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18 Natural Infrastructure Innovations
Confronting Climate Change from Underground

*More than 5 billion people could suffer water shortages by 2050 due to climate change, Pincreased demand and polluted supplies, concluded the UN's 2018 report on the state of the world's water. The report focuses on the role that **nature based-solutions** can play in improving the supply and quality of water and reducing the impact of natural disasters. The same issue now tops the agenda at World Water Week in Stockholm.*

What are nature-based solutions?
Also referred to as 'green' or 'natural' infrastructure, nature-based solutions focus on environmental engineering rather than civil engineering to improve the management of water resources. This means working with nature to support and manage naturally occurring processes that help provide larger, cleaner and more reliable water supplies.

Why is groundwater-based natural infrastructure important?
Globally, 2.5 billion people depend on groundwater to satisfy their basic water needs. Groundwater accounts for 43% of all water used for irrigation, and the subsurface environments containing it (known as aquifers) store 98-99% of Earth's liquid freshwater.

What are the benefits of groundwater-based natural infrastructure?
Managing the recharge, storage, discharge, and recovery of water in underground aquifers helps communities stay a step ahead of climate change. This natural approach can safely store water in times of excess, and make it available again in times of scarcity. In addition, naturally occurring biophysical and chemical processes belowground, when managed properly, enable communities to maintain or enhance water quality.

Where is groundwater-based natural infrastructure having an impact?
The International Water Management Institute (IWMI), along with partners from the Groundwater Solutions Initiative for Policy and Practice (GRIPP), has compiled a portfolio of 18 groundwater-based natural infrastructure solutions showing promise for improving water storage, quality and retention as well as environmental services worldwide.

Case Study 1: Smart Roads Pave the Way for Food Security in Ethiopia

In the developing world, poor road construction exacerbates flooding, waterlogging and erosion. Surveys of roads in upland Ethiopia and Uganda showed that every 10-kilometer stretch of road has 8 to 25 problem spots. MetaMeta's Roads for Water initiative aims to turn this problem into an opportunity for roads to improve water management by harvesting and retaining water, and acting as 'corridors for resilience'. The benefits are many. In semi-arid areas, moisture in the soils along roads increases, as do groundwater levels. In lowlands, roads can be used to mitigate flooding, and in mountains, better road planning can help stabilize catchments. Better control and distribution of floodwater helps boost farm productivity in nearby areas. Importantly, these measures also lower road maintenance costs. Measures include digging roadside infiltration trenches, road-water storage ponds and water diverters. The program in Ethiopia showed that USD $1,800 per kilometer is sufficient to implement such measures, yielding a four- to fivefold return in the same year. The scheme is now expanding to 12 more countries, including Kenya, Uganda and Bangladesh.

Case Study 2: Safe Underground Storage of Floodwater in India
Targeted recharge of floodwater into aquifers reduces flood risks and makes more water available for irrigation during dry spells and droughts, helping to strengthen food security and improve livelihoods. Dubbed Underground Taming of Floods for Irrigation (UTFI), this practice is being piloted in India's Ramganga river basin (part of the Ganges basin) by researchers at IWMI and the CGIAR Research Program on Water, Land and Ecosystems (WLE). This involves monsoonal flows being diverted from an adjacent irrigation canal system to a village pond retrofitted with a series of recharge wells for water infiltration. It demonstrates that significant quantities of water (up to 70,000 cubic meters) can be stored underground each year without detrimental impacts on the environment or groundwater quality. This amount of water enables farmers to grow up to 35 hectares of crops in the winter season or 11 hectares in the dry season. Local villagers perceive that their water availability has improved for both domestic and agricultural uses. Local communities and the Indian government increasingly accept the approach, with increased understanding of what benefits the system offers, how it works, and how to maintain and manage it. UTFI has been incorporated into the Rampur District development plan, opening the way for broader implementation.

Case Study 3: The Kenyan Town of Two Thousand Sand Dams

The town of Kitui in Kenya is situated 150 km east of Nairobi. The area is semi-arid, with rain falling in two wet seasons, usually as infrequent, intensive storms. During the dry season, surface water sources are scarce or absent. Walking distances to the few reliable water sources can be long. In response to these challenges, and given the good geological conditions for constructing sand storage dams, the government has budgeted for 2,000 sand dams to be built by 2021. A sand dam in Kitui stores 3,500-5,000 cubic meters of water during each rainy season, or up to 10,000 cubic meters per year. Thanks to the sand dams, a technique promoted by Acacia Water and others, the distance to drinking water sources in the dry season has declined by 1,700 meters, on average (in some cases, from over 10 to less than 1 kilometer). More water and soil moisture has become available for agriculture, increasing the irrigated crop area by 400%. Typically, the increase in income surpasses the construction and maintenance costs of sand dams, making them economically sustainable.

Case Study 4: Natural Treatment of Stormwater Boosts Australia's Summer Water Supply

In Adelaide, Australia, urban stormwater run-off is collected in winter, using small constructed wetlands to detain and treat the water before injecting it via wells into aquifers to provide a reliable water supply in summer. This approach, developed with support from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), provides about 10% of the city's water supplies. The freshwater is stored within brackish aquifers that are too salty for use. 80% of the freshwater injected is recovered and mixed with inherent water, making it suitable for irrigation and industrial uses. Along with wetlands, which reduce turbidity and metals in the stormwater, the aquifer acts as a natural treatment system by reducing bacteria and organic matter. Recovered stormwater is generally much cheaper than conventional drinking water sourced by the state-owned utility from large dams, the River Murray and seawater desalination. There are now more than 50 such systems and some are connected by pipes to form a wider supply network. Use of recharged stormwater for drinking water supplies has recently been assessed for its technical and economic viability, public health risks, public acceptance, resilience to climate change, and impacts on water reticulation systems. The results show that large-scale schemes have significantly lower costs and higher public acceptance than seawater desalination.

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Notes to editor

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The **International Water Management Institute (IWMI)** is a non-profit, scientific research organization focusing on the sustainable use of water and land resources in developing countries. Headquartered in Colombo, Sri Lanka, with regional offices across Asia and Africa, the Institute works with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health. www.iwmi.org

The CGIAR Research Program on Water, Land and Ecosystems (WLE) combines the resources of 11 CGIAR research centers, the Food and Agriculture Organization of the United Nations (FAO), the RUAF Foundation, and numerous national, regional and international partners to provide an integrated approach to natural resource management research. WLE promotes a new approach to sustainable intensification in which a healthy functioning ecosystem is seen as a prerequisite to agricultural development, resilience of food systems and human well-being. This program is led by the International Water Management Institute (IWMI) and is supported by CGIAR, a global research partnership for a food-secure future. http://wle.cgiar.org

The Groundwater Solutions Initiative for Policy and Practice (GRIPP) is designed to co-develop solutions to the challenges of groundwater overdraft and water quality degradation while enhancing resilience. Consisting of 30 international partners with expertise on groundwater, the initiative targets groundwater-dependent, food-producing areas of the world, particularly in low-income and emerging economies, contributing to greater water and food security and climate resilience. Through dynamic partnerships, GRIPP promotes and adapts tested technologies, and innovative policy and institutional approaches to help achieve the UN Sustainable Development Goals (SDGs) related to climate resilience, food security, livelihoods and sustainable water management. www.gripp.iwmi.org