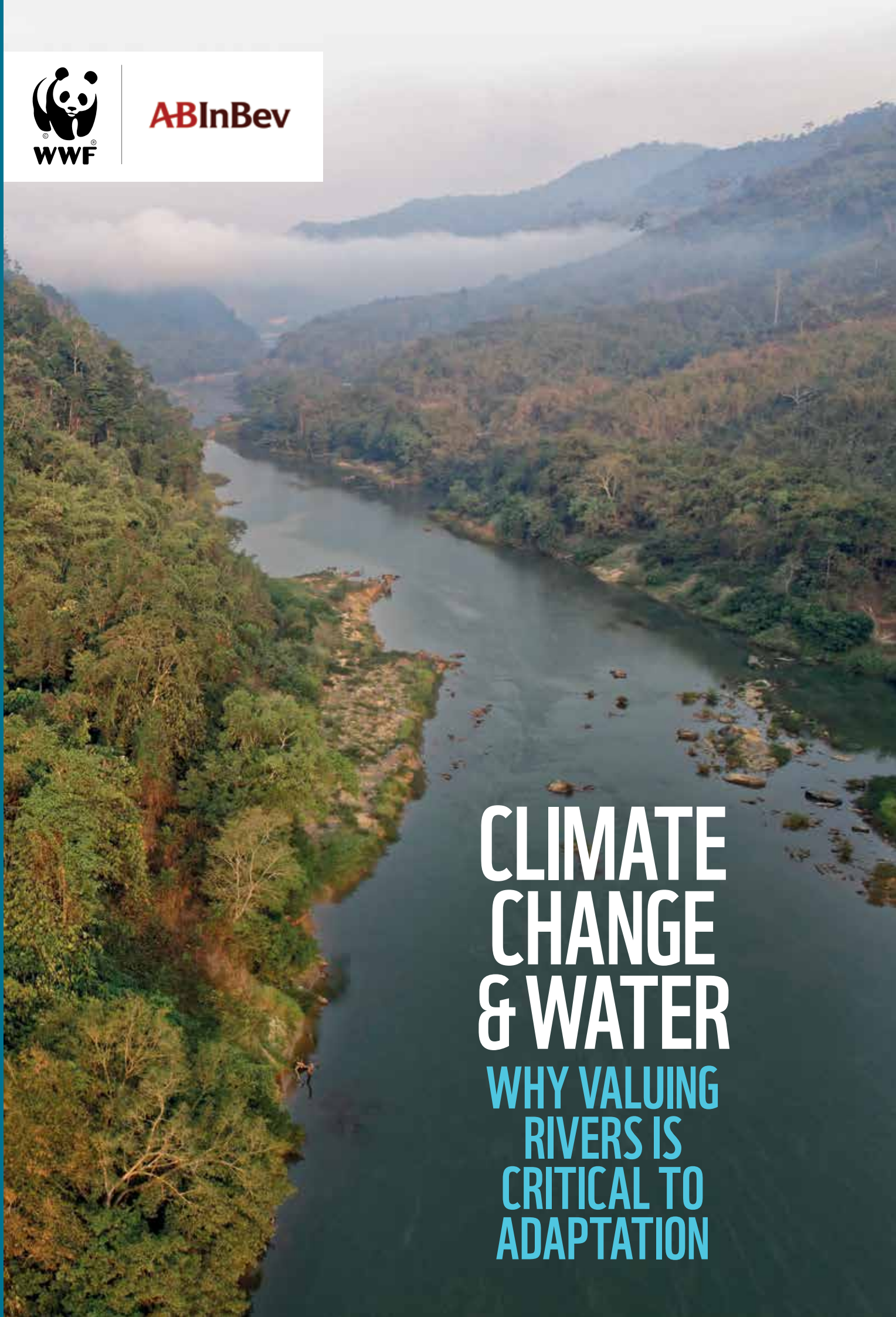


CLIMATE CHANGE & WATER

WHY VALUING RIVERS IS CRITICAL TO ADAPTATION

CONTENTS

1. INTRODUCTION 3
2. LIVING WITH CLIMATE CHANGE 8
3. SECURING OUR FOOD SUPPLY 12
4. SECURING OUR ENERGY SUPPLY 16
5 SECURING INFRASTRUCTURE AND LIVELIHOODS THROUGH NATURE-BASED SOLUTIONS 20
6. FINANCING CLIMATE ADAPTATION IN THE WATER SECTOR 22
7. PARTNER RECOMMENDATIONS 24

GLOSSARY 26

ENDNOTES 27

PUBLISHED JULY 2019

INTRODUCTION

WATER: WHERE CLIMATE IMPACTS ARE FELT AND WHERE RESILIENCE IS DEVELOPED

Climate action will be the focus of a series of critical conferences in 2019 and 2020, including the High-Level Political Forum, the United Nations Climate Summit and the official start of the Paris Climate Agreement.

As this report shows, freshwater conservation issues must be at the heart of the climate agenda and efforts to achieve Sustainable Development Goal (SDG) 13. While freshwater is a major conduit through which climate impacts are felt, it can also play a central role in climate adaptation and resilience-building for people, economies and nature. Managing water carefully through nature-based solutions is a crucial element in tackling the most serious global climate risks.[1]

Strengthening water resilience to climate change is a key strategic opportunity for countries aiming to meet their United Nations Framework Convention on Climate Change (UNFCCC) nationally determined contributions (NDCs). Cape Verde, for example, states that implementing integrated water resources management at a national level will be its NDC for climate adaptation. This report highlights the nature-based opportunities, which will help countries meet their NDCs at the same time as increasing their water resilience.

Climate change makes the water challenges we face more severe. However, at the same time, freshwater is the lever through which we can help mitigate climate risks. Sound water policies, practices, investments and governance that recognize the full value of functioning and healthy freshwater systems will make us more climate resilient. Water is the sector where most climate impacts are felt and where climate resilience must be developed.

RIVERS, LAKES AND WETLANDS UNDERPIN OUR SOCIETIES AND ECONOMIES.

Water is at the heart of food production, and huge quantities are used to produce everything we eat and drink. Through hydropower and cooling processes in other electricity generating stations, water keeps our lights on and helps power our industries. Rivers supply our cities with water and carry away our waste. Our economies and societies depend on having enough clean water, delivered through properly managed rivers, lakes and aquifers across the globe.

But this crucial resource is at risk: the quantity and quality of freshwater are both deteriorating. There is over-abstraction and pollution, poor management of resources and the continuing rapid loss of wetlands. What's more, climate change is making a bad situation worse. Ambitious action to reduce greenhouse gas emissions is essential to limit global heating to 1.5°C above pre-industrial levels and change our current disastrous climate trajectory. But we are already feeling the impacts of climate change.

CLIMATE CHANGE'S GREATEST IMPACTS ON PEOPLE AND NATURE ARE BEING FELT THROUGH WATER.[2]

In particular, changes to flows in rivers, affecting wetlands and lakes, will have increasingly large effects on human health and the economy.[3] Other climate impacts include an increasing demand for irrigation, along with reduced potential for hydropower and cooling water. Water-linked tourism, fisheries and navigation are all threatened.[4] Climate change is also bringing worse droughts and floods, and a higher risk of fires.

WE NEED TO ADAPT TO AND MITIGATE CLIMATE RISKS AS FAR AS WE CAN – AND WE CAN DO THIS THROUGH SUSTAINABLE WATER MANAGEMENT, BUILDING MORE RESILIENT ECOSYSTEMS, ECONOMIES AND SOCIETIES.

As the United Nations Economic Commission for Europe (UNECE) report on Water and Climate Adaptation states, "water is central to many different sectors that directly depend on water being available and of high quality. Therefore, water management can limit or enhance adaptation of water-related sectors."[5] Sound water sector policies, practices, investments and governance can help us transform water-related risks into climate resilience rewards, making water a catalyst for adaptation and not a constraint on society's needs.

CLIMATE CHANGE WILL IMPACT FRESHWATER ECOSYSTEMS BY CHANGING THE QUANTITY, QUALITY AND TIMING OF WATER SUPPLIES.

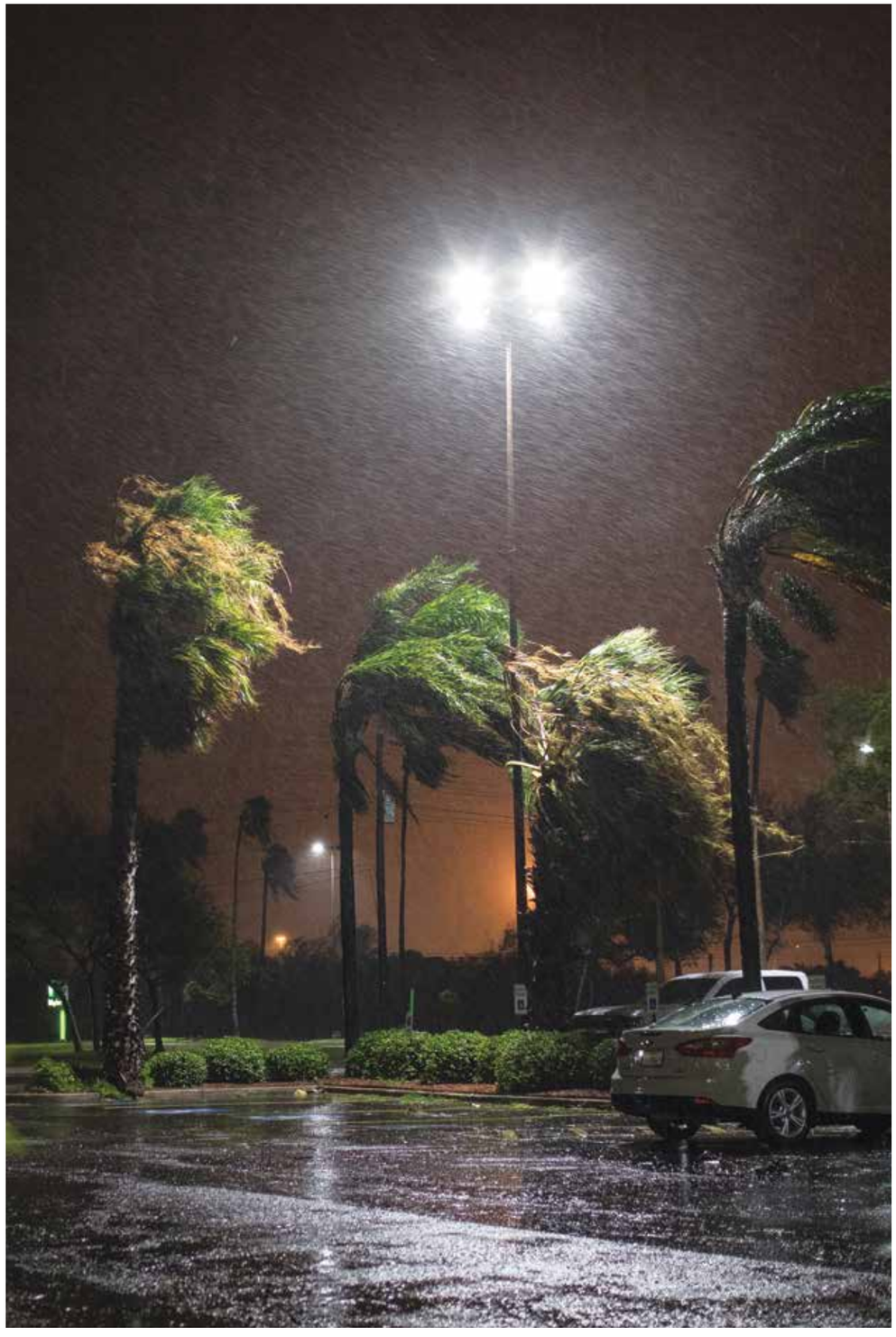
Driven by a range of factors, these impacts will be complex and hard to predict but will include:[6]

- Variations in the volume, seasonality and intensity of rainfall;
- Shifts from snow to rainfall;
- Alteration of surface runoff and groundwater recharge patterns;
- Shifts in the timing of snowpack melting;
- Changes in evapotranspiration;
- Higher air and water temperatures;
- Rising sea levels; and
- More frequent and intense tropical storm surges.

Ultimately, these changes will do the most harm to vulnerable communities and societies, which depend directly on freshwater ecosystems for their livelihoods, food, energy and housing. To ensure the future of such communities – which may find it particularly hard to adapt to projected changes – it is critical to protect the health of the world's freshwater ecosystems.

CHANGES TO THE VOLUME AND TIMING OF FRESHWATER FLOWS ARE ALREADY A LEADING DRIVER OF GLOBAL DECLINES IN FRESHWATER BIODIVERSITY, AND CLIMATE CHANGE IS LIKELY TO INCREASE THIS PRESSURE.

The Living Planet Index (2018) indicates that species populations are declining twice as quickly on average in freshwater as in marine and terrestrial environments – one-third of all freshwater species assessed by the IUCN are threatened with extinction (IUCN, 2019), and of all those classified as Critically Endangered, one quarter are freshwater species. The shocking 83 per cent decline in freshwater species populations on average between 1970 and 2014 (Figure 1) and the fact that wetlands are disappearing three times faster than forests should be causing global alarm, and providing the impetus to ensure climate change adaptation is prioritized in the water sector.



© Tamir Kalifa

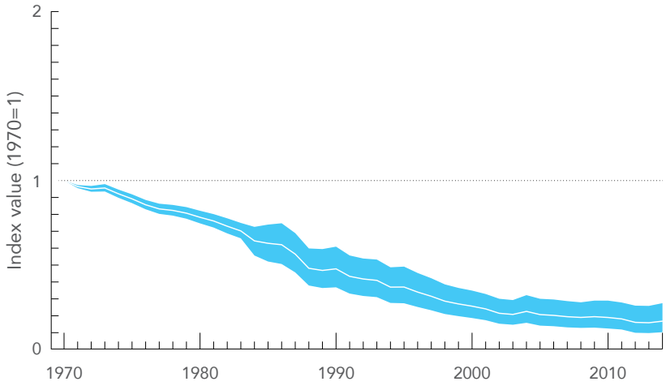


Figure 1:
The freshwater Living Planet Index shows a decline of 83% between 1970 and 2014[7]

Freshwater species are at particular risk of climate-related extinctions due to their high levels of endemism and niche adaptation, coupled with a reduced ability to shift like marine[8] or terrestrial species.[9] With this in mind, climate change poses significant risks to freshwater species in three different ways:

1) Direct impacts on the species themselves – for example, higher temperatures may leave populations unviable;
2) Changes to ecosystem structure and processes, such as shifts in flow timing, temperature changes, river or wetland shape; and
3) Secondary anthropogenic impacts influenced by climate change, e.g. increased water use, dam building etc.

THE IMPACTS OF CLIMATE CHANGE ON FRESHWATER ECOSYSTEMS WILL ALSO AFFECT BIODIVERSITY, ECONOMIES AND SOCIETIES.

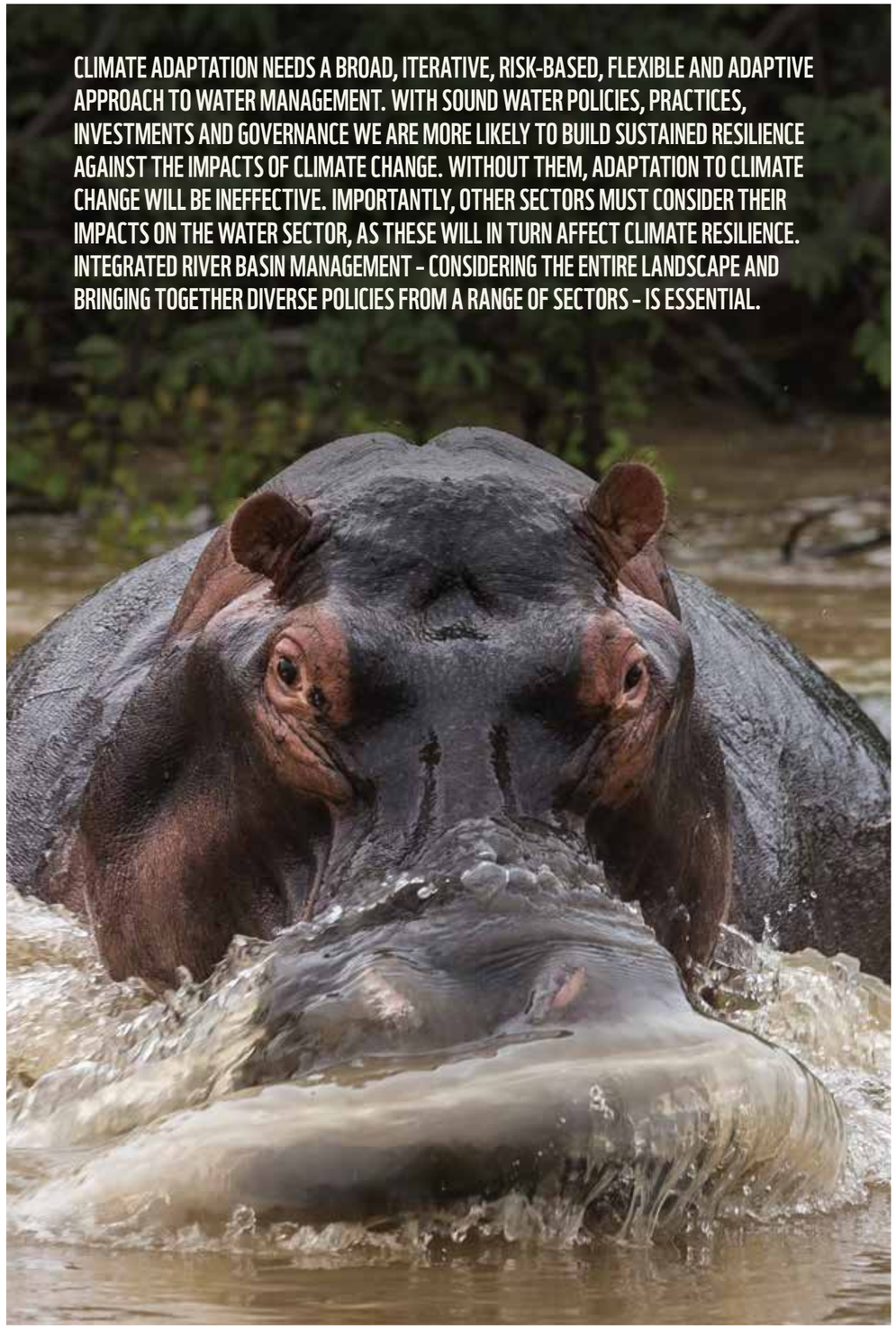
Freshwater ecosystems provide a range of services that underpin many sustainable development objectives, often for the most vulnerable communities: these include provisioning services such as inland fisheries and regulating services such as waste assimilation; sediment transport; flow regulation; and the maintenance of estuarine, delta and near-shore marine ecosystems. Freshwater ecosystems also underpin the world's irrigated agriculture, are core to the energy supply of many nations, and meet the water demands of cities and industries on every continent.[10] Ultimately, freshwater resources drive the economies of the world.

TO ENSURE RESILIENT ADAPTATION, WE MUST PAY MORE ATTENTION TO FRESHWATER ECOSYSTEMS IN THE TRADE-OFFS THAT COME WITH DEVELOPMENT.[11]

As the planet heats up, we need to be especially sure that ecosystems are resilient and flexible enough to respond to change – and this means giving healthy freshwater ecosystems greater priority in decision-making processes. The World Bank itself is very clear on this: "Adaptation requires that ecosystems stand at the centre of water resources development."[12] Economic development results in changes in land use, increasing urban and agricultural demand for water, and unsustainable resource exploitation – the cost of maintaining healthy freshwater ecosystems needs to be considered fully before decisions are made.

WATER ADAPTATION PLANNING NEEDS TO BE INCREASED, TAKING INTO ACCOUNT INCREASED WATER STRESS ALONGSIDE REDUCED PREDICTABILITY.

It is critical to balance water management priorities across a range of sectors (agriculture, energy, transport etc.), incorporate disaster risk reduction measures, and consider the needs of ecosystems and the environment. The Global Water Partnership (GWP) highlights this in a recent report: "Analysis of the adaptation components of NDCs of 80 countries reveals that nine out of every 10 countries prioritize investing in water infrastructure, institutions, or governance."[13] Governments seeking to achieve the SDGs need to realize that water-related adaptation is fundamental to overall adaptation planning, and that "integrated approaches to water management, in particular, help maximize resilience benefits while mitigating chances of unintended maladaptation."[14]



CHAPTER 2

LIVING WITH CLIMATE CHANGE

CLIMATE CHANGE AND PEOPLE ARE FUNDAMENTALLY INTERTWINED

In health terms, climate change can affect the spread of infectious (mostly water-borne) diseases, and alter the transmission seasons and geography of diseases like malaria or dengue.[15] It also drives migration, with millions of people around the world at risk of being displaced by shoreline erosion, coastal flooding and agricultural disruption.

© Karine Aigner / WWF-US

COMMUNITIES THAT ARE FORCED TO MIGRATE OFTEN REPRESENT THE MOST VULNERABLE SECTORS OF SOCIETY, WHO DEPEND ON NATURALLY FUNCTIONING ECOSYSTEMS FOR THEIR LIVELIHOODS

Climate change adaptation through stronger nature-based solutions is needed to support them. In particular, ecosystem services – such as functioning wetlands[16] or mangrove systems, or healthy rivers stocked with fish – should be a primary focus of adaptation measures. Expanding sustainable water resources management together with other nature-based solutions can help improve resilience for vulnerable communities around the world.

WATER SHOULD BE USED AS AN INSTRUMENT OF PEACE

The High Level Panel on Water and Peace report, *A matter of survival*, states: "we have to be aware not only of the consequences of climate change, such as massive displacement and the potential for conflicts within and among regions and nations, but also of the fact that water cooperation can be (and should be) a critical mechanism for adaptation to climate change". [17] Dialogue, planning and collective action between states is likely to improve management strategies for both surface and underground transboundary waters, while reducing the chances of violent water-related conflict.

TRADITIONAL, HARD INFRASTRUCTURE-BASED PROJECTS TO RESPOND TO CLIMATE RISKS OFTEN DECREASE THE ABILITY OF OUR NATURAL ECOSYSTEMS TO ADAPT

This is relevant not only for water storage, but also for flood defence infrastructure. For example, infrastructure such as dykes or levees may cut the connectivity of a floodplain, affecting sediment movement and the migration of key freshwater species. This may lead to soil erosion, land subsidence or the collapse of inland fisheries. However, when hard infrastructure is planned and integrated with nature-based solutions, some of these negative impacts can be reduced. An example of this is the Ramsar Wetland Cities Accreditation scheme, which is a practical way to encourage cities that are close to and dependent on wetlands, especially wetlands of international importance, to highlight and strengthen the positive role of these valuable ecosystems.[18] Healthy city wetlands provide flood risk mitigation (and hence reduce associated extreme event insurance

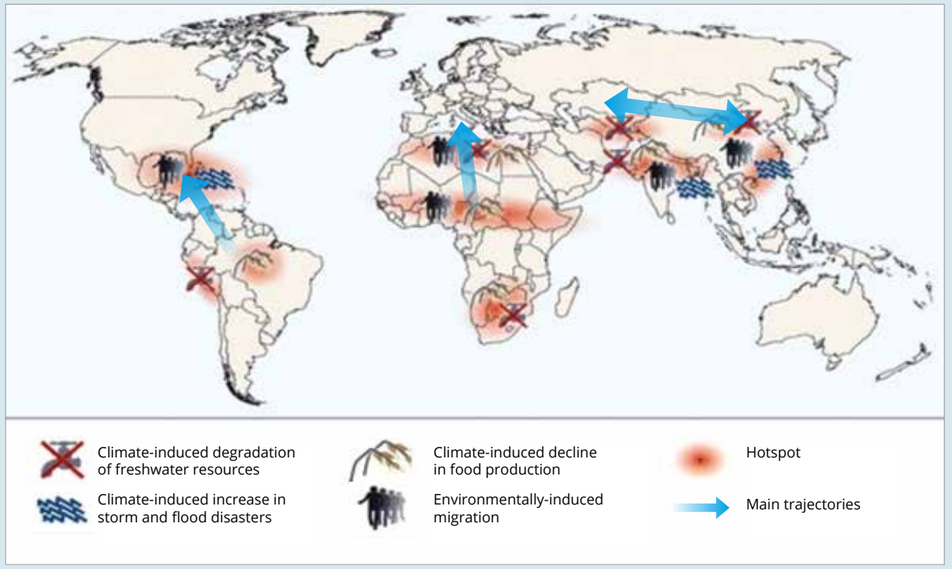


Figure 2: *The impact of climate change on human migration could be significant across a number of hotspots.*[19]

costs), and offer water supply and recreation opportunities. They may also help protect cities from subsidence and sea level rise.

HEALTHY FUNCTIONING RIVER SYSTEMS PROVIDE FAR MORE THAN PHYSICAL WATER SUPPLY

Economies and markets consistently fail to value rivers for their full spectrum of benefits. These benefits are poorly understood, recognized and quantified, and so are not a priority for river management until clear problems emerge from their neglect or through the impacts of climate change. The following three aspects of healthy, free flowing rivers have critical benefits for societies and economies – but they're usually undervalued:

Flood-risk reduction: Functioning floodplains and healthy wetlands reduce the risk of flooding for cities. Urban planning prioritizing development over natural flood defences will continue to exacerbate floods in cities across the world. The number of people threatened by flooding is also growing due to continued migration into flood-prone areas: nearly half of all urban development between today and 2030 will occur within areas with elevated risks of flooding.[20]

Freshwater fisheries: At least 12 million tonnes of freshwater fish are captured each year as a result of healthy functioning river ecosystems. This provides an invaluable protein source to some of the most vulnerable communities globally. Decisions about river management, including the construction of dams that block fish migration, tend not to factor in the economic costs of losing this crucial source of food.[21]

Sediment delivery: Globally, nearly a quarter of annual sediment flux is captured by dam reservoirs, an issue compounded by sand mining, the largest mined resource on the planet. Many of the largest deltas are now sinking and shrinking as a result – just as the world is warming and sea levels are beginning to rise. This is especially true in Asia, where the world's largest deltas are facing the same plight. WWF's ambitious new initiative 'Resilient Asian Deltas' will bring together a coalition of partners to tackle the factors responsible for the region's disappearing deltas (including upstream trapping of sediment and mismanagement of river systems) rather than just the symptoms alone (shoreline erosion etc.).[22]

THE IMPACT OF CLIMATE CHANGE IS COMPOUNDED BY DEVELOPMENTS UNDERMINING THE NATURAL ADAPTIVE RESILIENCE OF NATURE - INCLUDING FRESHWATER ECOSYSTEMS

In light of this conflict between nature and development, WWF has proposed a 'New Deal for Nature and People.' This would mean governments, businesses and societies committing to work together at all levels for urgent, decisive global action to halt biodiversity loss. By 2020, we need an agreed road map that recognizes the direct links between the health of nature, the well-being of people and the future of our planet.

Water in particular has an important role in the New Deal for Nature and People. On the one hand the largest biodiversity losses to this point have been in freshwater, while at the same time healthy freshwater ecosystems offer the best opportunities to build communities' climate change resilience. The New Deal for Nature and People will highlight six broad actions that the world can take to protect freshwater biodiversity and strengthen the climate-resilience of natural systems:

GLOBAL ACTION PLAN FOR FRESHWATER BIODIVERSITY

1. *Implement environmental flows (including sediment flows)*
2. *Restore water quality to sustain aquatic life*
3. *Protect and restore freshwater habitats*
4. *Bring exploitation of freshwater species and materials within sustainable limits*
5. *Stem the tide of invasive species in freshwater habitats*
6. *Ensure infrastructure development safeguards freshwater connectivity.*

James Suter / Black Bean Productions / WWF-US

CHAPTER 3

CHANGING TEMPERATURES AND PRECIPITATION LEVELS ARE LIKELY TO BRING CHANGES IN DEMAND FOR WATER, AFFECTING THE GLOBAL AGRICULTURAL ECONOMY

To give an obvious example, during droughts people in water-scarce areas increasingly depend on groundwater to supplement their needs, which in turn depletes aquifers, especially small and shallow ones. Meanwhile, in irrigated agriculture, higher temperatures lead to more evapotranspiration, which decreases runoff and increases water demand. Changes in quantity or timing of precipitation affect the viability of agricultural operations, leaving the most vulnerable farming communities at even greater risk. Reduced precipitation and higher temperatures increase demand for irrigation, directly impacting flow-rates in freshwater ecosystems.

SECURING OUR FOOD SUPPLY

Climate Change and Water

THE IMPACTS ON OUR FOOD SYSTEMS OF CLIMATE-DRIVEN CHANGES IN FRESHWATER AVAILABILITY AND TIMING ARE EXTENSIVE

Rivers irrigate 190 million hectares of land, or 62% of all irrigated land (Figure 3), accounting for about a quarter of total global food production. What's more, this figure does not include river fisheries or land used in flood-recession agriculture, which between them feed hundreds of millions of people.[23]

HEALTHY FRESHWATER ECOSYSTEMS ARE CRUCIAL FOR FISH AS WELL AS FOR IRRIGATION

As WWF points out in its *Valuing Rivers* report, "Globally, river fisheries provide nearly 12 million tonnes of freshwater fish harvested per year, sufficient to provide the primary source of protein for at least 160 million people. River fisheries provide livelihoods for 60 million people, with 55 per cent of those being women."[24] The productivity of the largest fisheries is supported through rivers that retain a natural flow regime and connectivity with floodplains. For instance, the Mekong River has an annual fishery harvest of more than 3 million tonnes, valued at US$17 billion per year. Myanmar's freshwater fisheries, dominated by rivers such as the Irrawaddy, produce more than 1.3 million tonnes of fish per year and employ some 1.5 million people.[25]

Fisheries also play an important role in terms of climate mitigation and adaptation. From a mitigation perspective, fisheries and aquaculture have a lower environmental impact than ruminant meat production, while inland fisheries have a particularly low carbon footprint in comparison with other food sources.[26] From an adaptation perspective, the mostly vulnerable communities that depend on freshwater fisheries as their affordable protein source effectively depend on healthy functioning river ecosystems for their survival.

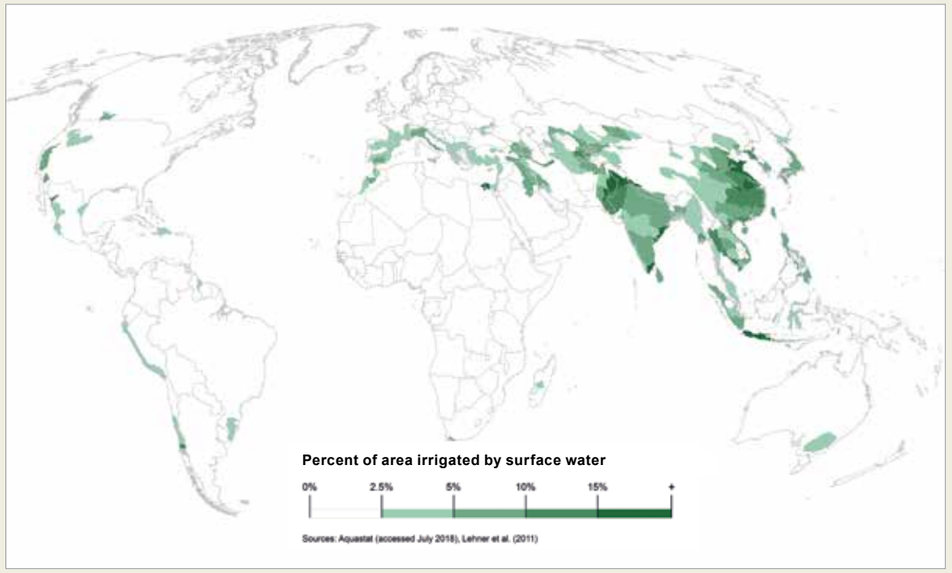
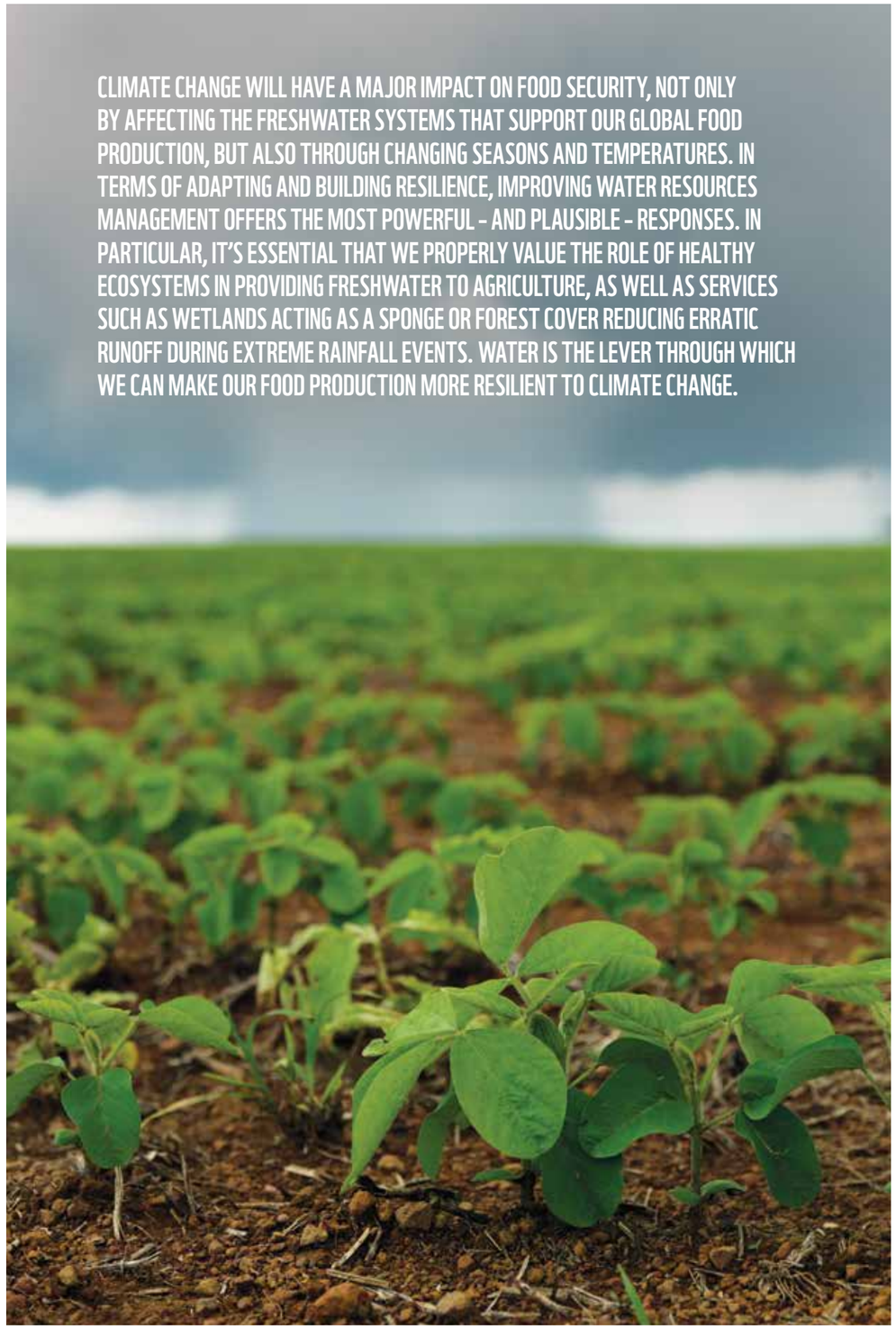


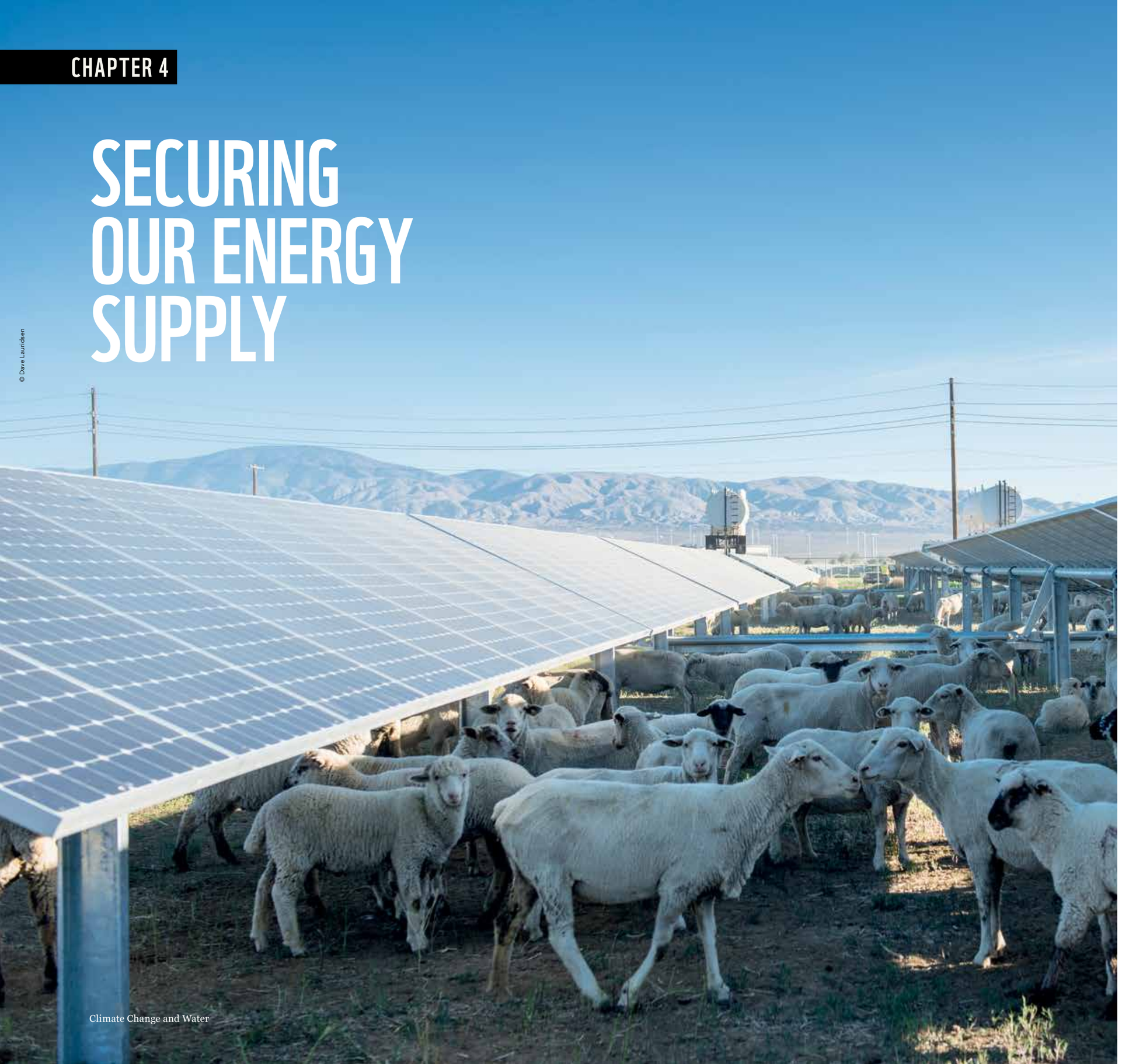
Figure 3: *Lands irrigated from river-based systems. Percentage of river basin area (Hydrosheds Level 4) irrigated from a river source (data from IWMI Global Irrigated Area Mapping)*

CLIMATE CHANGE WILL HAVE A MAJOR IMPACT ON FOOD SECURITY, NOT ONLY BY AFFECTING THE FRESHWATER SYSTEMS THAT SUPPORT OUR GLOBAL FOOD PRODUCTION, BUT ALSO THROUGH CHANGING SEASONS AND TEMPERATURES. IN TERMS OF ADAPTING AND BUILDING RESILIENCE, IMPROVING WATER RESOURCES MANAGEMENT OFFERS THE MOST POWERFUL – AND PLAUSIBLE – RESPONSES. IN PARTICULAR, IT'S ESSENTIAL THAT WE PROPERLY VALUE THE ROLE OF HEALTHY ECOSYSTEMS IN PROVIDING FRESHWATER TO AGRICULTURE, AS WELL AS SERVICES SUCH AS WETLANDS ACTING AS A SPONGE OR FOREST COVER REDUCING ERRATIC RUNOFF DURING EXTREME RAINFALL EVENTS. WATER IS THE LEVER THROUGH WHICH WE CAN MAKE OUR FOOD PRODUCTION MORE RESILIENT TO CLIMATE CHANGE.



CHAPTER 4

SECURING OUR ENERGY SUPPLY



Climate Change and Water

CLIMATE CHANGE WILL IMPACT ENERGY SYSTEMS ACROSS THE GLOBE

On the demand side, heating and cooling patterns will change due to rising temperatures. On the supply side impacts are numerous, including changes to the variability of wind, solar and hydropower resources; the availability of crops for bioenergy feedstocks; the costs and availability of fossil fuels due to melting sea ice and permafrost; the efficiency of PV panels, thermo-electric power plants and transmission lines due to rising temperatures; and technology downtime from more frequent and intense extreme weather events.[27] Today's energy planning needs to address the future impacts of climate change.

ONE SUPPLY SOURCE, HYDROPOWER, REQUIRES PARTICULAR ATTENTION

Not only is current hydropower generation under threat due to shifts in rainfall and temperature, but future hydropower development may have an impact on the adaptive response of rivers in the face of climate change. Building hydropower infrastructure without considering its effects on other river resources can be counterproductive, because a response in one sector can increase the vulnerability of another.[28] Hydropower may have detrimental effects on river flows, fish migrations and sediment dynamics, which support countless communities, especially in lowland floodplains and deltas.

The Mekong delta, for example, is eroding by an area equivalent to one and a half football fields every day as a result of sediment being trapped by dams and unsustainably extracted through sand mining.[29] River management that rests on a foundation of understanding and valuing rivers for their diverse benefits can produce much more balanced and sustainable outcomes.[30] Decision-making for infrastructure in rivers, including hydropower, requires a clear understanding of the environmental, social, and financial risks.

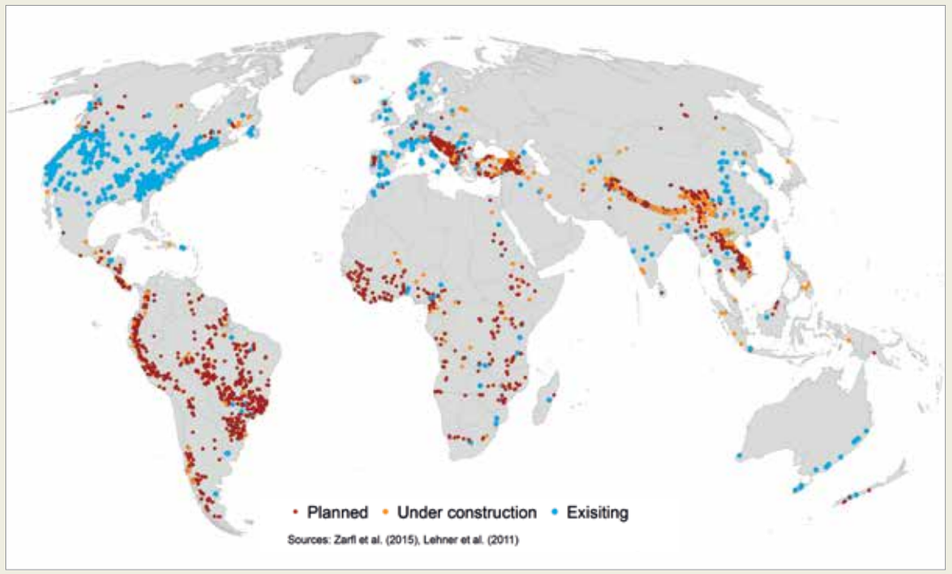


Figure 4 *Global hydropower dams (existing, under construction and planned); Data on existing dams from Global Reservoirs and Dams Database (GRanD), under construction and planned dams from Zarfl (2015)*

THE ENERGY SECTOR NEEDS TO IMPROVE PLANNING AND MANAGEMENT PROCESSES, TO ADDRESS THEIR SHORTCOMINGS AND MAXIMIZE THEIR STRATEGIC VALUES

This is especially the case when considering the compounding impact of climate change together with the detrimental impacts of hydropower on ecosystems. Poor planning leads to greater environmental and social impacts; and conflict, delays and cancellations bring investment and operational risks to national energy and water projects.

For example, in Zambia, hydropower makes up 95 per cent of the country's power supply, most of it from Lake Kariba, the world's largest man-made reservoir. But due to El Nino in 2016, water levels dropped to 13 per cent of their usual volume, putting the energy security of the country at risk.[31] Strategic planning and management at the system scale should assess the potential for maintaining or restoring free-flowing rivers and connectivity while still allowing energy generation.[32] Clear visualizations across economic, environmental and social values (Figure 5) are important so decision-makers and stakeholders understand the opportunities and trade-offs in play – and therefore the implications of selecting various options.

STRATEGIC PLANNING OF OUR ENERGY SYSTEMS NEEDS TO TAKE INTO ACCOUNT THE IMPACT OF CLIMATE CHANGE, INCLUDING THROUGH THE WATER SECTOR

Furthermore, when the role of healthy freshwater systems and their role in climate adaptation is fully acknowledged, it becomes clear that certain energy options are not viable. Alternative renewable energy options that do not undermine the ability of freshwater ecosystems to provide ecosystem services and support biodiversity are becoming more affordable.

As the recent WWF TNC report *Connected and Flowing* makes clear, "the potential of utility-scale, low-impact wind and solar, on converted lands, such as agricultural and degraded land and rooftops, represents the equivalent of 17 times the renewable energy targets that countries have committed to under the Paris Climate Agreement and should allow almost all countries to achieve power systems that are low carbon, low cost, and low impact on nature. For example, recent studies indicate countries in Southeast Asia can develop low carbon, low cost power systems that do not require dams on the Mekong River or its few remaining, free-flowing major tributaries."[33] The sooner we shift the mindset of traditional energy provision towards accelerating the renewable revolution, the better.

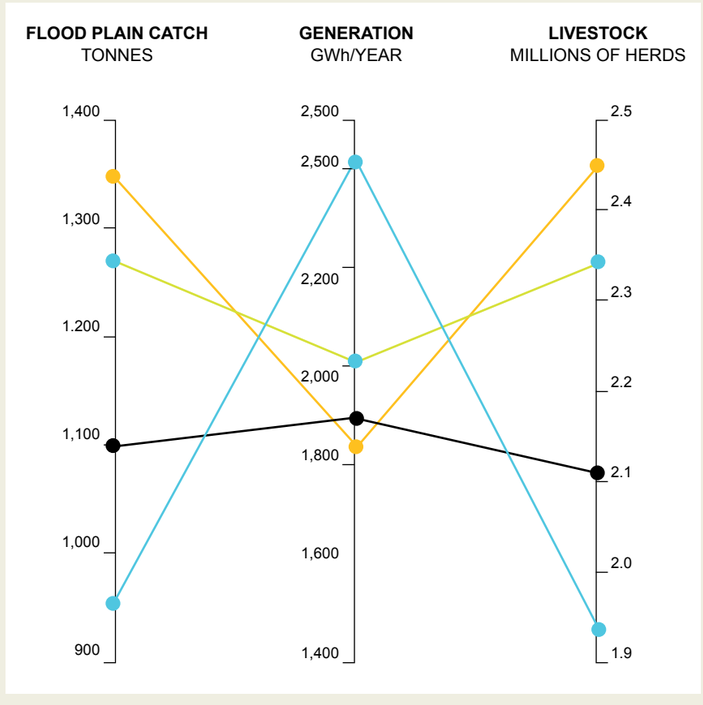
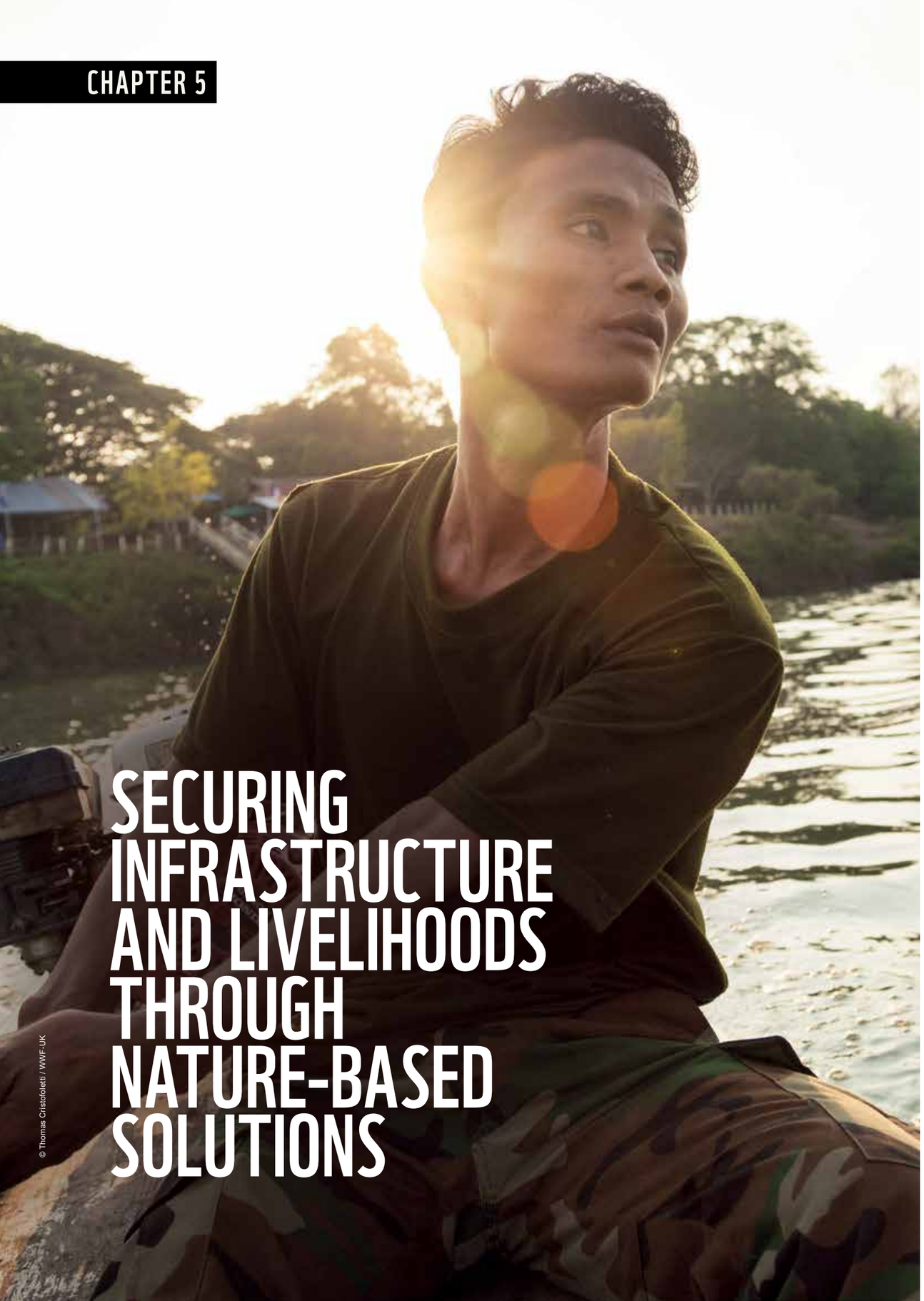


Figure 5: *Comparison of four different options (different coloured lines) for managing a cascade of dams on the Tana River, Kenya in terms of how each option performs across three metrics: harvest of floodplain fish, generation of electricity, and the ability of floodplain grasslands to support livestock. Performance is indicated by where a line representing an option crosses the axis for that metric, with better performance at the top of the line.*[34]

CHAPTER 5



SECURING INFRASTRUCTURE AND LIVELIHOODS THROUGH NATURE-BASED SOLUTIONS

NATURE-BASED SOLUTIONS SHOULD BE PART OF A 'DIVERSIFIED PORTFOLIO' APPROACH TOGETHER WITH HARD INFRASTRUCTURE TO ALLOW FOR MORE RESILIENT MANAGEMENT OF INFRASTRUCTURE SYSTEMS AND IMPROVED RISK REDUCTION

Almost a decade ago, a UNEP report titled *Dead Planet, Living Planet: Biodiversity and Ecosystem Restoration for Sustainable Development* (UNEP, 2010) underscored the huge economic benefits that countries might accrue by restoring wetlands, river and lake basins, and forested catchments.[35] More recently, UN Water's 2018 *World Water Development Report* emphasized that nature-based solutions should play a central role in the management of global water supplies in the context of growing demand and climate change. The report recommended a range of nature-based solutions, including using natural features to increase water availability (e.g. recharging groundwater and retaining water in soils) and using wetlands to improve water quality.[36]

NATURE-BASED SOLUTIONS INCLUDE A SPECTRUM OF ACTIVITIES AND ACTIONS THAT PROTECT, SUSTAINABLY MANAGE, AND RESTORE NATURAL OR MODIFIED ECOSYSTEMS, WHILE ALSO ADDRESSING SOCIETAL CHALLENGES BY PROVIDING HUMAN WELL-BEING AND BIODIVERSITY BENEFITS

Nature-based solutions should be integral to infrastructure and river management; supporting ecosystem services while also making infrastructure investments more resilient themselves. Investments in nature-based solutions can catalyze a diverse range of additional benefits, from carbon sequestration and habitat protection to recreation. Improved freshwater ecosystem health supports climate adaptation and builds long-term water system sustainability.

The following table shows potential nature-based solutions to some projected impacts of climate change.[37]

CLIMATE IMPACT ON FRESHWATER ECOSYSTEMS	NATURE-BASED SOLUTIONS IN RESPONSE
Increased low-flow episodes and water stress in some areas	Re/afforestation and forest conservation Reconnecting rivers to floodplains Wetlands restoration/conservation Constructing wetlands Water harvesting[38] Green spaces (bioretention and infiltration) Permeable pavements[39]
Increased evaporative losses, especially from shallow water bodies	
Shifts in the timing of floods and freshwater pulses	Re/afforestation and forest conservation Riparian buffers Reconnecting rivers to floodplains Wetlands restoration/conservation Constructing wetlands Establishing flood bypasses
Higher and/or more frequent floods	
Increased extremes of water temperatures	Re/afforestation and forest conservation Riparian buffers Reconnecting rivers to floodplains Wetlands restoration/conservation Constructing wetlands Green spaces (shading of water ways)
Shifts in the seasonality and frequency of thermal stratification of lakes	
Saltwater encroachment in coastal, deltaic and low-lying ecosystems, including coastal aquifers	Protecting/restoring mangroves, coastal marshes and dunes Protecting/restoring reefs (coral/oyster) Reconnecting rivers to floodplains Wetlands restoration/conservation Constructing wetlands
More intense runoff events leading to increased sediment and pollution loads	Re/afforestation and forest conservation Riparian buffers Reconnecting rivers to floodplains Water harvesting

CHAPTER 6

FINANCING CLIMATE ADAPTATION IN THE WATER SECTOR

CLIMATE ADAPTATION THROUGH THE WATER SECTOR SHOULD BE MADE A PRIORITY, AND BE GIVEN GREATER FINANCIAL SUPPORT

This is because the overwhelming proportion of climate change effects will be transmitted through the water sector. The estimated annual US$ 2.5 trillion investment gap to meet the global SDGs can only be filled by leveraging philanthropic and public sector capital with capital from the private sector. However, this approach is currently constrained by a lack of local sponsors with the capital to develop business cases, and weak regulatory environments that deter investors. Furthermore, traditional investment approaches risk repeating the mistakes of the past, in which a narrow set of objectives are pursued to the detriment of rivers' other diverse values. Investors and banks have a strong interest in financing more sustainable water projects, but there is currently a limited pipeline of viable projects.

© Xiaodong Sun / WWF-UK

THE WWF 'BANKABLE WATER SOLUTIONS' INITIATIVE WILL ADDRESS INVESTMENT AND SUSTAINABILITY CHALLENGES TO ENSURE ADAPTATION OPTIONS DO NOT DAMAGE NATURAL ECOSYSTEMS, RIVERS, LAKES AND WETLANDS

The initiative's key characteristics include taking a basin-scale view, integration across a number of financial players, a focus on supply chains, leveraging blended finance, and WWF's ability to help raise seed capital to bring bankable projects from concept to feasibility phase. Bankable Water Solutions aims to redirect finance from poorly planned infrastructure developments toward projects that will have positive impacts on river basins, while providing backers with an acceptable return on their investment.

IN ZAMBIA, IRREGULAR PRECIPITATION FROM CLIMATE CHANGE (AND RISING DEMAND FOR WATER) IS CREATING COMPETITION FOR SURFACE WATER FROM THE KAFUE FLATS

Using the Bankable Water Solutions model, stakeholders have come together to explore investments that will make them more climate-resilient and sustainable. By blending both grant and commercial finance, they can explore projects that produce a return while maintaining or restoring rivers' diverse values, including those that are hidden or overlooked – and often negatively impacted – by status quo approaches to investment. This is illustrated in the figure below, showing how a range of funding and financing opportunities are together able to ensure a more climate-resilient Kafue Flats.

A SYSTEM-SCALE APPROACH CAN ALIGN INDIVIDUAL INVESTMENTS WITH LANDSCAPE-SCALE CONSERVATION OBJECTIVES AND IDENTIFY NEEDS OR OPPORTUNITIES THAT REQUIRE TRADITIONAL CONSERVATION FUNDING

Through this approach, bankable solutions can help resolve trade-offs between infrastructure development and conservation. The overarching goal of this initiative is to help shift investment decisions so that they recognize and support river values up front, before these values are lost to poorly-planned infrastructure or water pollution. By investing in projects that highlight nature-based solutions we not only improve our water security and freshwater biodiversity, but we also improve our resilience to climate change.

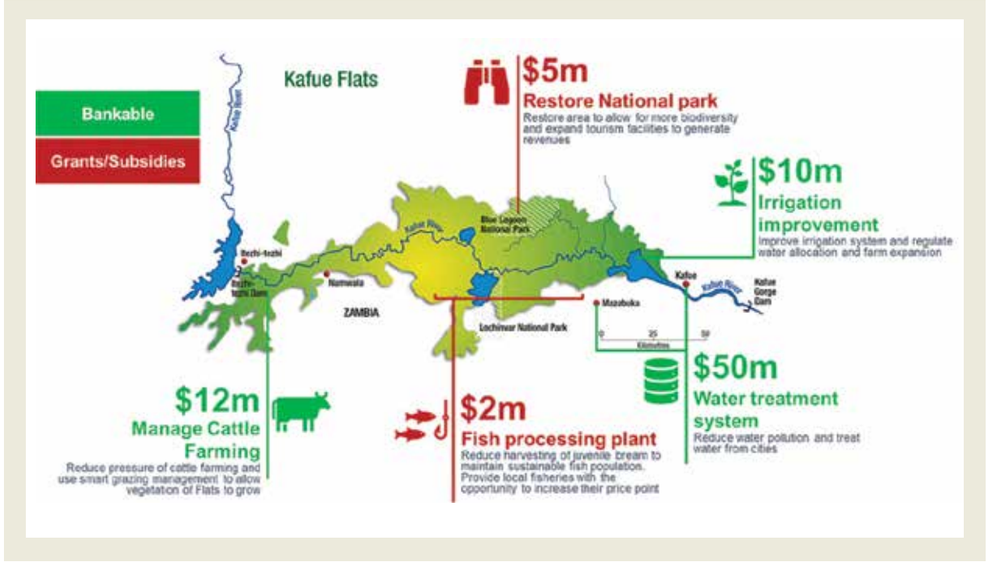


Figure 6: *A set of potential bankable water solutions for the Kafue Flats region, part of the Zambezi river basin in Zambia. The system-scale approach identifies a suite of projects that would work together to collectively contribute to landscape conservation objectives, as well as identify how to combine bankable solutions (that have an investment return, noted in green) with traditional conservation funding (grants and subsidies, noted in red) for synergistic impact.*

CHAPTER 7

© Minzayar Oo / WWF-US

PARTNER RECOMMENDATIONS

CLIMATE CHANGE AND THE NEED FOR ADAPTATION ALSO PROVIDE AN OPPORTUNITY FOR INNOVATION

This is especially true in the water sector, where, as the UNECE points out, we need to "shift from a supply-side approach to a more sustainable, demand-side approach to water resource management, focusing on conserving water and using it more efficiently."[40] Everyone involved in the climate and water worlds has a responsibility to ensure that nature-based solutions and improved water resources management are central to efforts to mitigate climate impacts. And building stronger partnerships – the focus of SDG17 – will also be critical since collective action is key to better water management.

To achieve this goal, WWF makes the following recommendations.

POLITICAL LEADERSHIP:

Political leaders providing financial and technical assistance in development decisions need to take the initiative in using nature-based solutions to meet sustainable development and disaster risk reduction goals. These leaders need to be visionary in communicating the future benefits of decisions made today, as well as to bring innovative thinking to the planning process and challenge the current benefit distribution model of traditional 'grey' infrastructure development.

In order to adapt to climate change, we need to build resilient governance and institutions that are able to adapt to an uncertain future.[41] Infrastructure planners need to have flexible decision-making processes that promote resilient future construction and operations.[42] It's essential to ensure that our adaptation efforts are least-regret options that maintain the environment's ability to adapt naturally (and possibly more effectively than via man-made interventions).

Practical steps for political leadership include:

- **Invest** in adaptive institutional capacity and enabling frameworks for successful climate adaptation, including:
  - Adaptive water allocation mechanisms;
  - Effective water management institutions;
  - Opportunities for stakeholder involvement; and
  - Increased monitoring, evaluation and enforcement capacity.
- **Implement** policies and mechanisms to protect (and if necessary restore) environmental flows in rivers.
- **Promote** nature-based solutions instead of hard infrastructure to reduce vulnerability to climate change and increase freshwater ecosystems' adaptive capacity.

CORPORATES AND THE PRIVATE SECTOR:

- **Recognize** that climate change and water-related risks impact upon your business. In many cases mitigation of these risks is impossible internally, so collective sectoral action will be needed.

CIVIL SOCIETY:

- **Demand** a change to the current hard infrastructure planning status quo, where development plans (including hydropower) often fail to consider either the system-scale opportunities for improved outcomes or the use of nature-based solutions.

RESEARCH, ADVOCACY AND ACADEMIA:

- **Raise awareness** and understanding through campaigns, technical training and cross-sector discussions about sustainable nature-based solutions for adapting to climate change.
- **Research and monitor** the results of using nature-based solutions to address climate-related water challenges.

GLOSSARY

Adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.[43]

Climate resilience: The ability to anticipate, prepare for and respond to hazardous events, trends or disturbances related to climate. Improving climate resilience involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks.[44]

Ecosystem-based adaptation: The use of biodiversity and ecosystem services as part of an overall adaptation strategy to address the adverse effects of climate change.[45]

Ecosystem resilience: Measure of the magnitude of disturbance that can be absorbed before the (eco)system changes its structure by changing the variables and processes that control behaviour.

Ecosystem services: Benefits people derive from ecosystems. Ecosystem services are divided into four main categories: provisioning (e.g. provision of food, water and raw material); regulating (e.g. climate regulation, erosion prevention and water treatment); cultural (e.g. recreational and spiritual services); and supporting services (e.g. nutrient cycling, primary production).[46]

Mitigation: In the context of climate change, a human intervention to reduce the sources or enhance the 'sinks' of greenhouse gases. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other sinks to remove greater amounts of carbon dioxide from the atmosphere.[47]

Nature-based solutions: 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.[48]

ENDNOTES

1 WWF, 2018, Understanding climate risks within the practice.
2 WWF, 2018, Understanding climate risks within the practice.
3 World Bank, 2010. Flowing Forward: Freshwater ecosystem adaptation to climate change in water resources management and biodiversity conservation.
4 UNECE, 2009. Guidance on water and adaptation to climate change. www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf
5 UNECE, 2009. Guidance on water and adaptation to climate change. www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf
6 World Bank, 2010. Flowing Forward: Freshwater ecosystem adaptation to climate change in water resources management and biodiversity conservation.
7 www.wwf.ca/newsroom/reports/living_planet_report_2014.cfm
8 For example, 70% of marine fish species in UK waters have been found to have shifted further north or into deeper waters in relation to climate change (Simpson et al., 2013). https://wwforguk-my.sharepoint.com/personal/khughes_wwf_org_uk/Documents/AAA%20KATHY/Biodiversity_Primer/Lin_Report/v7_merged_Biodiversity_Primer%20DT&AA_Comments-Incorp.docx#_ftnref1
9 Poff, Olden and Strayer, 2012
10 https://water.fanack.com/impact-of-climate-change-on-water-resources/
11 UNECE, 2009. Guidance on water and adaptation to climate change. www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf
12 World Bank, 2010. Flowing Forward: Freshwater ecosystem adaptation to climate change in water resources management and biodiversity conservation.
13 GWP, 2019. Addressing Water in National Adaptation Plans – Water Supplement to the UNFCCC NAP Technical Guidelines. 978-91-87823-51-0. www.gwp.org/globalassets/global/gwp_nap_water_supplement.pdf
14 GWP, 2019. Addressing Water in National Adaptation Plans – Water Supplement to the UNFCCC NAP Technical Guidelines. 978-91-87823-51-0. www.gwp.org/globalassets/global/gwp_nap_water_supplement.pdf
15 https://unfccc.int/news/climate-change-impacts-human-health
16 16 https://www.wetlands.org/news/global-platform-for-disaster-risk-reduction-2019-emphasises-the-key-role-of-ecosystems/
17 Global High-Level Panel on Water and Peace. 2017. A matter of survival. https://www.genevawaterhub.org/sites/default/files/atoms/files/report_of_the_ghlpwp_final_withcover_20171220.pdf
18 Ramsar Wetland Cities Accreditation Scheme. https://www.ramsar.org/news/wca-applications
19 https://www.climategen.org/blog climatechange-and-migration/20
20 http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
21 http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
22 http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
23 WWF, 2018. Valuing Rivers. http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
24 Opperman, J. J., S. Orr, H. Baleta, M. Dailey, D. Garrick, M. Goichot, A. McCoy, A. Morgan, L. Turley and A. Vermeulen. 2018. Valuing Rivers: How the diverse benefits of healthy rivers underpin economies. WWF.
25 FAO. 2018. The State of World Fisheries and Aquaculture 2018 – Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.
26 FAO. 2018. The State of World Fisheries and Aquaculture 2018 – Meeting the sustainable development goals. Rome. Licence: CC BY-NC-SA 3.0 IGO.
27 https://link.springer.com/article/10.1007/s10584-018-2265-4
28 UNECE, 2009. Water and Climate Adaptation. www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf
29 WWF, 2018. Valuing Rivers. http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
30 WWF, 2018. Valuing Rivers. http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
31 www.dw.com/en/hydropower-supply-dries-up-with-climate-change/a-42472070
32 WWF, 2018. Valuing Rivers. http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
33 Opperman, J., J. Hartmann, M. Lambrides, J.P. Carvallo, E. Chapin, S. Baruch-Mordo, B. Eyler, M. Goichot, J. Harou, J. Hepp, D. Kammen, J. Kiesecker, A. Newsock, R. Schmitt, M. Thieme, A. Wang, C. Weatherby, and C. Weber, 2019. Connected and flowing: a renewable future for rivers, climate and people. WWF and The Nature Conservancy, Washington, DC
34 From Opperman et al. (2017) used with permission from The Nature Conservancy. Data for the figure are from Anthony Hurford and Julien Harou (University of Manchester) from a project supported by colleagues from the International Water Management Institute (IWMI), ODI, BC3 and ACCESS, under the IUCN-led WISE-UP to Climate Project. WISE-UP to Climate is funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).
35 World Bank, 2010. Flowing Forward: Freshwater ecosystem adaptation to climate change in water resources management and biodiversity conservation.
36 WWF, 2018. Valuing Rivers. http://awsassets.panda.org/downloads/wwf_valuing_rivers__final_.pdf
37 UNEP, 2014. Green Infrastructure Guide for Water Management: Ecosystem-based management approaches for water-related infrastructure projects
38 Consists of built ('grey') elements that interact with natural features and seek to enhance their water-related ecosystem services.
39 Consists of built ('grey') elements that interact with natural features and seek to enhance their water-related ecosystem services.
40 UNECE, 2009. Water and Climate Change Adaptation. www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf
41 Regardless of the multiple possible climate futures, in order to limit pressure on our water systems, climate action to limit global warming to 1,5 °C as compared to pre-industrial levels is crucial.
42 World Bank, 2010. Flowing Forward: Freshwater ecosystem adaptation to climate change in water resources management and biodiversity conservation.
43 https://unfccc.int/index.php/process-and-meetings/the-convention/glossary-of-climate-change-acronyms-and-terms#m
44 www.c2es.org/content/climate-resilience-overview/
45 www.iucn.org/sites/dev/files/content/documents/2019/iucn_global_nbs_standard_-_public_consultation.pdf
46 www.iucn.org/sites/dev/files/content/documents/2019/iucn_global_nbs_standard_-_public_consultation.pdf
47 https://unfccc.int/index.php/process-and-meetings/the-convention/glossary-of-climate-change-acronyms-and-terms#m
48 www.iucn.org/sites/dev/files/content/documents/2019/iucn_global_nbs_standard_-_public_consultation.pdf

CLIMATE CHANGE AND WATER

100% RECYCLED

83%

Decline in freshwater species populations on average between 1970-2014

12 MILLION

Tonnes of freshwater fish caught per year

19%

Of global GDP comes from watersheds with high to very high water risk

17

SDG17: Partnerships for the Goals is crucial to progress on climate & water

WWF

Working to sustain the natural world for people and wildlife

together possible™ panda.org

AB InBev

Anheuser-Busch InBev is the world's leading brewer. Our Dream is to bring people together for a better world. We are committed to building great brands that stand the test of time and to brewing the best beers using the finest natural ingredients. Geographically diversified with a balanced exposure to developed and developing markets, we leverage the collective strengths of approximately 175,000 employees based in nearly 50 countries worldwide.