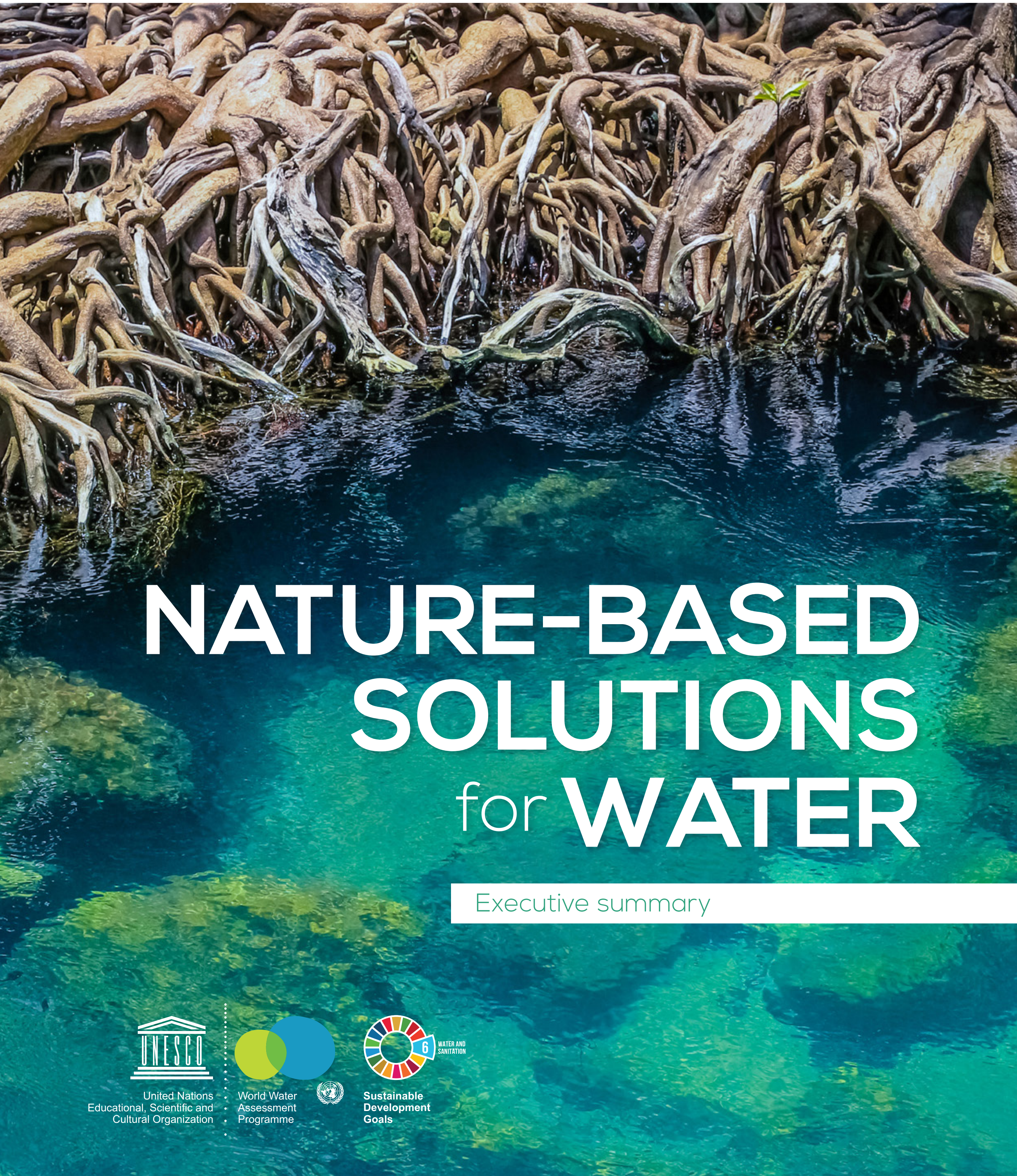
UN WATER

Report

The United Nations World Water Development Report 2018



NATURE-BASED SOLUTIONS for WATER

Executive summary

United Nations Educational, Scientific and Cultural Organization

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Nature-based solutions (NBS) are inspired and supported by nature and use, or mimic, natural processes to contribute to the improved management of water. An NBS can involve conserving or rehabilitating natural ecosystems and/or the enhancement or creation of natural processes in modified or artificial ecosystems. They can be applied at micro- (e.g. a dry toilet) or macro- (e.g. landscape) scales.

Despite rapidly growing investments in NBS, the evidence suggests that this is still well below 1% of total investment in water resources management infrastructure

Attention to NBS has significantly increased in recent years. This is evidenced through the mainstreaming of NBS into a wide range of policy advances, including in water resources, food security and agriculture, biodiversity, environment, disaster risk reduction, urban settlements, and climate change. This welcome trend illustrates a growing convergence of interests around the recognition of the need for common objectives and the identification of mutually supporting actions – as illustrated best in the 2030 Agenda for Sustainable Development through its acknowledgment of the interdependency of its various goals and targets.

Upscaling NBS will be central to achieving the 2030 Agenda for Sustainable Development. Sustainable water security will not be achieved through business-as-usual approaches. NBS work with nature instead of against it, and thereby provide an essential means to move beyond business-as-usual to escalate social, economic and hydrological efficiency gains in water resources management. NBS show particular promise in achieving progress towards sustainable food production, improved human settlements, access to water supply and sanitation services, and water-related disaster risk reduction. They can also help to respond to the impacts of climate change on water resources.

NBS support a *circular economy* that is restorative and regenerative by design and promotes greater resource productivity aiming to reduce waste and avoid pollution, including through reuse and recycling. NBS also support the concepts of *green growth* or the *green economy*, which promote sustainable natural resource use and harness natural processes to underpin economies. The application of NBS for water also generates social, economic and environmental co-benefits, including improved human health and livelihoods, sustainable economic growth, decent jobs, ecosystem rehabilitation and maintenance, and protecting/enhancing biodiversity. The value of some of these co-benefits can be substantial and tip investment decisions in favour of NBS.

However, despite a long history of and growing experience with the application of NBS, there are still many cases where water resources policy and management ignore NBS options – even where they are obvious and proven to be efficient. For example, despite rapidly growing investments in NBS, the evidence suggests that this is still well below 1% of total investment in water resources management infrastructure.

THE WORLD'S WATER: DEMAND, AVAILABILITY, QUALITY AND EXTREME EVENTS

The global demand for water has been increasing at a rate of about 1% per year as a function of population growth, economic development and changing consumption patterns, among other factors, and it will continue to grow significantly over the next two decades. Industrial and domestic demand for water will increase much faster than agricultural demand, although agriculture will remain the largest overall user. The vast majority of the growing demand for water will occur in countries with developing or emerging economies.

At the same time, the global water cycle is intensifying due to climate change, with wetter regions generally becoming wetter and drier regions becoming even drier. At present, an estimated 3.6 billion people (nearly half the global population) live in areas that are potentially water-scarce at least one month per year, and this population could increase to some 4.8–5.7 billion by 2050.

Since the 1990s, water pollution has worsened in almost all rivers in Africa, Asia and Latin America. The deterioration of water quality is expected to further escalate over the next decades and this will increase threats to human health,

the environment and sustainable development. Globally, the most prevalent water quality challenge is nutrient loading, which, depending on the region, is often associated with pathogen loading. Hundreds of chemicals are also impacting on water quality. The greatest increases in exposure to pollutants are expected to occur in low- and lower-middle income countries, primarily because of higher population and economic growth and the lack of wastewater management systems.

The trends in water availability and quality are accompanied by projected changes in flood and drought risks. The number of people at risk from floods is projected to rise from 1.2 billion today to around 1.6 billion in 2050 (nearly 20% of the world's population). The population currently affected by land degradation/desertification and drought is estimated at 1.8 billion people, making this the most significant category of 'natural disaster' based on mortality and socio-economic impact relative to gross domestic product (GDP) per capita.

ECOSYSTEM DEGRADATION

Ecosystem degradation is a leading cause of increasing water resources management challenges. Although about 30% of the global land remains forested, at least two thirds of this area are in a degraded state. The majority of the world's soil resources, notably on farmland, are in only fair, poor or very poor condition and the current outlook is for this situation to worsen, with serious negative impacts on water cycling through higher evaporation rates, lower soil water storage and increased surface runoff accompanied by increased erosion. Since the year 1900, an estimated 64–71% of the natural wetland area worldwide has been lost due to human activity. All these changes have had major negative impacts on hydrology, from local to regional and global scales.

There is evidence that such ecosystem change has over the course of history contributed to the demise of several ancient civilizations. A pertinent question nowadays is whether we can avoid the same fate. The answer to that question will depend at least partly on our ability to shift from working against nature to working with it – through, for example, better adoption of NBS.

THE ROLE OF ECOSYSTEMS IN THE WATER CYCLE

Ecological processes in a landscape influence the quality of water and the way it moves through a system, as well as soil formation, erosion and sediment transport and deposition – all of which can exert major influences on hydrology. Although forests often receive the most attention when it comes to land cover and hydrology, grasslands and croplands also play important roles. Soils are critical in controlling the movement, storage and transformation of water. Biodiversity has a functional role in NBS whereby it underpins ecosystem processes and functions and, therefore, the delivery of ecosystem services.

Ecosystems have important influences on precipitation recycling from local to continental scales. Rather than being regarded as a 'consumer' of water, vegetation is perhaps more appropriately viewed as a water 'recycler'. Globally, up to 40% of terrestrial rainfall originates from upwind plant transpiration and other land evaporation, with this source accounting for most of the rainfall in some regions. Land use decisions in one place may therefore have significant consequences for water resources, people, the economy and the environment in distant locations – pointing to the limitations of the watershed (as opposed to the 'precipitationshed') as the basis for management.

Green infrastructure (for water) uses natural or semi-natural systems such as NBS to provide water resources management options with benefits that are equivalent or similar to conventional grey (built/physical) water infrastructure. In some situations, nature-based approaches can offer the main or only viable solution (for example, landscape restoration to combat land degradation and desertification), whereas for different purposes only a grey solution will work (for example supplying water to a household through pipes and taps). In most cases, however, green and grey infrastructure can and should work together. Some of the best examples of the deployment of NBS are where they improve the performance of grey infrastructure. The current situation, with ageing, inappropriate or insufficient grey infrastructure worldwide, creates opportunities for NBS as innovative solutions that embed perspectives of ecosystem services, enhanced resilience and livelihood considerations in water planning and management.

A key feature of NBS is that they tend to deliver groups of ecosystem services together – even if only one is being targeted by the intervention. Hence, NBS usually offer multiple water-related benefits and often help address water quantity, quality and risks simultaneously. Another key advantage of NBS is the way in which they contribute to building overall system resilience.

NBS FOR MANAGING WATER AVAILABILITY

NBS mainly address water supply through managing precipitation, humidity, and water storage, infiltration and transmission, so that improvements are made in the location, timing and quantity of water available for human needs.

The option of building more reservoirs is increasingly limited by silting, decrease of available runoff, environmental concerns and restrictions, and the fact that in many developed countries the most cost-effective and viable sites have already been used. In many cases, more ecosystem-friendly forms of water storage, such as natural wetlands, improvements in soil moisture and more efficient recharge of groundwater, could be more sustainable and cost-effective than traditional grey infrastructure such as dams.

Agriculture will need to meet projected increases in food demand by improving its resource use efficiency while simultaneously reducing its external footprint, and water is central to this need. A cornerstone of recognized solutions is the 'sustainable ecological intensification' of food production, which enhances ecosystem services in agricultural landscapes, for example through improved soil and vegetation management. 'Conservation agriculture', which incorporates practices aimed at minimizing soil disturbance, maintaining soil cover and regularizing crop rotation, is a flagship example approach to sustainable production intensification. Agricultural systems that rehabilitate or conserve ecosystem services can be as productive as intensive, high-input systems, but with significantly reduced externalities. Although NBS offer significant gains in irrigation, the main opportunities to increase productivity are in rainfed systems that account for the bulk of current production and family farming (and hence provide the greatest livelihood and

poverty reduction benefits). The theoretical gains that could be achievable at a global scale exceed the projected increases in global demand for water, thereby potentially reducing conflicts among competing uses.

NBS for addressing water availability in urban settlements are also of great importance, given that the majority of the world's population is now living in cities. Urban green infrastructure, including green buildings, is an emerging phenomenon that is establishing new benchmarks and technical standards that embrace many NBS. Business and industry are also increasingly promoting NBS to improve water security for their operations, prompted by a compelling business case.

NBS FOR MANAGING WATER QUALITY

Source water protection reduces water treatment costs for urban suppliers, and contributes to improved access to safe drinking water in rural communities. Forests, wetlands and grasslands, as well as soils and crops, when managed properly, play important roles in regulating water quality by reducing sediment loadings, capturing and retaining pollutants, and recycling nutrients. Where water becomes polluted, both constructed and natural ecosystems can help improve water quality.

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Non-point (diffuse) source pollution from agriculture, notably nutrients, remains a critical problem worldwide, including in developed countries. It is also the one most amenable to NBS, as these can rehabilitate ecosystem services that enable soils to improve nutrient management, and hence lower fertilizer demand and reduce nutrient runoff and/or infiltration to groundwater.

Urban green infrastructure is increasingly being used to manage and reduce pollution from urban runoff. Examples include green walls, roof gardens and vegetated infiltration or drainage basins to support wastewater treatment and reduce stormwater runoff. Wetlands are also used within urban environments to mitigate the impact of polluted stormwater runoff and wastewater. Both natural and constructed wetlands also biodegrade or immobilize a range of emerging pollutants, including certain pharmaceuticals, and often perform better than grey solutions. For certain chemicals, they may offer the only solution.

There are limits to how NBS can perform. For example, NBS options for industrial wastewater treatment depend on the pollutant type and its loading. For many polluted water sources, grey-infrastructure solutions may continue to be needed. However, industrial applications of NBS, particularly constructed wetlands for industrial wastewater treatment, are growing.

NBS FOR MANAGING WATER-RELATED RISKS

Water-related risks and disasters, such as floods and droughts associated with an increasing temporal variability of water resources due to climate change, result in immense and growing human and economic losses globally. Around 30% of the global population is estimated to reside in areas and regions routinely impacted by either flood or drought events. Ecosystem degradation is the major cause of increasing water-related risks and extremes, and it reduces the ability to fully realize the potential of NBS.

Combining green and grey infrastructure approaches can lead to cost savings and greatly improved overall risk reduction

Green infrastructure can perform significant risk reduction functions. Combining green and grey infrastructure approaches can lead to cost savings and greatly improved overall risk reduction.

NBS for flood management can involve water retention by managing infiltration, overland flow, and thereby the hydrological connectivity between system components and the conveyance of water through it, making space for water storage through, for example, floodplains. The concept of ‘living with floods’, which, among other things, includes a range of structural and non-structural approaches that help to ‘be prepared’ for a flood, can facilitate the application of relevant NBS to reduce flood losses and, most importantly, flood risk.

Droughts are not limited to dry areas, as is sometimes portrayed, but can also pose a disaster risk in regions that are normally not water-scarce. The mix of potential NBS for drought mitigation is essentially the same as those for water availability and aim to improve water storage capacity in landscapes, including soils and groundwater, to cushion against periods of extreme scarcity. Seasonal variability in rainfall creates opportunities for water storage in landscapes to provide water for both ecosystems and people over drier periods. The potential of natural water storage (particularly subsurface, in aquifers) for disaster risk reduction is far from being realized. Storage planning at river basin and regional scales should consider a portfolio of surface and subsurface storage options (and their combinations) to arrive at the best environmental and economic outcomes in the face of increasing water resources variability.

NBS FOR ENHANCING WATER SECURITY: MULTIPLYING THE BENEFITS

NBS are able to enhance overall water security by improving water availability and water quality while simultaneously reducing water-related risks and generating additional social, economic and environmental co-benefits. They allow for the identification of win-win outcomes across sectors. For example, NBS in agriculture are becoming mainstream because they deliver increased sustainable agricultural productivity and profitability but also enhance overall system-wide benefits, such as improved water availability and reduced downstream pollution. Watershed restoration and protection has become increasingly important in the context of meeting multiple challenges in sustaining water supplies to rapidly growing cities and reducing risks in them. Urban green infrastructure can yield positive results in terms of water availability, water quality and flood and drought reduction. In the context of water and sanitation, constructed wetlands for wastewater treatment can be a cost-effective NBS that provides effluent of adequate quality for several non-potable uses, including irrigation, as well as offering additional benefits, including energy production.

CHALLENGES AND LIMITATIONS

Challenges to upscaling NBS so that they reach their full and significant potential are somewhat generic across the sectors and at global, region-specific or place-based scales. There remains a historical inertia against NBS due to the continuing overwhelming dominance of grey infrastructure solutions in the current instruments of the Member States – from public policy to building codes and regulations. This dominance can also exist in civil engineering, market-based economic instruments, the expertise of service providers, and consequentially in the minds of policy makers and the general public. These and other factors collectively result in NBS often being perceived to be less efficient, or riskier, than built (grey) systems.

NBS often require cooperation among multiple institutions and stakeholders, something that can be difficult to achieve. Current institutional arrangements did not evolve with cooperation on NBS in mind. There is a lack of awareness, communication and knowledge at all levels, from communities to regional planners and national policy makers, of what NBS can really offer. The situation can be compounded by a lack of understanding of how to integrate green and grey infrastructure at scale, and an overall lack of capacity to implement NBS in the context of water. Myths and/or uncertainty remain about the functioning of natural or green infrastructure, and about what ecosystem services mean in practical terms. It is also not entirely clear, at times, what constitutes a NBS. There is a lack of technical guidance, tools and approaches to determine the right mix of NBS and grey-infrastructure options. The hydrological functions of natural ecosystems, like wetlands and floodplains, are much less understood than those provided by grey infrastructure. Consequently, NBS are even more neglected in policy appraisal and in natural resource and development planning and management. This situation is partly compounded by insufficient research and development in NBS and particularly by the lack of impartial and robust assessments of current NBS experience, especially in terms of their hydrological performance, and cost–benefit analyses in comparison or conjunction with grey solutions.

There are limits to what ecosystems can achieve and these need much better identification. For example, 'tipping points', beyond which negative ecosystem change becomes irreversible, are well theorized but rarely quantified. It is therefore necessary to recognize the limited carrying capacity of ecosystems and determine the thresholds where any additional stresses (e.g. the addition of contaminants and toxic substances) will lead to irreversible damage to the ecosystem.

The high degree of variation in the impacts of ecosystems on hydrology (depending on ecosystem type or subtype, location and condition, climate and management) cautions to avoid generalized assumptions about NBS. For example, trees can increase or decrease groundwater recharge according to their type, density, location, size and age. Natural systems are dynamic and their roles and impacts change over time.

An often overstated assumption about NBS is that they are 'cost-effective', whereas this should be established during an assessment, including consideration of co-benefits. While some small-scale NBS applications can be low- or no-cost, some applications, particularly at scale, can require large investments. Ecosystem restoration costs, for example, can vary widely from a few hundred to several millions of US dollars per hectare. Site-specific knowledge on the field deployment of NBS is essential yet often inadequate. Now that attention to NBS has increased, NBS practitioners need to greatly increase knowledge to support decision-making and avoid overstating NBS performance if this new impetus is not to be squandered.

RESPONSES – CREATING THE ENABLING CONDITIONS FOR ACCELERATING THE UPTAKE OF NBS

The required responses to these challenges essentially involve creating enabling conditions for NBS to be considered equitably alongside other options for water resources management.

Leveraging financing

NBS do not necessarily require additional financial resources but usually involve redirecting and making more effective use of existing financing. Investments in green infrastructure are being mobilized thanks to the increasing recognition of the potential of ecosystem services to provide system-wide solutions that make investments more sustainable and cost-effective over time. Assessments of the returns on investments in NBS often do not factor in these positive externalities, just as those for grey infrastructure often do not take all negative environmental and social externalities into account.

Payment for environmental services schemes provide monetary and non-monetary incentives to upstream communities, farmers and private landowners to protect, restore and conserve natural ecosystems and adopt sustainable agricultural and other land use practices. These actions generate benefits to downstream water users in the form of water regulation, flood control, and erosion and sediment control, among others, thus ensuring a constant, high-quality water supply, and helping reduce water treatment and equipment maintenance costs.

The emerging 'green bond' market shows promising potential for mobilizing NBS financing and, notably, demonstrates that NBS can perform well when assessed against rigorous standardized investment performance criteria. The private sector can also be further stimulated and guided to advance NBS in the areas in which it operates. Building in-house expertise and awareness of the effectiveness of NBS will facilitate this.

Transforming agricultural policy represents a significant pathway for financing the further uptake of NBS. This requires overcoming the fact that the vast majority of agricultural subsidies, and probably the majority of public funding and almost all private sector investment in agricultural research and development, support the intensification of conventional agricultural, which increases water insecurity. Mainstreaming the concept of sustainable ecological intensification of agricultural production, which essentially involves deploying NBS (e.g. improved soil and landscape management techniques), is not only the recognized way forward in order to achieve food security, but would also be a major advance in NBS financing for water.

Assessing co-benefits of NBS (through a more holistic cost–benefit analysis) is an essential step in achieving efficient investments and tapping into financial resources across multiple sectors. All benefits, not just a narrow set of hydrological outcomes, need to be factored into an assessment of investment options. This requires a detailed systematic approach, but evidence shows it will lead to significant improvements in decision-making and overall system performance.

Creating an enabling regulatory and legal environment

The vast majority of current regulatory and legal environments for water management were developed largely with grey-infrastructure approaches in mind. Consequently, it can often be challenging to retrofit NBS into this framework. However, rather than expecting drastic changes in regulatory regimes, much can be achieved by promoting NBS more effectively through existing frameworks. In places where enabling legislation does not yet exist, identifying where and how NBS can support existing planning approaches at different levels can be a useful first step in this process.

National legislation to facilitate the implementation of NBS at the local level is particularly crucial. A small but growing number of countries have adopted regulatory frameworks promoting NBS at the national level. In Peru, for example, a national legal framework was adopted to regulate and monitor investment in green infrastructure. Regional frameworks can also stimulate change. The European Union, for instance, has significantly increased opportunities for NBS deployment through the harmonization of its legislation and policies regarding agriculture, water resources and the environment.

At the global level, NBS offer Member States a means to respond to and use the various multilateral environmental agreements (especially the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, the Ramsar Convention on Wetlands, the Sendai Framework on Disaster Risk Reduction, agreed frameworks for food security and the Paris Agreement on Climate Change), while also addressing economic and social imperatives. An overarching framework for promoting NBS is the 2030 Agenda for Sustainable Development with its Sustainable Development Goals (SDGs).

Improving cross-sectoral collaboration

NBS can require much greater levels of cross-sectoral and institutional collaboration than grey-infrastructure approaches, particularly when applied at landscape scale. However, this can also open opportunities to bring those groups together under a common approach or agenda.

In many countries, the policy landscape remains highly fragmented. Better harmonization of policies across economic, environment and social agendas is a general requirement in its own right. NBS are not only a beneficiary of such harmonization but also a means to achieve it, because of their ability to deliver multiple, and often significant, co-benefits beyond just hydrological outcomes. Clear mandates from the highest policy level can significantly accelerate NBS uptake and foster improved intersectoral cooperation.

Improving the knowledge base

Improving the knowledge base on NBS, including in some cases through more rigorous science, is an essential overarching requirement. Established evidence helps convince decision makers of the viability of NBS. For example, a frequently raised concern is that NBS take a long time to achieve their impact, implying that grey infrastructure is quicker. However, the evidence shows that this is not necessarily the case and timescales to deliver benefits can compare favourably to those of grey-infrastructure solutions.

Traditional or local-community knowledge of ecosystem functioning and the nature–society interaction can be a significant asset. Improvements need to be made in the incorporation of this knowledge into assessments and decision making.

A priority response is the development and implementation of common criteria against which both NBS and other options for water resources management can be assessed. Common general criteria for an assessment of water resources management options (e.g. green versus grey solutions) can be developed on a case-by-case basis. The full inclusion of all hydrological benefits and other co-benefits and the full range of the costs and benefits of ecosystem services (for any option) is a key requirement. This in turn will require consensus building across the various relevant stakeholder groups.

THE POTENTIAL CONTRIBUTION OF NBS FOR WATER MANAGEMENT TO ACHIEVING THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

NBS offer high potential to contribute to the achievement of most of the targets of SDG 6 (on water). Areas in which this contribution translates into particularly striking positive direct impacts on other SDGs are with regards to water security for underpinning sustainable agriculture (SDG 2, notably Target 2.4), healthy lives (SDG 3), building resilient (water-related) infrastructure (SDG 9), sustainable urban settlements (SDG 11), and disaster risk reduction (SDG 11 and, as related to climate change, SDG 13).

The co-benefits of NBS are particularly significant in relation to the ecosystem/environment-related SDGs, including the reduction of land use pressures on coastal areas and the oceans (SDG 14) and the protection of ecosystems and biodiversity (SDG 15). Some other areas where the co-benefits of NBS deliver particularly high rewards in terms of achieving the SDGs include other aspects of agriculture; energy; inclusive and sustainable economic growth; full and productive employment and decent work for all; making cities and human settlements inclusive, safe, resilient and sustainable; ensuring sustainable consumption and production patterns; and combating climate change and its impacts.

MOVING FORWARD

Increased deployment of NBS is central to meeting the key contemporary water resources management challenges of sustaining and improving water availability and its quality, while reducing water-related risks. Without a more rapid uptake of NBS, water security will continue to decline, and probably rapidly so. NBS offer a vital means to move beyond business-as-usual. However, the necessity and opportunities for increased deployment of NBS remain underappreciated.

World Water Development Reports have consistently argued for transformational change in how water is managed. The inadequate recognition of ecosystems' roles in water management reinforces the need for transformational change, and increased uptake of NBS provides a means to achieve it. This transformational change can no longer just be aspirational – the shift needs to rapidly accelerate and, more importantly, translate into fully operationalized policy, with improved action at site level. The objective needs to be to minimize costs and risks, and maximize system returns and robustness, while providing optimal 'fit-for-use' performance. A role of policy should be to enable the right site-level decisions to be taken in these regards. We have made a good, if somewhat belated, start in this process but there is a long way yet to go.

CODA

As humankind charts its course through the Anthropocene, and tries to avoid the tragedies of the past, adopting NBS is not only necessary for improving water management outcomes and achieving water security, it is also critical for ensuring the delivery of co-benefits that are essential to all aspects of sustainable development. Although NBS are not a panacea, they will play an essential role in building a better, brighter, safer and more equitable future for all.

Prepared by WWAP | Richard Connor, David Coates, Stefan Uhlenbrook and Engin Koncagül

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Programme Office for Global Water Assessment

Division of Water Sciences, UNESCO
06134 Colombella, Perugia, Italy
Email: wwap@unesco.org
www.unesco.org/water/wwap

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