NATURE FOR LIFE

Nature for Water
Nature for Life

Nature-based solutions for achieving the Global Goals

NATURE FOR LIFE

Convention on Biological Diversity

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Citation
United Nations Development Programme. 2018. *Nature for Water, Nature for Life: Nature-based solutions for achieving the Global Goals.* New York, USA: UNDP.

Design
First Kiss Creative LLC

Published by
United Nations Development Programme
March 2018
Printed in the United States

Photo credits
Cover: Quangpraha, Pixaby.com; pg. 3: Sociedade Civil Mamirauá, Brazil; pg. 7: Conservation Area Management Committee – Parche, Nepal; pg. 8: Conservation Area Management Committee – Parche, Nepal, Nepal; pg. 11: Sasint, Pixaby.com; pg. 12/13: Rural Green Environment Organization, Afghanistan; pg. 14: Maasai Conservation Wilderness Trust, Kenya; pg. 16/17: Ujamma Community Resource Trust, Tanzania; pg. 19: Rural Green Environment Organization, Afghanistan; pg. 21: Rural Green Environment Organization, Afghanistan; pg. 22: Programa de Campesino a Campesino, Nicaragua; pg. 26: Guassa-Menz Community Conservation Area, Ethiopia; inside back cover: Bright_Neon, Pixaby.com.

Acknowledgements
UNDP gratefully acknowledges the Leonardo DiCaprio Foundation for its support to the Global Programme on Nature for Development.

EXECUTIVE SUMMARY

About this publication

The purpose of this publication is to highlight the importance of safeguarding nature in order to secure water-related services, and to achieve the Global Goals. This document serves as a call to action, to governments, to land use planners, to corporations, and to citizens everywhere to take urgent action to secure nature for life.

Water is essential to achieving the Global Goals

Without sufficient quality and quantity of water, we will not be able to achieve the Global Goals, especially goals associated with poverty, food, health, economic development, energy, and gender.

Our current level of water consumption is unsustainable

Only a tiny fraction of the Earth's water is freshwater that can be accessed for human use. Our current rate of water consumption is unsustainable. Over a quarter of the world's population lives in areas with potentially severe water scarcity, and nearly half the world's population experiences water scarcity at least one month per year.

We will face acute water shortages in the future, creating many barriers to achieving the Global Goals

Driven by increasing irrigation, ground water extraction, changing diets, increasing energy demands, and a changing climate, global demand for water is expected to grow by more than 50 percent by 2030. This will lead to acute water shortages. Water quality is also expected to decline, as a result of pesticide use, salinization, industrial waste, and municipal sewage. Together, these will result in urban water crises, food insecurity, vulnerability to natural disasters, political instability, rising tensions, and increasing corruption, all of which will disproportionately affect the poor and vulnerable.

Nature – especially forests, grasslands, mountains, wetlands – are essential for water security

Nature has a vital role to play in securing water resources, including regulating water flow, ensuring water quality, and reducing impacts from natural disasters. Particularly important are wetland, forest, mountain, and grassland ecosystems. Forest protected areas supply drinking water for one-third of the world's largest cities, and the Himalayas supply water to one out of five people in the world.

Despite the importance of nature for water services, a large portion of the world's important areas for water security are unprotected, degraded, or converted

Over the past three decades we have lost ten percent of the planet's wilderness, covering an area the size of half of the Amazon. In roughly the same time period, from 1990 to 2015, we lost 129 million hectares of forest. As a result, 40 percent of source watersheds for the world's top 4,000 cities have moderate to high levels of degradation. In addition, only a fraction of the world's source watersheds have legally-designated protection.

Nature-based solutions are effective and cost-efficient, and deliver multiple co-benefits

More than 3,200 of the world's largest cities could significantly improve their water quality and quantity through nature-based solutions, at a cost of less than US$2 per person annually. In many cases, forest restoration has already become an investment asset class.

There are many examples around the world of using nature-based solutions at local and national scales

Communities and governments have long recognized the value of nature for water. Examples from around the world show the same trend – safeguarding nature secures water-related services at a low cost, and is an investment that has multiple co-benefits that align closely with the Global Goals.

There is an urgent need for a call to action to protect, restore, and manage nature if we are to ensure water security and to achieve the Global Goals

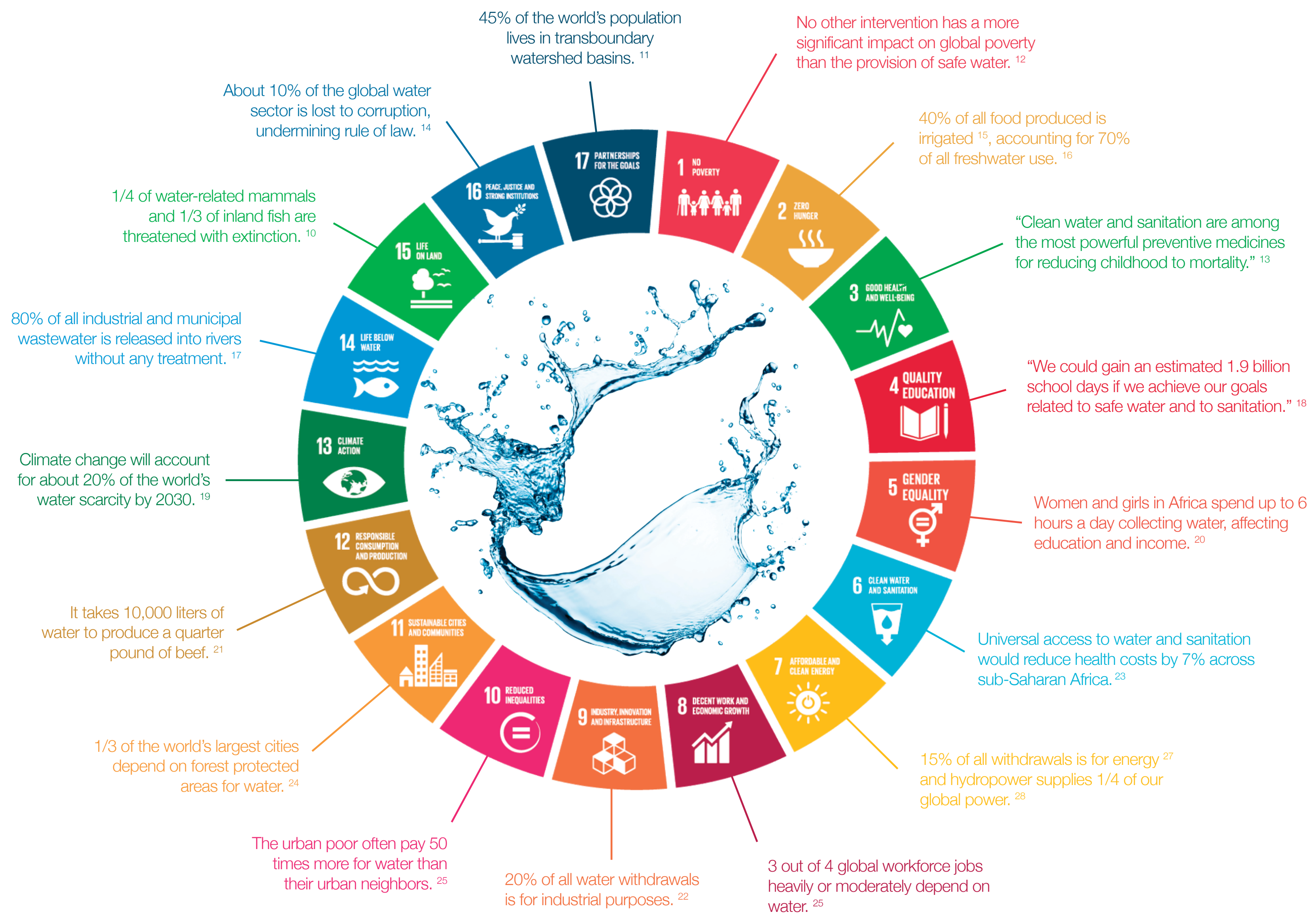
Governments around the world have already made bold commitments to protect, restore, and sustainably manage ecosystems. Action has been taken through National Biodiversity Strategies and Action Plans of the Convention on Biological Diversity, Nationally Determined Commitments of the UN Framework Convention on Climate Change, the Bonn Challenge for forest restoration, and the Sendai Framework to reduce disaster risk, among others.

WATER AND THE GLOBAL GOALS

Adopted in 2015 by all countries, the 2030 Agenda for Sustainable Development and its associated Global Goals represent humanity's best efforts to end poverty and hunger, to help all humans enjoy prosperous lives, to foster peaceful, just and inclusive societies, and to protect the planet from degradation. In implementing these goals, we must commit to leaving no one behind, and we must ensure that no single goal is achieved at the expense of others, as the goals are integrated and indivisible. The Global Goals, also known as the Sustainable Development Goals, include Goal 6, which focuses on ensuring the availability and sustainable management of water and sanitation for all, and Goal 15, which focuses on protecting, restoring and sustainably managing terrestrial ecosystems. Together, these two goals form the foundation upon which many other goals depend.[1,2,3]

The development of our national economies has long been based on the exploitation, rather than conservation, of natural resources and ecosystems. However, over the past few decades, studies such as the Millennium Ecosystem Assessment[4] and The Economics of Ecosystems and Biodiversity[5] have increased awareness of how healthy ecosystems underpin our well-being and the functioning of our economies and societies. In particular, these studies have increased widespread awareness of the role of ecosystems in securing water services.[6]

If we are to achieve the 2030 Agenda, we must identify new pathways for growth and development, integrate new data on ecosystem functioning, and turn knowledge of sustainability into practice.[7,8] For water, this means investing in the conservation, restoration, and sustainable management of the ecosystems that play a crucial role in providing freshwater. The choices we make now about the management of our forests, grasslands, mountains, and wetlands will decide our water future over the coming century, with ramifications across all areas of sustainable development.



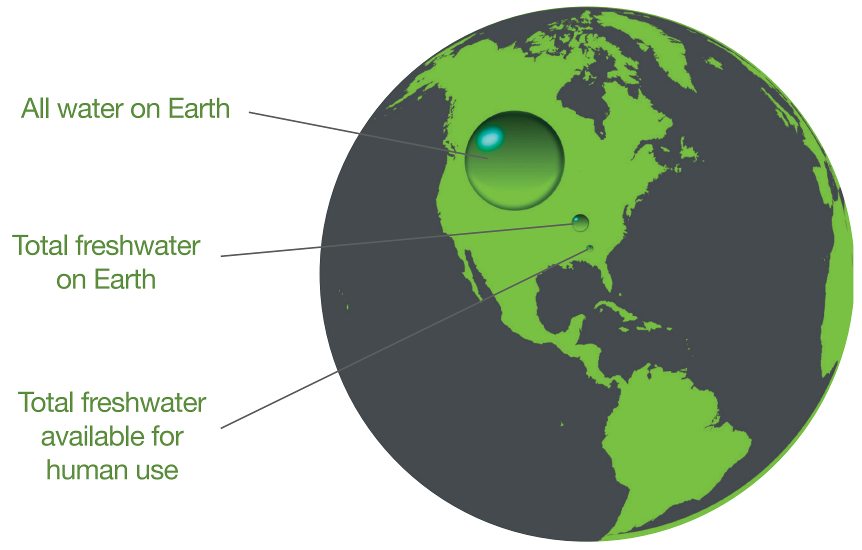
WATER – GLOBAL CONTEXT, STATUS, AND TRENDS

Although the world is covered with water, most of this water is saltwater, or is in the form of snow and ice. Only 0.007 percent of global water is readily available freshwater.[28, 29] Over 1.7 billion people already live in areas where water use is greater than natural replenishment; by 2025, two-thirds of the world's population are expected to be living in water-stressed countries.[30]

Increased water scarcity

Usable water is scarce and getting scarcer. Our rate of water consumption is not sustainable. Over the past century, the world population has tripled, but water consumption has increased six-fold.[31] Global demand for water is expected to grow by more than 50 percent by 2030, to a level 40 percent above current water supplies.[32] This increased water demand is driven by several factors, detailed below.

GLOBAL WATER AVAILABILITY



Adapted from https://water.usgs.gov/edu/gallery/global-water-volume.html

Increasing irrigation

Agriculture accounts for 70 percent of all water use, and even more in some areas that are facing critical water stress.[33] Moreover, most newly converted agricultural land is likely to be irrigated.[34]

Increasing groundwater extraction

Surface water shortages are encouraging greater reliance on groundwater, of which extraction has increased ten-fold in 50 years.[35] Groundwater is currently used on 38 percent of global irrigated lands.[36]

Changing diets

Changing diets, particularly increased meat consumption, are increasing water demands. Many foods are water intensive. A single almond, for example, requires a gallon of water to produce.[37] Maize requires 900 cubic meters of water per ton, chicken requires 3,900 cubic meters per ton, and beef a hefty 15,500 cubic meters per ton.[38] Increases in family income and a growing global middle class are driving shifts toward more water-intensives diets, with profound implications.

Increasing energy demand

Energy already accounts for 15 percent of water withdrawals globally,[39] and energy demand is expected to increase by more than 50 percent by 2030.[40] Much of this demand will depend on water withdrawals. A massive increase in dam building for hydropower is altering flow patterns in many rivers. Globally, at least 3,700 major dams are planned or under construction, which will reduce the planet's remaining free flowing rivers by over one-fifth.[41]

Climate change

Various studies have predicted that the average global temperature is likely to increase by 1.4 to 5.8°C. Even small levels of temperature increase would result in substantial reductions in freshwater resources by 2100. Approximately 75 percent of the Himalayan glaciers are already retreating and are likely to disappear by 2035,[42] which means the loss of a water source for more than 1.5 billion people.[43] Moreover, in Sub-Saharan Africa, rainfall could drop by 10 percent.[44]

Decreased water quality

Along with increased water scarcity, water quality is declining over much of the planet. Lack of access to potable drinking water remains a major hazard; in 2014, 1.8 billion people still used unsafe water supplies, and another 1.1 billion relied on water with at least a moderate risk of contamination.[45] Decreases in the loss of water quality are the result of several factors, detailed below.

Run-off

Pesticides and fertilizers have harmful effects on aquatic life[46] and contaminate drinking water. Since the 1960s, application of synthetic nitrogen fertilizers has grown nine-fold, with a 40 to 50 percent increase expected in the next 50 years.[47] Phosphate use has tripled since 1960,[48] exacerbating impacts of nitrate pollution from nitrogen fertilizers.[49] Global run-off is currently at 32.6 million tons per year,[50] causing major eutrophication problems in inland and marine waters.[51]

Salinization

Irrigation, particularly with mineralized groundwater, increases soil salinity and decreases crop yields, with estimates of 20 to 50 percent of the world's irrigated land now affected,[52] including 2.7 million hectares of rice paddy.[53] Half of all arable lands could be at risk by 2050.[54]

Industrial waste and sewage

On average, 80 percent of all industrial and municipal wastewater across the globe is released into rivers without any treatment, with major impacts on water quality.[55]

Impacts of water scarcity and declining water quality

The water crisis appears to be accelerating. Water demand is expected to increase by 55 percent globally between 2000 and 2050; with increases projected to in manufacturing (up 400 percent from current levels), electricity (up 140 percent), and domestic use (up 130 percent).[56] The world's population is increasing at a rapid rate, and is projected to double or even quadruple in Africa by the end of the century.[57] In 1960, there were only 11 cities in Africa with over half a million inhabitants; by 2015 there were 84 cities with over half a million inhabitants south of the Sahara, and by 2030 there will likely be over 140.[58] By 2050, it is expected that 70 percent of the global population will be living in urban areas,[59] where water use is generally higher. Projections suggest that water demand will soon exceed reliable supply on a global scale.[60,61,62]

Climate change is increasing extremes in water availability, with more droughts and more heavy rainstorms, followed by flooding and subsequent soil erosion. Since 1900, 90 percent of disasters from natural hazards have been related to water.[63] Floods killed almost 250,000 people around the world from 1998 to 2008,[64] particularly in less developed countries and among poorer populations.[65] Everywhere, disasters carry high economic costs: the 2006 Danube floods, for esample, cost over €600 million.[66]

IMPACT OF GLOBAL WATER TRENDS ON THE GLOBAL GOALS

Water security is recognized as one of the great challenges of the 21st century. The triple decline in quantity, quality, and reliability of potable freshwater poses numerous serious problems. These problems also have the potential to cause a domino effect by threatening food systems, increasing disaster risk, and destabilizing peace and security. When water becomes scarce, it can become a potent driver of criminality and corruption. The World Economic Forum's Global Risks Report 2018 assesses water crises among five risks likely to have the biggest impact on human well-being in the next decade. Furthermore, three of the other identified risks (extreme weather, natural disasters, and failure of climate change mitigation and adaptation) are themselves directly influenced by water security.[67] If our management of global water supplies slips further out of control, the ramifications will be felt throughout the world. The effects of water insecurity will likewise compromise our ability to achieve the Global Goals, in particular those goals listed on the following page.

No poverty

From Dhaka to New Orleans, it is the poorest communities who are most likely to be at risk from the impacts of water stress and natural disasters. The effects of shortages, poor water quality, and flooding disproportionately impact the poorest and most vulnerable in many societies as larger and more powerful players monopolize water sources.[68] At the most basic level, urban poor without easy access to safe drinking water can be forced to rely on water vendors and pay far more per liter than their richer neighbors.[69] The poorest often have no access to pure water, suffer when pollution undermines artisanal fisheries, and are forced to live in those areas most at risk of climate-related disasters. The World Water Development Report 2015 emphasized the links between water and poverty, environment and governance, with inadequate water management impacting negatively on all three issues.[70] Many communities are facing dramatic changes to supplies of water and hydrological regimes that have previously remained constant for generations.

Food security

Lack of water security means lack of food security. Food security is impacted in multiple ways: direct water shortages limit irrigation, decline or collapse of fisheries can occur due to pollution and sedimentation, and salinization can lead to a creeping loss of cropland. Shifting climatic norms will reduce agricultural production in some areas and increase it in others, with a range of geopolitical implications. Water availability and accessibility are the most constraining factors on crop production. In the future, these constraints will become even more severe due to competition for water from other sectors of the economy, including from biofuel production.[71] Decreasing water availability also affects inland fisheries. For example, Lake Chilwa in Malawi is shallow but highly productive, supporting a US$10 million per year fishery industry, but rainfall variations have led to the periodic drying-out of the entire lake with grave implications for the industry.[72]

Clean water and sanitation

Major cities in both developed and developing countries already struggle with sporadic shortages. Cape Town, one of the most developed cities in sub-Saharan Africa, is facing a predicted crisis by limiting permitted water use to 50 liters per person per day or less. Whereas the situation and compliance remains problematic, the immediate 'Day Zero' has been pushed towards the future. Critics complain that shortages are made worse by the continuing sale of subsidized water to farmers for irrigation, even though agriculture only contributes four percent to the province's economy.[73] Cities likely to face similarly severe water crises in this century include São Paulo, Bangalore, Beijing, Cairo, Jakarta, Moscow, Istanbul, Mexico City, London, Tokyo, and Miami;[74] Indeed, already today, many of these cities, which together are home to more than 150 million people, face some level of urgency or crisis.

Decent work and sustainable cities

Water insecurity fuels livelihood insecurity. Within states, this often leads to widespread and sudden migration of people in response to either flooding or drought. In Syria, between 2006 and 2007, 1.5 million people migrated from rural to urban areas after a three-year drought caused widespread crop failure and livestock death.[75] Conversely, increased flooding in the Ganges

Delta has dramatically increased urban migration in Bangladesh. Dhaka is now the fastest growing megacity in the world due to migration from coastal and rural areas that is often due to environmental factors.[76] This rapidly shifting distribution of populations in response to water insecurity and loss of livelihoods can have major impacts on the sustainability of cities.

Reduced inequality

Water shortages create a market and are an easy invitation to criminality. More insidiously, water insecurity provides fertile ground for corruption and the continuation of social and economic inequality. Water insecurity has such immediate impacts on human health and livelihoods that the sector attracts considerable donor and private support. However, the multiple agencies and sectors that need to be involved in water management make it relatively easy to hide theft, and thus water has become an attractive target for the corrupt. Within governments and industry, large-scale theft from water projects is not uncommon, benefitting an elite minority while needed investment remains unsupported. Privatization of water resources has also sometimes allowed corrupt governments and businesses to exploit what should be a basic human right.[77]

Climate action

The top three natural hazards by number of deaths are droughts, storms, and floods.[78] These hazards and other climate-related disasters are impacted by water management and mismanagement. Irregularity of precipitation will increase water insecurity,[79] and further disrupt natural flow regimes.[80,81] This increases the likelihood of more extreme climatic events and more disasters, including from flooding, drought, avalanche, and other water-related events. The number and severity of natural disasters increased throughout the last century[82] and this trend looks set to continue, exacerbated both by greater climatic instability and by increased populations in disaster-prone locations. In 2000, 30 percent of global urban land was already situated in high-risk flood areas and this is projected to grow to 40 percent by 2030.[83]

Peace, justice and strong institutions

Political insecurity follows in the wake of water insecurity. Food and livelihood insecurity caused by water insecurity drives political insecurity, causing tensions both between and within countries.[84] The international community seems to be recognizing the genuine risks involved in rising political tensions connected to water availability. UN Environment states: "The degradation of ecosystems – including freshwater ecosystems – is also widely understood as a major driver of disaster and conflict risk and a key component of disaster and conflict vulnerability."[85] Tensions between India and the neighboring countries of Nepal, Pakistan, and Bangladesh often include arguments about water, with nationalists in all countries calling for less sharing of resources.[86] Tensions about water rights in the Tigris-Euphrates basin often run high, with countries using water access as political leverage.[87] Other watersheds noted as experiencing political tension related to water resources include the Han, Incomati, Kunene, Kura-Araks, Lake Chad, La Plata, Lempa, Limpopo, Mekong, Ob, Okavango, Orange, Salween, Senegal, Tumen, and Zambezi.[88]

ROLE OF NATURE IN SECURING WATER

Nature has a vital role to play in securing water resources, including regulating water flow, ensuring water quality, and reducing impacts from natural disasters. Of particular importance are wetlands, forests, mountains, and certain grasslands.

Role of nature in securing water – wetlands

Healthy, natural wetlands are a critical component of water security. Wetlands not only supply water, they also play a key role in purifying water and in regulating water flow. Rivers, floodplains and large, interconnected natural wetlands all help to absorb water in times of excess, and to release them gradually in times of shortage. The majority of the world's irrigated agriculture relies on well-functioning hydrological systems sustained by wetlands.

Wetlands have a natural ability to filter effluents and absorb many pollutants, if not overloaded, and can contribute directly to sustaining water quality. Wetland vegetation can absorb excess nutrients, such as those resulting from agricultural run-off, and some water plants can concentrate toxic materials in their tissues, thus purifying the water in which they grow.[89] For example, in Florida's cypress swamps, 98 percent of all nitrogen and 97 percent of all phosphorous entering the wetlands from waste water are removed before this water entered the groundwater reservoirs.[90] The East Kolkata Wetlands complex, which includes 12,500 hectares of marshlands connected to the Hooghly branch of the Ganges and eventually flowing into the Sundarbans mangroves, has been absorbing the city's sewage for more than 150 years, developing a unique ecosystem which supports the largest sewage-fed fish farming system in the world. The wetlands are able to lower the coliform bacteria count in sewage water by 96 percent,[91] while producing safe fish and agricultural fertilizer.

Wetlands can also play critical roles in reducing flood damage by absorbing floodwaters and thereby reducing risks to the wider water management infrastructure. Examples of flood risk plans around the world show that protecting floodplains can be the most cost-effective way of addressing flooding. For example, protection of 3,800 hectares of wetlands in the Charles River, in Massachusetts in the United States saves an estimated US$7 million a year in management and damage costs.[92] The Whangamarino Ramsar site in New Zealand had a flood prevention

value estimated at an average of more than US$600,000 annually in 2003.[93] In addition to their role in cost-effectively managing flooding, floodplains also often provide rich seasonal meadows or cropland due to the silt deposited by floodwaters.

Role of nature in securing water – forests

Forests help to ensure high quality water by regulating flow and often boosting amounts of available water. Forests generally provide cleaner water than other forms of land cover by reducing soil erosion and sediment load. Additionally, because forests generally receive far fewer pollutants, such as agrochemicals and human waste, water flowing through natural forests typically requires less treatment than water flowing in other ecosystems.[94] While forests will not filter out all contaminants – the parasite Giardia for instance – they radically reduce the amount of treatment that drinking water requires. Many municipal authorities recognized this function long ago, and city planners in New York, Melbourne, Singapore, and Quito consciously work with protected area authorities and others to maintain watershed forests in good condition. In New York, voters passed initiatives to invest in a new water treatment plant and to support forest protection in the 100,000-hectare Catskill State Park, which protects much of the Delaware and Croton watersheds, the city's main sources for drinking water.[95] In other places, commercial forests are managed with water quality as a main priority. In Stockholm, for example, Lake Bornsjön is a major water supply for the city. The city manages the surrounding forest to Forest Stewardship Council standards with a primary focus on protecting water quality.[96]

Forests also help to regulate the rate of water flow by reducing sudden surges after heavy rain or snowmelt, and then releasing water more slowly over a longer time period. Conversely, the risk of flooding and landslides is increased by deforestation,[97] road building, and many other forms of development in forest ecosystems.[98] Some forests, notably cloud forests[99] and some old growth eucalyptus forests,[100] also increase net water flow.

Lastly, forests play critical roles in controlling both climate and weather. A huge volume of carbon is stored in forests; retaining this carbon, or increasing it further through forest restoration and sequestration in old-growth forests[101] is widely viewed as a major step in climate mitigation strategies.[102] At a continental scale, forests create clouds that frequently supply critically important water supplies to agriculture far away. For example, the Amazon forest recycles 50 to 75 percent of annual rainfall,[103] pumping seven trillion tons of water per year into the atmosphere.[104] Water vapor is carried to a vast area bounded by Cuiabá, São Paulo, Buenos Aires, and the Andes, in a circulation system that has become known as the 'flying rivers' of the Amazon.[105] This area responsible for 70 percent of the continent's GDP, primarily from agriculture. This process is repeated around the world, with more localized forest-climate interactions supporting agriculture and other livelihoods in communities worldwide.

Role of nature in securing water – mountains

Mountains cover over a quarter of the earth's land surface and are critical for the national water supply in many countries. The health of mountain ecosystems also goes a long way in determining the quality of the water flowing down their slopes and the regularity with which it flows. Many of the world's mountain ranges attract high levels of rainfall and snow; others capture water from clouds and mist. However it arrives, water on mountains eventually evaporates or flows downstream, creating streams and rivers and eventually reaching the plains where the majority of the human population lives.

The importance of mountains in supplying water is increasingly recognized, and the term 'water towers' is often used to describe this value.[106] Over half the mountains in the world have an essential or supportive role in providing water to downstream communities.[107] The ten largest rivers originating in the Hindu Kush Himalayas alone supply water to over 1.35 billion people, 20 percent of the world's population.[108] Snow and glacier melt in the Hindu Kush region make up to 50 percent of the annual flow in the greater Indus River Basin.[109]

As important as the total amount of water that mountains supply is the seasonality of flow, which can support both specialized ecosystems and ecologically-adapted agricultural communities. Where mountains release water from gradual snowmelt, or discharge from glaciers, much of it comes in the warmer summer months, when there is less rainfall and other sources are unavailable. Climate change, by reducing snowfall and glaciations, puts further threats on the seasonality of water supply for many communities downstream. Other river systems show high variation due to a monsoon or rainy season. For example, the Marañon River, the main source for the Amazon, originates in the high Yungas forest in Peru, where the intimate relationship between the Andes and Amazon creates a water pulse during the wet season, with a difference in river height of six to nine meters. This has resulted in special adaptation in both ecosystems and local human communities.[110]

A combination of mountains and forests can play a particularly important role in water provision, especially in the tropics. Some forest types, especially tropical mountain cloud forests, increase the net flow of water out of the catchment. These forests contain especially evolved leaves and foliage that glean water from clouds and mist, so that it condenses and runs down into the catchment.[111] The cloud forests in protected areas around Quito and Tegucigalpa provide a high-quality water supply.[112] 80 percent of Quito's population drink water comes from just two protected areas, La Tigra National Park supplies 40 percent of the water for Tegucigalpa, and 20 million people in Mexico City benefit from cloud forest water.[113]

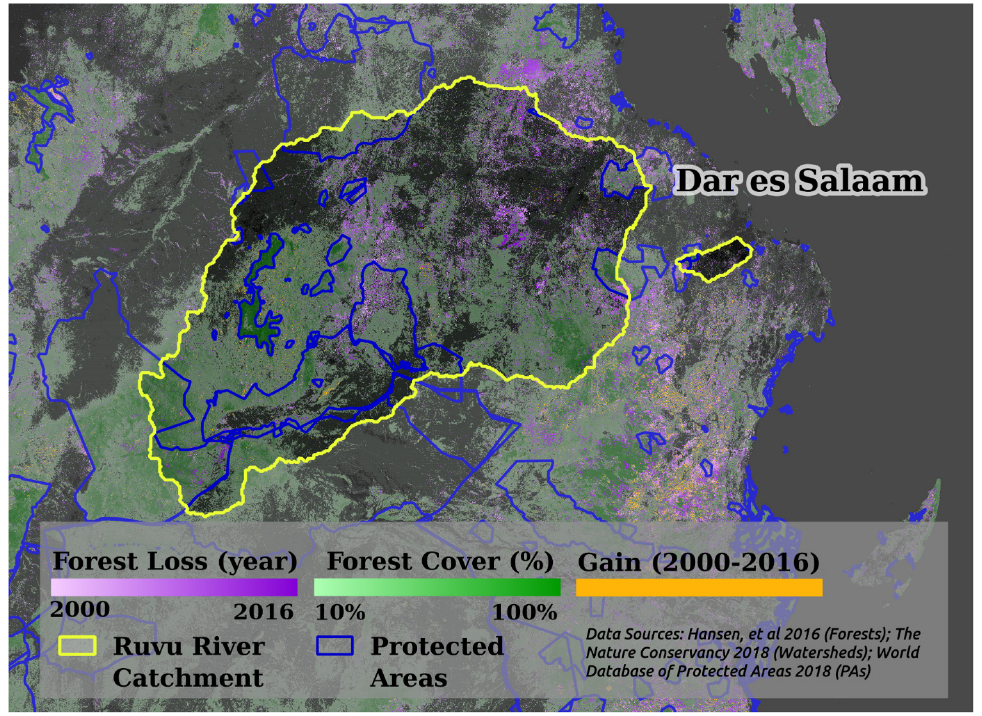
Role of nature in securing water – Grasslands

Grasslands and steppes play a critical role in hydrological systems. Natural grasslands and similar non-forested ecosystems provide a range of water provision services, which help to maintain water security particularly in high-altitude ecosystems with less forest cover. Some high-altitude grasslands, for instance, retain humidity in soils and vegetation, and thus regulate water flows.[114] The upland *páramos* vegetation in the Andes plays a similar role, increasing net water flow into the catchment. In Bogotá, Colombia, 80 percent of water for the city comes from Chingaza National Park, which protects *páramos* in the hills above.[115]

Grasslands assume an even more important function in the hydrological cycle in dryland ecosystems. Despite their name, drylands are important water sources for millions of people. Drylands by their nature receive less precipitation and are characterized by extreme unpredictability in rainfall, with this unpredictability increasing under climate change. Water storage in drylands is thus of critical importance. Dryland communities have adapted to lifestyles that maximize access to water, drawing on a deep knowledge of how the natural ecosystem works developed over millennia. In Tanzania, the Sukuma people set aside *ngitili* areas for private or communal grazing or fodder reserves,[116] while the *hima* system in the Arabian Peninsula is one of the world's oldest protected area methods, established to prevent land degradation.[117] In dryland ecosystems, loss of vegetative cover can be catastrophic for agriculture and livelihoods, leading quickly to soil erosion, desertification, sand storms, and a massive loss of water retention within the ecosystem. Over a third of the world's major river basins have at least half their extent in the drylands.[118] In these cases, loss of vegetation means increased soil erosion and thus sedimentation. For example, the Yangtze Delta generates around a fifth of China's GDP,[119] yet poor management upstream is creating increased pollution and siltation, reducing water quality and increasing flooding.[120]

LOSS OF NATURE MAY LEAD US TO A GLOBAL WATER CRISIS

The role of nature in securing water resources is clear. Yet over the past three decades, we have lost ten percent of the planet's wilderness, covering an area the size of half of the Amazon.[121] In roughly the same time period, from 1990 to 2015, we lost 129 million hectares of forest.[122] As a result, 40 percent of source watersheds for the world's top 4,000 cities have moderate to high levels of degradation.[123] In addition, only a fraction of the world's source watersheds have legally-designated protection. Although all ecosystem types play important roles in the provision of water, this degradation of forests in source watershed areas has particularly large implications for the world's cities.



Percent forest cover and year of forest loss over the period 2000 - 2016 for the Ruvu River catchment, the source catchment for the city of Dar es Salaam, Tanzania. Areas in black indicate areas without forest cover, or areas with forest cover below 10%.

As an example, one of the major sources of water for Dar es Salaam in Tanzania is the Ruvu River catchment, an 18,000 square kilometer river basin. The Ruvu River catchment area has experienced significant forest cover loss over the past two decades, over an area that accounts for 10 percent of watershed. Moreover, protected areas cover only about a quarter of the watershed,[124] a fact which leaves it vulnerable to further exploitation. Dar es Salaam has for decades faced annual shortages as the flow of the Ruvu River has huge seasonal fluctuations. These shortages may be compounded in the future as total flows of the river are dramatically falling. By improving land management and especially forest cover, the seasonal fluctuations might stand to be reduced for the benefit of the city of Dar es Salaam.

This story is repeated throughout the world, where source watersheds for hundreds of major municipal areas are largely unprotected, and have seen large amounts of ecosystem degradation. This situation, combined with increases in irrigated agriculture, rising population, increases in water-related energy consumption, increases in water demand from rising populations, and stressed ecosystems from climate change, is a recipe for a global water crisis.

NATURE-BASED SOLUTIONS TO WATER-RELATED CHALLENGES

A number of organizations have begun to recognize the value of nature-based solutions in solving some of the most vexing challenges to achieving the Global Goals, including the role of nature in achieving Goal 6 on water.[125,126,127,128,129,130,131] Nature-based solutions have been defined in various ways, including: "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"[132] and "solutions inspired and supported by nature and use, or mimic, natural processes to contribute to the improved management of water,"[133] among others. A wide range of actors are increasingly recognizing the important role that nature-based solutions can play in securing sustainable water supplies for humanity, while at the same time providing a wide range of co-benefits.[134,135] For example, implementing nature-based solutions in the world's major source watersheds would benefit 7 million people in the 100 largest cities.[136]

Nature-based solutions are often as cost effective, or more so, than traditional infrastructure solutions for water, such as water filtration systems. The cost of supplying and treating drinking water around the world is very high, and continues to increase; in a third of large cities, the average costs have increased by 50 percent per unit of water. According to a recent report,[137] four out of five cities – more than 3,200 in all – could make significant gains in water quality by reducing sedimentation or decreasing fertilizer run-off, and a third could improve water flow, through forest protection, reforestation and improved agricultural practice, all for under US$2 per day per year.[138]

Nature-based solutions for water-related challenges involve a wide range of strategies, including protection, restoration, management, connectivity, mitigation of impacts, and integration into key sectors.

Solution 1: Protect

Protected areas are a cornerstone of water management, as well as of biodiversity conservation. Protected areas, defined as a "clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values,"[139] currently cover 14.7 percent of the world's terrestrial surface, including inland waters, over 19.8 million square kilometers.[140]

In addition to legally-designated protected areas, a new designation of 'other effective area-based conservation measures' – area-based approaches that provide measurable and long-term biodiversity conservation but are not protected areas – is gaining increasing attention.[141] Taken together, protected areas and other effective area-based conservation measures could protect half of the planet's land surface as natural or mainly natural ecosystems, an idea that is gaining increasing support.[142]

The designation of an area as protected does not necessarily mean that no ecosystem degradation will occur. However, if legal designation or other means are not in place, then land conversion and degradation of important ecosystems is all but guaranteed.

Solution 2: Restore

Where ecosystem loss and degradation are already advanced, restoration remains the only option. The extent to which restoration is viable depends on the ecosystem, the level of degradation, and the political and economic opportunities. Restoration has different benefits across different ecosystem types.

Restoring forests can boost water quality, stabilize flows, and in some cases increase net availability of water. The Global Partnership on Forest Landscape Restoration estimates that a billion hectares of previously forested land are suitable for broad scale or mosaic restoration – approximately six percent of the planet's total land area.[143] Investors have taken note of the economic potential of restoration, and have recently launched a US$2 billion fund for large-scale restoration.[144] Large-scale restoration is possible, as witnessed by the restoration of virtually all of South Korea's forests following massive deforestation during the Second World War and Korean War,[145] and massive restorations across Nepal, China and Ethiopia.[146]

Direct restoration of wetlands is also possible. After the first Gulf War in the 1990s, Saddam Hussein's government drained the Mesopotamian marshes to punish the indigenous tribes, the Marsh Arabs, destroying both the only source of freshwater in the region and a unique, 5,000 year-old culture.

Canals took the water to the Euphrates and Tigris Rivers, reducing the marshes to one-tenth of their original size, increasing salinization, destroying wildlife, and forcing the Marsh Arabs to leave. Restoration since 2003 has restored much of the marshland and wildlife, by blocking canals and restoring water levels. Further restoration work and agreement on equitable allocation of water rights are still required to ensure these restored ecosystem values are not subsequently lost again.[147]

Solution 3: Manage

Sustainable management of forests, mountains, wetlands and grasslands, including agricultural lands, is essential for maintaining water-related services. Key management actions include: management of riparian zones, especially strips of vegetation along streams, as well as the river and stream banks; sound agricultural management, including cover crops, reduced tillage, the use of strips of natural vegetation along farms, and reduced pesticides and fertilizer use; management of ranching and cattle grazing such as through adhering to maximum stocking densities; management of fires appropriate the to fire regimes of key ecosystems, to reduce the risks of catastrophic fire, including increased soil erosion and sedimentation; and management of roads and other infrastructure that can have negative impacts on soils, water, and species. Sustainable management of wetlands requires consideration of a range of different factors, including: removing natural resources from the ecosystem at a sustainable rate, preventing leakage into the system of pollutants at a damaging level, and maintaining flow patterns that ensure adequate storage and distribution.

Sustainable management of all ecosystem types frequently requires transboundary governance. The Ramsar Convention's concept of 'wise use', which stresses that human use on a sustainable basis is entirely compatible with wetland conservation, remains critically important across the world's wetlands and other ecosystems that play a role in safeguarding our water security. Yet countries often do not adhere to this precept in practice, especially when wise use requires negotiating transboundary management. Huge changes, such as the drying up of most of the Aral Sea in Central Asia and Lake Chad in Africa, demonstrate what can happen when one state or region takes water that was previously shared by many.

Solution 4: Buffer and mitigate

Land use planners and policymakers can also focus on mitigating the impacts of pollution and other stresses, typically through buffer areas. Reducing pollution can return life to rivers that were once thought virtually destroyed, such as the Thames River in London. While pollution control is a feature in the Convention on Biological Diversity's Aichi Biodiversity Targets[148] (Target 8) and of the Sustainable Development Goals (Goal 6.3), pollution has received only a fraction of the attention of many other targets and there is a need for urgent action on these issues.[149]

Solution 5: Integrate

Policymakers have begun to integrate natural ecosystem management into national water plans, although the first response by many governments typically remains focused on engineering solutions. The latter will also be necessary; robust plans will generally mix nature-based 'green' and engineering 'gray' solutions. However, for many years the bias has tended towards trying to secure water security by forcing watersheds into a human-designed construct rather than working with the strengths of the existing hydrological system.

Increasing attention to nature-based solutions is nonetheless starting to emerge. The National Water Plan of Nepal mentions: "mitigation measures such as afforestation and bioengineering with people's participation, involving community-based organizations, non-governmental organizations, and women's groups in river bank protection and conservation of critical areas."[150] In the Netherlands, for example, the government aims "… on the one hand, to have nature combinations included at an early stage – the exploratory phase – and, on the other, to select actual design and implementation solutions that are able to adapt to natural processes and build with nature (eco-engineering)."[151] Despite these efforts, similar approaches are comparatively rare; many national water plans scarcely mention nature-based approaches. Better integration of water planning and ecosystem management remains an urgent priority.

Impacts of nature-based solutions

Implementing nature-based solutions yields a wide variety of benefits for water-related services.[152,153] Some of these include:

- **Improved water quality** – Intact forests and wetlands, as well as best management practices for agriculture, can reduce agricultural and industrial run-off, thereby ensuring supplies of safe, clean water. This service can help to avoid the expensive costs of water filtration.
- **Enhanced water availability** – Forests, wetlands, and grasslands help to regulate the movement of water across the landscape, making it more available for use over a longer period of time. Intact mountain ecosystems often act as a natural sponge, gradually releasing water over the course of a season or a year.
- **Retained soil moisture** – Practices such as reducing tillage and planting cover crops can help in retaining soil moisture and require less irrigation.
- **Recharged groundwater** – Forests, wetlands, and grasslands can play a vital role in recharging groundwater, helping to offset withdrawals for irrigation and other purposes.
- **Reduced water-related diseases** – Wetlands and forests can effectively capture many of the microbes responsible for water-related diseases.
- **Reduced sedimentation** – Intact forests, especially along streams, can reduce sedimentation, which can have downstream impacts.
- **Controlled soil erosion** – About a quarter of the world's land is susceptible to desertification, and we are losing between 20 and 30 gigatons of soil to erosion annually.[154] Intact forests, wetlands, and grasslands can prevent the erosion of soils, and can help keep desertification at bay.
- **Regulated water temperature** – Forest canopy cover along streams and rivers helps to regulate water temperature, which can help mitigate the impacts of rising temperatures from climate change, and maintain key habitat for temperature-sensitive fish.
- **Controlled floods** – Intact wetlands and floodplains distribute the impacts of heavy rainfall events, and help to mitigate the impacts of floods on communities and cities.

A GROUNDSWELL OF ACTION: NATURE-BASED SOLUTIONS FOR WATER SECURITY AT LOCAL AND NATIONAL SCALES

Communities and governments have long recognized the value of nature for water. Examples from around the world show the same trend – where communities have safeguarded nature, they have been able to secure water-related services comes at a low cost. These actions typically also lead to multiple co-benefits, all of which align closely with the Global Goals. The following stories showcase nature-based solutions to water security implemented at the national level by government agencies and at the local level by recipients of the prestigious Equator Prize, awarded by the UNDP Equator Initiative partnership, which recognizes local, nature-based solutions for sustainable development.

Enabling Afghanistan's Kishim River Valley to spring back to life

Deep in a remote valley of Afghanistan along the Kishim River, hillsides had been left barren from rampant illegal deforestation, and had given way to soil erosion and destructive landslides that destroyed farmland. Climate change brought more extreme weather, including intensified floods and droughts. The land was left unable to naturally absorb and regulate water, and families struggled to grow adequate food. Starting in 2012, the Rural

Green Environment Organization responded through a massive wave of reforestation, planting more than 200,000 trees and vines, and protecting them with forest patrols. An additional 120 kilometers of river-facing slopes also were terraced, increasing water absorption and reducing excessive run-off. Through this effort, the hillsides of the watershed have been stabilized, slowing the flow of rain and snow towards the river, and reducing the likelihood of landslides and floods that once destroyed farmland below. By utilizing the natural ability of reforestation to regulate the water cycle, the Kishim River Valley of Afghanistan has sprung back to life.[155]

Protecting source water in the 'Heart of Mesoamerica'

The Bosawás Biosphere Reserve in Nicaragua is naturally capable of absorbing and filtering vast quantities of source water. Spanning more than two million hectares, Bosawás is the largest protected rainforest north of the Amazon basin, and the third largest protected forest in the world. This reserve and its buffer zones are also home to more than 100,000 people, many of whom rely on subsistence farming. During recent decades, slash-and-burn farming caused widespread deforestation, while unsustainable hillside agriculture continued to encroach into the reserve—damaging soils, speeding erosion, and threatening the land's ability to naturally protect source water.

Recognizing the risk to the watershed, community leaders mobilized during the 1990s to protect the reserve and its buffer zones. Today, the Programa de Campesino a Campesino (Farmer-to-Farmer Program) has protected 20,000 hectares of land from deforestation, created 1,000 hectares of farmer biological corridors adjacent to the reserve, and planted more than 35,000 trees. A peer-to-peer farmer education program has also promoted sustainable farming practices – protecting soil and water – to more than 3,000 subsistence farming families. As a result of these efforts and others, the Bosawás Biosphere Reserve and its buffer zones, which combined comprise one of the largest protected forest areas on Earth, continue to naturally store and filter water.[156]

Reawakening water-filtering wetlands along Kenya's Kipsaina River

In the Great Rift Valley of Kenya, biologically rich swamps and wetlands surrounding Saiwa National Park once served as a natural sponge and filter by retaining and cleaning water moving through. In their natural state, these wetlands improve water quality, protect communities from floods and droughts, and provide biodiverse habitat. But, following decades of degradation, much of this area was drained and converted to cultivation and livestock grazing land. The change was so significant that the once-healthy river was reduced to a stream and wildlife disappeared.

Today, these wetlands are reawakening following 25 years of restoration and conservation education within local communities. The Kipsaina Crane and Wetlands Conservation Group has inspired many community members to cease cultivation on smallholder plots in favor of establishing community-conserved wetlands. More than 200,000 native trees have been planted, and a 1.5 kilometer continuous wetland now thrives along the Kipsaina River in the place of formerly degraded lands.

Leaders also promote organic farming practices that reduce water pollution caused by pesticides and fertilizers. By facilitating alternative livelihood activities such as agroforestry, fish farming, and beekeeping, the Kipsaina Crane and Wetlands Conservation Group provides additional incentive to allow the wetland to do one of its most important natural jobs: conserving water. As a result of this work, these wetlands also support an increasing level of biodiversity. The population of threatened Grey Crowned Cranes has doubled since the wetlands were restored.[157]

Securing Watershed Services through Sustainable Land Management in the Ruvu Catchment

The Ruvu Catchment in Tanzania highlighted earlier provides water for six million people in Dar es Salaam, Morogoro, Dodoma, Tanga, and the coastal regions. The catchment area also supplies water for livestock, irrigation, industries, domestic use, and wildlife in the Selous Game Reserve, Mikumi National Park, and Saadani National Park. In addition to deforestation, uncontrolled bush fires, land degradation, and unsustainable grazing practices, the Ruvu River was also under stress from upstream gold mining. A new partnership between the Global Environment Facility, the Ministry of Water and Irrigation of Tanzania, and the United Nations Development Programme has initiated a program to secure watershed services through sustainable land management, including forestry, grazing, and farming. If the project is successfully implemented, it is likely to increase water quantity and quality by ten percent by the year 2020.

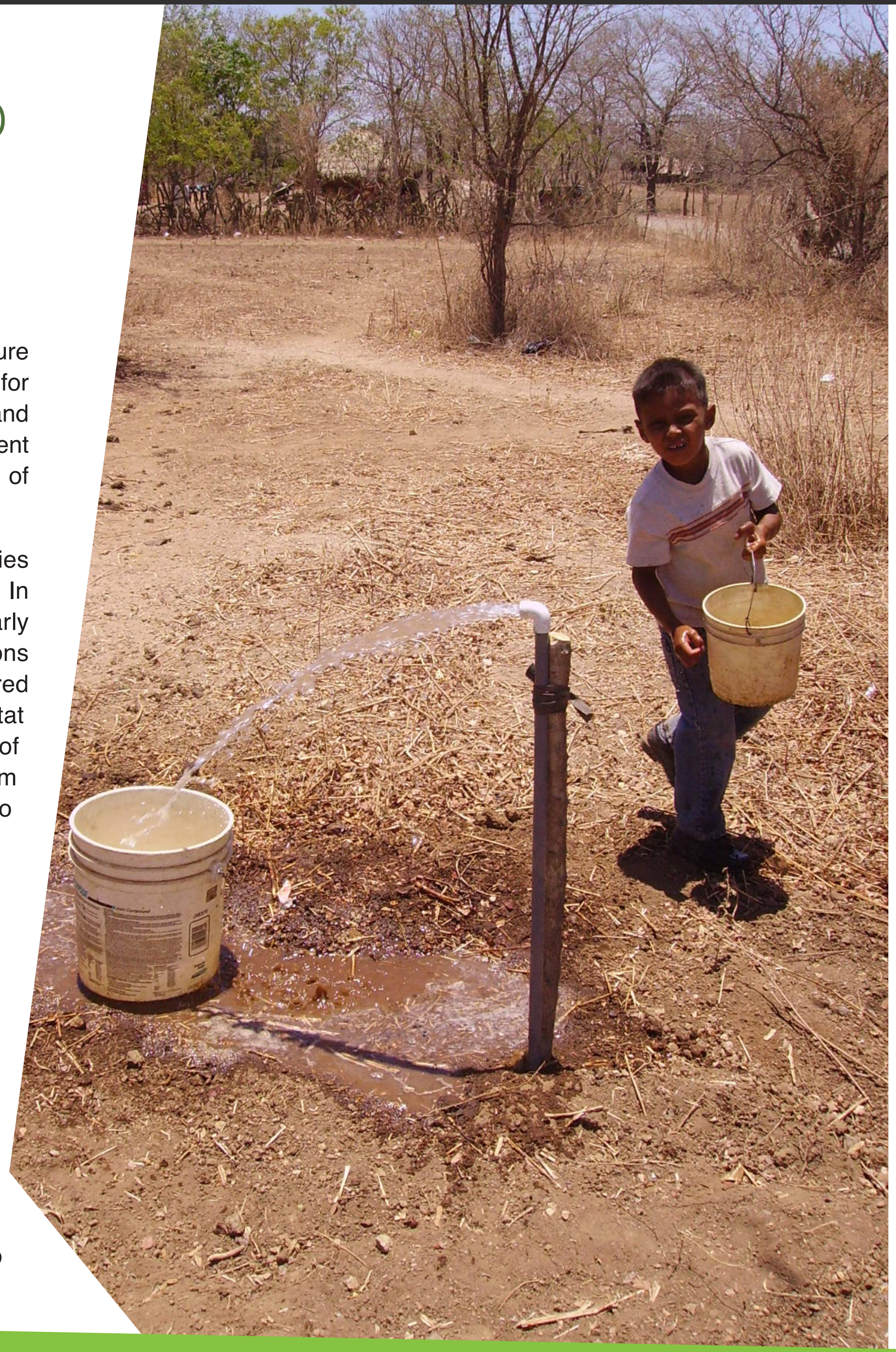
CALL TO ACTION TO SAFEGUARD NATURE FOR WATER, AND FOR THE GLOBAL GOALS

The world faces many serious challenges, now and in the future, if we are to ensure sufficient quality and quantity of water. The good news is that viable examples for all the ideas presented in this publication already exist, often at a large scale, and many with decades of experience to draw from. The failures in water management have largely not been from a lack innovation or ideas, but rather from a lack of political will and action.

Governments, donors, and private companies are waking up to the opportunities of investing in nature as the green infrastructure required to secure water. In 2015, governments, water utilities, companies, and communities spent nearly US$25 billion on payments for green infrastructure for water, with transactions growing an average of 11.8 percent a year between 2013 and 2015. This covered 419 programs in 62 countries and protected, rehabilitated, or created new habitat on more than 486 million hectares of land, an area nearly 1.5 times the size of India. Almost all this funding came in the form of direct subsidy payments from supra-national, national, and sub-national-level governments to landholders to protect and restore habitats.[158]

Commitments already made under the Convention on Biological Diversity, the UN Framework Convention on Climate Change, the UN Convention to Combat Desertification, and the Ramsar Convention, would, if fully implemented, address the challenges outlined in this publication by securing nature. A recent study found that reforestation, forest protection and agricultural best management practices, if fully implemented across ecosystems important for water sources, would mitigate ten gigatonnes of carbon dioxide per year, or 16 percent of the 2050 emissions reduction goal.[159] Between four and eleven percent of this potential could be realized through municipal investments in source water protection activities that would also achieve meaningful sediment or nutrient reductions, all at an affordable or even revenue-generation basis.

We call on different stakeholder groups to safeguard nature for water and to deliver on the Gobal Goals.



Call to action for conventions:

- Encourage governments to fulfill their commitments and obligations.
- Link ecosystem services and the nature-based values of conservation clearly to water-related services.
- Encourage linkages of nature-related strategies to water-related Global Goals.
- Encourage governments to highlight the benefits of nature-based water solutions to the broader Global Goals.

Call to action for the international donor community:

- Help support the switch from approaches over-reliant on technological solutions to an integrated approach that brings nature-based solutions more fully into government policies.
- Fund nature-based solution projects and ensure that they are located within all parts of government and not confined to 'conservation' departments.

Call to action for governments:

- Support nature-based solution for water through realistic pricing policies, removal of perverse incentives, and ensuring proper integration in approaches across all ministries and departments.

Call to action for companies:

- Invest in nature-based solutions to water security for companies that make reforestation and sustainable management solutions their core business.
- Factor in payments for water-related ecosystem service schemes as a core element in business expenses.

Call to action for NGOs:

- Create innovative approaches to promote payment for ecosystem service schemes.
- Broker between different sectoral stakeholders.
- Ensure that communities and the frequently disempowered have a place at the negotiating table and a fair share of any benefits.

Call to action for researchers:

- Provide clear information about what does and does not work in terms of both nature-based and alternative solutions to water management.
- Develop holistic ways of monitoring progress at watershed level under the Global Goals and other international goals and targets.

Call to action for civil society:

- Recognize the finite and fragile nature of water and adjust behavior accordingly.
- Understand the implications of different lifestyle choices on water security and react accordingly.

Call to action for all:

- Recognize and internalize the full value of nature for water.

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