



New decision-making tools make it easier to analyze climate risk in water infrastructure projects.



Mexico City is testing a different approach to meet growing concerns over water scarcity.

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WATERFRONT

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ECOSYSTEMS & ECONOMICS

Finding answers
in nature and
doughnuts



*Aquifers in danger –
looming threat to the
world's groundwater*

The search for solutions in nature

It is an exciting moment in time. The traditional view on the relationship between ecosystems and human development is increasingly being challenged. In the past nature has at times been seen as a foe to be conquered, but we're now starting to realize that nature in fact holds the key to solving many of humanity's most pressing challenges.

Yet, the shift is not happening fast enough. Investment in nature-based solutions and ecosystems research is clearly insufficient. To hopefully help speed things up, this year's World Water Week will explore some of these issues through its theme Water, ecosystems and human development.

In this issue of WaterFront we also look at the connections between humans and nature, such as the alarming threat to the world's major aquifers on page 4. There is also plenty of good news, with signs of a global rethink – on page 12 you can read about how the World Bank wants to bring ecological expertise into their projects at an earlier stage and a story on page 14 explores new tools that help infrastructure planners calculate climate risks. To learn more about how economists are trying to bring ecosystems into the equation, turn to page 18. Last, but not least, don't miss Torkil Jønych Clausens' reflections of what really happened at the High-level Political Forum on page 22.

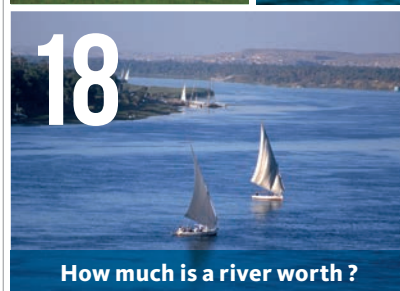
We hope that you will also like the visual facelift we've given WaterFront to make it more accessible.

Enjoy the read!



Torgny Holmgren
Executive Director,
SIWI

SIWI
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REGULAR FEATURES:

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- 23 CALENDAR** Events coming up

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Growing threat of uranium in Indian groundwater

According to a study published in Environmental Science & Technology Letter, uranium contamination of the groundwater in India is a growing problem. Avner Vengosh, professor of geochemistry and water quality at Duke University in North Carolina, lead author of the study, links the uranium build-up to falling groundwater levels in combination with nitrate pollutants from chemical fertilisers, which make uranium more soluble.



Scientists worry about biodiversity research in Brazil

Brazil is one of the most biodiverse countries in the world and often at the forefront of biodiversity research. But researchers worry that a new law may soon change this. Attempting to prevent biopiracy, Brazil has made it mandatory for both local and international researchers to register all their activities in the national system for genetic resource management, SisGen, with 5 November as the deadline. In a letter to the scientific journal Science, 16 scientists warn that the extremely detailed procedure combined with heavy fines for non-compliance, could lead to a collapse of biodiversity research in Brazil.

The top ten conflict issues

Which environmental problems cause most conflicts around the world? The answer can be found in the Environmental Justice Atlas, published by the Institute of Environmental Science and Technology at the Autonomous University of Barcelona. The authors have collected and categorised about 2500 ecological distribution conflicts. Water plays a key role in almost all of them, directly or indirectly.

- 1 Landgrabbing**, with more than 600 ongoing conflicts. One reason is the booming market for palm oil, which drives farmers from their land and cause deforestation, water pollution and infertile soils.
- 2 Renewable energy** conflicts, where 326 of the 357 listed conflicts relate to water infrastructure. Mega-dams force people to relocate and can wreak havoc on ecosystems, causing rivers to run dry.
- 3 Mega-mining** is at the centre of 270 conflicts. In Latin America and Western Africa local communities fear new technology lead to chemical pollution and over-extraction of water.
- 4 Unburnable fuels**, 178 conflicts. The fossil fuel industry has moved extraction to remote areas, but Arctic drilling, oil sand drilling, fracking and deep-water extraction are met with opposition. Fresh water contamination and devastation of marine systems are issues of concern.
- 5 Trash economy**, 126 conflicts. People living near waste sites are worried by many health issues, including water pollution.
- 6 Sand mafias**, 82 conflicts.
- 7 Fighting for fish**, 77 conflicts. Over-fishing and pollution from fish farms create conflicts in many parts of the world.
- 8 In China**, the Atlas accounts for 76 internal conflicts over for example air quality, coal-fired power plants and wastewater issues.
- 9 Nuclear power** continues to raise criticism with 57 conflicts registered.
- 10 Pesticides** are linked to water pollution and many other health problems, 23 related conflicts are on file.

75%

Pakistan may see a 75 per cent increase in heat waves by 2030, according to a new report from the COMSATS Institute of Information Technology.

New water strategy for Africa

In a chapter of a new book, Professor Malin Falkenmark argues that a shift in water thinking is needed if Africa is to meet present and future challenges.

Professor Falkenmark, who is Senior Advisor to SIWI, has long called for an African Blue-Green Water Revolution. In arid Africa, blue water (i.e. liquid freshwater in for example streams or groundwater) is insufficient and with rapid urbanization and population growth, farmers cannot expect to have access to this kind of water. Instead, farming methods must make clever use of green water (from precipitation, evaporation and retained in soil).

The article *Shift in Water Thinking Crucial for Sub-Saharan Africa's Future* can be found in *Assessing Global Water Megatrends*, edited by Asit K. Biswas, Cecilia Tortajada and Philippe Rohner.



Malin Falkenmark

THE WORLD'S NATURAL



In Sri Lanka, groundwater has taken on increased importance, with new wells being built. Photo: Dominic Sansoni / World Bank

AQUIFERS AT RISK



Text | Randall Hackley

When scientists evaluating satellite data say a third of the planet's major aquifers are being unsustainably depleted, threatening groundwater reserves and putting ecosystems and life-sustaining water supplies at risk, perhaps it's time to more seriously assess the global severity.

Here's a look at some of the most stressed aquifers on Earth and a snapshot of the reasons why "red flags" are being raised about the amount of water underground that's declining amid population growth, urban, industrial and farming demand, and poor management.

The Arabian aquifer system, whose groundwater accounts for about 84 per cent of total freshwater use across the arid Arabian Peninsula, is among the most overstressed. There, a study showed 10 countries from Saudi Arabia to Iraq, Jordan, Yemen and Syria, are essentially at Ground Zero as the planet warms amid climate change: Almost 90 per cent of the water withdrawn from the Arabian aquifer goes to agriculture, often paid for by oil revenues that subsidize the energy-intensive pumping of groundwater.

In a world in which two of five people, or 40 per cent of the planet's population, live in water-stressed areas, and weather extremes are making droughts more debilitating, the groundwater stored in

"hotspots" of aquifer depletion in a 2016 report. The aquifer is almost liquid gold, supplying California's agricultural breadbasket that provides 25 per cent of the US food and three-quarters of irrigated land in the state.

Over-pumping of the Central Valley aquifer, heavily depleted by irrigating-thirsty crops such as almonds during droughts, including California's recent 5-year one, caused some roads and farmland to subside or sink several metres (feet), despite the system's medium water recharge rate.

Farmers rely heavily on groundwater pumped from wells, from California and the US Midwest, to Morocco, Spain and much of India. Increasing populations, including those migrating from rural, infrastructure-lacking areas to job-supplying cities, and the negative effects of climate change conspire to pressure groundwater supplies.

At least 2 billion people of the 7.6 billion on Earth use groundwater as their primary source of water.

At least 2 billion people of the 7.6 billion on Earth use groundwater as their primary source of water.

aquifers is taking on increased importance. As the Los Angeles Times noted in a July op-ed piece, "The best place for California's water is underground".

Indeed, California's Central Valley aquifer system was sixth of the global

Growth and economic development in the most-populous nations, China and India, means both countries ●●●

●●● and their neighbours have trans-boundary aquifer systems at serious risk of depletion. Like parts of the Middle East and Asia, hydropolitical concerns affect Egypt and Ethiopia's relations.

The Indus basin, for example, encompasses sections of India, Pakistan, Afghanistan and China. Some 300 million people, most of them in India and Pakistan, rely on its aquifer because almost all farms are irrigated, often with subsidized electricity and overused and unregulated water pumps. Agriculture accounts for about 92 per cent of the Indus basin's freshwater withdrawals. Studies show the water table in some areas of Pakistan has fallen as much as 20 feet (6 metres).

Similarly, the Ganges-Brahmaputra basin suffers aquifer depletion and groundwater pollution stresses that are only in part offset by its high annual recharge rates. The basin that includes swathes of India, China, Nepal, Bangladesh and Bhutan is home to about 10 per cent of the planet's population.

Bangladesh, where an estimated 97 per cent of residents use wells for their drinking water, has degraded large areas of the aquifer system, exposing about 75 million people to arsenic pollution in the aquifer, studies show. Arsenic poisoning can occur naturally, such as in arsenic-rich rocks that gets filtered in the water in India, but as waters in an aquifer lower, concentrations can rise. Continued exposure can be deadly.

Research trying to quantify renewable groundwater stress using satellites measuring shifts in the total amount of water showed some of the world's aquifers may be nearing a "tipping point", according to Henk Ovink, water envoy for The Netherlands. He didn't elaborate except to say "past their tipping point means that a natural recovery has become impossible."

A research team, led by Alexandra Richey and including co-authors from NASA and the National Center for Atmospheric Research in the USA, found in their study that the most overstressed aquifer examined was the one that supplied about 60 million people in north Africa: the Arabian aquifer system.

The regions of most concern of those studied were in northern Africa, the Middle East, Pakistan and northwest



Growth and economic development in the most-populous nations, China and India, means bo

India, where the second most-stressed aquifer was the Indus basin aquifer. Of the 37 biggest groundwater basins that the team examined, they found that each year 21 lost more water than they gained.

In Africa, the Northwest Saharan and Nubian aquifer systems are considered two of the larger underground water storage sites under stress.

The Nubian system, the biggest non-renewable aquifer in the world, flows under parts of Egypt, Libya, Sudan and Chad. Mostly underlying Egypt and Libya, it's considered a high-stress site due to un-

sustainable withdrawal rates and demographic pressures. Libya depends on the aquifer for about 95 per cent of its water.

The system also features one of the few transboundary aquifer agreements. Worldwide, six transboundary aquifers exist with specific agreements, and two aquifers with informal accords.

The Northwest Saharan aquifer system that underlies 60 per cent of Algeria, almost a third of Libya and part of Tunisia is another transboundary aquifer with high levels of water withdrawals. It too features a cooperation pact and is



th countries and their neighbours have transboundary aquifer systems at serious risk of depletion.

Some of the world's aquifers may be nearing a "tipping point", according to Henk Ovink, water envoy for The Netherlands.

similar to the Nubian system in being non-renewable. Its extraction pressures come mainly from agricultural irrigation and industry.

In Asia, the North China aquifer system has significant depletion pressures. Agriculture uses almost two-thirds of its water and industry about a quarter amid land degradation issues in a region that includes the capital Beijing and about 11 per cent of the Chinese population.

Northern China depends on groundwater for about half of its total water

usage, mostly for agriculture and municipal demand. The South-North Water Diversion inter-basin transfer project to divert Yangtze River waters to the region is designed in part to help alleviate demand and water levels in non-renewable areas of the aquifer that have fallen drastically.

Water doesn't always correspond easily to administrative or political boundaries so many aquifers are shared by two or more countries. Local water stress and climate change can then become ●●●



California's Sierra Nevada mountains loom in the distance beyond a lone water hydrant in a yet-to-be-developed field. Photo: Randall Hackley

●●● “root causes for conflict and migration,” Ovink said by email. “We need to understand water in its complexity better, value it comprehensively and manage it at all scales and across all interests and layers of society and our institutions.”

stream flows – in about 20 per cent of the planet’s aquifers, according to research. Almost 2 billion people reside in these areas.

In the past half-century, ground water abstraction from such sites as

In the Ica-Villacuri aquifer beneath the Ica Valley desert in Peru, he noted, growers of asparagus that’s exported to European markets pump water from the aquifer for irrigation at a much faster rate than it can recharge.

Groundwater withdrawals already exceed groundwater availability – defined as groundwater recharges minus groundwater contributions to environmental stream flows – in about 20 per cent of the planet’s aquifers, according to research.

Projections under current usage, global population pressures and growth scenarios suggest a possible 40 per cent shortfall in water availability within just 12 years, including the almost 600 aquifers that cross sovereign borders.

Groundwater withdrawals already exceed groundwater availability – defined as groundwater recharges minus groundwater contributions to environmental

the Caspian and Aral Sea areas to the US’s over-utilized Ogallala aquifer has increased more than 300 per cent, said Tales Carvalho-Resende, a water expert with UNESCO.

According to Arjen Hoekstra, who created the water footprint concept, about 22 per cent of the water use in the world is for producing export products.

Water depletion is not always obvious because groundwater, often unseen, is difficult to measure and monitor. More data to quantify the water underground and water-saving technologies such as Israel uses can help.

Water, after all, may be considered mankind’s common currency. “Water touches nearly every aspect of development,” the World Bank wrote in a blog for a UN forum on sustainable development. “It flows through and connects the 17 Sustainable Development Goals (SDGs) by driving economic growth, supporting healthy ecosystems, cultivating food and energy production, and ensuring access to sanitation.”

Yet, it added, “water represents a silent emergency and a risk to our goals of building shared economic progress and sustainable development.” ●

Green solutions – the new black

Text | Anna Tengberg and Maria Sköld

By the year 2050, population growth is expected to have led to a 50 per cent increase in global food demand. Climate change will have caused major shifts in rainfall patterns and extreme weather phenomena could be much more common. At the same time, nature has hopefully helped us find new solutions.



Awareness is growing that we need to change how we do things like growing food, building roads and generating energy. Often smarter and more sustainable solutions can be found in nature. The use or mimicking of natural processes can contribute to improved water management, but to be able to draw on them we need to better understand the links between water, ecosystems and human development.

Discussions around nature-based solutions are gaining traction this year. They are an important part of the theme of this year's World Water Week and they were also the topic of World Water Day 2018 and the World Water Development Report from UN Water.

Looking ahead, there is progress to be made on several fronts to better leverage nature's capabilities:

The agricultural sector must find production methods that produce higher yields with less irrigation and more efficient water use. Increased climate

variability calls for more regulation and management of water, not least to make sure that agriculture has enough water without endangering environmental health and habitats. Water management is critical to avoid unwanted tipping points and threats also to human life.

The forestry sector has its own set of challenges, with tree cover loss in 2017 the second-highest on record. This trend must be rapidly reversed, or it will exacerbate both climate risks and water scarcity. Trees and forests regulate water flows, clean water, store carbon, enhance biodiversity and reduce erosion and runoff from landscapes. But more research is needed before we fully understand their impacts on the hydrological cycle.

Meanwhile, urban planners are beginning to grasp how reliant they are on ecosystems for cities to be resilient and sustainable, which will become even more apparent with rapid urbanization and more extreme weather.

The search for more nature-based solutions is on. In this issue of WaterFront, we look at some examples.

Sources: The report *Water for Productive and Multifunctional Landscapes*; *World Water Development Report 2018* and World Resources Institute.

Agriculture

Intercropping in Lesotho

Agriculture needs to become more water efficient, high-yielding and resilient to climate change. In the southern African country of Lesotho, a local mixed intercropping initiative has proven to be an effective way to achieve that. The method was originally developed by farmer J.J. Machobane in the 1940s but was reintroduced in the 1990s to tackle the mountainous country's erosion problems.

The system is based on rows of potatoes intercropped with rows of pumpkin or watermelon. In the same rows as the pumpkins and watermelons it is possible to grow grain crops such as maize, peas,

sorghum or wheat, amounting to at least seven crops being cultivated simultaneously. Potatoes are gradually covered with soil, forming ridges which, as well as increasing the potato yield, serve as windbreaks and small water-retaining "terraces".

Compared to conventional monocropping of maize, the Machobane system is more adaptive and resilient to climate change, leading to greater food security. Soil fertility has been improved and the increased plant cover throughout the year prevents erosion. To many farmers, the cash crops also provide a welcome extra income.



Landscapes

Mainstreaming NBS in Sweden

Nature-based solutions, NBS, are increasingly being mainstreamed into policies and action plans. In Sweden, the County Administration of Västra Götaland, an important agricultural region, has developed an NBS tool on how to manage flood risk in its agricultural and forest landscapes. The tool is targeted at communities to help adapt to climate change and increased flood risk in the landscape.

Communities need to think about how they should tackle climate change using natural measures, such as natural water retention measures to prevent flooding.

The cost is lower than for hard engineering measures and they give multiple positive outcomes, not least for biodiversity.

Examples of natural flood management measures include: enhanced soil infiltration, river bank buffer strips, trees for infiltration and slowing of water flows, measures in ditches and dams. These measures can usually be implemented easily and cost-effectively. However, there are also bigger projects that need more effort, such as restoring lakes and flood plains, which can be very efficient in reducing floods, but are also more expensive.

Bohuslän, on the Swedish west coast, is increasingly turning to nature-based solutions.



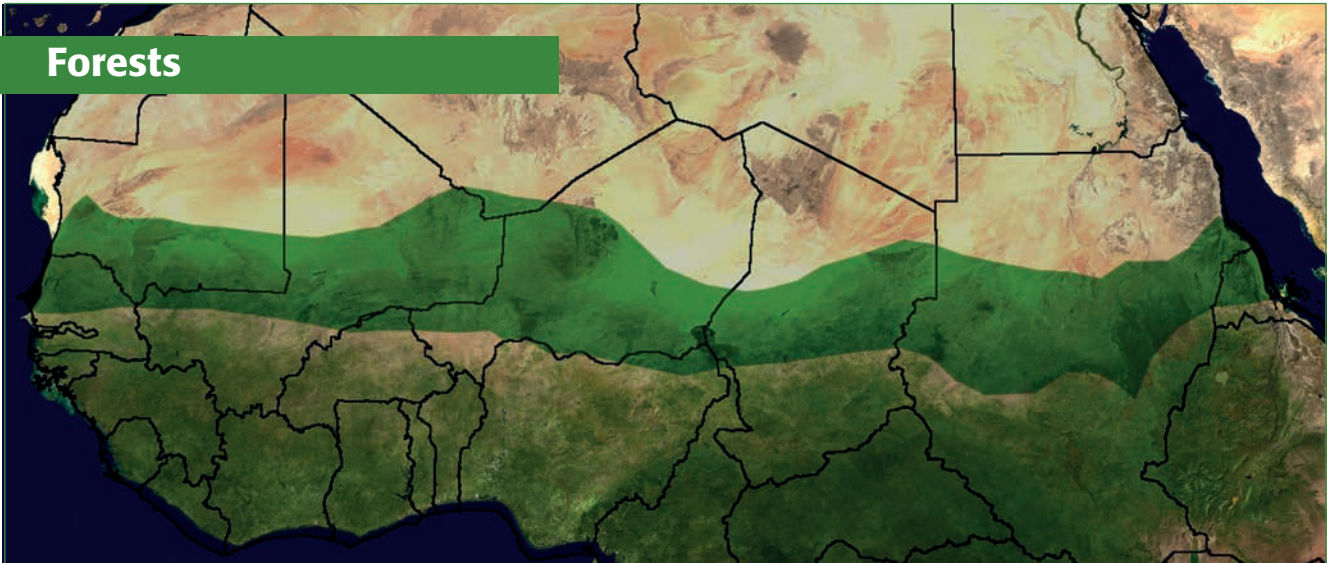
Goals for forest landscapes

Ambitious targets have been set internationally for forest landscape restoration, such as the Bonn Challenge, which is a global effort to restore 150 million hectares of the world's deforested and degraded land by 2020, and 350 million hectares by 2030. It was launched in 2011 by the German government and IUCN, and later endorsed and extended by the New York Declaration on Forests at the 2014 UN Climate Summit with the 2030 goal. These are voluntary commitments, and by 2017, there were 156 million hectares committed to restoration (i.e. statements of political intent), mostly by countries from the Global South that are so far leading the process.



Drip irrigation in a Sahelian agroforestry parkland, Niger.
Photo: Anna Tengberg

Forests



More than 20 countries participate in the ambitious restoration scheme. Illustration: Felix Koenig with a photo by NASA/Wikipedia.

The Great Green Wall in Africa

Globally, drylands cover 41.5 per cent of the land surface, and are home to two billion people. With climate change, drylands are expected to expand by 11–23 per cent.

FAO is involved in the Great Green Wall (GGW) initiative that is an African response to climate change and zero hunger (SDG2). It is not a wall of trees, but a mosaic of sustainable land management practices.

The objective is to restore 10 million hectares of land per year. Communities and their preferences are at the heart of forest and landscape restoration activities, and the focus is not only on trees, but also feed, medicines, food, fuel, etc. Moreover, water is at the centre of restoration in drylands.

Read more about the Great Green Wall initiative in [WaterFront 2-3/2017](#).

New tool to monitor forests and water

FAO is developing a Forest and Water Monitoring Framework and online tool to enable practitioners to consider water in their forest/tree-related projects and improve our understanding of forest-water interactions.

The tool, which has been developed using a participatory process, will provide guidance to the necessary standardized indicators, variables and methods to measure the effects of forest and land management decisions on water. In addition, users will be able to customize how they monitor forest-water interactions by selecting the most appropriate recommended methods.

The online tool will eventually provide aggregated and/or synthesized data that can provide local, national, regional and global information, which will be used to inform integrated forest, water and landscape management practices and policies.

Along with the monitoring framework, a training programme has also been established that involves multiple modules to meet the needs of countries and stakeholders wishing to implement the framework at a national or project-based level.



Freshwater Resilience by

Text | Maria Sköld



The Rufiji, Wami-Ruvu and Pangani river basins are of key importance to Tanzania.

Mexico City and Tanzanian national parks are pilots for a new way of building ecosystems analysis into decision-making about water resources. The World Bank recognizes the need to place economic and ecological perspectives on a more equal footing. The Hydrosystems Group at the University of Massachusetts has been tasked with figuring out how.



Sarah Freeman

For two years now, Sarah Freeman from University of Massachusetts Amherst has headed a research project about how the water management of Mexico City could be improved. The aim is not only to find solutions to the Mexican capital's water woes but to learn lessons that could also help megacities in other parts of the world.

It is a challenge in many ways. For starters, nearly one fifth of Mexico City's 22 million inhabitants lack daily water services and that number is expected to rise in coming years due to population growth, infrastructure degradation and climate change. At the same time, 60 per cent of the city's water supply is sourced from already depleted groundwater resources. On top of that comes a complex water management system with a myriad of stakeholders.

"Mexico City is under incredible stress, so the question for us is how it could be improved. How can we think differently? How do we plan for increased resilience?" says Sarah Freeman.

The project is also part of a larger attempt to understand how resilience can be built into water projects. The Hydrosystems Group at the University of Massachusetts' Civil and Environmental Engineering Department works together with the World Bank to develop a new methodology that could turn water planning on its head.

"The aim is to apply a freshwater resilience approach to decision-making. Usually, the water investment design starts with the economic perspective and then you evaluate which impact a certain proposal would have on the environment. But that way you lose sight of possible benefits from ecosystems. So instead we want to place the economic and ecological perspectives on an equal footing from the start and build that into the design of a project," explains Professor Casey Brown who heads the Hydrosystems Group.

The approach is called Freshwater Resilience by Design and is a systematic process for evaluating and ranking investments singularly and in combination. The first step is a stakeholder consultation to incorporate as many aspects as possible, not least ecological. The team working on a project will thereafter continuously seek input from these stakeholders to make sure that the ecological perspective is fully integrated.



Casey Brown

"We need many perspectives to be able to account for future climate variability and other uncertainties. And when we need to make trade-offs, we must really understand the choices," he says.

The Freshwater Resilience by Design concept stems from work done at the Rockefeller Foundation on resilience of water systems in different settings, from landscapes and agriculture, to cities. For the ideas to be put into investment practice, they have teamed up with the World Bank.

"It would be a very influential move if the World Bank would incorporate resilience into their Multi-Donor Trust Funds and their framework. But for that to happen, they need to really know what works.

Design in Mexico and Tanzania

This is where our research group comes in. We have previously assisted the Bank in implementing The Decision-Tree Framework for climate change, so to work with them on resilience is the logical next step. Our pilots in Mexico City and in river basin planning in Tanzania will give many valuable new insights,” Brown says.

In Tanzania, the Hydrosystems Research Group works with the Tanzanian government and the World Bank to demonstrate freshwater resilience principles in the Rufiji, Wami-Ruvu and Pangani river basins. This kind of understanding is crucial to making the right trade-offs between different competing sectors and aligning the previously uncoordinated development plans for the basins. Many other countries need similar tools for handling the competition between development and preservation of natural resources.

Urban planners can also learn from the case of Mexico City.

“It is challenging to apply the concept here because we’re working with systems that are already highly modified. Mexico City really doesn’t resemble a natural system anymore, so we need to establish how we can measure progress,” Freeman says.

The stakeholder dialogue has been a definite success factor. Given the complicated governance structure, just convening representatives from some 60 interest

groups was quite an achievement. Residents were also happily surprised to be asked about their views.

“The reception has been extremely positive, this is something people have been

waiting for. On a day-to-day basis, people are reaching out to us, saying ‘Have you thought about this?’ and that helps us constantly learn new things. It’s really important to understand both the ecological and the human aspects of resilience,” she says.●

“The aim is to apply a freshwater resilience approach to decision-making.”

Casey Brown, Hydrosystems Group



Citizens and other stakeholders have been invited to discuss the many water challenges facing Mexico City.



Girl gathers drinking water from a community water pipe. Photo: Dominic Sansoni / World Bank

New **tools** to measure climate change risks

Text | Bill Hinchberger

New decision-making tools that factor in climate change are sparking a quiet revolution in the analysis of risk and vulnerability in water infrastructure.

The Collaborative Risk Informed Decision Analysis tool (CRIDA), formulated by a coalition of institutions, will be released in the coming weeks under the auspices of the United Nations Educational, Scientific and Cultural Organization (UNESCO). It follows in the footsteps of the World Bank's Decision Tree Framework (DTF), in place since 2015. A London-based consultancy called Acclimatise has come up with a decision-making support tool called Aware that is being used by the Asian Development Bank and the European Investment Bank. Some agencies and institutions are adapting models in the public domain for their specific needs.



Kristin Gilroy

CRIDA “takes you step-by-step” though a process to decide if climate change is an issue and what to do if it is,” said Kristin Gilroy, a former water resources engineer at the US Army Corps of Engineers.

Both CRIDA and DTF have already produced dividends. Some insiders believe they are about to shake up the water world.

“This is a big story,” said John Matthews, head of the Alliance for Global Water Adaptation (AGWA), a network of organizations and institutions that led the drive to come up with CRIDA.

“In the next 5–10 years,” he added, “this is the way we will manage water. We won’t talk about climate change [in isolation] anymore. This is just what we will do.”

The early successes of CRIDA and DTF have prompted experts such as Patrick Ray, assistant professor of Environmental Engineering at the University of Cincinnati, to build on them and call for updates and upgrades in the entire project analysis and development process – one that engineers and decision-makers have relied upon since the mid-20th century.

“Climate change was the motivation, but it is a nice moment to look at all types of risk,” Ray said.

Elaborate water infrastructure dates back to the ancient Romans and before, but today’s modus operandi began to take shape in the 19th century. Since then engineers have pretty much dictated how water infrastructure is built.

In the late 1950s, a group of leading water management scholars in the United States called together colleagues from other disciplines, including economists and political scientists, to help factor in



Case study – Nepal

UPPER ARUN HYDROPOWER PROJECT

Hydropower production is affected by climate variability and in South Asia, the World Bank has been using the Decision Tree Framework to advise local governments on screening and mitigation measures.

The analysis of a World Bank-funded dam project on the Arun River in Nepal determined that run-off from melting glaciers is likely to be more voluminous than expected. That prompted planners to consider a larger turbine.



“In the next 5–10 years, this is the way we will manage water. We won’t talk about climate change [in isolation] anymore.”

John Matthews, head of the Alliance for Global Water Adaptation (AGWA)

●●● additional variables. The result of their collaboration came to be known as the Harvard Water Project, named after the US academic institution that helped spearhead the initiative. When published in 1962, it represented the first time that trade-offs on water infrastructure were explicitly recognized. It became the industry standard for the analysis of water projects.

Variables such as demographics and economic growth received their due, but most environmental factors, including climatic shifts, were set aside in line with “the idea that natural systems fluctuate within an unchanging envelope of variability” – a concept known as stationarity. That quote comes from a landmark paper published in 2008 in *Science* titled “Stationarity Is Dead: Whither Water Management?”

Efforts to include climate change in project analysis started in the late 1970s, but the *Science* paper galvanized that trend. Yet initial efforts proved disappointing. The best available data came from the

Intergovernmental Panel on Climate Change (IPCC), associated with the United Nations. Critics charged that its data were too general to be useful when looking at specific sites. And studies often led nowhere.

“A climate scientist would deliver a document that was several inches thick that concluded that the future is uncertain,” said Guillermo Mendoza, senior engineer with the International Center for Integrated Water Resources Management, established by the US Army Institute for Water Resources (IWR) and associated UNESCO. “That is not how you plan.”

People were asking the “wrong question,” Mendoza argued. “It is not what the future will look like but what failure would look like. Engineers are comfortable with that.”

Discussions about a more objective and utilitarian instrument began within AGWA as early as 2010. The World Bank beat everybody to the punch with its DTF, but it proved too bank-specific to be much use to anyone else.

AGWA pulled in collaborators from around the globe, with special honourable mentions to IWR, the Dutch think tank Deltares and the University of Massachusetts Amherst.

“We had a clear target audience in mind: the analyst,” said Ad Jeuken, expert advisor for climate change adaptation and water management at Deltares.

“To help them support decision makers. And keep it practical enough to achieve something.” ●

Case study – Zambia

PREVENTING ENERGY SHORTAGES

Frequent outages at the Iolanda water treatment plant were wreaking havoc on a section of the Zambian capital. The main inputs, water and energy, are inextricably linked.

For example, the Kabira hydroelectric dam chronically underperforms partly because its reservoir is usually almost empty. Upon closer analysis, there seemed to be enough water to keep the plant going. Energy shortages caused most of the shutdowns.

Officials opted for a low-cost solution: industrial-scale generators to provide back-up electricity.

Case study – Mexico

BASELINES FOR ALL THE WATER BASINS

Working with the World Wildlife Foundation (WWF), Mexican water officials created baselines for all the country’s water basins that would allow for sustainable development and ecological health.

One of their biggest fears was “ecological drought,” as AGWA’s John Matthews put it. “When so much water would be taken out that a combination of climate change and overuse could lead to collapse.”

Applying a CRIDA-inspired virtual stress test, they were able to come up with a management framework. The Interamerican Development Bank may apply the approach to other parts of Latin America which have similar collective water ownership systems, inherited from Iberian traditions.



Case Study – Udon Thani, Thailand

PLANNING FOR CITY EXPANSION IN UDON THANI, THAILAND

Udon Thani in north-eastern Thailand is one of the country’s largest and fastest-growing trade hubs. In the coming decade, the city aims to double in both size and population but there is concern about water supply as well as increased flood impacts.

The International Center for Integrated Water Resources Management of the US Army Corps of Engineers is supporting Udon Thani in its ambition to be both an economic hub and a “liveable city”. Udon Thani relies on a single source of water, the Huay Luang Reservoir, but according to the Institute, the reservoir operations have been increasingly constrained. The fear is that the reservoir could run out of water before the next rainy season, so that rice farmers can’t

irrigate their crops, the urban water supply dries up and blackouts become commonplace.

Using CRIDA, analysts “can model any kind of failure,” said Guillermo Mendoza from the Institute. Through “incremental cost analysis,” analysts were able to present the mayor with a series of options. Waterfront improvement could attract private investment, so that made the first cut. Other more politically-sensitive initiatives, for example construction projects that would temporarily create traffic jams, were put off until early successes could help build more political capital.



The river Nile is of key importance to most human activity in the region, but how can that be measured?

“The most powerful tool in economics is not money, not even algebra. It is a pencil. Because with a pencil you can redraw the world.”

Oxford economist Kate Raworth



HOW MUCH IS A RIVER

A growing number of economists are looking for new ways to bring the value of ecosystems into their calculations, including with the help of doughnuts. In the 21st century, we must adjust to living in a world of scarcity and planetary boundaries.

Text | Maria Sköld **Photo** | Susanna Starck and iStock

Somewhat surprisingly, doughnuts are starting to enjoy a reputation as the healthy choice. At least in economics. When Oxford economist Kate Raworth wanted to draw a picture of an economy that is good for the planet, she made it doughnut-shaped. The idea is now spreading.

Her main message is that economies must be kept within the nine planetary boundaries; dropping off the doughnut’s

outer edge is not safe. But, in addition, we want our societies to be just, so we should also avoid falling into the doughnut’s middle hole, where human needs are not met. In Raworth’s opinion, traditional thinking on economics doesn’t give us much guidance on how to get this balance right.

“We need to design an economy that is compatible with the preconditions of the living world. In current models, that date back to the 19th century, economic

growth is expected to be endless, which living life never is,” she recently said at a seminar in Sweden, hosted by SIWI and Stockholm School of Economics.

The word “design” is important here. Raworth argues that economists have come to treat assumptions about human and market behaviour as mechanical laws, leaving little room for policy choices. But an increasing number of these basic tenets – the self-interested, rational economic man for example – have been challenged either by breakthroughs in research or by breakdowns in real-world finance. In her view, this opens up for a new era of freedom for economists and politicians to design an economic system in the safe and just space of the doughnut.



WORTH — ANYONE?

Instead of adhering to outdated concepts from traditional economics, economists have much to learn from other academic fields, including Earth-system studies, behavioural science and systems thinking, Raworth argues.

In the 1950s, few economists may have felt the need to understand Earth’s life-giving systems since it was widely believed that human activities could never be on a scale to significantly alter the ecological balance. Since then, the global population has almost trebled in size and the global GDP has increased sevenfold. Freshwater withdrawal has more than trebled and we use ten times as much fertiliser. Species are disappearing at a greater rate than ever before due to damaged ecosystems.

“In a single lifetime, humanity has become a planetary-scale geological force,” Raworth quotes Earth-system scientist Will Steffen as saying. Steffen, Johan Rockström and fellow scientists in 2009 introduced the concept of planetary boundaries, nine limits that we can’t transgress without pushing Earth towards potentially irreversible tipping points.

For policy makers, this leads to new questions about how to establish the value of resources and ecosystems, not least in relation to water. David Zetland, Assistant Professor at Leiden University College in the Netherlands, argues that water is unnecessarily wasted because regulations and pricing schemes reflect an era of abundance that is now over. ●●●

“We used to take water for granted and save money by building inefficient systems. When water is scarce, we need to change systems so we don’t use — or lose — as much.”

David Zetland,
Assistant Professor
at Leiden University
College





People in Amsterdam are good at saving water.

●●● In his book *Living with Water Scarcity* he rhetorically asks how it can be that residents in San Diego in his native California consume five times as much water per day as people in Amsterdam. San Diego is as arid as Amsterdam is wet. Water officials are increasingly worried about shortages, but that is not reflected in the price, which is instead based on delivery costs. Pumping water from San Diego's old aqueducts is cheaper than treating water from Amsterdam's natural sources and pumping that water through a well-maintained network.

"We need to learn to manage water differently and do away with many institutions that are not functioning well any more since they were created for the era of abundance," David Zetland says.

"We used to take water for granted and save money by building inefficient systems. When water is scarce, we need to change systems so we don't use – or lose – as much."

To manage scarce water effectively, he believes that water should be divided into two separate categories, each guided by a separate logics. The first category is the domain of politicians, who should

set aside water for collective use, for example for maintaining functioning ecosystems – the outside of the doughnut. But this category also applies to the inside of the doughnut, making sure that poor people have access to water.

The second category of water is to be used for everything else, from drinking to agriculture to energy production, and should be the domain of markets.

"You can say that this is the doughnut itself, the actual economy, and for that to work effectively, you must allow for markets, prices and incentives to promote efficient use," Zetland says.

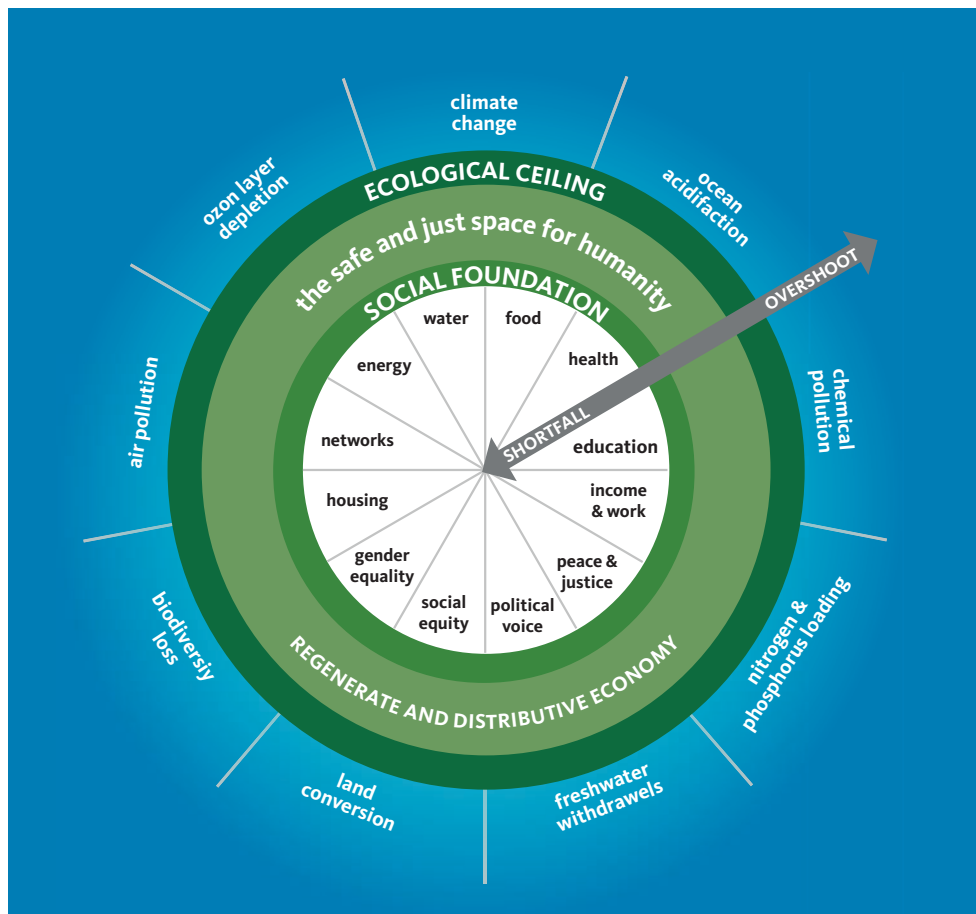
In the case of San Diego, he thinks this should mean that residents pay also for the "opportunity cost" when they get to use the water. And that they pay the full price, without subsidies, for new sources of water, for example from desalination.

In low-income countries it is trickier to get this model to work, mainly due to problems with corruption and lack

of accountability. David Zetland claims that offering poor residents water for free often means that they end up without any public water at all since no one is interested in offering them services that lose money. As a solution, he suggests a national water registry that entitles everyone to a share of the royalties paid by whoever uses the water. Those subsidies would give everyone enough income to pay for quality drinking water services.

Tackling corruption is the single most important aspect of improving water governance, he argues. One of the most efficient ways to do this would be to avoid mega projects like huge dams or the gigantic river-linking projects currently championed by countries like China and India. Environmental risks aside, those projects tend to fuel corruption and waste.

"With new technology, it makes much more sense to look for small-scale solutions that can be managed by people locally. There are many great examples out there already," he says.





John Joyce

John Joyce, Chief Economist at SIWI, also feels that we are at a kind of cross-roads. The traditional growth model assumed an abundance of

capital, but now its resource constraints, opportunity costs and scarcity are front and centre. Well-maintained ecosystems are essential to achieving economic and social goals,” Joyce says.

Degraded systems mean the extinction of freshwater species, impacting on the systems’ resilience and productive capacity. The rising damage costs, both

lated to freshwater systems that should be unimaginable in 10 years time,” he says.

These signals are being picked up by companies and investors. Joyce expects a growing market where for-profit companies deliver solutions that enable ecological improvements, driven by societal preferences.

“Decoupling freshwater from production processes will be the landscape of the future. This will drive economic growth firmly from a sustainability perspective. More forms of capital are available than ever before, the bonds market is growing and sustainable finance is on the rise. Finance is not the constraint it used to be.”

In Joyce’s view, there is reason for cautious optimism.

“Many of these processes are still in their infancy, but the signals and structures are definitely there. We can expect to see many new market opportunities linked to recovery and restoration of damaged freshwater ecosystems. Finally, the tide will start to turn.” ●

“In a similar vein as the smoking ban and seatbelts in cars, there are many practices today related to freshwater systems that should be unimaginable in 10 years time.”

John Joyce, Chief Economist at SIWI

freshwater resources and led to over-allocation, inefficient use and mismanagement. As a consequence, river basins are drying up and many of the world’s watersheds do not reach the sea anymore.

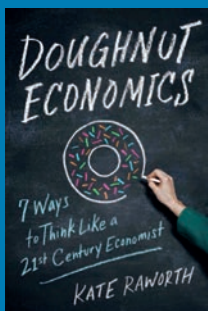
“The economics of water has traditionally been about the limitations of

ecological and social, is something that societies increasingly are no longer willing to accept.

“We can expect a big societal push back on the way water is used. In a similar vein as the smoking ban and seatbelts in cars, there are many practices today re-

Redrawing the world

Is drawing doughnuts really going to change the world? Kate Raworth clearly thinks so. In her book *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist* she writes “The most powerful tool in economics is not money, not even algebra. It is a pencil. Because with a pencil you can redraw the world.”



The doughnut is used to change where we draw the line when it comes to economics – what does and what does not belong in that category. By first visualizing another economic order, it becomes easier to then present arguments underpinning it.

Convincing others with the help of pictures is of course something humans have always done, at least since prehistoric cavemen first discovered the joy of scribbling on walls, but it took modern neuroscience to figure out why this is so effective.

Turns out our brains are wired for visuals. According to Raworth, there are several reasons why what we see has such strong influence on us. Firstly, half of the nerve fibres in our brains are linked to our vision and we only need 150 milliseconds to recognize an image. We may even see faces in the clouds or monsters in lakes that

are not really there, because our brains are so tuned to pattern-spotting. Second, images tend to stick. Unlike words, they go directly into long-term memory. And when text and images send conflicting messages, images are more likely to win.

So if you have an idea you really want to share with the world, pick up a pencil and draw it.

SDG 6 and beyond: great ambitions, great challenges



Text | Torkil Jønych Clausen Photo | Sigrun Sauerzapfte

When the world adopted the Sustainable Development Goals (SDGs), one of the 17 goals was SDG 6, to “ensure availability and sustainable management of water and sanitation for all”.

The water community was jubilant. Finally, specific and ambitious targets were set for all countries to, by 2030, achieve full access to safe water and adequate sanitation, and universal implementation of Integrated Water Resources Management (IWRM) at all levels. At the same time commitments were made to improve water quality, halve the proportion of untreated wastewater, increase recycling and reuse, increase water-use efficiency, reduce suffering from water scarcity, and protect and restore ecosystems. Countries are now developing SDG implementation plans and the global water community is developing indicators and monitoring systems for each of the six specific SDG 6 targets.

Now, in 2018, the honeymoon is over and we are called to task to actually deliver. The question arises: can we? Will the world mobilize the resources and create the capacity to accelerate development and scale up implementation to meet these targets?

The recent Review of SDG 6 in New York in July 2018 was sobering. For some of the targets we may get close, for others far from. The Review recognized that a process has been started, but that the level of commitment and action needs to increase sharply if we are to achieve the SDG 6 targets.

The six SDG 6 targets are mutually inter-dependent, and cannot be achieved if we treat them in isolation. Good water quality (6.3) is a pre-condition for achieving the water supply and sanitation targets 6.1 and 6.2, which in turn depend on sustainable water use (6.4) and healthy ecosystems (6.6). This links everything to good water governance and IWRM (6.5). Will countries well before 2030 have governance systems and public-private partnerships in place that allow thinking and acting across these targets? Will the international community be able to cooperate across traditional professional divides? Can we revitalize IWRM to become more relevant for the 2030 Agenda ahead?

But looking at SDG 6 alone does not do it. Water is a connector across the SDGs, and most of the other goals depend on water for their achievement. In many cases this connection is win-win and targets are in synergies with SDG 6, as for example between SDG 6 and targets for poverty reduction (SDG 1), hunger and malnutrition (SDG 2) and reduction of water-borne diseases (SDG 3). In other cases, the SDGs are in potential conflict, such as targets on water quality, water use and ecosystems that may be negatively impacted by increased

access to energy (SDG 7), economic growth (SDG 8) and infrastructure development (SDG 9).*

We now need to take bold steps out of our usual comfort zones to interact and integrate with other communities that we often talk “about”, but not “with”, both national and global. The water community talks about the Water, Energy and Food Security Nexus, linking SDGs 2, 6 and 7, but engaging particularly the energy community is difficult. The ocean community recognizes that land-based activities pollute and litter the oceans, yet getting the freshwater and ocean communities to engage hand-in-hand to link SDGs 6 and 14 is difficult. For practically every water-related SDG there are such examples.

On the one hand, we are at the beginning of the 2030 road and need to be realistic and patient when trying to create a new paradigm of cross-sectoral, cross-community cooperation. On the other hand, we have little time to lose: if we do not accelerate integrated SDG implementation now, we shall fail on many of our great ambitions.

With the SDGs, a great stage has been set to take water-related development to a new level. The ambitions are justified, and the challenges to reach them expected. We may not be able to deliver on all ambitions, but this is our chance. We have no excuse not pursuing it. ●

*See UN-Water 2016: *Water and Sanitation Linkages Across the 2030 Agenda for Sustainable Development*.



ABOUT THE AUTHOR

Torkil Jønych Clausen is Chair of World Water Week's Scientific Programme Committee.



14 SEPTEMBER
Deadline for the Public Dialogue on the SDG 6 Synthesis Report

UN Water has tracked global progress on SDG 6 in the SDG 6 Synthesis Report 2018 on Water and Sanitation and now the public has been invited to join the discussion. Feedback on the report can be submitted until 14 September.

<http://dialogue.unwater.org/>



2-4 OCTOBER
Asia Water Forum 2018

"Information, Innovation, and Technology" is the theme for this year's Asia Water Forum, held in Manila, Philippines.

<https://www.adb.org/news/events/asia-water-forum-2018-information-innovation-and-technology>

7 NOVEMBER
Our Future Water Berlin

Young water leaders get together in the German capital to discuss future challenges.

<http://www.ourfuturewater.com/berlin/>

21-29 OCTOBER

COP13 Ramsar Convention on Wetlands

The 13th Conference of the Contracting Parties to the Ramsar Convention on Wetlands will be held in Dubai, United Arab Emirates. The theme is "Wetlands for a Sustainable Urban Future".

<https://www.ramsar.org/about-the-cop13>



All publications can be found online at www.siwi.org/publications

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WATER IN THE LANDSCAPE

SIWI Swedish Water House has produced a new report, Water for Productive and Multifunctional Landscapes, from the cluster group Landscapes and Water. The report highlights both Swedish and international examples.



OPEN LETTER AND SIWI POLICY

Ahead of the High-level Political Forum in July, SIWI produced a policy brief on the importance of water in the implementation of the sustainable development goals, *Water: the path to Agenda 2030 implementation*. In addition, SIWI also took the initiative to an Open letter, which can also be found as a policy brief, named *Building a resilient future through water*.

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STOCKHOLM **WATERFRONT**



Foto: Henrik Trygg



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