



# Land, Water, and People

From Cascading Effects to Integrated Flood and Drought Responses

SUMMARY FOR  
DECISION-MAKERS



IHDP

International Human Dimensions Programme  
on Global Environmental Change



Global Water  
System Project

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# IMPRINT

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## FOREWORD

Practically everyone on earth lives on land, and we all rely on water without exception. Water is life. It nourishes and gives vitality to mankind, to the land, and to the natural environment upon which we all depend.

We are all aware of the devastating consequences of water scarcity. As recently as 2012, we saw water scarcity in the form of drought wreaking havoc in the grain-producing regions of the Black Sea, ravaging the monsoon-dependent South Asia, hitting the heartland of the USA and exacerbating poor harvests across the already drought-prone Sahel region of Africa. Without exception, both food exporting regions and small producers in poor countries were affected by the droughts, resulting in a significant impact on local and global food prices and food security across the globe.

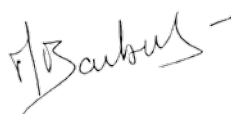
But these regions are no strangers to floods either. In 2013, several parts of Asia, Africa, the Americas, and Central Europe recorded levels of precipitation, as well as single storm rainfalls, more than double the previous records, many bringing about flash floods. The year 2013 saw parts of the Philippines hit by the worst floods in living memory. Early in 2014, torrential rains set off floods in Indonesia, the Philippines and England, with high waters displacing thousands of people.

The combined scenarios of droughts and floods are becoming increasingly common and frequent around the world. The economic costs of these twin hazards have been debilitating over the past few years, particularly in poorer countries. Recent research has found droughts and floods to significantly damage economic growth. According to the study a 1% increase in the area affected by drought can slow a country's gross domestic product (GDP) growth by 2.7% per year and a 1% increase in the area experiencing extreme precipitation can reduce GDP growth by 1.8%.

The impacts on human well-being have been staggering, and recovery a daunting undertaking for many. Populations of the world that are vulnerable to these dual threats will no doubt have a difficult development journey ahead as they struggle to cope with a new climate reality. These two hazards together vividly emphasize to policy-makers the need to address what has undoubtedly become one of the most urgent challenges of the 21st century, one with frightening social, political, environmental, and economic implications considering the need to sustain global food security, and social and political stability.

Too little or too much water is often damaging to overall economic well-being, requiring effective institutional and policy frameworks for the long-term management of the associated hazards. As with many catastrophes, the twin hazards of droughts and floods provide opportunities for reflection and action. They provide an opportunity to face head-on two of the water hazards that have been long ignored. Redirecting funding already available to increase the resilience of local communities would be a sensible first step from a sustainable development perspective.

Going forward, giving affected populations around the world the proper tools to weather the debilitating impacts of droughts and floods requires policy-makers to understand the intricate relationship among the people, the land they inhabit, and the water that nourishes them. It will require building capacity for policy development and innovation from different local and global players in both private and public sectors. This Summary for Decision-Makers is a crucial step in the right direction, and we at UNCCD welcome both this publication, and the interdisciplinary problem-solving collaboration between policy-makers and the scientific community that IHDP has initiated to bring it about.



Monique Barbut  
Executive Secretary  
UNCCD Secretariat  
January 2014

# Background

Land, water, and people; it is the most basic and traditional of relationships, yet today the relationship has become so complex that we find ourselves ill-equipped to understand all of its interconnections and to plan a future that is sustainable.

Why is it important to talk about land and water, and why talk about them together in the context of understanding prospects for human well-being? That land and water resources are essential for sustaining life is of course well understood, as are the many stresses on these resources; but, less obvious and appreciated is the convergence of recent weather-related events that directly afflict our land and water resources together and across the world. The cost to society of the year-long drought that afflicted the midwest plains of the United States in 2012 was estimated at US\$35 billion (Aon 2013). Considering also the flooding and other damage resulting from Hurricane Sandy on the east coast of the United States the same year, the economic loss totals \$100 billion, making this drought and flood combination the two most costly disasters globally in 2012 (Aon 2013; USA Today 2013). In 2012, flooding in China realized \$14 billion in economic loss (Aon 2013), and in Australia's Murray-Darling Basin the loss of hydrologic ecosystem services alone stemming from the millennium drought, which finally re-

leased its grip in 2012, was estimated at \$810 million (Banerjee et al. 2013). These recent events come on the heels of the 2011–12 Horn of Africa drought, cited as the worst to hit the east Africa region in over 60 years (BBC 2011). Across Africa, over 220 million persons are exposed to drought and 1.5 million affected by floods each year (Pokorsky da Cunha 2013); most of the human, animal, and economic costs of these annual events are never calculated. Estimates exist for Kenya, where between 10 to 16 percent of GDP was lost due to floods and droughts in 1997–2000 (Pokorski da Cunha 2013). These are just the numbers. The loss of human well-being that gives meaning to these numbers (which affects the poorest inhabitants and poor countries the most) is the reality and the new face of the now-chaotic and unpredictable relationship among land, water, and people.

Future prospects for this complex relationship also appear bleak. A 2013 report on coastal cities pegs the average global flood loss in 2005 at approximately \$6 billion, with projections showing an increase to \$52 billion by 2050 considering socio-economic change alone (Hallegatte et al. 2013). When climate change and subsidence are considered in the context of coastal cities, “present protection will need to be upgraded to avoid unacceptable losses of US\$1 trillion or more per year (Hallegatte et al. 2013).”

*Regions of the world that have historically been vulnerable to both floods and drought are seeing a more frequent occurrence of floods and droughts and their back-to-back occurrence. For example, in 2011 the Red River Valley shared between U.S. and Canada experienced a flood that cost taxpayers in the province of Manitoba \$1 billion. A record one-third of cropland was too flooded to seed at the beginning of the growing season (Winnipeg Free Press 2011). In what was cited as “weather whiplash,” the crops that were able to go to seed after the flood, wilted after experiencing two months without any rain (Globe and Mail 2013).*

The situation was referred to as “jarring” with one farmer aptly summing up the situation as follows: “I could be receiving flood and drought insurance payments at the same time. That’s crazy. You would never believe it to be possible (Globe and Mail 2013).” The Rocky Mountain region of the U.S. state of Colorado experienced its own “climate disaster whiplash” in the fall of 2013



## VUNERALBLE REGIONS OF THE WORLD

Regions of the world that are vulnerable to the dual threat of floods and droughts will no doubt have a difficult development journey ahead. The landscapes involved represent a significant portion of the global land mass. Consider Figure 1 which presents an overlay of flood and drought occurrence produced for this paper using the World Resources Institute's Global Water Stress Mapping tool (WRI Aqueduct 2013). The regions of medium to extremely high risk of flood and drought appear as orange to red shading and illustrate that no continent is immune to the threat of floods and droughts occurring together in the same location.

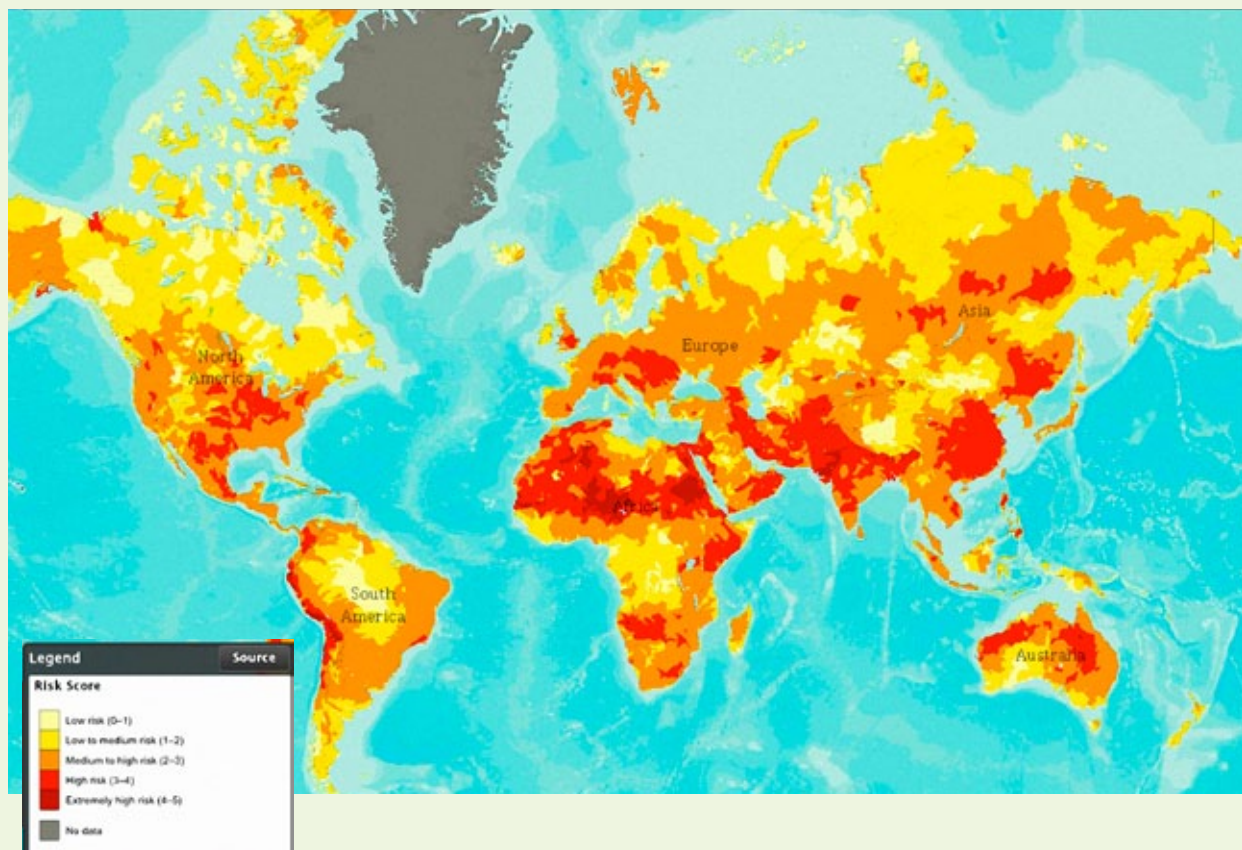
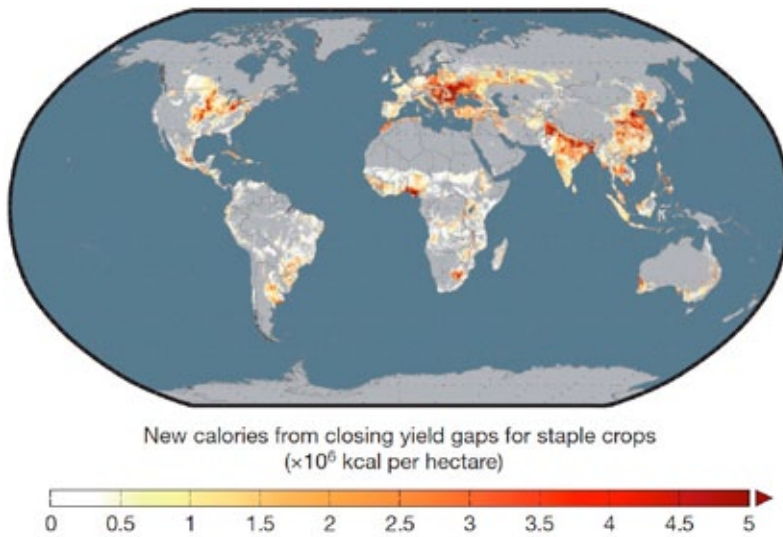


FIGURE 1:

Overlay of risk scores for flood occurrence (number of floods recorded from 1985 to 2011) and drought (average length of droughts times the dryness of the drought from 1901 to 2008) produced using the WRI Aqueduct Global Water Stress Mapping Tool (WRI Aqueduct 2013).

(National Geographic 2013). Before September 2013, approximately 90 percent of the state was in a drought condition. The dry summer season saw unprecedented wildfires that ravaged 140,000 acres around the major centers of Fort Collins and Colorado Springs, with many ranchers needing to cull their herds due to a lack of feed. The massive recreational ski industry in the state had to shorten its season and communities had to put in place water conservation measures. But during September, typically a dry month in the region, a perfect storm converged and hovered over the

Rocky Mountains with some cities receiving record monthly precipitation as well as single storm precipitation more than double the previous record. Damage from the unexpected fall flooding was estimated at \$2 billion (Reuters 2013). Strangely, two months prior to this flood, and only slightly further north in the Canadian Rocky Mountains, a similar weather anomaly converged on the city of Calgary and surrounding region bringing with it close to \$6 billion in flood damage (Calgary Herald 2013), making it the most costly natural disaster in Canadian history (CBC 2013).



**FIGURE 2:** Regions where additional calories can potentially be produced from existing cropland area by closing yield gaps (from Foley et al. 2011).

This picture of floods and droughts and droughts and floods can be seen around the world. During 2012–13, several drought-ravaged districts of the Indian state of Maharashtra experienced unprecedented flooding with up to two times the average rainfall, with an estimated 350,000 hectares of residential and agriculture land were reported to be under water (Down to Earth 2013). In China, the 2013 summer saw record high temperatures in parts of the country. The heat wave impacted 13 provinces which left approximately 6 million people and 2 million heads of livestock short of drinking water (Xinhuanet 2013).

The economic costs of this drought are estimated at \$2 billion and affected 2 million hectares of farmland, with about 350,000 hectares unable to be harvested at all (Xinhuanet 2013). At the same time and in the northern parts of China, the Gansu Province received double the normal annual precipitation. In Tianshui City in July, four successive rainfall events triggered floods, landslides, and mud-rock flows across seven townships and affecting 1.22 million people (Xinhuanet 2013). In Europe, 2013 the weather whiplash of flood and drought continued. For example, during May and June “much of Central Europe was affected by extreme flooding in many areas: causing damages to houses, infrastructure, and services (Europa 2013).” Then in July, crops in Austria and Hungary were subjected to unusually high temperatures in excess of 40 degrees Celsius which shriveled the harvest (Deutsche Welle 2013).

It was also reported that Austria’s disaster fund which was set up to cover natural events such as floods and droughts cannot cover all of

today’s claims, claims which more than doubled in 2012 compared to a decade earlier (Deutsche Welle 2013). Floods and drought, drought and floods. The impact on human well-being from such events over the past few years is staggering. So too is the opportunity cost of investments made to recover from such disasters when one tries to imagine the positive development impact that such investment could bring. The situation today, and more importantly of tomorrow, appears to be that of trying to walk up a downward moving escalator – forward progress it seems, is becoming virtually impossible.

The criticality of these flood- and drought-prone areas is brought into even starker relief when considering the agriculture potential of future food production regions. Foley et al. (2011) describe “policy solutions for a cultivated planet” and demonstrate that bringing the world’s existing crop producing regions to within 95 percent of their yield potential could increase global crop production by 58 percent – with no new cropland area expansion.

Their map, shown in Figure 2, shows where the most new calories could be produced by closing the “yield gap” for 16 crop varieties. While there is no consensus that closing yield gaps should be a focus of agriculture research and policy, when viewing Figures 1 and 2 together it becomes evident that many of these existing and potential future higher yielding agriculture production zones are also in regions that are simultaneously stressed by floods and droughts. Among these areas are parts of central North America, Eastern Europe, north India, eastern China, northern Africa, southeast Australia, and central Mexico.

The purpose of this summary for decision-makers is to help illuminate the intimate relationship among land, water, and people and, most importantly in the context of future global change, to stress the urgent need for integrated planning and management in order to flood- and drought-proof regions of the world where such stresses converge and negatively impact on ecosystem services and human well-being.

# Key Questions

## WHAT IS THE RELATIONSHIP AMONG LAND, WATER, AND PEOPLE?

Crucial environment and development policy challenges lie ahead for the 21st century, necessitating an intensely efficient and effective targeting of public and private investment. Specifically, this entails meeting the dual challenge of achieving high human development within the earth's limits.

The oft-cited relationship between national ecological footprints and human development indices, shown in Figure 3, perhaps best encapsulates the challenge. The lower right area of the graph is a representation of sustainable human development and is bounded statistically in this instance by the UNDP threshold for high human development and the world average biocapacity. Two points are abundantly clear. First is that only a few countries at present occupy the statistical space defined as sustainable human development, and even among these select few, the general trend is one of increasing ecological footprint (UNDP 2013). Second, high human development has come hand-in-hand with a high ecological footprint. Uncoupling this linkage, or at least weakening it, is the conundrum of 21st century sustainable development.

An understanding of the many complex relationships among land, water and people remains at the epicenter of addressing the 21st century sustainable development conundrum. This understanding is essential for informing smart public and private investment in our landscapes in such a way that every dollar spent has co-benefits.

Progress has been made the past five years toward this improved understanding of complex relationships. The nexus discussions around water, energy, food security, and climate change are a prime example. A review of the last three annual editions of the World Economic Forum's (WEF) Global Risk Report from a land and water perspective shows that water, energy and food security, and climate change are recurring themes among the top five global risks in terms of impact and likelihood (WEF 2013, Figure 6). And importantly, the potential failure of climate change adaptation is now for the first time ranked among the top five global risks with respect to impact. The 2013 Global Risk Report also highlights the critically important role of co-benefits in effectively managing the global risk landscape and in addressing the traditionally confounding relationship among environment and economic development. The report cites the following in this regard:

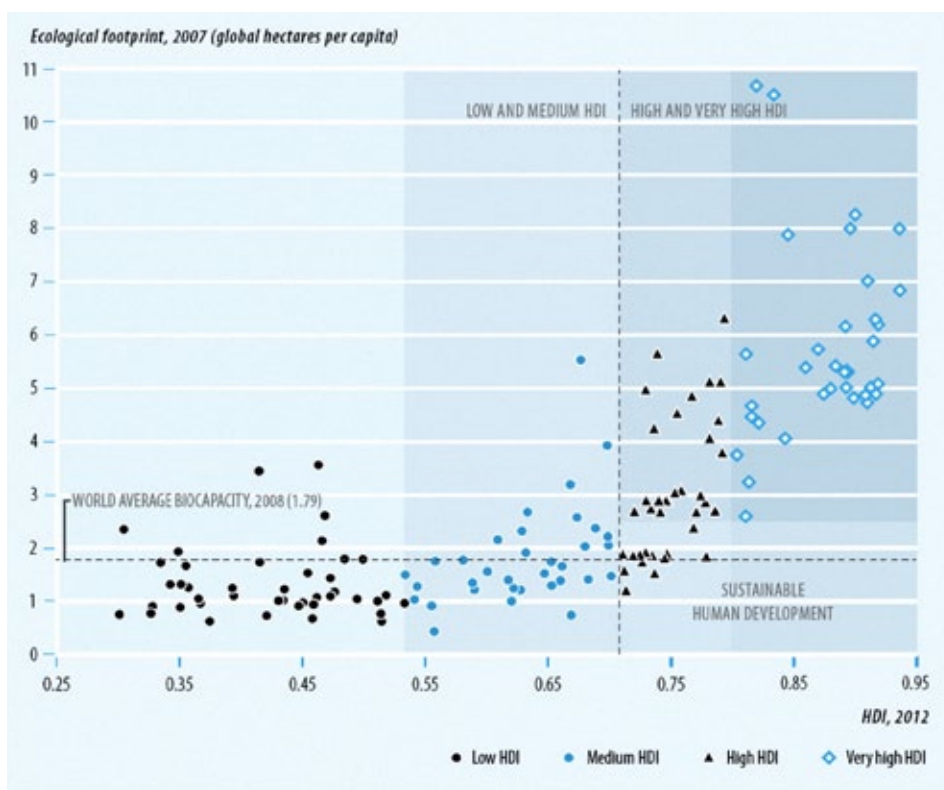


FIGURE 3:

Relationship between the Human Development Index (HDI – 2012) and the Ecological Footprint (EF – 2007) for 151 countries (from UNDP 2013, p. 35). Note: ecological footprint is a measure of the biocapacity of the earth. It depends on the average productivity of biologically productive land and water in a given year.

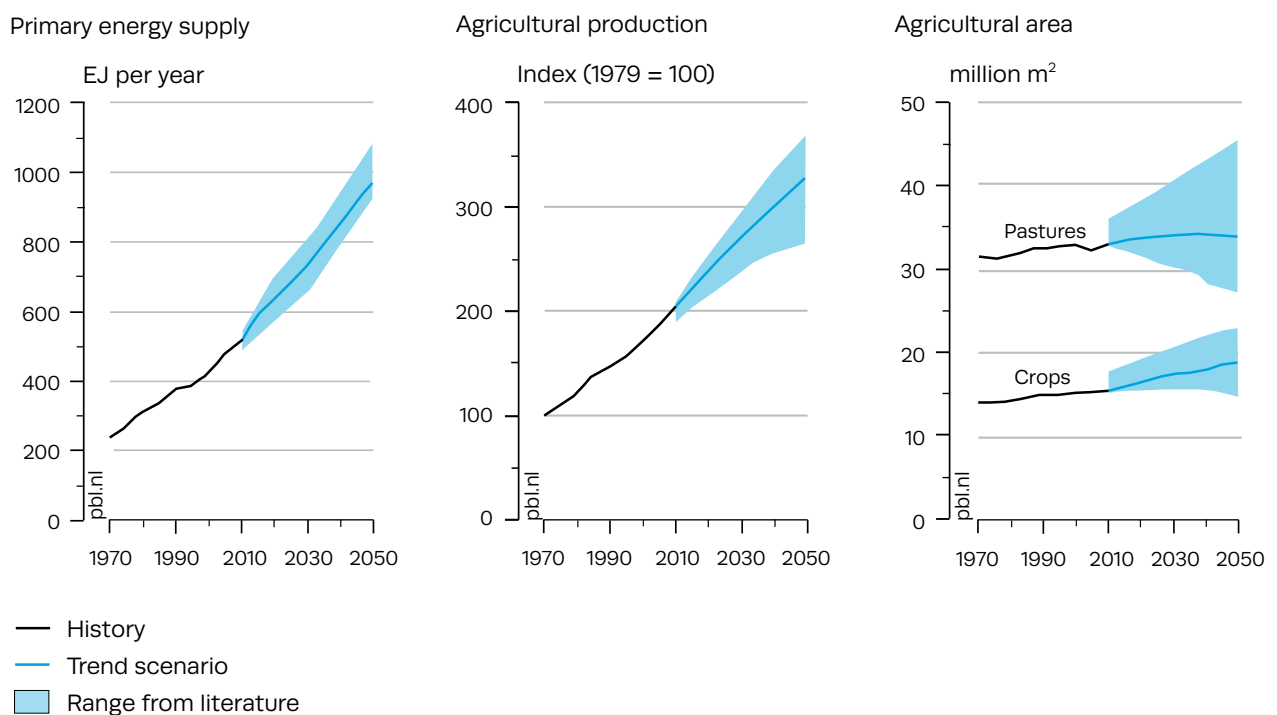
*“Continued stress on the global economic system is positioned to absorb the attention of leaders for the foreseeable future...On the environmental front, the Earth’s resilience is being tested by rising global temperatures and extreme weather events that are likely to become more frequent and severe. A sudden and massive collapse on one front is certain to doom the other’s chance of developing an effective, long-term solution. Given the likelihood of future financial crises and natural catastrophes, are there ways to build resilience in our economic and environmental systems at the same time (WEF 2013)?”*

The Water, Energy, and Food Security Resource Platform has emerged out of a diverse stakeholder dialogue to provide insights toward systems-level solutions for the green economy and sustainable development goals (NEXUS 2013a). Specifically, the policy recommendations that emerged from this dialogue set as a first imperative the achievement of water, energy, and food security for the poorest of the poor, emphasizing the fulfillment of this most basic human right. Second, the group concludes that “sustainable development and growth beyond poverty eradication can be achieved through better management of the world’s ecosystems and a more informed and optimal use of water, land and other natural resources.”

A group of researchers representing a host of international organizations has separately advanced the CLEWS framework as a means for better and smarter assessment for integrated resource management (Howells et al. 2012). The acronym stands for Climate, Land-use, Energy, and Water Strategies. They observe that “current assessment practices are not sufficient to support the decision-making and help to ensure sustainable development and future access to water, food and energy” and further, that “the lack of integration of resource assessments and policy-making leads to inconsistent strategies and inefficient use of resources.” Howells et al. describe the relationship as this: the exploitation of land, energy, and water resources contributes to climate change, and the systems which provide these resources are themselves vulnerable to climate change; hence underscoring the urgency of more efficient use of resources for both mitigation and adaptation.

Global statistics provide a good illustration of the intimate relationship among land, water, and people, and help clarify the drivers of change. Agriculture accounts for 70 percent of global water withdrawals, with industrial uses, mostly thermal cooling processes for energy production and manufacturing, accounting for another 22 percent (Howells et al. 2012). It is projected that during the decade spanning 2008 to 2018, one-half of the increase in global demand for wheat and

**FIGURE 4:** Global projections for energy supply, agriculture production and agriculture area (from PBL 2012).



maize production and one-third of oil seed demand will go toward biofuel production (Howells et al. 2013). Global population and income projections from across the literature provide a clear signal of the impending drivers of change: from 6.5 billion persons today to anywhere from 8 to 11 billion by 2050; and from an average annual income of approximately US\$5,000 per person today to anywhere from \$10,000 to \$18,000 in 2050 (UNEP 2012).

With both the number of persons and the purchasing power increasing over time, the demand on water, energy, and land resources will follow suit. A review of global scenarios undertaken by the Netherlands Environmental Assessment Agency reveals a potential doubling of primary energy supply between 2010 and 2050 (Figure 4), with the majority increase occurring in low income countries and a likely continued domination of fossil fuels (PBL 2012). Over the same period, global scenarios suggest that agriculture production could increase by 75 percent with land area for agriculture crops and pastures each growing as much as 40 percent. The number of persons living in highly water-stressed areas is estimated at almost 2 billion and between 2010 and 2050 this is projected to almost double to 3.7 billion persons (PBL 2012). Global projections for energy supply, agriculture production and agriculture area (from PBL 2012).

Alduous et al. (2011) describe freshwater ecosystems as “among the most imperiled” by climate change, which is likely to manifest as increased frequency, duration, and intensity of drought, changes in the timing and volume of runoff, decreased groundwater recharge, higher rates of evapotranspiration, and increased water temperatures (Bates et al. 2008). Alduous et al. go on to note that “the novelty with climate change will be in the rising frequency of extreme events such as storms and droughts, and shifts in the timing of hydrologic events in unregulated river basins (Bates et al. 2008).”

Both droughts and floods will increasingly affect the Earth’s land and water resources and thus both food and water security. It is highly uncertain how future droughts and floods will evolve in response to climate, land use change, and other anthropocentric influences. How we manage the drivers and consequences of floods and droughts will therefore significantly determine future livelihoods and overall well-being. The rural poor, who often still depend on rain-fed agriculture, are the most affected by variable

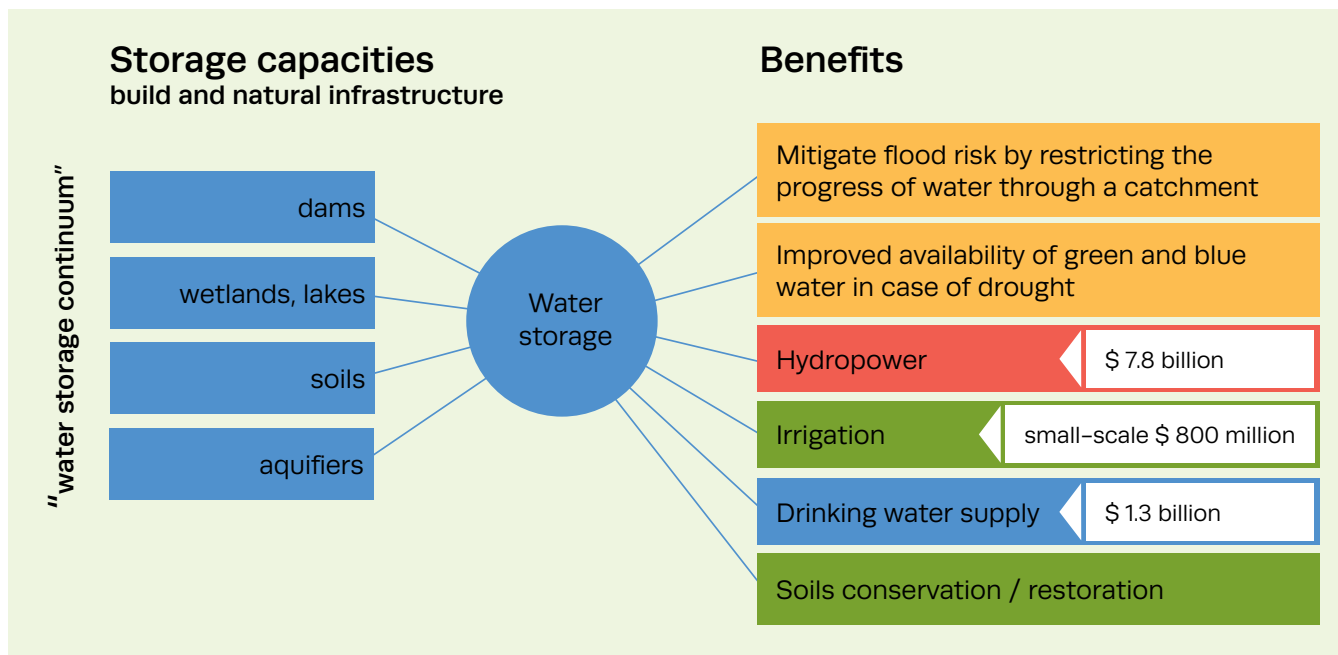
access to water supplies. Yet, water resource variability also has beneficial aspects: floods benefit fisheries and floodplain agriculture, and both droughts and floods may kill pests. The challenge is, therefore, to reduce the negative impacts of water resource variability while simultaneously exploiting its benefits. Understanding how we can better manage water resources variability and adapt to extreme climate events has the potential to save billions of dollars and millions of lives.

### HOW DID LAND AND WATER POLICY BECOME SO SEPARATE AND HOW CAN INTEGRATION BE ADVANCED?

A common sequence of events following a disastrous flood includes emergency response, short-term aid for displaced families, and repair of critical infrastructure, followed by disaster relief and insurance payouts, where they exist, to re-invest in rebuilding what was lost and creating some (and sometimes a lot of) new infrastructure or management practices to better deal with the next flood. When a drought occurs some years later in the same region, the same type of sequence of responses usually occurs with various levels of adaptation occurring in the interim.

When a flood occurs, re-investment and new investment target flood mitigation, and seldom, if ever, does it consider how it could also benefit future drought management, and vice versa. What has given rise to such an unfortunate separation between flood and drought responses? There are a host of reasons to explore.

First and at a high level, our systems of governance in relation to natural resources have traditionally been delineated on the basis of promoting and managing the growth of sectors. Forestry departments manage forested lands; fisheries departments often manage water; agriculture departments manage agriculture lands; mining departments manage mining lands; and so on and so forth. Policy silos have proliferated over the years for a range of reasons; however, as we are reminded in a 2010 OECD study entitled *Breaking Down the Silos: Doing More with Less*, “[I]n the context of the economic recovery and public budget cuts, policy silos and fragmented



**FIGURE 5:** Water storage strategies for climate change resilience to floods and droughts in Africa (from Pokorski da Cunha 2013).

short-term policy interventions have also become luxuries that our economies can no longer afford (OECD 2010)."

It is also the case that sector departments are often grouped within a supra-department or ministry of natural resources as a move toward integration; however, this has not manifest in any serious degree of systems-level planning and management. There has been some progress toward place-based landscape and water resource planning and management, delineated by watershed or eco-zone boundaries, but again, the traditional sector-based policy silos remain mostly intact and wield most of the power when it comes to decision-making at the local or regional level. Disciplinary silos are also another contributor to the separation between land and water policy and management. Academic institutions have traditionally provided educational opportunities based on specific disciplines, producing hydrologic engineers, mining engineers, agrologists, forest managers, soil scientists, and so on. And for good reason – each discipline is a complicated field requiring multiple years of education and apprenticeship. Few students are trained to be landscape managers with systems thinking skills and multi-disciplinary knowledge. Progress has occurred in this regard, as evidenced by the emergence of some interdisciplinary and systems-based programs; however, once trained, young professionals are thrust immediately into the silos dictated by either the government department or the private sector business in which they are employed.

For floods and drought specifically, the temporal nature of occurrence also plays a role in creating policy silos. Historically and in regions stressed by both floods and droughts, the events rarely occurred in the same approximate time interval. If a flood was to occur, it would be several years before the same region would be afflicted by a severe drought. Human and political nature essentially dictates that we address the problem in front of us. When a flood or a drought occurs, recovery measures are undertaken in the aftermath and, if severe enough, some new mitigation measures also might be put in place. Large dam and water reservoir projects are an exception to this, where in some situations the infrastructure is planned to provide storage for flood control and drought protection and is managed in this manner.

For broader land use and landscape management investment however, it is only recently with regions seemingly being stressed more frequently by floods and droughts in the same year, are we starting to see examples of integrated initiatives. And many of these efforts are motivated by climate change adaptation concerns.

In 2009, the World Meteorological Organization (WMO) published a concept paper on integrated flood management (WMO 2009) defining it as "a process promoting an integrated – rather than fragmented – approach to flood management. It integrates land and water resources development in a river basin, within the context of integrated water resources management (IWRM), and aims at maximizing the net benefits from the use of floodplains and minimizing loss of life from

flooding.” While this proposed approach takes management beyond traditional ad hoc approaches to include broader land use, coastal zone, and hazard management, it does not explicitly mention drought.

More recently, the Global Water Partnership in collaboration with the WMO, launched an Integrated Drought Management Programme (IDMP) “to improve monitoring and prevention of one of the world’s greatest natural hazards (GWP 2013).” While the new program aims “to create more “proactive, forward-looking national drought policies to replace the current piecemeal, reactive approach,” there is no explicit mention of integration with flood management.

The combined effects of floods and droughts are also identified as key risks by The Mekong River Commission for Sustainable Development (MRC 2013). Attention is given to both the costs and the ecosystem services benefits of events in the region, for example: “[W]hile annual floods have the potential to cause damage to unprepared communities, spoil crops and endanger food security, they also play a vital role in agriculture. Additionally, annual flood pulses sustain the world-renowned productivity of Mekong freshwater fisheries.” The MRC cites the average annual cost of flooding in the Lower Mekong Basin at between \$60 and \$70 million, but also notes that “the average annual value of flood benefits is approximately US\$8–10 billion. The goal – and challenge – of flood management is to reduce the costs and impacts of flooding while preserving the benefits.” The cost-benefit balance sheet is not so favorable on the drought side however. The MRC further recognizes that “the cost of drought in the Lower Mekong Basin dwarfs the cost of flooding, but that unlike floods, droughts provide no apparent benefit.”

Reducing current vulnerability will be the first step to prepare for such anticipated changes (Oki and Kanai 2006). The future development of hydrology requires improved communication between scientists and policy-makers to ensure that hydrological expertise is translated into actions that address water challenges (Oki et al. 2005) and to make sure that scientists understand what kinds of knowledge are required by policy-makers and by society at large (McIntosh et al. 2013; Oki and Kanai 2006).

It seems that even with the emergence of integrated approaches for flood management, drought management, and climate change, that policy silos are still somewhat pervasive. There

are significant risks to not taking into account the holistic risk picture within a given landscape setting, and this is particularly so for regions which have experienced both floods and drought in the past. Aside from the immediate impact on human well-being, prospects for future development are similar to walking up a downward moving escalator. Progress toward human development (i.e., including education and health) is very difficult, or near impossible, when a region has to continually respond to costly floods and droughts using taxpayer dollars.

It is important to note at this point that some advances have certainly been made in the arena of integrated land and water management and policy. Efforts toward integrated water resources management (IWRM) in all regions of the world are an example of this, as are instances of pasture management and communal land management systems. However, integrated land and water management is mostly still the exception rather than the rule, where in the developing world there exist “sharp sectoral boundaries between land and water policies, rights and institutions” and that these “separate systems for administering land and water are often a barrier to efficient, equitable and sustainable use (FAO 2011a).” Additionally, cooperation at the international and regional levels in natural resource management, including the private sector, has seen a “significant increase” and water challenges have “taken center stage in global environmental diplomacy” within the United Nations since the Stockholm Conference in 1972 (FAO 2011b). However, as the FAO reports through its State of Land and Water Resources thematic reports, despite this attention to land and water challenges over the past several

### THE WATER, ENERGY, AND FOOD NEXUS

“The ‘water–food–energy’ nexus: A rapidly rising global population and growing prosperity are putting unsustainable pressures on resources. Demand for water, food and energy is expected to rise by 30–50% in the next two decades, while economic disparities incentivize short-term responses in production and consumption that undermine long-term sustainability. Shortages could cause social and political instability, geopolitical conflict and irreparable environmental damage. Any strategy that focuses on one part of the water–food–energy nexus without considering its interconnections risks serious unintended consequences.” Source: World Economic Forum 2011 Global Risk Report, 6th Edition

decades, there still exist numerous challenges related to “limited compliance with conventions and international laws, limited funding support for regional and international initiatives, and slow progress in implementing the Paris Convention on aid effectiveness (FAO 2011b).”

How best then do we begin to move toward integrating multiple scientific and professional disciplines to mitigate and adapt to drought and flood impacts? An array of approaches have begun to emerge over the past decade.

A “nexus solutions” approach is advocated by the Water, Energy, and Food Security Platform. The “nexus solutions” approach was born out of the inaugural Bonn Nexus conference in 2011 to bring a systems thinking approach to efforts for advancing “the Green Economy and the consideration of sustainability development goals (Nexus 2013b).” With financial support from the German government, the Resource Platform supports a host of initiatives and knowledge sharing services to support integrated thinking and action for addressing water, energy, and food security. The water, energy, and food security nomenclature has gained significant traction in the international economic as well as environmental communities (Howells et al. 2013; World Economic Forum 2013) and is helping bring focused attention to exploring and realizing co-benefits in development and climate change adaptation action.

A “nexus solutions” approach can help to identify specific landscape level strategies. For example, Pokorski da Cunha (2013) in a presentation to the Tokyo International Conference on African Development recommends multi-purpose water storage as the key for mitigating water resource variability in Africa (Figure 5). He reports that “over 220 million Africans are exposed to drought and 1.5 million affected by floods each year” and in Kenya, 10 to 16 percent of GDP were lost due to floods and droughts in 1997–2000. For these reasons, Pokorski da Cunha (2013) purports that “Africa cannot afford to ignore the potential for synergies between the different uses of water storage.”

Climate change adaptation strategies are another important approach for achieving integration among land and water issues, and between flood and drought management specifically. The water storage strategy described above is one such example. Additionally, Alduous et al. (2011) in recognizing that climate change is expected to have “significant impacts on hydrologic regimes and freshwater ecosystems” promote that climate change adaptation strategies “can build on exist-

ing freshwater conservation activities, and incorporate predicted climate change impacts.” They illustrate three case studies in which climate change was taken into consideration in flood or drought management. The first case is in the Upper Klamath Basin of the western United States, where a shift in land management practices was found to buffer the landscape from a declining snowpack. The second case was in Australia’s Murray-Darling Basin where it was found that identification of the requirements of flood-dependent natural values would better inform the delivery of environmental water in response to reduced runoff and less water. Third, the Savannah Basin of the southeastern United States illustrated a case where dam managers are considering technological and engineering upgrades in response to more severe floods and droughts, which in turn, would also improve the implementation of recommended environmental flows.

And further to climate change adaptation strategies as a mechanism for achieving integration, agriculture strategies for mitigating greenhouse gas emissions provide another important dimension. This is often referred to as the mitigation-adaptation nexus or in the specific case of food production, “climate-smart agriculture – CSA (FAO 2013)”. In describing CSA, the Food and Agriculture Organization of the United Nations focuses on a landscape approach and notes that “enhancing food security while contributing to mitigate climate change and preserving the natural resource base and vital ecosystem services requires the transition to agricultural production systems that are more productive, use inputs more efficiently, have less variability and greater stability in their outputs, and are more resilient to risks, shocks and long-term climate variability.” In contrast to agriculture mitigation and adaptation strategies which generally reduces resource use or increase resource use efficiency, many non-agriculture mitigation efforts tend to increase water and land use (i.e., production of biofuels).

The benefits of an integrated approach are significant, whether it be via a water-energy-food nexus solutions approach or climate change adaptation and mitigation strategies or both. The benefits are generally twofold. The first relates to the co-benefits and trade-offs that can be achieved among water, food, and energy security and other issues. Second, and stemming from the first, is a more efficient use of public and private funds. Consider the case example labelled as a Box as a prime example of these benefits.



## INTEGRATED FLOOD AND DROUGHT MANAGEMENT IN THE LAKE WINNIPEG AND RED RIVER BASINS

The Red River Basin covers approximately 116,000 square kilometres across five Canadian provinces and American states and is extremely flat – often referred to as flat as a pancake. Taking advantage of the rich soils in the basin, settlers in the region drained many of the original wetlands and built ditches and water channels to move water downstream (Kurz et al. 2008). Here a unique re-engineered landscape concept was introduced as an integrated approach to flood and drought management which included small-scale distributed storage, referred to as “waffles” (Kurz et al. 2008). The waffle design uses the existing raised road infrastructure network of the prairie landscape to temporarily store water, much like a waffle stores syrup. The storage areas and network of existing raised roads and drainage structures would temporarily store water until the river crest passes and thereby reducing the volume of water needed to be managed by dikes and diversion structures downstream (Kurz et al. 2008). This controlled release of water from agricultural areas produced multiple co-benefits in reduced local and watershed-scale flooding, reduced washout of roads and culverts, and increased soil moisture for times of drought (Kurz et al. 2008). Economic analysis of the waffle system for the basin reveals direct net benefits on the order of \$350 to 400 million (DeVuyst et al. 2009).



FIGURE 6:  
The Lake Winnipeg  
and Red River Basins  
(adapted from IISD 2013).

Organizations in the region looked even further for other co-benefits that could be achieved from natural and engineered wetlands. These efforts were motivated by the fact that Lake Winnipeg, the Red River Basin's predominant landscape feature and tenth largest freshwater lake in the world was becoming highly eutrophic. In fact, in 2013 it was named the world's most threatened lake, owing to eutrophication caused by phosphorous loading from the agriculture landscapes and community wastewater disposal (Global Nature Fund 2013). The Lake Winnipeg Bio-economy Project, voted one of the top 100 sustainability innovations in 2012 (Sustainia100 2012), involves the harvesting of cattails (typha) that flourish in natural and engineered wetland areas (IISD 2008) to achieve multiple co-benefits. The primary benefit of harvesting the biomass from cattails is the reduction of phosphorus loading to Lake Winnipeg – the predominant feature of the region and tenth largest freshwater lake. Other environmental co-benefits of the Lake Winnipeg Bio-economy Project include the use of the harvested biomass as a viable feedstock for bioenergy to displace coal, and the certification of cattails through the voluntary market for generation of carbon offset credits (IISD 2008).

## HOW COULD AN ECOSYSTEM SERVICES APPROACH CONTRIBUTE TO EFFECTIVE FLOOD AND DROUGHT PREVENTION, MANAGEMENT AND ADAPTATION?

The use of ecosystem services classifications as introduced in the Millennium Ecosystem Assessment (MA 2005a) have a proven track record for providing an effective analytical framework for understanding landscapes and their potential economic benefits. For example, The Economics of Ecosystem and Biodiversity (TEEB) initiative of UNEP employs the approach directly in its effort to understand the costs of biodiversity loss in landscapes (UNEP 2010).

Additionally, the European Environment Agency has catalyzed the creation of the Common International Classification of Ecosystem Services (CICES) to support the agencies recommendations to the revisions of the System of Environmental-Economic Accounting (SEEA) led by the United Nations Statistical Division (EEA 2013).

The utility of the Millennium Ecosystem Assessment framework goes beyond providing a framework for ecosystem services classifications, it also illustrated the potential linkages with various aspects of human well-being (Figure 7). This comprehensive ecosystem services and human well-being framework provides users with the ability to connect environmental changes to human well-being more rigorously, thereby providing analysts a more effective way to communicate with decision-makers.

Applying the ecosystem services approach offers significant potential for enhancing planning, implementation and assessment efforts for integrated land and water management. The examples below illustrate this claim.

### Assessment

Because of its comprehensiveness and inventory-like classifications, the ecosystem services approach is extremely useful to the assessment process of integrated land and water management, and more specifically, integrated flood and drought management. Its application to broader integrated assessment is well-documented in the Millennium Ecosystem Assessment itself and its sub-global assessments (MA 2005b), as well as the Global Environment

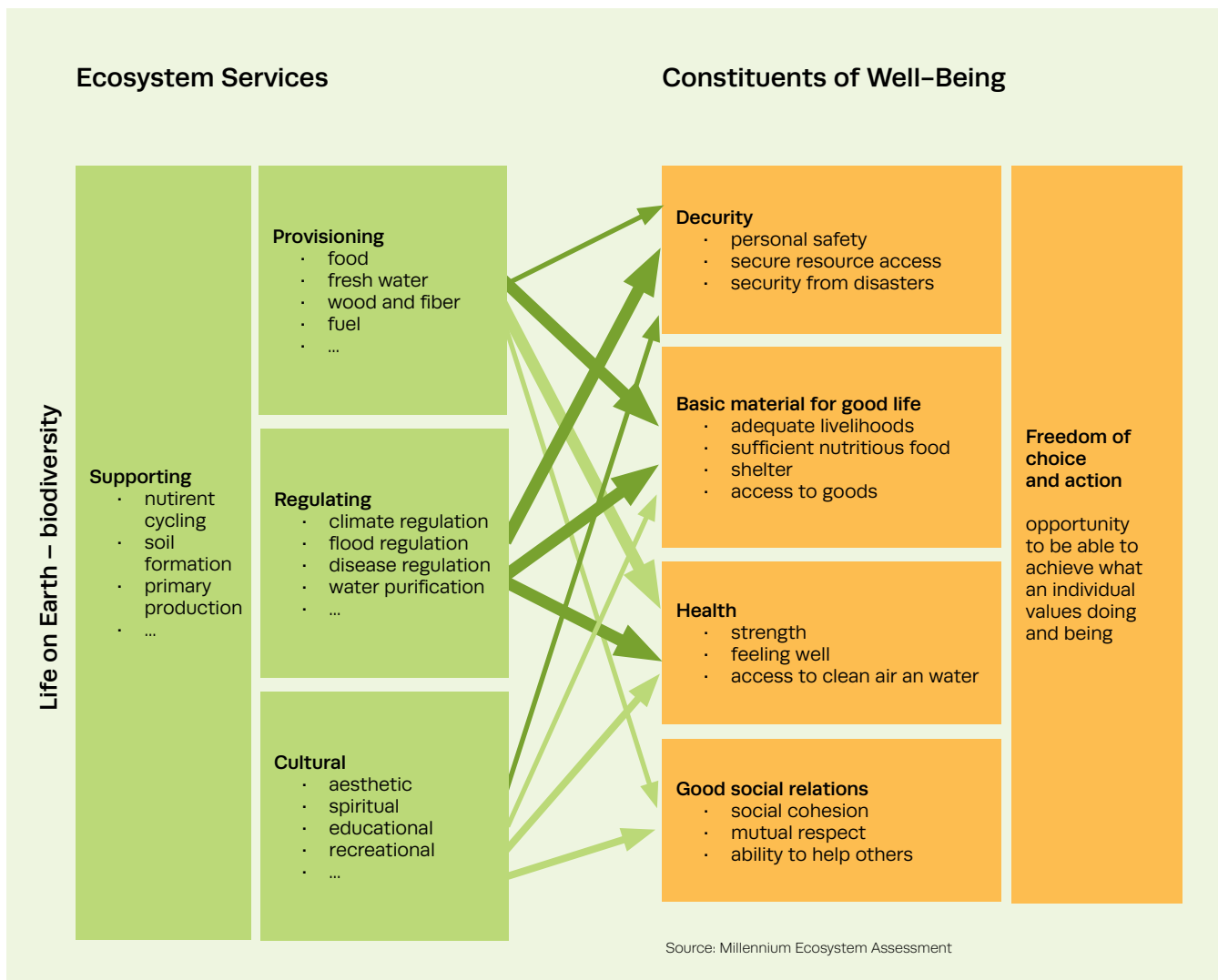
Outlook (GEO) reporting series of UNEP's Division of Early Warning and Assessment (UNEP 2007; UNEP 2012).

For application to at the watershed or water basin scales, the ecosystem services and human well-being approach can create a common reference point for change through the identification of the key ecosystem services of the basin. The impact on the key services brought on by excess water due to flooding or a lack of water from drought (i.e., Liu et al. 2013) and the associated impacts on human well-being aspects can be assessed and compared, resulting in an integrated view of environmental change from flood and drought stress.

### Planning

Application of an ecosystem services approach can greatly facilitate the planning process in basins for drought and flood management by helping to identify benefits and trade-offs of management interventions (Lautenbach et al. 2013). For example Liu et al. (2013) used an ecosystem services approach in Australia's Murray-Darling Basin where a lack of understanding in the broader benefits and trade-offs related to reducing the amount of water diverted for irrigation to improve ecosystem health was hampering the planning process. The ecosystem services approach (Figure 7), combined with multi-criteria decision analysis, proved an effective way to communicate the interdependence of humans and nature and led to better informed and more transparent decisions in the basin.

Bryan and Crossman (2013) applied an ecosystem services approach to understand the interaction of different financial price incentives affect across a range of ecosystem services in an agriculture landscape. This ecosystem services assessment revealed synergies and tensions between different price incentives. They conclude that "failure to understand these interactions between incentives and their effect across multiple ecosystem services can result in inefficient policy outcomes such as unintended negative impacts and the inflated costs of ecosystem services."

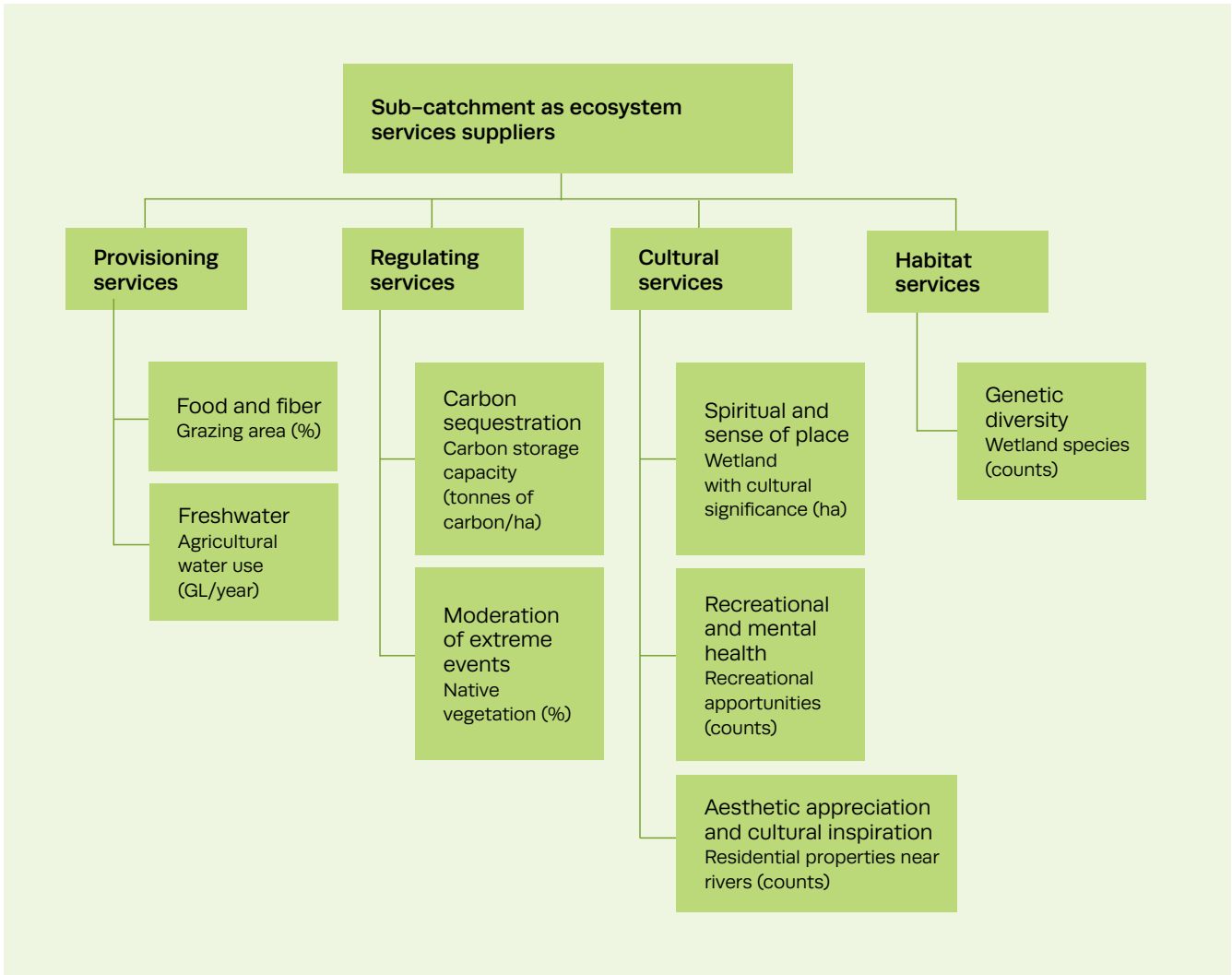


## Implementation

Ecosystem services concepts have a proven use in certain implementation mechanisms. For example, payment for ecosystem services (PES) schemes represent a clear example of the utility of the ecosystem services approach in relation to landscape-level interventions relevant for drought and flood management. The Global Environment Outlook 5 report lists PES systems as a key policy instrument for achieving transformational change toward sustainability (UNEP 2012). The approach was pioneered in Latin America in countries like Costa Rica (Wunder 2007) for forest management, and China has implemented some of the largest schemes in the world (ADB 2010). Wendlund et al. (2010) report that PES schemes are being used more and more by conservationists because they “have the potential to create new funding opportunities for biodiversity protection and other ecosystem services that

contribute to human well-being.” They highlight the Heredia Declaration and one of its guiding principles addressing the “bundling of joint products of intact ecosystems in PES schemes in order to maximize the benefits to society.”

**FIGURE 7:** Ecosystem Services and Human Well-Being Conceptual Framework (from MA 2005a).



**FIGURE 8:**  
Ecosystems services value tree (from Liu et al. 2013).

### HOW CAN WE SCALE UP EFFECTIVELY?

Scale is important for integrated planning and management, and for several reasons. First, integrated land and water management is particularly tricky as it needs to address an entire range of spatial scales geographically from the micro-watershed to entire mountain ranges, and administratively from single villages to regional and national boundaries.

The right scales and levels to use in any context will be determined by a combination of biophysical-ecological and social-institutional patterns and processes, as has been illustrated in the Mekong River Basin (i.e., Dore and Lebel 2010).

Second, experiences with development interventions in agriculture and water resource management contexts have shown that by promoting variability in policy approaches and enabling the

self-organizing potential of stakeholders, these factors facilitate the ability of stakeholders to adapt to change and increase the ability of policies themselves to be adaptive (Swanson et al. 2010; UNEP GEO 2012). The key message from these examples is that an effective scaling up of successful integrated land and water action requires a respect of and attention to scale.

Land and water planning is largely viewed by governments through a techno-engineering lens, using integrated spatially-based modeling approaches coupled with remote sensing and GIS, and engineering of water structures on the ground. Yet traditional local community approaches to integrated land-water management exist across the globe (i.e., Gibson et al. 2000; D'Souza and Nagendra 2011). Such approaches have shown tremendous promise for revival and scaling up in new contexts, coupling the use of ecological approaches such as tree plantation with agricultural changes such as a reduction in

the use of water-intensive crops like sugarcane, and the large scale restoration of rain water harvesting structures (Shah and Raju 2001).

Top-down policy approaches of course continue to play an integral role in scaling up best practices at a landscape level, and particularly so when they incent and reinforce bottom-up initiatives. For example, consider the European Commission's preparatory action on development of prevention activities to halt desertification in Europe. Connected with such actions and to improve the understanding and management of water resources, the European Environment Agency (EEA) has created ECRINS. ECRINS is acronym for European Catchments and Rivers Network System. It is a fully connected system of watersheds, rivers, lakes, monitoring stations, dams. In 2012, the European Commission presented a Blueprint to Safeguard Europe's Water Resources. This document assessed the implementation and achievements of EU water policy and identified actions to strengthen water policy and to address ongoing vulnerability of the water environment.

## WHAT ARE THE INSTITUTIONAL AND KNOWLEDGE GAPS AND OPPORTUNITIES FOR MOVING FORWARD?

Integrated land and water management with respect to floods and droughts is beginning to emerge as evidenced so far in this summary for decision-makers. But a number of institutional and knowledge gaps exist which are creating barriers to more widespread practice.

One gap is a basic awareness among policy-makers and policy analysts of the importance and need to identify co-benefits in policy and programme interventions on landscapes. An appreciation of the urgent need for leveraging co-benefits comes from a knowledge of the economics of dealing with future climate change impacts as well as of the instability of financial markets and their impact on government fiscal ability. We have seen early in this paper that regions simultaneously stressed by floods and drought will be constantly responding to costly damage if adaptation efforts are not implemented; and coupled with existing fiscal constraints, there will in the near term be less money available to meet an increased need for landscape investment. So interventions must seek the potential for co-benefits or there simply will not be enough money to go around. This general knowledge of adaptation and fiscal resilience exists, so the processes for their communication need to be strengthened and even redirected. This knowledge and awareness should target not just the landscape planners themselves, but those in government who are the gatekeepers of annual budget approvals and allocations. These include finance departments and their analysts and audit departments and their risk analysts.

There is also a need for better assessment and forecasting tools for informing integrated land and water policies and programmes, including access to high resolution topographic and other information. Where this gap prevents the proper assessment of landscape change there will exist a lack of understanding of the broad benefit and trade-offs of land and water management decisions and programmes (Lie et al. 2013). Integrated assessment approaches using nexus solution and climate change adaptation approaches were discussed previously and are important here, including the use of ecosystem services concepts



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within these approaches to provide more comprehensive identification of costs, benefits, and trade-offs.

With regard to closing knowledge gaps for improving the quantification and valuation of ecosystem services, Crossman et al. (2013) describe the need for “new high spatial and temporal resolution integrated assessment models developed at global to local scales that include biophysical and socio-economic drivers of land use change and ecosystem service supply and demand impacts.” Furthermore they highlight that standards and consistent approaches in the use of such models and tools are important to provide certainty to end users and decision-makers. Strengthening international cross-disciplinary collaborations through the land science and ecosystem services communities are a way forward in this regard (Crossman et al. 2013).

The institutional gaps are significant in relation to integrated land and water management. Aside from the policy silos issue which has already been mentioned, there is another general governance misalignment in relation to the localization of decision-making. The co-mingling of issues that manifest at the landscape level are best understood, appreciated and addressed

from a place-based perspective where the issues “hit the ground.” But our institutions are predominantly sector-based and function at high altitude from federal and provincial scale government departments. Needed is a more decentralized approach to land and water planning and management where the responsibilities and fiscal resources and capacities are made available to existing or new place-based agencies (Fabricius et al. 2007; Kemper et al. 2007; Swanson et al. 2010). Many jurisdictions do have watershed or eco-zone-based associations or offices, but most typically do not possess the necessary mandates over higher level sector development pursuits that occur within their local jurisdictions.

# Conclusion

Integrated land and water management is absolutely essential in regions stressed by both floods and droughts. Without integrated management, achieving development progress in these regions will be similar to walking up a downward moving escalator. In other words, the majority of public and private investment will be consumed by continual and costly repairs to existing infrastructure, leaving little to no fiscal resources for advancing human well-being and sustaining ecosystems for current and future generations.



Grand Dessalines Haiti © UN Photo / Marco Dormino

# Key Findings & Recommendations

## 1 AN URGENT NEED FOR INTEGRATED FLOOD AND DROUGHT POLICY

**FINDING:** Reducing water resource variability—which is instrumental for both floods and droughts can significantly enhance global GDP and reduce loss of life and property damage. There needs to be a greater understanding among decision-makers at all levels about hotspots where drought and flood issues converge and the importance of seeking landscape level changes that have co-benefits for floods and drought. Several integrated river basin management projects during the last decade have shown that the collaboration and integration of different sectors is fruitful and supports sustainable water and land use development.

**RECOMMENDATION:** Integration which is appropriately bounded can be a basis for sustainable management of water resources (Hering and Ingold 2012) and can lead to the implementation of landscape-level changes with multiple co-benefits for floods, drought, and water quality. An Integrated Water and Land Resources Management (IWLRM) approach is needed “in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Falkenmark and Rockström 2004)”. This can be achieved by quantifying ecosystem services and identifying trade-offs and interactions in landscapes to derive optimum land and water management strategies (Lautenbach et al. 2013; Seppelt et al. 2013). The level of international acceptance of IWLRM warrants a concerted effort on the part of the technical community to overcome barriers to its implementation. In this regard, Hering and Ingold (2012) propose a pragmatic approach to integration that uses case- and site-specific conditions to set both the appropriate geographic scale and scope of integration, and further note that “less ambition may result in better delivery.”



## 2 AN URGENT NEED FOR IMPROVED CAPACITIES TO ASSESS INTEGRATED FLOOD AND DROUGHT ISSUES AND TO IDENTIFY ACTIONS WITH CO-BENEFITS.

**FINDING:** Supporting IWLRM will require improved capacities in assessment, planning, and management that can identify and communicate costs, benefits and trade-offs of flood and drought management policies, programs, and projects in a comprehensive and holistic manner. The importance of such capacity building is starting to be realized (i.e, U.K. Parliament 2013). This would include understanding the strengths and limitations of engineering and technological solutions, and the potential of community-based approaches and traditional knowledge in mitigating and adapting to floods and droughts.

**RECOMMENDATION:** An ecosystem services approach can provide an analytical basis for decision support systems to ensure that assessments are commensurate with the complexity of integrated floods and drought policy and management issues and IWLRM in general. Decision support systems that can effectively communicate across scientific, policy, and civil society communities and incorporate scientific-technical as well as traditional knowledge are needed and must orientate towards the needs and demands of the user (McIntosh et al. 2011; Volk et al. 2010).

## 3 AN ECOSYSTEM SERVICES APPROACH MUST TAKE INTO ACCOUNT MULTIPLE PERSPECTIVES.

**FINDINGS:** Trade-offs in integrated management are inevitable – almost any intervention, whether land- or water-focused, will lead to improvements in the state of selected individuals, while worsening the condition of others. Such trade-offs are important to identify and address transparently, focusing on issues of equity and human well-being (Nagendra et al. 2013) through deliberative interactions (Shah and Raju 2001; Dore and Lebel 2010).

**RECOMMENDATION:** While pursuing an ecosystem services approach, it is important that multiple spatial, temporal, and stakeholder perspectives are viewed and respected. Multiple world-views and multiple metaphors are a key feature of ecosystem services and green infrastructure approaches. Integration of multiple disciplines needs to respect these multiple views if land and water assets are to be created and protected for mitigating drought and flood risk.

## 4 ENGAGEMENT OF COMMUNITIES, CIVIC GROUPS, AND THE PRIVATE SECTOR CAN BE USEFUL TO STIMULATE INNOVATION AND PROMOTE INVESTMENT.

**FINDINGS:** The current and looming fiscal challenges of the 21st century are being exacerbated by climate change, and particularly in regions simultaneously stressed by floods and droughts. Integrated flood and drought management in such regions will necessitate innovative collaborations among governments, local communities and civic groups, and the private sector. Examples exist of programs and projects where the public sector is collaborating with local communities, and of private–public partnerships to improve land and water management for increased drought and flood resilience. Critical to future development planning are policy frameworks that promote and support the involvement of communities (D’souza and Nagendra 2011) and private sector investment (Suhas et al. 2010). It is important to assure that involvements of local communities and private sector investments result not just in gains in profit and efficiency, but also that the benefits received are accessible by all, including the poorest and most vulnerable sections of society. Research shows that equity issues are frequently exacerbated by private – public partnerships in the absence of adequate monitoring capacity by governments (Tucker et al. 2010), which is often lacking in parts of the world that are most vulnerable to floods and droughts.

**RECOMMENDATION:** Public, community, and private landscape investment partnerships can be considered, and local community groups and entrepreneurs encouraged to consider investment in the “conservation industry” (Yang et al. 2010) in an effort to not only sustain the natural and social capital of basins stressed by both floods and drought, but to enhance them as an investment hedge against the future risks of climate change (Bizikova et al. 2013). The mainstreaming of green infrastructure (or ecosystem services) frameworks will require standardized methods and approaches to provide greater levels of confidence to investors. At the same time, it is critical to ensure adequate monitoring capacity by local governments to ensure the accessibility to benefits by all, including the poorest and most vulnerable. This requires close attention to motives other than profit-making which necessitate close monitoring by governments, and are not recommended in areas where such monitoring is inadequate or lacking (Tucker et al. 2010).

## 5 INSTITUTIONAL INFRASTRUCTURE IS REQUIRED AT ALL SCALES

**FINDINGS:** Public policy that encourages investment in land and water infrastructure to mitigate drought and flood risk must be integrated to avoid competing policies and competing and/or perverse outcomes. This public policy endeavour will demand “breaking down the silos” (OECD 2010) which exist across sectors, professional disciplines, scales of government, and generations.

**RECOMMENDATION:** A shift in focus is needed from project-based assessment to place-based integrated and cumulative assessment of land and water investment, along with a shift in focus from sector-based high-altitude governance to localized place-based planning and management that involves local communities, and promotes cooperation and coherence across scales.

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Land, water, and people. It is the most basic and traditional of relationships, yet today the relationship has become so complex that we find ourselves ill-equipped to understand all of its interconnections and to plan a future that is sustainable.

The Global Land Project (GLP), established in 2006, aims at improving the understanding and modelling of the effects of human actions on natural processes of the terrestrial biosphere. The Global Water System Project (GWSP) was launched in 2004 to foster understanding of how human actions are changing the global water system and what environmental and socio-economic feed-

backs arise from the anthropogenic changes in that system.

In this summary, we examine conclusions of the two projects related to the issue of floods and droughts, and offer key findings and recommendations to decision-makers as they target some of the crucial environment and development policy challenges that lie ahead for the 21st century.

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