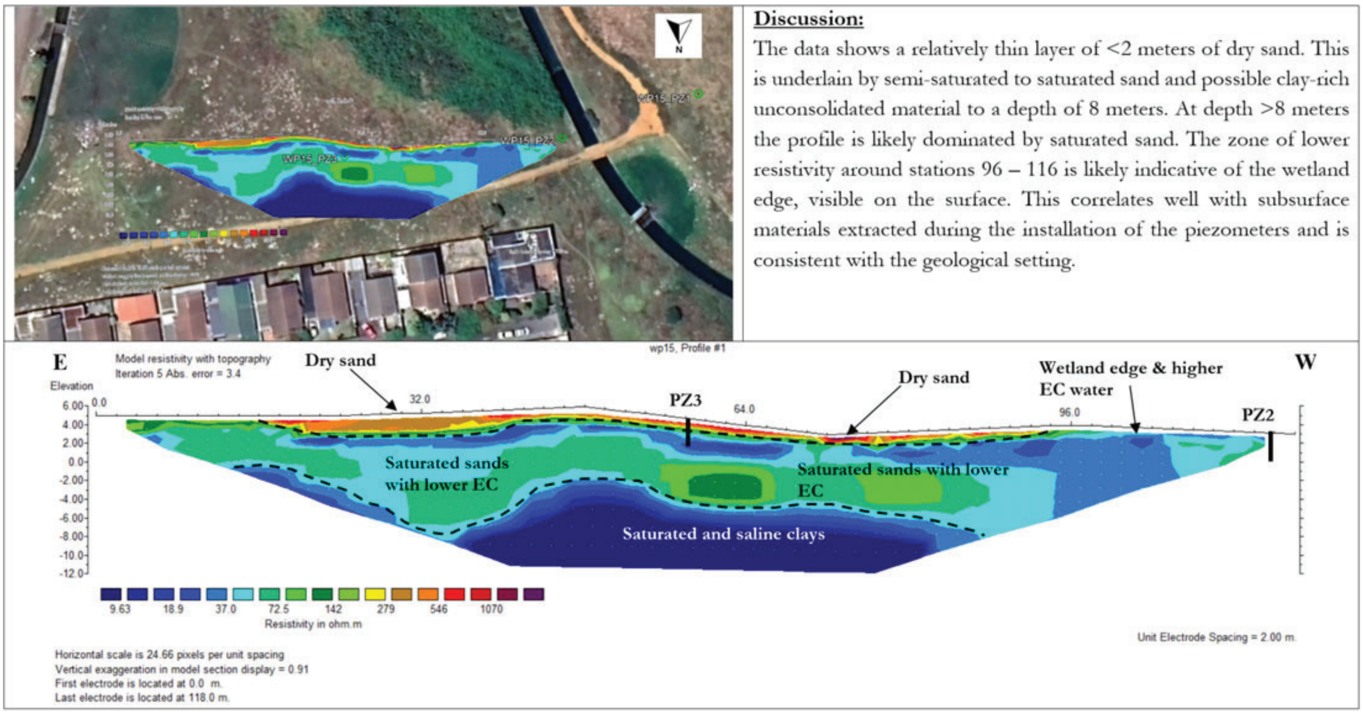
Sponge cities and water-sensitive cities share numerous similarities. Both aim to create interconnected waterways, channels, and ponds throughout neighbourhoods, fostering urban ecosystems, boosting biodiversity, and offering cultural and recreational opportunities. Various interventions, such as bio-swales, bio-retention systems, porous roads, and natural ponds and wetlands, are commonly employed. These sustainable drainage systems enable the gradual release of stormwater, facilitate groundwater infiltration, and provide habitat and ecological services.



Schematic representation of the study methodology and purpose.

Implementing the Livable Urban Waterways (LUW) Programme requires a paradigm shift in how we work. It demands collaborative planning and management of waterways, the development and implementation of incentives and regulations, direct investment in new and existing infrastructure, and the co-design of solutions. When infrastructure investments are necessary, they should adhere to sound ecological and engineering principles, utilizing green infrastructure and water-sensitive design.

The vision is to create a water-sensitive Cape Town with safe, healthy, functional, and productive waterways. This entails protecting waterways, restoring river corridors, and enhancing the quality of life for communities and the environment. The LUW Programme aims to establish a collaborative and systematic approach to waterway rehabilitation throughout Cape Town. By employing water-sensitive design and innovative waterway management methods, the programme aims to achieve multiple benefits.



Resistivity traverse across the study site, with interpreted lithologies.

A Livable urban waterway consists of six elements, where each element has a key performance indicator that can be used to assess a waterway before and after a LUW project. In summary, the elements and their indicators include (City of Cape Town, 2021):

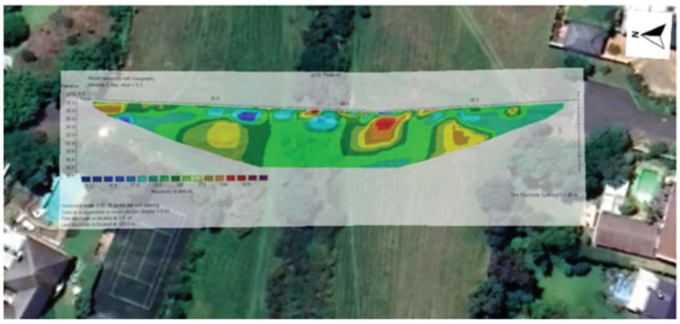
1. Water Quality: Livable urban waterways maintain acceptable water quality, free from sewage, litter, and invasive species, while supporting indigenous aquatic life. Indicators include E.coli concentrations per 100ml, nitrogen and phosphorus nutrient concentrations, litter and sediment levels, and other relevant factors.
2. Flood Management: Livable urban waterways are designed to accommodate flooding and effectively manage floodwater without posing risks to surrounding communities. The indicator is the ability to accommodate return period storm events.
3. Ecological Functioning: Livable urban waterways provide a diverse habitat structure that supports a healthy biodiversity of indigenous aquatic life. They also promote connectivity for the movement of plants and animals. The indicator measures the present ecological status or habitat integrity.
4. Connectivity to Water Table and Floodplain: Livable urban waterways are hydraulically connected to aquifers, floodplains, and wetlands. This connection allows water to move naturally, recharge groundwater, and sustain wetlands. The indicator assesses the percentage of permeable area enabling connectivity to the floodplain or aquifer.
5. Community Engagement: Livable urban waterways serve as linear pathways connecting communities and are enjoyed by people for recreational, educational, and exercise purposes. The indicator measures the number of amenity uses and their frequency.
6. Ecosystem Services and Benefits: Livable urban waterways act as green infrastructure, utilizing natural processes to treat water, reduce flooding, enhance biodiversity, trap sediments, recycle nutrients, reduce heat, and sequester carbon. They can also provide economic benefits and ecosystem services. The indicator measures the number of additional ecosystem services, economic benefits, or social benefits provided.

GROUNDWATER AND EARTH SCIENCES
GEOSS
SOUTH AFRICA (Pty) Ltd

GEOSS South Africa (Pty) Ltd were appointed by Lukhozi Consulting Engineers as the hydrogeological specialists on the project, tasked with characterising the hydrogeology of the Sand River catchment, as well as how the site could be improved in terms of its functioning as a Livable Urban Waterway from a hydrogeological perspective.

The study included the installation of piezometers for assessing groundwater elevations and flow directions to assist in characterising the nature of groundwater – surface water interaction through the catchment. While the type interaction varied through the catchment, it generally transitioned from a losing stream in the upper reaches, to a flow through system in the middle reaches, to a gaining stream in the lower reaches.

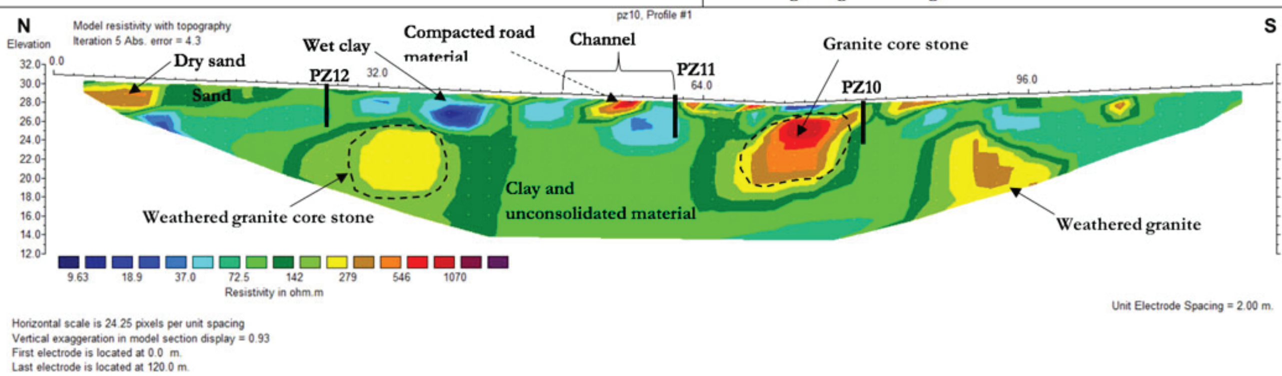
Extensive water sampling for stable isotope and inorganic chemical parameters was undertaken at identified target sites throughout the catchment, enabling characterisation of the catchment and identification of areas of potential concern.



Summary:

The data shows a relatively thin layer of transported sand varying between depths of 0 – 2 mbgl across the profile, which is underlain by saturated clays to depths of approximately 6 mbgl. Around stations 56 – 62 at <6 mbgl the channel position and saturation can be seen. From stations 28 – 38, 68 – 80 and 88 – 96 weathered to competent granite core stones occur from 2 – 12 mbgl.

Below 2 mbgl it is anticipated that the subsurface comprises unconsolidated, clay-rich material grading into weathered granite bedrock with depth. This correlates well with subsurface materials extracted during the installation of the piezometers and is consistent with the geological setting.



Resistivity surveys were undertaken across the channels of the various tributaries, in addition to trial pits and augering, allowing for assessment of the aquifer, its characteristics, and ability to receive and contribute water. This information is also useful in assessing constraints in terms of the potential interventions at the various target sites.

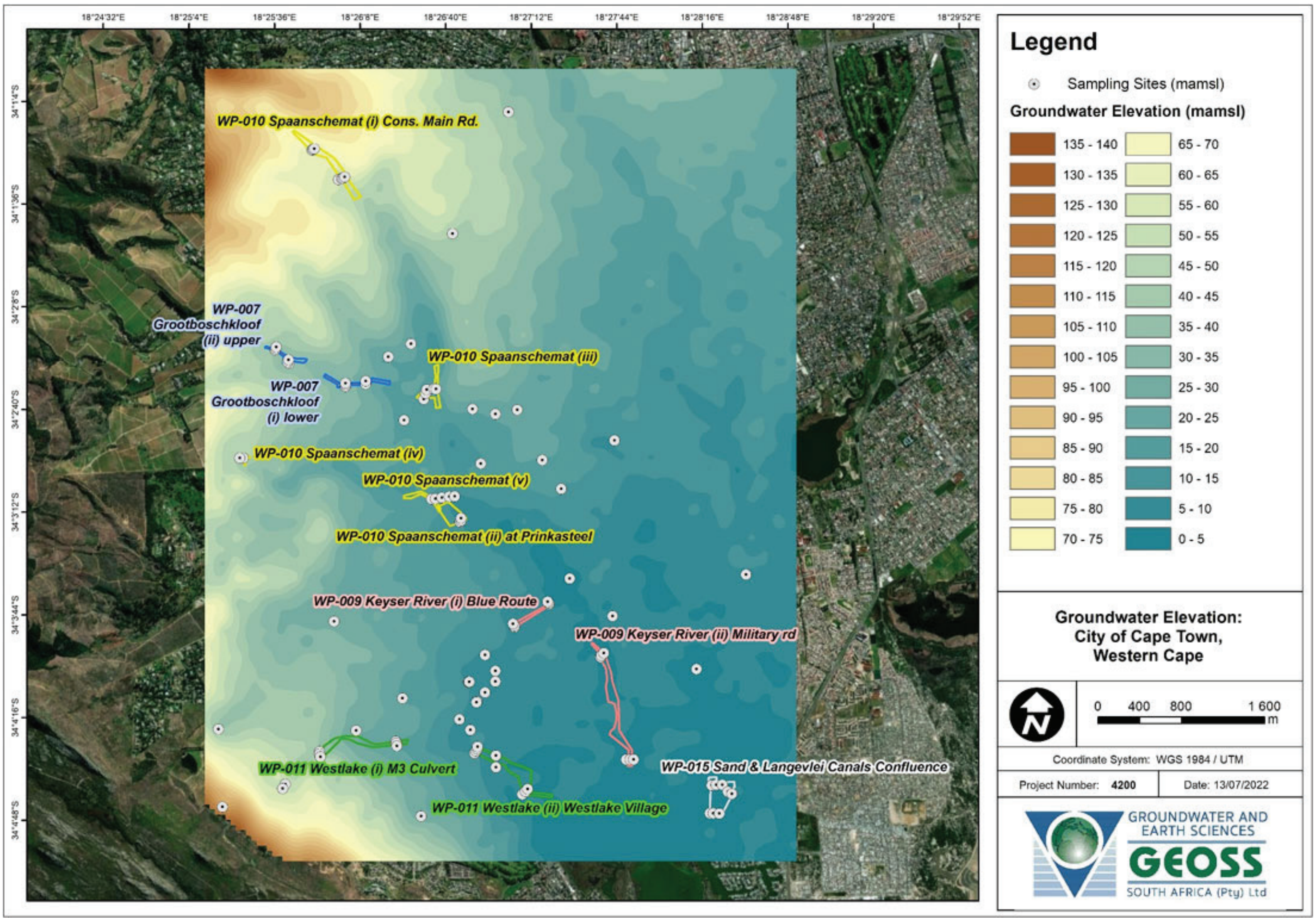
At certain locations through the catchment, groundwater interaction with surface water is limited on account of the lined canalised river. In these instances, the implications of removing the canal lining could be assessed.

From the assessment, it was determined that the Sand River (and its tributaries) could be improved in terms of its suitability to be a Livable Urban Waterway (LUW), particularly regarding the ability to:

- Accommodate flooding (by allowing interaction with the aquifer, and bank storage)
- Have acceptable water quality (better interaction with the aquifer would likely limit the variability in surface water quality)
- Have a functioning ecology (Groundwater can limit low flows, and potentially allow for increased wetland area using MAR techniques).
- To be connected to the water table and floodplains (by removing the canal lining, and using MAR techniques).

The detail of the various specialist studies was then used to conceptually design interventions that can be implemented at strategic locations throughout the catchment.

GROUNDWATER AND EARTH SCIENCES
GEOSS
SOUTH AFRICA (Pty) Ltd



References:

1. City of Cape Town (2021). Liveable Urban Waterways Implementation Framework. January 2021. Water and Sanitation, Resilience, Environmental Management, Urban Planning and Design, Recreation and Parks Departments.
2. GEOSS (2022). Hydrogeological Assessment: Grootboschkloof River Corridor (WP007) Rehabilitation and Public Space Enhancement, Cape Town. Report Number: 2022/06-17. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.
3. GEOSS (2022). Hydrogeological Assessment: Keysers River Corridor (WP009) Rehabilitation and Public Space Enhancement, Cape Town. Report Number: 2022/07-27. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.
4. GEOSS (2022). Hydrogeological Assessment: Sand & Langevlei Canal Confluence (WP015) Rehabilitation and Public Space Enhancement, Cape Town. Report Number: 2022/07-21. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.
5. GEOSS (2022). Hydrogeological Assessment: Spaanschemat and Prinskasteel Corridors (WP010) Rehabilitation and Public Space Enhancement, Cape Town. Report Number: 2022/07-25. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.
6. GEOSS (2022). Hydrogeological Assessment: Westlake River Corridor (WP011) Rehabilitation and Public Space Enhancement, Cape Town. Report Number: 2022/07-29. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.
7. Kaner, D. (2019). Rivers Rising: Urban Waterways Catalyze Resilience. 100 Resilient Cities. Retrieved from https://www.100resilientcities.org/rivers-rising-urban-waterways-catalyze-resilience/
8. World Future Council. (2016, January 20). Sponge Cities: What is it all about? Retrieved from World Future Council: https://www.worldfuturecouncil.org/sponge-cities-what-is-it-all-about/