BECOMING A GREEN UTILITY

A didactic tool for changing and evolving water utilities

CONCEPT NOTE

ABSTRACT

An overview of the driving factors and global considerations for water utilities becoming ‘greener’. Further, an assessment framework and the dimensions of a Green Utility are described, followed by a discussion on benefits and challenges of their implementation. Part of the Green Utility Toolkit under BEWOP.

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Green Utility Concept Note

The Green Utility (GU) Concept Note is primarily intended for facilitators of the GU Tool. It can also be shared with participants (and a broader audience) if time and interest allow.

The Concept Note begins with a summary of academic and practitioner literature to situate the emergence, and need for, a GU. This section provides facilitators with a historical explanation of sustainability/"greenness" in the water sector, so as to foster a broader view and guide participants engaged with the tool in their utility.

Further, this Concept Note explains the theoretical dimensions of a GU, the evolution of GUs, and the respective benefits and challenges of becoming a GU. A thorough understanding of the GU dimensions is fundamental for facilitators, as these need to be explained to participants. The GU evolution and benefits/challenges are presented to support staff in garnering support for the implementation of the GU Tool through a broad benchmarking scheme, selling points, and opportunities for growth.

Most of the topics covered in this Concept Note have corresponding presentation slides in the Green Utility Presentation contained in the GU Toolkit. These are provided at the end of the presentation. It is to the discretion of the facilitator which topics are relevant to present during the implementation of the GU Tool.

The following boxes provide a concise summary of the topics covered in order to highlight the connection between them and the implementation of the GU Tool, as well as streamline the use of this Concept Note:

> *Boxes in this format highlight key information for the facilitator regarding the section's topic and its relation to the GU Tool.*

One of the main underlying notions of the GU Toolkit is that water utilities around the world are at different development stages. The GU Tool is intended to be flexible enough to be used by these different water utilities at different stages. Considerations for local contextual factors, particularly between the Global North and South, are presented in the *Background* section in sets of boxes like these:

North vs South: These boxes provide insight into some of the local considerations for water service providers from different parts of the world.

We welcome your experiences, suggestions, and questions. Broader dissemination and the lessons learned thereon will provide valuable information for academics and practitioners alike. Becoming a Green Utility, is an ongoing process.

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Table of Contents

List of Figures

List of Tables

Introduction

"[T]here is an increasing clash between the demand for and limits to resources that result in ecological, economic and cultural 'strains' (Vlachos and Braga, 2001). From an urban water perspective, these strains have led various authors to suggest that the current model of service provision is no longer appropriate (Pahl-Wostl, 2002; Ashley et al., 2003; Milly et al., 2008; Pearson et al., 2010; Brown et al., 2011)."

Marlow et al. (2013, p. 7150)

"[W]e need to ensure that in striving to achieve water and sanitation access [SDG] targets (6.1 and 6.2) we do not inadvertently undermine the achievement of related water resource management targets (6.3–6.6) or other SDGs with explicit environmental sustainability agendas (such as clean energy, sustainable cities and communities, climate action, life below water, and life on the land). This requires considering interconnections when designing our approaches."

Carrard and Willetts (2017, p. 223)

The already existing pressures on water service[1] providers (WSP) to achieve coverage and adequate levels of services are being compounded by the global discourse on achieving development sustainably, as exemplified by the Sustainable Development Goals set forth by the UN. Faced by this, what can water service providers do? How are they to respond to these various pressures? And, can becoming 'green'[2] support them in engaging and solving these complex issues?

This concept note aims to present the driving factors that have led WSP discourses to incorporate environmental consideration, and from here offer the foundations for a conceptual framework for assessing a Green Utility in the water service sector. Taking into account the activities of water utilities, three foundations for a Green Utility are proposed: *Green 'turn-over'*, *Pathways,* and *Current Practices*. These 3 foundations can serve as a guide in identifying, prioritizing, and implementing green changes for water service providers. From here, the benefits and challenges for maturing into a Green Utility are discussed. Finally, a planning and monitoring framework is presented to facilitate WSP interested in beginning or continuing to advance their greening process.

Overall, greening a water utility aims to improve its performance in terms of long-term sustainability and increased efficiency, while fostering resilience through incorporating the natural environment and their communities in their operations.

[1] Water services refers to potable water, wastewater, and sanitation services.
[2] For the Green Utility Toolkit, the terms 'green' and 'greening' refer to the processes and activities implemented by utilities along the 3 pillars of sustainability – Social, Environmental, and Economical – while considering a long-term business horizon.

Background

The following section overviews the various factors that have influenced the development of a Green Utility concept. It first elaborates on the current state of water services and the main foreseen challenges for providers. Further, the future horizon of the sector and expected global goals are discussed. Specific considerations for water service providers in the Global South[3] are addressed at the end of each sub-section.

Historical overview of urban water services

The emergence of the *Green Utility* can be linked to the broader historical context of the development of urban space. As cities have grown and progressed, so have the type and scope of water services offered to the population. The evolution of citizens' knowledge and values, along with respective government policies, have catalysed the development of broader and more ambitious service delivery functions. The historical evolution of water services is chronologically portrayed by R. R. Brown, Keath, and Wong (2009) as:

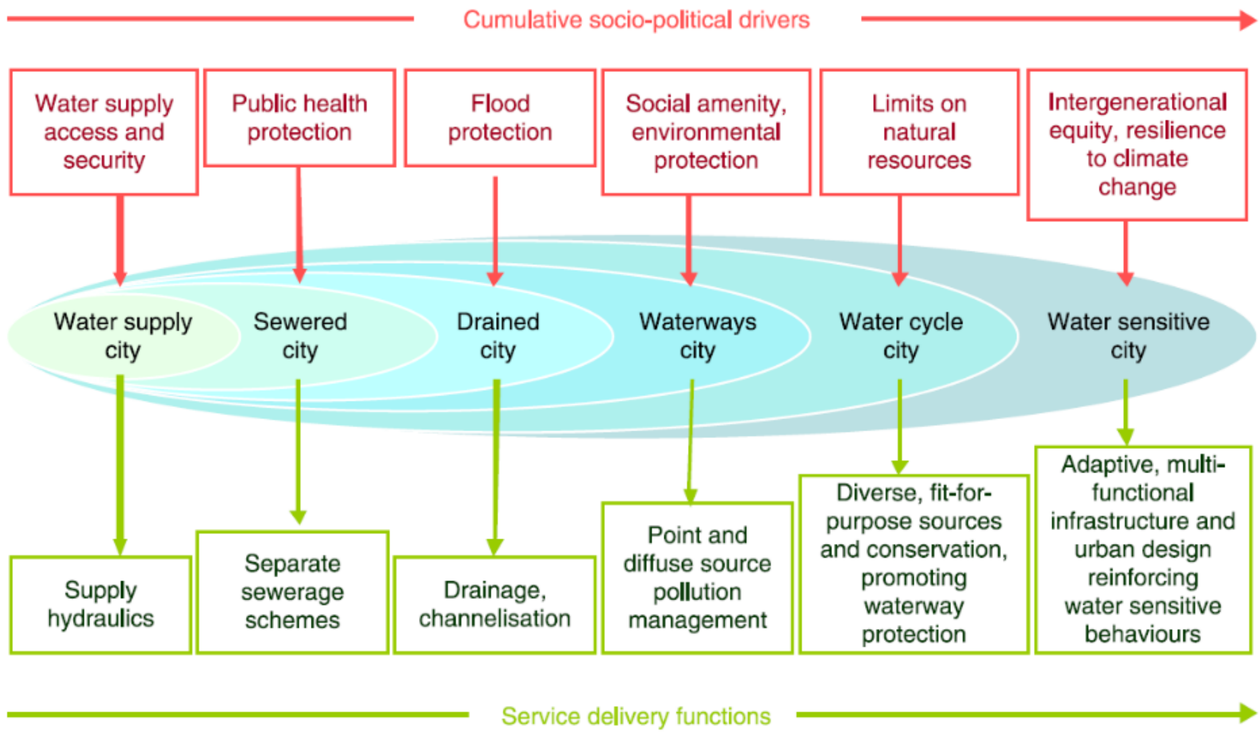

Figure 1: Urban water management transitions framework - Source: R. R. Brown et al. (2009)

This 'cumulative' process progressively escalates from fixed service delivery functions – providing water supply, improving public health, and managing run-off water – towards a broader, environmentally-centric service delivery dealing with issues of environmental protection, limited resource availability, long-term sustainability and resilience. In parallel, this process assumes a change in citizen involvement. Shifting from limited citizen involvement towards an (envisioned) integrated process validated through active citizen participation – an evolution of what R. R. Brown

[3] "The terms Global North and Global South (or Northern and Southern countries) refer to the comparative degree of socio-economic development of countries, rather than their geographical location. Northern countries are those with high levels of development, such as Western Europe, U.S., Australia, and Japan, while Southern countries are those considered to have medium and low levels of development, such as Latin America, Africa, Middle East and South-East Asia. For further information on this terminology see Mimiko (2012); Therien (1999)". (Bichai & Cabrera Flamini, 2018, p. 7)

et al. (2009) call the *hydro-social contract*. Whether active citizen participation can be achieved, or is even necessary for a resilient city, in terms of water service provision, remains a point of contest[4]. Further, citizens' choices have been found to run counter to the achievement of a sustainable,

> *When defining sustainability in Step 1, it may be useful to briefly explain the local historical context of water service provision, so participants can situate where they are and where they want to go.*

resource efficient water scheme (Carrard & Willetts, 2017).

Two points are worth noting on the above framework. First, a city's movement along this framework is not necessarily forward or linear. Cities may regress, jump, or simultaneously experience various stages. These service provision stages are shaped by the existing socio-political drivers, the viable technical approaches, and their inter-related nature. For example, citizens' demands and expectations may 'regress' in the face of a disaster, opting for public health over future equity or resilience. This narrows the number of potentially feasible technologies. Alternatively, through the exchange of innovative socio-political and technical arrangements, cities may be able to 'jump' towards tackling later stages in service delivery while implementing solutions to current demands. Different areas within cities may receive varying levels of service, i.e. residential vs slums. Second, developed countries are currently (mainly) in the Waterways city phase, with progress from the Water Cycle city onwards remaining largely academic and theoretical (R. R. Brown et al., 2009). Further research and reflection from academics and practitioners is vital to coherently address the wicked problems of evolving urban water management paradigms.

Transitioning in the Global South: The framework in Figure 1 was developed based on Australian cities; that is, it describes the transition as experienced in the Global North. Countries in the Global South – which still have considerable gaps in achieving water and sanitation coverage – may engage various stages at the same time, having to **tackle varying challenges simultaneously.**

Potential impacts of this ongoing transition for the Global South include:

Pros: Lower 'overall' investment costs, as lessons learned and more efficient technologies and processes can be 'imported' from developed countries.

Cons: Each Southern country has unique characteristics which may render Northern processes inapplicable. Additionally, the priority in Southern countries, both from government and citizens, is to accomplish basic service provision; this can diminish interest and allocation of resources in achieving the later stages of the framework.

Climate change and urban population growth

The challenges faced by water utilities in providing adequate levels of service will be exacerbated by the foreseen impacts of climate change and urban population growth (Burn, Maheepala, & Sharma, 2012; Koop & van Leeuwen, 2017; McDonald et al., 2014).

[4] In the Netherlands, where consumer participation is largely facilitated by free-of-charge voting via postmail, 22% and 44% of eligible voters participated in the 2008 and 2015 Waterboard elections, respectively.

The effects of climate change related impacts to water services are numerous and often inter-related, generally affecting the predictability and quality of the resource. Scenarios of future climate change impacts highlight the probability of increased and erratic precipitation – leading to intense floods and protracted droughts (Keath, 2008) – and impacts on hydrological systems. Both changes haphazardly affecting the quality and quantity of water resources (IPCC, 2014). These extreme climate events increase the risk of degrading water quality and, consequently, of potential health impacts on the consumers (Delpla, Jung, Baures, Clement, & Thomas, 2009). Floods can increase sediment loads in water sources. Prolonged droughts can impact the quality of water resources due to changes in evaporation rates, salinity, and temperature (Levine, Yang, & Goodrich, 2016). Zwolsman and Van Bokhoven (2007) found that summer droughts degraded water quality in terms of eutrophication, major ions, and heavy metals. The driving factors were higher water temperatures and an increases in concentration loads. Treating degraded water quality requires integrated flexible adaptation measures and processes, particularly during treatment processes. In addition, it must be ensured that adequate and efficient responses to these extreme climate events occur (Delpla et al., 2009; Levine et al., 2016).

A continuously growing population. A multitude of demands for adequate services. Catering to existing and future generations. These factors will intensify the pressure on existing water resources and their availability (McDonald et al., 2014). The expected population growth for the next 40 years is projected to be concentrated in urban areas, with 86% and 64% of the population living in urban areas of developed and developing countries, respectively (Van Leeuwen, 2013). The demand for water services will continue to grow. Water withdrawals in 2025 are expected to increase by 18% and 50% in developed and developing countries, respectively (UNESCO, 2012). Additionally, the quantity available and quality of water resources will be impacted by urban and industrial developments that alter and destroy existing habitats (UNEP, 2007). Considering these current growth trends, it is expected that by 2030 there will be a 40% shortage in supply for water resources (2030 Water Resources Group, 2009). As such, water service providers will be faced with the double challenge of an increasing demand for water and an overall reduction in the availability of the resource.

> *When evaluating the constraints towards a Green Utility in Step 5, climate change and urban population growth will likely be mentioned. The potential magnitude of their impact can be presented to facilitate insight into local impacts and perceptions.*

As described above, water service providers, particularly those in urban settings, will have to reckon with the impacts of climate change and population growth. This requires water service providers, and the stakeholders involved in their processes, to adapt and prepare adequate measures – such as the rehabilitation and expansion of infrastructure, as well as the adaptation of their current practices – in order to effectively deal with these challenges (Bertule et al., 2014; Delpla et al., 2009; Levine et al., 2016).

Greater challenges for the Global South: Although the impacts of climate change events and urban population growth will be felt by all countries, **these impacts will be considerably more pronounced in countries in the Global South**. Climate change impacts – generated largely by countries of the Global North (Althor, Watson, & Fuller, 2016) – already, and increasingly, continue to disproportionately affect the poor in developing countries (IPCC, 2014). The poor have fewer resources available for coping, and generally inhabit areas at higher risk of adverse climate impacts (OECD, nd.; United Nations, 2016). Urban population growth is also expected to be considerably higher in developing countries (McDonald et al., 2014).

These conditions exacerbate the existing challenges of both meeting basic services coverage, and furthering the consideration and implementation of environmentally sound practices. As highlighted by Carrard and Willetts (2017, p. 215), the WASH sector as a whole has focused on achieving social and economic development, neglecting environmental protection as it is deemed "'too hard'…[and] something to be resolved or 'dealt with later'". Under current development discourses, such as the SDGs, service providers in **the Global South will likely be pressed to achieve all three objectives simultaneously.**

Evolving urban water management (UWM) paradigms[5]

Over the past decades, in response to the growing concerns of 'unfit' urban water service provision models, various water management paradigms have emerged. This section highlights some of the most relevant paradigms found in literature and practice, along with their commonalities. Most of these paradigms approach the broader water management context, rather than specifically focusing on water utilities. Considering their influence over policy, discourse and decision-making arenas, they are considered in their potential impact to water service providers' plans and operations.

> *The UWM paradigms can be useful for generating discussions about concepts and approaches to sustainability (Steps 1 & 2). These paradigms expose participants to various 'ideal' city-level approaches where they can situate their current and future Green Utility (Steps 4 & 5).*

Integrated Urban Water Management (IUWM)

The emergence of IUWM took place in the 1960's when engineers and planners found similar recurrent problems. These problems were attributed to the operations of the pervading *linear centralized* treatment systems. In response to this, they began to promote circular, integrated approaches to urban water management as a solution (Mitchell, 2006). IUWM posits that sustainable triple-bottom line[6] benefits can more readily be achieved, through the resource-efficiency gains of a circular, integrated approach (Barton, Smith, Maheepala, & Barron, 2009). This transition is exemplified by Pinkham (1999, p. 5) (Figure 2 below) when he compares the shift between the 'old' and 'emerging' paradigms.

[5] See further: Bichai & Cabrera Flamini (2018)
[6] Social, economic and environmental

Sustainable Urban Water Management (SUWM)

In face of the growing challenges for water service provisioning, the concept of Sustainable Urban Water Management (SUWM)[7] has risen under the premise that the current approach to service provision is unfit when considering relevant environmental, social, and economic criteria (R. Brown, Ashley, & Farrelly, 2011; Milly et al., 2007; Pahl-Wostl, 2002). SUWM is a manifestation of a growing awareness – within the historical development of urban water services – towards "community wellbeing, ecological health and sustainable development", i.e. the green movement (Marlow et al., 2013, p. 7151).

The two central aspects of SUWM are: i) the shifts towards decentralized systems and ii) 'fit-for-purpose' water schemes. The first aspect aims to reduce the dependence on expensive infrastructure. The large financial capital required for this infrastructure can range between 50-75% of a water system's operating and capital expenses (Marlow et al., 2013). As these large investments are 'sunk' (and therefore relatively permanent), they have an impact on the future generations of consumers (Burn et al., 2012). These younger generations rarely play a role in defining the type of water system they find most suitable. The second aspect emerges considering that, currently, "only a relatively small percentage of potable water supplied to customers is actually used for potable purposes", and implementing re-use processes can lower water demand and improve environmental conditions (Marlow et al., 2013, p. 7152). Thus, 'fit-for-purpose' schemes can lead to decreasing wasted costly treated water and mitigating the pressure on the natural environment.

Water Sensitive Cities (WSC)

During the Millennium drought in Australia, the concept of Water Sensitive Cities became prominent in academia. WSC supports a significant innovation turn-over towards alternative systems that can cope with severe water stresses (Bichai, Grindle, & Murthy, 2016; Bichai et al., 2015; Wong & Brown, 2009). As described by the CRC for Water Sensitive Cities (2016), a WSC is characterized by four aspects:

i) *Liveable* – a city that "create[s] public spaces that collect, clean, and recycle" water flows,

ii) *Resilient* – a city that is aware and pro-active in "mitigate[ing] flood risk and damage",

iii) *Sustainable* – a city committed to "enhance and protect the health of waterways and wetlands, the river basins that surround them, and the coast and bays",

iv) *Productive* – a city that can "provide the water security essential for economic prosperity through efficient use of diverse available resources".

For cities to achieve these aspects, WSC's proposes three pillars of action. First, cities must be viewed as water catchments where diverse sources complement the existing supply through fit-for-purpose and alternative systems. Second, promote the recognition of urban ecosystem services that benefit the environment and the citizens. Third, foster empowered water-aware communities where water professionals and decision-makers work across a range of disciplines (re)shaping the existing institutional context. In the historical evolution of water service provision, the WSC is considered the final stage of the continuum, remaining an academic and theoretical horizon to strive for.

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[7] For a review of the concept and challenges for SUWM, see Marlow et al. (2013)

The Old Paradigm	The Emerging Paradigm
Human waste is a nuisance. It is to be disposed of after the minimum required treatment to reduce its harmful properties.	*Human waste is a resource.* It should be captured and processed effectively, and put to use nourishing land and crops.
Stormwater is a nuisance. Convey stormwater away from urban areas as rapidly as possible.	*Stormwater is a resource.* Harvest stormwater as a water supply, and infiltrate or retain it to support urban aquifers, waterways, and vegetation.
Build to demand. It is necessary to build more capacity as demand increases.	*Manage demand.* Demand management opportunities are real and increasing. Take advantage of all cost-effective options before increasing infrastructure capacity.
Demand is a matter of quantity. The amount of water required or produced by water end-users is the only end-use parameter relevant to infrastructure choices. Treat all supply-side water to potable standands, and collect all wastewater for treatment in one system.	*Demand is multi-faceted.* Infrastructure choices should match the varying characteristics of water required or produced by different end-users: quantity, quality (biological, chemical, physical), level of reliability, etc.
One use (throughput). Water follows a one-way path from supply, to a single use, to treatment and disposal to the environment.	*Reuse and reclamation.* Water can be used multiple times, by cascading it from higher to lower-quality needs (e.g. using household graywater for irrigation), and by reclamation treatment for return to the supply side of the infrastructure.
Gray infrastructure. The only things we call infrastructure are made of concrete, metal and plastic.	*Green infrastructure.* Besides pipes and treatment plants, infrastructure includes the natural capacities of soil and vegetation to absorb and treat water.
Bigger/centralized is better. Larger systems, especially treatment plants, attain economies of scale.	*Small/decentralized is possible, often desirable.* Small scale systems are effective and can be economic, especially when diseconomies of scale in conventional distribution/collection networks are considered.
Limit complexity: employ standard solutions. A small number of technologies, well-know by urban water professionals, defines the range of responsible infrastructure choices.	*Allow diverse solutions.* A multiplicity of situation-tuned solutions is required in increasingly complex and resource-limited urban environments, and enabled by new management technologies and strategies.
Integration by accident. Water supply, stormwater, and wastewater systems may be managed by the same agency as a matter of local historic happenstance. Physically, however, the systems should be separated.	*Physical and institutional integration by design.* Important linkages can and should be made between physical infrastructures for water supply, stormwater, and wastewater management. Realizing the benefits of integration requires highly coordinated management.
Collaboration = public relations. Approach other agencies and the public when approval of pre-chosen solutions is required.	*Collaboration = engagement.* Enlist other agencies and the public in the search for effective, multi-benefit solutions.

Figure 2: IUWM: 'Old' vs 'Emerging' Paradigms – Source: Pinkham (1999)

Common threads between UWM paradigms

An overview of these UWM paradigms reveals a common overarching goal and similar approaches proposed. Their common goal: to cover the water demand of current and future consumers through effectively engaging an integral water cycle, while considering the health and protection of the surrounding environment. These paradigms jointly approach this goal by i) actively engaging and improving the efficiency of the various water flows throughout the city, and ii) by stressing the importance of engaging with a broader range of stakeholders, including the end-user of the water system(s). Through these approaches, these paradigms are thought to improve the overall sustainability of the water systems by fostering context-adequate and consensus-generated solutions.

Refer to the previous paragraph to facilitate a discussion of the city-level goals for the water utility. This is useful for Step 5, Vision towards a Green Utility.
The following five sustainability guidelines can guide and inspire potential approaches. These are useful for Step 6, Dimensions towards a Green Utility.

Among proponents of these urban water management paradigms, the benefits of adopting them are broadly considered to be:

i) A more 'natural' water cycle, particularly in regards to stormwater, and hence a more environmentally-sound flow of water.
ii) Increased water security through local source diversification, highlighting the role of fit-for-purpose approaches.
iii) Greater efficiency through fit-for-purpose water use. Higher-cost treated water (usually potable) is used solely for essential uses shifting towards full resource recovery.
iv) A broader approach to water systems' sustainability through awareness of customers' values and needs, enhancing socially aligned long-term plans and investments.
v) The uptake of decentralized systems allows for more 'radical' innovation which may lead to higher efficiency, improved community well-being, and source protection.

However, it is worth taking these benefits with a grain of salt. Regarding the technical aspects, for example, the 'nearly-permanent nature' of the infrastructure of water services renders complete system innovation impractical in political, financial and technical terms. This leads water systems to opt for 'system hybridisation' (Marlow et al., 2013). Only components of the technical system, not the technical system itself, can be innovated at a time. This allows only small, constrained innovations to occur. This limitation in the water system goes beyond the 'technical' aspects, and also includes forms of social and economic innovation, as these are influenced by cultural and political externalities. For example, decentralized systems require the coordination of (and establishment of accountability for) the administrative, organizational, and institutional aspects. Who would be responsible for each decentralized solution implemented, and how would they be supported/facilitated in fulfilling this role?

An additional hurdle for these paradigm shifts is that the decision-makers and investors of urban water schemes – who are held accountable for the projects implemented – do not wish to risk heavy investments into innovative (and therefore uncertain) solutions. Particularly, for systems that currently do not affect the reliability of the service or have large support from consumers (as these do not want to spend resources on an 'invisible' problem) (Marlow et al., 2013).

Being aware of these challenges, water service providers can harness the potential of these paradigms. These can provide guidance and alternatives when upgrading parts of the current system. They can be used to generate the space and political will for piloting innovative approaches. If this process becomes incorporated into a long-term vision/plan, it can lead to a full greening of existing infrastructure. Second, fostering the awareness for (and development of) decentralized systems increases the set of potential service delivery options for both service providers and consumers. This facilitates mapping and arriving to consensual "fit-for-purpose", cost-effective solutions. Further, by adopting a broader view of the urban water flows, water service providers can strategize and gain support from key stakeholders in other sectors, such as the agriculture and energy sectors.

UWM paradigms, a dream of the North? UWM paradigms are actively discussed in countries that have already achieved an adequate level of service, i.e. those in the Global North. Developing countries, on the other hand, are still struggling with service coverage mainly focused on the dealing with the impact of urban pollution on water systems and public health (Marlow, Moglia, Cook, & Beale, 2013). Few Northern countries have actually gone beyond these discussions, with the limited actions implemented being dispersed and lacking a systematic approach (Marlow et al., 2013). **To date, there is not a single city in the world that can be considered a Water Sensitive City (Wong & Brown, 2009).** Thus, the implementation of UWM paradigms in developing countries remains a relatively unchartered territory (one of the few attempts has been documented by Poustie and Deletic (2014). While this does provide the international community with the opportunity to mainstream UWM approaches in developing countries – through its involvement in local policy, technological investments, and societal programmes – the question remains, if developed nations have yet to successfully embody it, does the imminent call for paradigm shifts in UWM remain a dream of the North?

Sustainable Development Goals (SDGs)

With the closure of the Millennium Development Goals in 2015, the world's governments, international organizations, and citizens embarked in a consultative process to define the global developmental goals for the next 15 years (United Nations, 2015b). Sustainable development was the driving and transversal factor for these new goals, 17 in total and aptly called the Sustainable Development Goals (SDGs).

The SDGs are a global call to action intended to solve various issues – including poverty, gender equality, environmental conservation, and water and sanitation – by providing common development goals for governments, organizations, and communities. At least until 2030 (the deadline set forth for the SDGs) global, national, and local development efforts will focus and be monitored in their contribution towards achieving the SDGs. As such, understanding the SDGs becomes paramount for all stakeholders involved in development processes, including those regarding water and sanitation.

> *Sustainable Development Goal 6 serves as a common axis for water sector goals: it facilitates the interaction of potentially relevant/interested stakeholders; it provides a common ground for selecting potential indicators; it sets a horizon in 2030. Useful in Steps 3, 5 & 6.*

Goal 6: *Ensure access to water and sanitation for all*, states the following specific targets for the sector (United Nations, 2015a):

1. By 2030, achieve universal and equitable **access to safe and affordable** drinking water for all.
2. By 2030, achieve **access to adequate and equitable** sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

3. By 2030, **improve water quality** by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and **substantially increasing recycling and safe reuse** globally.
4. By 2030, substantially **increase water-use efficiency** across all sectors and **ensure sustainable withdrawals and supply of freshwater** to address water scarcity and substantially reduce the number of people suffering from water scarcity.
5. By 2030, **implement integrated water resources management at all levels**, including through transboundary cooperation as appropriate.
6. By 2020, **protect and restore water-related ecosystems**, including mountains, forests, wetlands, rivers, aquifers and lakes.
7. By 2030, **expand international cooperation and capacity-building** support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.
8. Support and strengthen the **participation of local communities** in improving water and sanitation management.

As highlighted by the bolded sections, water services providers will have a crucial role to play in achieving these targets. From increasing service coverage in an affordable and equitable manner (Targets 1 and 2), to implementing activities that ensure the quality and quantity of water resources in the long-term (Targets 3, 4, and 6), while engaging with a broader range of stakeholders in different social, environmental, and political arenas (Targets 5, 7, and 8). Political and social pressure will likely increase for water service providers in the search for achieving the SDG's. It is worth recalling the warning provided by Carrard and Willetts (2017), that in seeking to achieve some of these targets, our efforts do not inadvertently hinder or harm other SDG goals and targets. For water service providers, this requires a continuous awareness and evaluation of the impacts their processes and practices have in the broader development environment.

The boxer against the ropes: Over the last decades, water service providers have increasingly had to **balance differing and (at times) conflicting objectives** – for example increasing access to low income areas while achieving cost-recovery in their operations. The addition of "sustainable access" by 2030 troubles the existing challenges of water service providers, particularly in the Global South. Considering this, it becomes necessary for water services providers to **discuss and debate within and across sectors**, i) what roles and responsibilities they want to undertake and which they have to bear, ii) how they will fulfil these roles, and iii) what they need to get there.

The Green Utility

Having examined the factors that fostered the emergence of sustainable and green discourses in the water sector, we arrive at the focal point of this concept note: the water utility[8]. This section begins with an overarching framework that suggests different stages in the evolution of a Green Utility. As each water utility will have unique interests and challenges in these stages, the dimensions of a Green Utility are presented to allow for flexibility in designing relevant approaches. These dimensions facilitate exploring which stakeholders, current processes and future significant changes the water utility could engage with in order to foster sustainability. Further, some of the challenges and benefits water utilities may encounter in becoming green are described.

The stages of a Green Utility

When does a water utility become a Green Utility? Is there a specific point when a utility becomes green, or rather, is it more of a continuous process, which (re)develops as internal and external circumstances change?

From the *Background* section, it is evident that every water utility has a unique internal and external context, making a universal or standard definition (and threshold) for 'greeness' unlikely and impractical. To help situating utilities that engage with greening processes, a three-stage green continuum (Figure 3) is proposed, comprised of the Early, Emerging, and Mature stages. These stages are meant to serve as a guide for water utilities in self-assessing the internal capacity to implement green processes, and use it as a starting point for planning their green goals and activities.

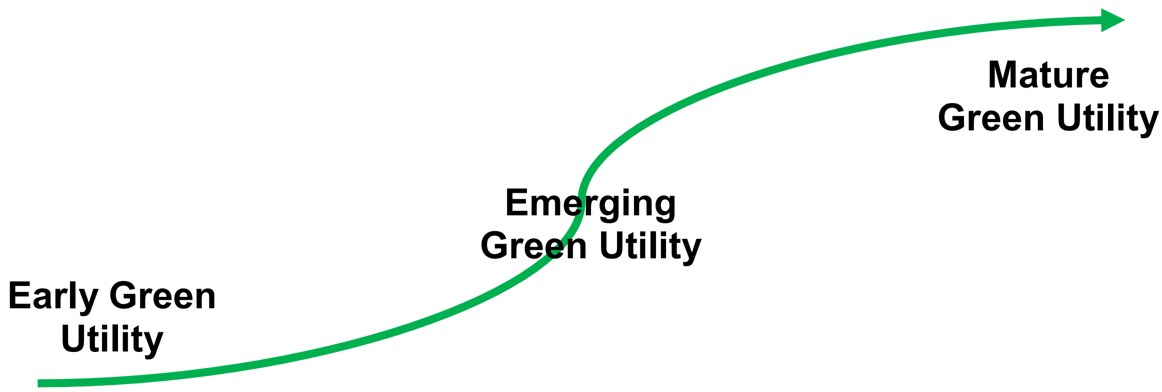

Figure 3: Stages of a Green Utility – Source: Author

These stages have been distinguished by considering the following variables, based on Rebekah R Brown (2008): the organizational commitment, the political capital, the internal expertise and capacity, and the organizational structure and culture.

[8] Recognizing the variety of water service providers that exist (formal vs informal, large- vs. small-scale providers, urban vs rural vs peri-urban vs small towns, emergency response, etc.) this concept note primarily considers formal urban water utilities, where the Green Utility Toolkit is designed for. It is hoped that the approaches and tools discussed here can also serve other water services providers in their processes towards becoming green.

The three-stage green utility continuum facilitates identifying the current internal organizational capacity devoted to greening process. It also suggests potential avenues for strengthening this capacity. These stages can be used to broadly benchmark a utility's progress towards streamlining sustainable green processes. Useful in Steps 2 to 5.

Early Green Utility

For an Early Green Utility, the uptake and implementation of greening processes occurs solely from the need to comply with external regulations, e.g.: environmental regulations regarding resource protection or pollution control. Internally, the Early Green Utility does not consider greening as a priority or part of their mandate, and therefore lacks the political, financial, and human resource capitals to enact change. When green processes or projects *must* be carried out, these are handed to junior staff members and/or out-sourced to a consultant. As such, there is no internally dedicated department or group within the utility for advancing greening processes; instead, ad-hoc assignments are handed to staff members with relatively little (if any) structural influence on the utility. Additionally, there is no (or barely any) engagement with a broader external network of key stakeholders for greening processes, including local government and consumers.

Emerging Green Utility

During the Emerging Green Utility stage, greening process have been recognized as a relevant aspect of a utility's functioning. A staff member or a team within a department of the utility (e.g. operations, commercial, human resources) has been designated solely for this purpose. Although at times the team may count with input and participation from other departments, the majority of work is carried out independently by the assigned staff member or department. This situation results in two particular challenges for the individual or team: i) as greening planning and processes have not been established utility-wide, there will likely be uncertainty and friction over roles and responsibilities across and within departments, and ii) the green unit will need to compete with other departments for limited internal funds. These situations can generate barriers within the utility, which require competent and transparent guidance from management. At this stage, members of the green unit should focus on communicating across the utility the potential risks and benefits of greening approaches to the utility's reputation and performance.

Aside from staff time, the majority of financial resources used for greening processes come from proposals submitted to external funding organizations. As the green unit grows in experience, influence, and capacity, larger and more strategically structured funding mechanisms can be achieved. During this stage, engagement of external stakeholders becomes more prominent, mainly in order to gain the political backing necessary to strengthen and firmly demonstrate the need for a dedicated green organizational unit. The main stakeholders most likely to be engaged will be the local government and the consumers.

Mature Green Utility

The Mature Green Utility has integrated greening considerations and approaches throughout the utility. Progressively, greening is seen as a competitive advantage that harnesses the interest and will of higher level staff, as they believe it is a vital component of the utility's development plans. Thus, the utility's mandate and strategic plans explicitly prioritize greening process by establishing relevant green goals in a mid- to long-term frame, and devoting the necessary financial and human resources to achieve them. Whereas before the resolve towards greening was located within a single team or department, the Mature Green Utility has green champions nested in various departments. These green champions are actively and continuously working together to further streamline the utility's green objectives.

Further, developing and testing greening processes becomes central to the utility. This occurs as the utility evolves from seeking internal legitimacy for green processes, towards becoming recognized as a leading expert in the field. As part of this, the Mature Green Utility strategically broadens its network of stakeholders to include research institutions and environmental organizations. In parallel, the utility becomes active in supporting local governance efforts as due to the recognized benefits and need for consensual actions. As greening becomes an intrinsic part of the utility's culture, the development of staff's capacity regarding sustainable practices (social, financial, and technical) is pro-active and continuous.

> *The stages above are broadly indicative of the utility's internal capacity for the uptake of greening processes. Each utility should consider for itself what each stage entails for them, to ensure challenging yet achievable goals – the Circles of (Green) Development exercise can be useful for this. This is worth highlighting when using the GU tool, to avoid employing benchmarking metrics that are not applicable or relevant in the local context.*

The above stages present a heuristic tool for water utility staff members to assess their progress in becoming green. In each stage, the utility's internal commitment, external outreach, and organizational structure are considered. It is worth noting that utilities may find themselves spread across these stages, and at times jumping backwards or forwards from them. These situations should inform the utility's decision-makers on which areas need to be further developed. Having looked at these different stages, the following section proposes a set of foundations that utilities can use in order to support their advancement across these stages.

The dimensions of a Green Utility

The driving concept underlying a Green Utility is the recognition that water utilities have current challenges and demands to meet, which must now be tailored towards sustainability within their broader surrounding context. As such, three dimensions have been identified to support streamlining this process, as shown in Figure 4. These dimensions contribute to the three Water-Sensitive Cities' pillars of action (see page 9).

Current practices recognizes the multitude of processes and activities water utilities commonly engage in (business-as-usual) and seeks to reflect on ways to evolve these tried-and-tested approaches towards greater sustainability. *Pathways* highlights the connections and influences that water utilities (and their potential green units) can have, and are subject to, within a broad range of external stakeholders. Finally, *Green 'turn-over'* addresses the novel approaches and principles that can be supported (particularly in key decision-making instances) by water utilities, such as green-grey infrastructure, resource efficiency, and environmental finances.

These dimensions are not intended to separate and categorize different green approaches. Instead, they are intended to assist utilities in conceiving innovative approaches from a common ground. As such, some potential green activities and processes may overlap between dimensions. These overlaps point towards synergies between processes, stakeholders and goals that can be taken advantage of by water utilities.

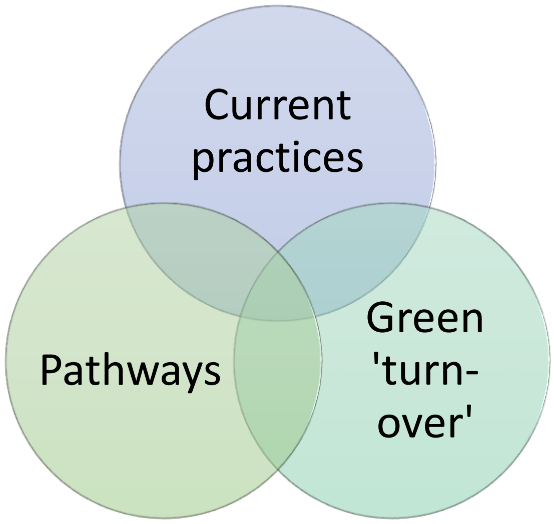

Figure 4: Foundations for a Green Utility - Source: Author

> *The dimensions serve as the common ground with which water utilities can identify, consider, and design their desired green/sustainable approaches. Each dimension explores potential avenues for furthering the greening efforts of water utilities.*
> *Step 6 of the GU Tool requires a thorough understanding of these three dimensions.*

Current Practices: Building on water utilities' experience

When considering the way forward towards a Green Utility, it is vital to analyse the current practices that water utilities have tried-and-tested for decades. These provide both an initial baseline and the possibility of identifying quick-wins, which can garner support from within the utility. Water utilities have a wealth of local experience and, in some aspects, already practice potentially green approaches towards water service provision. Each utility needs to further decide how and when each practice can be deemed *green*. A good starting point can be to create a checklist of all relevant current practices, and discuss if, how and to what degree these can be greened.

As each water utility will need to identify its own processes, the examples presented below are in no way exhaustive or restrictive. These examples are intended to present some common practices that can be greened, in order to serve as a starting ground for staff to reflect on their current practices.

Asset Management – Ongoing asset management allows utilities to periodically and methodically evaluate their infrastructure's capacity and condition. This can foster strategic planning towards the rehabilitation and replacement of the water system's components, such as treatment plants, conduction lines, and pumping equipment. By nature of its continuous monitoring and time-bounded assessments, asset management can facilitate in judging when, how, and what components and processes – such as maintenance, procurement, and replacement – can be 'greened', as well as incorporate the consideration of full lifecycle costs for all components (EPA, 2012). It is worth noting that through full lifecycle costs, a longer time-frame for balancing costs and benefits occurs; this can support shifting a water utility's decision-making process from short- to long-term.

Non-Revenue Water (NRW) – "Nothing makes a utility system more resilient than controlling its wanton leakage…Being sustainable means managing water resources responsibly, and controlling NRW should be part of that needed response but so far is not" (Workman, Feb. 29, 2016). NRW, if framed adequately, has the potential of covering multiple aspects of a water utility's objectives. NRW is mostly discussed in issues of cost-efficiency for the water utility, ensuring that the investment costs from extraction, treatment, and distribution are not leaked along the way. However, improving NRW can also be considered as a green practice: by reducing losses along the way, less raw water must be extracted from the natural source and, overall, pumped through the water system. If the natural resource is over-exploited, or nearing this, an effective NRW strategy has the potential of improving conditions significantly. As such, tackling NRW can be one of the most sustainable approaches a water utility can take: it makes sure every drop is used as efficiently as possible.

Operation & Maintenance – O&M activities cover the day-to-day processes carried out by water utilities. They can serve as a core area for the uptake of green initiatives as actions and their results are readily visible. For example, take the assessment and implementation of resource and energy efficient activities, such as using alternative energies or environmentally-friendly chemicals for water treatment. Comparing alternatives and implementing small pilots of these changes can be relatively simple and time-effective. This facilitates the uptake, dissemination and testing of green approaches.

Customer Service (Awareness and Water Demand Management) – The water utility, in most cases, already engages its customer base through their Customer Service. With an adequate communication strategy, Customer Service can be used to highlight the value of each drop of water to consumers and utility staff. Alternatively, Customer Service can act as the first line of contact for consumers and thus serve as a base for engaging them more actively (as discussed in the *Pathways* section below).

Water Safety Plans –Water Safety Plans (WSPs) have the potential of supporting greening a water utility in two distinct ways. One, as WSPs aim at reducing risks throughout the whole water cycle (from source to tap), they identify and can provide measures for protecting vital environmental resources. Second, the development of a WSP requires the involvement of a broad range of stakeholders. Thus, through their implementation, they generate an arena for various different stakeholders to work together around a common goal, strengthening the water utility's links.

The above alternatives highlight how small changes in current approaches can support water utilities in achieving their usual goals while improving their greenness. **Quick-wins**, **which can garner support, can be identified at an early stage by framing current practices in a green lens**. Additionally, discussing current practices provides water utilities with the opportunity to reassess their approaches in order to incorporate green initiatives. For example, ensuring adequate rate structures for sufficient funds of green O&M and infrastructures in the long-term, as well as gauging the support from the community in implementing these rate structures.

Pathways: Fostering a utility's (potential) networks

Water utilities are connected to their social, economic and natural environment from source to tap. As shown in Figure 5, water utilities can engage with diverse stakeholders in various arenas of the urban space. From this framework, it can be seen how different groups (citizens, businesses, and public services) and different sectors (energy, industry, and agriculture) interact with water utilities. These pathways, and those involved in them, are influenced by the local context's existing regulations and prevalent values.

Figure 5: Water Pathways – Source IWA (2016)

Actively fostering water utilities' relationship with their communities (geographical and institutional) becomes necessary in order to harness adequate support (EPA, 2012). This is particularly relevant when considering utilities' space in the existing and emerging UWM paradigms.

Whether in managing and negotiating the flows of water in the urban space with other stakeholders (IUWM and WSC), or in fostering and participating in the implementation of a decentralized service provision scheme (SUWM and WSC), the networks of water utilities become vital. Clarity and accountability, between a water utility and its broader community, are a necessary foundation for pursuing sustainable changes. It is worth emphasizing that these *pathways* run in both directions: towards the water utility as well as emerge from it. Considering this, water utilities can also benefit from transparently showing and communicating the actual value of their services, as well as setting themselves as sector leaders in green processes.

These pathways can provide a framework with which to seek potential synergies for greening water utilities, not only in terms of joint projects and processes, but also by building a network that provides internal and external political support and renders accountability. The following aspects, drawn from IWA (2016), are worth considering when exploring a water utility's connections within its context:

1. Consumers are progressively becoming more involved in demanding and designing how a service is provided. Greater environmental awareness can act as a driving factor for consumers. Thus, as citizens become more aware of their choices and impacts (which are strongly trending towards sustainability), they can become advocates or adversaries to how services are provided. With the emergence of water-wise communities, the utility will need to actively involve and engage their communities if they wish to count on their support.

2. Currently, most sectors are dealing with social, political, and economic pressures to lower environmental footprints and degradation. As such, water utilities need to be aware of changing demands and regulations, as well as seize the opportunity to learn from other sectors' processes and innovations. This can potentially lead to i) sharing responsibility for infrastructure between sectors (e.g. water & energy, agriculture, or tourism), ii) improvement in resource and energy efficiency through sector-wide coordination, and iii) full life-cycle considerations (cradle-to-cradle).

3. The natural environment is not a passive resource bank, but rather as active player in the chain of water services provision. Understanding the different aspects in which water utilities can engage with their natural environment requires basin- or city-level approaches, such as IWRM or IUWM. These approaches can promote the use of "natural" infrastructure, with the potential added benefit of closing the loop between water services and water resources management practices.

Historically, the consumer may have seemed as the (passive) end-point for water utilities' processes. However, their role in the political process is becoming increasingly prominent, even reaching the point "that [the] individual decisions of cities' inhabitants are, collectively, more powerful than their governments' ability to intervene"(Economist Intelligence Unit, 2009, p. 17). Thus, it is paramount for a water utility to streamline the engagement with local communities into their processes to safeguard their sustainability. This process can be approached through continuously considering community's goals (within and outside of the water sector), including them in the utility's planning, and ensuring that the utility's work supports these goals (EPA, 2012). The *Handbook for Water and Wastewater Utilities* (EPA, 2012) adds the following advantages regarding the active involvement communities in their water utilities' planning processes:

a. Communities can provide input early in the process (prior to heavy infrastructure investment) and support choosing no-regret measures.

b. Understanding community's goals and values allows for aligning water utilities' strategic planning with an analysis of alternative solutions/approaches.
c. Support from the community can facilitate changing service levels and/or necessary revenues for ongoing operations.

The pathways discussed so far take an outwards view from the water utility, considering the broader networks that UWM approaches stress are vital. Looking inwards towards the water utility, a complementary set of pathways appear. As shown by the evolution of the GU stages, the integration of green goals and processes across horizontal (departments) and vertical (senior to junior staff) organizational sections is paramount for a Mature Green Utility. Particularly during the Emerging stage, the support obtained from internal pathways can impact the credibility and buy-in (and therefore the future) of the green unit. As such, staff's awareness of the current GU stage can support in selecting which pathways should be prioritized at a given moment.

By being aware of their internal and external pathways, water utilities can generate new business models that foster i) societal support to their plans, ii) synergies and shared responsibilities with other sectors, iii) an integrated approach with the natural environment, and iv) the internal and external leverage necessary to prioritize and endorse the uptake of greening processes.

Green 'turn-over': Key moments for change

The Green 'turn-over' dimension considers the important decision-moments that allow a water utility to make a significant, if not radical, shift to 'green approaches'. The decision-moments – for example: development of new infrastructure, selection of new technologies, etc. – potentially allow the utility to introduce novel approaches and principles. The driving logic behind the Green 'turn-over' is for water utilities to minimize their water, carbon, and ecological footprint in a cost-effective manner and enhance their resilience to climate change and disasters. Potential ways to achieve this are through the consideration and incorporation of eco-system services, decentralized processes and broader funding sources, as discussed below:

I. **Resource efficiency.** This approach runs parallel to the Current Practices dimension as it is intended to highlight key decision-moments were current practices can progressively or radically be shifted towards more efficient processes. Such activities may target the large investments in non-revenue water, technical innovations in nutrients recovery, increasing energy efficiency through alternative sources or state-of-the-art innovations, or implementing reuse capabilities within a treatment plant. It is clear that resource-efficient utilities are able to combine greater productivity with lower costs and reduced environmental impact. The Green 'turn-over' dimension highlights that although these processes may require higher-cost initial investments, with an adequate long-term strategy and coherent decision-moments the overall costs will eventually be lower.

> *The dimensions of a Green Utility presented in this section can guide water utilities in becoming more sustainable by: i) improving and building on their existing expertise and practices, ii) emphasizing the importance of identifying and fostering their networks, and iii) taking advantage of key decision-moments to strategically shift long-term investments and developments.*

II. **Green-grey infrastructure solutions.** This concept refers to optimizing the current provision of water services through the integration of built, 'grey' infrastructure with environmental green eco-system services (Figure 6). For example, wetlands restoration can be implemented as a form of source protection, which can support the improvement of water quality and thus reduce operating costs. The creation of green spaces for bio-retention and infiltration can be developed as part of the water utility's practices in integrating with urban planning (providing support and direction for UWM paradigms). Such nature-based solutions namely contribute to restoring the 'natural' water cycle in urban settings, providing climate change resilience and cost-effective benefits to water utilities through improved water quality and quantity (IUCN, 2015). Additionally, they can increase a water utility's reserve capacity, which can serve as a climate adaptation strategy (Levine et al., 2016).

The integration of green infrastructure with grey infrastructure can also bring additional social and environmental benefits (such as: recreational, aesthetic, and ecosystem health) that are increasingly more valued and demanded by citizens. Green-grey infrastructures can facilitate the implementation of "fit-for-purpose" (R. R. Brown et al., 2009) waters, diversifying the number of sources and

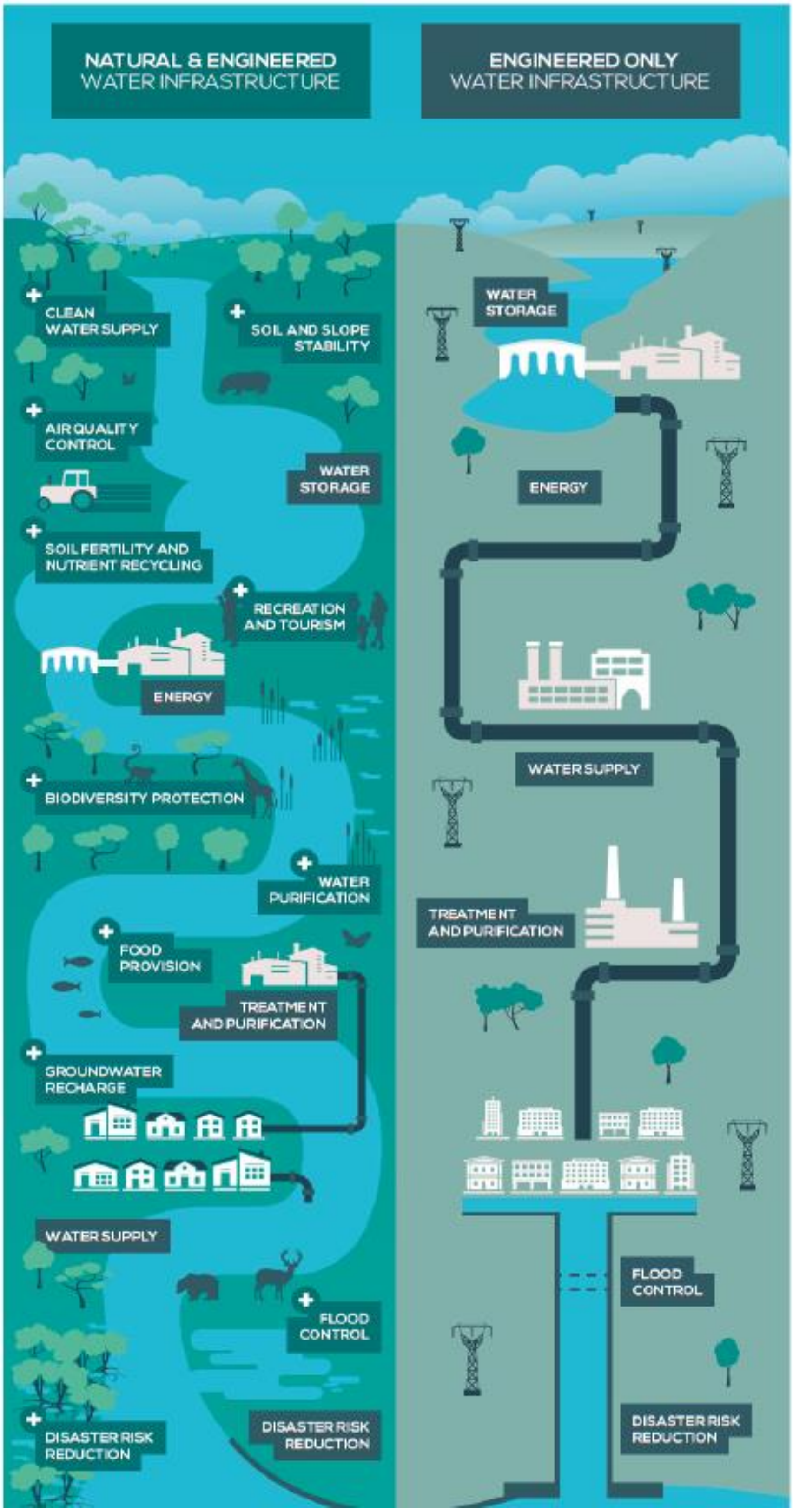

Figure 6: Services provided by natural & engineered water infrastructure - Source: IUCN (2015)

fostering thoughtful use of higher-cost treated water. Overall, green-grey infrastructure is thought to have the potential to support the achievement of SDGs 2, 6, 8, 11, 13, 15, and 17 (Green Utility Network, 2016).

III. **Decentralized infrastructure solutions.** Along with green-grey infrastructure, the decentralization and diversification of sources for water supply, as prominently suggested in UWM paradigms, can provide lower process-related footprints and increase resilience of the overall system, especially by securing supply throughout periods of drought. Alternative sources – such as rainwater, grey water and wastewater reuse – offer the potential to develop decentralized supply schemes that allow planning for supply augmentation in a progressive, flexible and preventive manner, while reducing the pressure on traditional water sources. By being developed at smaller, local scales, such decentralized alternatives allow greater flexibility in the overall system design, which may prove especially useful in improving services to the poorest who are disproportionately located in difficult-to-reach areas. Water utilities that manage a diversified range of water systems are also proactively reducing risks to natural or man-made disasters, thus improving water supply security.

IV. **Green funding.** An additional aspect of the Green 'turn-over' relates to utilities seeking and employing broader financial streams coming from local and global environmental funds. Aspects such as green-grey infrastructure or the implementation of alternative energy sources (such as solar power), are potentially eligible to these funds (see for example https://www.climatebonds.net/about). Accessing these new additional funding sources lowers the financial pressures utilities face to kick start green initiatives alongside their daily operations and yearly strategies. It is recommended that the search and application to green funds occur in the Emerging and Mature Green Utility stages, as knowledge of the utility's green potential and demonstrated organizational buy-in are required.

Overall, engaging in a Green 'turn-over' can **broaden a water utility's capacities, performance, and resilience**, while at the same time ensuring adequate consideration and care for the natural environment and the integrity of the water cycle. Again, this dimension becomes particularly relevant as water utilities become more invested in greening processes, i.e. Emerging and Mature Green Utility phases.

> *The dimensions of a Green Utility presented in this section can guide water utilities in becoming more sustainable by: i) improving and building on their existing expertise and practices, ii) emphasizing the importance of identifying and fostering their networks, and iii) taking advantage of key decision-moments to strategically shift long-term investments and developments.*

Potential benefits for Green Utilities

Having covered the stages and dimensions of a Green Utility, some of the potential benefits derived from its uptake are highlighted here. These benefits are in no way exhaustive. They aim to provide staff of water utilities with arguments to gain support across the utility for shifting towards green processes. Some of the expected benefits specific to the water utility, as adapted from those identified by EPA (2012), include:

1. **Cost saving**: through investment choices that support more efficient resource use, integrating the natural environment in processes, and seeking urban and sector-wide synergies, all of which can potentially drive the utility's operating costs down.
2. **Longer financial horizons**, which allow for a broader analysis of returns on investment. With sustainable processes in mind, the costs of investment over a life-time will be lower hence increasing Return on Investment (ROI). This will support the development of long-term operational and financial planning, as well as support staff in making more comprehensive investment decisions.
3. **More options**: the Green Utility considers a broader range of alternatives, including decentralized systems and green-grey infrastructure. This allows the utility's staff and community members to find the most adequate solution for their local situation. Additionally, it can provide utilities with space and political will to explore innovative and state-of-the-art approaches.
4. **Stronger support**: through developing social and sector-wide networks. The Green Utility identifies the various stakeholders and actively engages with them, particularly their communities. As citizens and governments become more concerned with environmental issues, water utilities can ensure their work is valued and supported by actively and regularly taking into account their stakeholders' values and needs.
5. **Diverse funding sources**: the variety of funds a water utility can potentially access broadens to green/environmental funds. This is particularly relevant considering global commitments towards the SDG's. That is, donors and governments are increasingly shifting or conditioning their funds to programmes and projects that demonstrate a commitment to sustainability.
6. **Resilience**: through an increase in diversity of sources, treatment options, and support from stakeholders, water utility's engaged in greening processes increase their capacity to withstand adverse events.

Greening a water utility also provides benefits for the broader context of the utility. Implementing environmentally-sound integrated approaches to water systems can improve water security and availability for the city as a whole (Daigger & Crawford, 2007; Marlow et al., 2013). Additionally, if the water utility opts towards implementing decentralized schemes, these have the advantage of delivering better water quality at the consumer (Peter-Varbanets, Zurbrügg, Swartz, & Pronk, 2009), as well as improving the utility's technical, economic, environmental, and resilience aspects (Poustie et al., 2015).

> *The benefits presented here intend to provide momentum for change within the water utilities, as they provide examples and potential quick-wins for evolving into a Green Utility. These can be used to obtain the necessary buy-in from decision-makers to implement the GU Tool in their utility.*

As water utilities continue changing and innovating practices towards more sustainable, green approaches, further benefits (particularly long-term) will likely emerge. Although there is still a knowledge gap in terms of the advantages and impacts of green approaches, **the pro-active involvement of water utilities is paramount in order to further understand and develop the sustainability of the water sector**.

Challenges for the uptake of Green Utilities

Considering the context in which water utilities transition towards a Green Utility, several barriers innate to the water sector, and particularly to water provision, are foreseen as potential challenges. It is worth noting that water utilities core mandate revolves around adequate service levels and coverage to its population, which can at times run counter to implementing green practices. However, in order to achieve their goals now and in the future, the water sector and water utilities must incorporate environmentally-sounds practices in order to avoid "transgressing planetary boundaries or embarking on a path that will do so in the future" (Carrard & Willetts, 2017, p. 225).

> *The macro-, utility-, and consumer-level challenges presented below are in no way exhaustive. They are presented so that proponents of the Green Utility can prepare and adapt their strategies accordingly. These can be useful to cover in Step 5 when discussing constraints.*

Table 1: Challenges for the uptake of Green Utilities

Level of challenge	**Identified challenges**
Macro-level	• A slow-paced impeding regulatory environment. Practices such as re-use and alternative water sources cannot be implemented or included in a timely manner to a utility's development and strategic plans due to a restricting regulatory environment. • Rigid funding policies attached to traditional approaches. Without adequate financial support to foster innovative approaches, the implementation of green approaches is heavily hindered. This is particularly for water utilities that depend on foreign funds to carry out any development programmes. • Aiming for long-term objectives and processes in short-term investment cycles. A shift towards becoming a Green Utility requires time. If political will cannot support long-term developments and objectives, investments will be sporadic and inconsistent with the water system's requirements. • Lack of awareness from decision-makers. Without the understanding and support from decision-makers, staff in water utilities will lack the political support to implement change. • Donor-driven expansions of water services that do not take into account local drivers and barriers. • The intrinsic complexity of coordinating interdisciplinary and multi-organizational arenas with regards to an overarching topic, such as sustainability.
Utility-level	• Water utility senior staff tend to have an aversion to innovations as their advantages are uncertain at the time and their implementation risks impacting public health. • There is considerable complexity in analysing the costs and benefits of green alternatives. For one, there are conflicting approaches to what greening processes entail. Additionally, some of the benefits provided are difficult to quantify or measure monetarily, making it challenging to objectively compare traditional and new approaches.

	• Actively engaging with a broader set of stakeholders poses challenges of defining roles and responsibilities, broader section coordination, and developing channels of communication. As this will likely be a new area for water utilities, resources will need to be devoted to its development. • Generally, staff tend to have biases towards current systems, as they are familiar with their scope of operations and already know how to operate and maintain them. • With regards to implementing decentralized systems, two additional challenges emerge. First, water utilities aim to achieve cost-recovery in order to be financially sustainable. The implementation of decentralized schemes would potentially remove part of the (potential) costumer base for water utilities as these consumers would have a separate source for water access. Second, a decentralized scheme would likely require establishing a responsible party for coordination and regulation of the various service provision schemes. Whether this is an additional task for the water utility or must be assumed by the relevant governmental authority, the institutional landscape will require resources and trials before it can successfully be implemented.
Consumer-level	• Resistance from citizens to support alternative approaches to provision of water. This can occur because citizens see other sectors as priority for funding, they do not see a need to change as long as they receive the delivery of the service, or they have aspirational perceptions towards the current system (as a symbol of status). • Consumers may not be interested or willing to engage with the water utility.

Based on Bertule et al. (2014); (R. R. Brown & Farrelly, 2009); Green Utility Network (2016); IWA (2016); Marlow et al. (2013)

Overall, **there is currently a lack of information and understanding of how a Green Utility can, or is meant to, function**. This leads to i) uncertainty in the benefits and costs that can be generated (particularly short-term wins that can facilitate uptake), ii) a vacuum in staff and stakeholder knowledge regarding evaluation, monitoring, and implementation of green projects, and iii) a gap in existing funding mechanisms and political will to support water utilities greening projects. With these issues in mind, the following section provides a guidance framework for water utilities, in order to provide an assessment and way-forward towards becoming green.

Conclusion and Way Forward

The need for water utilities to continue evolving into sustainable, environmentally-friendly organizations is paramount. The increasing pressures of population growth and climate change threaten the capacity to provide adequate levels of service while ensuring a healthy environment for current and future populations. Global and city-level water management paradigms have been set forth to provide guidance on how to achieve this. However, the path for water utilities to integrate and support these initiatives, while continuously and effectively providing their services, remains challenging due to the diversity of local contexts (e.g. North vs South) and lack of a systematic approach. As global and local sustainability challenges continue to evolve and change, water utilities will need to habitually reflect on their capabilities in order to improve their processes and be able to respond accordingly.

The Green Utility Toolkit aims to support addressing these challenges by providing an overarching framework with which to consider and guide utilities towards greener processes. It does so by helping water utilities internally and consensually define what a sustainable, green utility means for them. This provides the necessary ground for steering their development plans in a manner that is context-adequate for them. Through the Green Utility Toolkit, staff members also define how they will measure their progress, as well as design approaches to achieve it based on the Green Utility's three dimensions. Through this process, water utilities will construct a starting point and action plan that can serve as points of reflection in each utility's sustainability journey.

Becoming a Green Utility is a continuous and necessary process that utilities, communities and other stakeholders must engage with in order to face the development and water sector challenges of today and tomorrow.

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