Financing for Water

Technological Innovations in Water Resource Management

ICED
Infrastructure & Cities for Economic Development

This summary paper looks at some of the most promising technological innovations in water resource management, to provide context for explanations of anticipated financial flows. It forms the second part of a four-part series of summary papers based on research, commissioned through ICED, on innovative financing approaches to mobilise public and private financing for freshwater management.

Water Source Solutions

Nature-based solutions incorporated into grey infrastructure

Nature-based solutions (NBS) is a term to describe interventions that are inspired by and supported by nature to use or mimic natural processes to contribute to the improved management of water resources. This could include a wide range of activities, including the conservation or rehabilitation of natural ecosystems, or the creation or enhancement of natural processes in modified or artificial ecosystems. NBS can address issues of managing water availability by interventions such as restoring natural wetlands, water quality by solutions such as green infrastructure to reduce runoff or oyster beds to clean polluted water, and also water-related risks such as floods or drought by managing ecosystem degradation and reducing the vulnerability to the extremes of climate events. NBS can often be applied in combination with grey infrastructure to lead to cost savings and improved overall risk reduction.[1]

Hydropower

Hydropower reservoirs, or dams, can serve multiple purposes. They can be designed and operated to provide services beyond its primary purpose of electricity generation and/or storage of power, such as water supply, flood and drought management, irrigation, navigation, fisheries, environmental services, and recreational activities. While some of these objectives, especially regarding power generation, water quantity management, and ecosystems services and local livelihoods can sometimes be conflicting, they can also be complementary. Developed under a framework for Integrated Water Resource Management (IWRM) sustainable hydropower reservoir development is possible to provide positive benefits to all water users and ecosystems, and provide a revenue-generating source of income.[2]

Aquifer recharge

Managed aquifer recharge, or groundwater replenishment, is the purposeful recharge of water to aquifers for subsequent recovery or environmental benefit. It can include methods such as riverbank filtration, stream bed weirs, infiltration ponds, and injection wells as methods for replenishing aquifers, and can use natural water sources, or adequately treated stormwater or sewage, and other waste waters to increase groundwater storage. The goals of aquifer recharge are to store, protect, and improve water quality, and improve quantity or add spare capacity for times of drought and for emergency supplies. The Cape Town Water Strategy has identified groundwater recharge as one of several ways to provide sufficient capacity to deliver water supply during times of drought to increase water resilience.[3]

River restoration

River restoration includes a variety of different actions to modify river channels and riparian zones and floodplains, with the goal of replacing lost, damaged, or compromised elements of the natural ecosystem to improve a degraded watershed. Restoration activities can cover management and engineered solutions to provide bank stabilisation, riparian fencing, and the removal

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[1] United Nations (2018) World Water Development Report 2018: Nature Based Solutions for Water
[2] Branche (2017) The multipurpose water uses of hydropower reservoir: The SHARE concept
[3] International Association of Hydrogeologists

or retrofitting grey infrastructure that has been installed to limit the interactions between rivers and floodplains, such as levees, canals, and dams. The goals of river restoration practices are to increase natural ecosystems' ability to control floods and water flows, increase biodiversity and habitat by allowing fish passage and allow breeding habitats to be free from disturbance, improve the quality of water by restoring natural flows of the river ecosystem.[4]

Removal of invasive alien species

Alien or non-indigenous vegetation, also referred to as invasive alien species can cause a number of negative impacts to the water source and its environment. Alien vegetation can reduce the ability to farm effectively, cause erosion, destruction of rivers, siltation of dams and estuaries, cause mass extinction of indigenous plants and animals. Many of these consequences lead to poor water quality, an increase in water use, and an increase in vulnerability to natural hazards such as flooding and fires. Alien vegetation are the single biggest threat to plant and animal biodiversity. In South Africa, for example, alien vegetation has led to a 7% wastage of the country's water resources. The removal of alien vegetation can be done through an integrated approach that includes a mix of physical, chemical, and biological control methods. These could include: basal bark herbicide treatment, hand pull removal, ring barking, frill cuts, herbicide, cut stump treatment, and stem injection.[5]

Agricultural and Industrial Users

More sustainable agricultural practices

Changes in agricultural practices, including land management, can be implemented to produce positive environmental outcomes. A wide variety of agricultural best management practices to manage cropland exist, including drainage systems to remove excess water, extend field access, lengthen the growing season, conserve topsoil, and make the best use of the land available. Practices that aim to reduce non-point sources of pollution from croplands include: conservation tillage (leaving crop residue on soil surfaces) to reduce runoff and soil erosion, crop nutrient management to prevent excessive build up in soils, pest management, and conservation buffers to capture potential pollutants that might move into surface waters. Other activities include: irrigation water management to reduce nonpoint source pollution of ground and surface water, introduction of non-chemical pesticides to protect against water pollution, grazing management to minimise water quality impacts, animal feeding operations management to reduce waste discharges through runoff controls and waste storage, and erosion and sediment control to conserve soil and reduce sediments moving into water bodies.[6]

Use of non-potable water

Many industries have traditionally used reclaimed water for cooling tower purposes, including those from pulp and paper, and textile facilities. Industrial use of non-potable water also extends to a range of industries, including electronics, food processing, and the energy industry, which is one of the largest water users by industry. Non-potable water can be used in a number of different applications, including water for mining purposes, process water, boiler feed water, cooling tower, flushing toilets, and site irrigation. A desire to be in compliance with green building standards has also incentivised industries and commercial sites to re-use non-potable water to raise their sustainability profile.

Utilities

Augmentation: desalination

Desalination is the removal of salt, bacteria, and pollution from a water source, and can be created from sea water and also from groundwater. The process allows for the extraction of non-traditional water sources for a potential to provide sustainable, drought-proof water supply. While desalination provides only 1% of the world's supply of drinking water, this is increasing, and global capacity is expected to double by 2030. Over the last 30 years, desalination has become a viable alternative water supply, due to the increasing risks of water scarcity. In many arid parts of the world,

[4] Wohl et al. (2015) The Science and Practice of River Restoration. Water Resources Research.
[5] Venter, J. H. (2003) Invasive species and the Working for Water programme in South Africa
[6] US EPA (unknown) Agricultural Management Practices for Water Quality Protection. Watershed Academy Web.

such as the Middle East, Australia, Northern Africa, desalination provides an alternative source of water to provide water security in times of crisis. In Australia, desalination accounted for 39% of Perth's water source 2013, and 41% in Adelaide. Desalination was identified by Cape Town in its Water Strategy as one of several approaches to increasing the city's resilience to water-related risk.[7]

Augmentation: effluent reuse

Around 80% of the world's wastewater is discharged into waterways which can result in health, environmental, and climate-related hazards. Used water, or effluent reuse, is an under-exploited resource which provides an opportunity for the water sector to tap into the circular economy, with resource recovery from wastewater becoming increasingly commercially viable.[8] In Singapore, where water security has been a matter of national concern since its establishment in 1965, with low rainfall, land scarcity, and high population exacerbating factors, the city has looked to high-grade reclaimed water as a financially viable means of alternative water supply for non-potable use industry, and for potable use to the general population. Over the past 15 years Singapore has scaled up this means of water supply to be capable of meeting more than 50% of the population's water demand.[9]

Reduction in non-revenue water levels

Non-revenue water describes water that is lost through the water supply system before it reaches the consumer and is therefore not paid for. Losses can stem from the physical loss of water due to leaks and degrading infrastructure, they can also occur by metering inaccuracies or inefficiencies (using estimate readings instead of real readings, for example), or unauthorised consumption, through illegal water connections, withdrawal from hydrants for other uses, or meter tampering. Estimates indicate that up to 32 billion cubic meters of water is lost each year globally. In developing countries roughly 45 million cubic meters of water is lost per day, totalling an economic loss of over USD 3 billion per year. Tackling this issue is challenging, with water utilities facing barriers including low capacity, lack of incentives, poor financial discipline, and effort to find and fix leaks as opposed to building new water facilities. But the potential for recovering substantial amounts of water, and in turn, more money to reinvest in water sources is huge. Performance based contracting is one method to address high levels of leakage, to allow for utilities to address their capacity and equipment gaps with payments based on results, increasing the incentives to perform and the risk of non-performance is reduced.[10]

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[7] International Water Association (2016) Desalination – Past, Present, Future
[8] International Water Association (2018) Wastewater Report
[9] Lee and Tan (2016) Singapore's experience with reclaimed water – NEWater. Water Resources Development.
[10] PPIAF (2016) Using Performance-Based Contracts to Reduce Non-Revenue Water