



BIODIVERSITY AND CLIMATE CHANGE ISSUE PAPER No. 3



Convention on
Biological Diversity

FRESHWATER AND CLIMATE CHANGE: DEALING WITH TOO MUCH, TOO LITTLE AND BOTH

Climate change affects ecosystems and people mainly by affecting the availability of water. In most areas, there will be more or less water and increasing frequency and extremes of drought and flood. Water security, already the world's most important natural resource issue, will be significantly worsened by climate change. The role of ecosystems in sustaining the availability of water and reducing water-related risks is central to climate change adaptation. The economic case for working with nature, instead of against it, is strong.

Impact of climate change on water

The science may be complicated but the conclusion is simple: the impacts of climate change occur mainly through freshwater (box 1). Ocean acidification (issue paper No. 7) is the major exception. Water moves through the Earth's ecosystems through the water cycle (figure 1). Global warming affects the Earth by changing this cycle at the global, regional and local levels.

Changing weather patterns are characterized by shifts in temperature, wind and water — water being the basis of atmospheric humidity, cloud cover and precipitation of rain and snow. Although extreme temperatures (e.g., heat stress) and excessive wind can be a problem for both people and nature, it is what happens to water that matters most. Water causes the main damage from storms through flooding, and its absence is responsible for prolonged drought and desertification. The impact of climate change will vary from region to region, and often locally, but most

areas will experience either more or less annual rainfall and, importantly, more frequent and extreme flooding and drought – too much water or not enough of it, and often both at different times in the same place.

Interestingly, however, the solubility of gaseous CO₂ is dependent on temperature: CO₂ is more soluble in colder water than in warmer water. It follows that the cold surface waters of high latitude oceans, which accumulate a higher concentration of CO₂ than others, will be the first areas to experience ocean acidification.

Box 1: Climate change impacts on ecosystems – it's mainly about water

The findings of the Intergovernmental Panel on Climate Change confirm that the changing water cycle is central to most of the expected climate change-related shifts in ecosystems and human well-being. The Panel's fourth assessment report, for example, in its summary for policy makers, lists 32 examples of major projected impacts of climate change in eight regions (covering the entire planet). Of these, hydrological changes are wholly or largely responsible for 25. These hydrological changes include flooding and drought; reduced snow and ice cover; changes in river flows, soil moisture and groundwater; shifts in erosion rates and coastal deposition of sediments; and rising sea levels due to melting ice and permafrost. Of the other seven examples, changes in water are involved but not explicit and two are generalized. Only one of the 32 refers to a main impact not caused directly by changes in the hydrological cycle: coral bleaching. Notably, most of the impacts on terrestrial vegetation and fauna, including on crops and livestock, are also driven largely by hydrological shifts. The Panel's technical report on climate change and water (IPCC 2008) is more specific, concluding unambiguously that "the relationship between climate change and freshwater resources is of primary concern and interest"; that to date "water resource issues have not been adequately addressed in climate change analyses and climate policy formulations"; and that, according to many experts, "water and its availability and quality will be the main pressures, and issues, on societies and the environment under climate change". An expert study for the fifteenth session of the United Nations Commission on Sustainable Development states similar conclusions (CSD 2007). The Stern Review (The Economics of Climate Change, 2006) recognizes that climate change presents very serious global economic risks – often mediated through water.

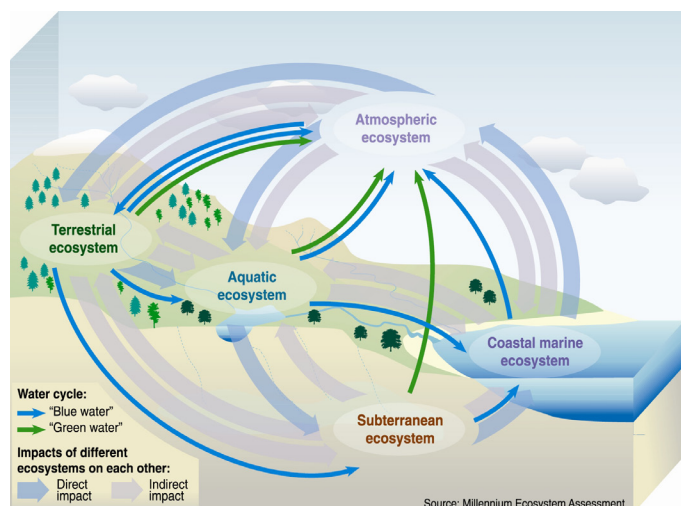


Figure 1: The water cycle on Earth

Source: Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Wetlands and Water Synthesis. World Resources Institute, Washington, D.C., 2005.

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This series provides a synopsis of issues relevant to the Rio Conventions. It is part of ongoing collaboration between the United Nations Environment Programme and the Secretariat of the Convention on Biological Diversity.





How important is water?

Without water there is no life. The quantity, quality and timing of water availability are essential for ecosystem functioning, not just for rivers, lakes and wetlands but also for all terrestrial ecosystems and the biodiversity that they support. What makes freshwater a central resource, however, is its importance to humans. There is growing recognition that freshwater is our most important and valuable natural resource. Freshwater underpins practically all natural resources required for health, well-being and economic development. It is required for agriculture, drinking, industry, energy generation, sanitation and most aspects of health and well-being. Water is the key element linking the various Millennium Development Goals (figure 2). The subject of water forges the strongest links between environment, economic and development interests.

Despite its importance, we continue to mismanage, pollute and overuse water. Based on business-as-usual models, the outlook for sustaining freshwater availability for ecosystems and people is already grim indeed (box 2). In a draft report prepared for discussion at its 2009 meeting the World Economic Forum noted that “we are living in a water ‘bubble’ as unsustainable and fragile as that which precipitated the collapse in global financial markets” and concluded that “we are now on the verge of water bankruptcy” (WEF 2009). Climate change is set to make things a lot worse and, disturbingly, in areas where serious problems and extremes of drought and flood already occur. Both developed and developing countries are vulnerable, but the latter are much less able to cope.

What does this have to do with ecosystems and biodiversity?

The provision of water of sufficient quality and quantity for both ecosystem and human use is a service provided by ecosystems and hence underpinned by biodiversity. Wetlands play an obvious key role in sustaining the water cycle, and are affected by changes in it, but terrestrial ecosystems are also part of the cycle. For example, an average of 60 per cent of precipitation on land arises from evapo-transpiration through terrestrial vegetation, particularly forests (figure 3). Water needs to be managed in an ecosystem context; climate change, therefore, also requires a holistic ecosystem approach.

Looking ahead: opportunities

The degradation of ecosystems and decline in the services that they provide has already affected the availability of water and increased water-related risks in many areas. Ecosystems are a key factor determining the timing, duration and location of water availability on local and regional scales. Sustaining ecosystems, and where necessary restoring them, is therefore our best option for dealing with increased water problems due to climate change.

The primary adaptation response to climate change, and the increased frequency and severity of droughts and floods associated with climate change, will be to reduce risks by increasing water storage (UNWWAP 2009). There are significant opportunities to use natural ecosystem infrastructure more wisely to that end,

including by increasing resilience in the face of extremes, and thereby achieve better water security. This valuable natural infrastructure consists not only of wetlands but also terrestrial vegetation (especially forests) healthy soils (including the ability to absorb and retain water) and renewable groundwater, which is recharged partly by ecological processes including those provided by wetlands and soils. Importantly, such approaches offer not only more sustainable solutions and other benefits of biodiversity, but can also result in considerable cost savings. Such approaches are already being adopted successfully (box 3).

Box 2: The water crisis

Freshwater withdrawals have tripled over the last 50 years due to rapid population growth. Total global freshwater use by all sectors is estimated at about 4,000 km³ per year, 70 per cent of which is for agriculture; another 6,400 km³ of rainwater is also used “directly” in agriculture, often called “green water” (Comprehensive Assessment 2007). This is already at the limits of ecological sustainability (Molden 2009).

There are, however, large regional and local variations. Large areas have already exceeded sustainable water use—the mid-western region of the United States of America, North Africa and the Middle East being examples—and by 2030 almost half of humanity will be living in areas of high water stress (OECD 2008). Yet demand continues to escalate: based on current patterns, almost a doubling of water use will be required to meet food requirements in 2030, not to mention increasing demand from energy, industry and growing urbanization.

Conflicts over water are already widespread. Nature is still the most important user of water and evapo-transpires an estimated 70,000 km³/year from forests, other natural vegetation and wetlands. It is inevitable that as water for humans becomes scarcer we will take an increasing share of this, with implications for all biomes, and ourselves, if ecological limits are further exceeded.

Climate change affects all water-related needs and issues, amplifying existing problems. In the Himalaya region, for example, retreating glaciers result initially in increased spring river flows but in the long term cause reduced flows. This will threaten water supplies for some 2.3 billion people by 2030 (UNWWAP 2009).

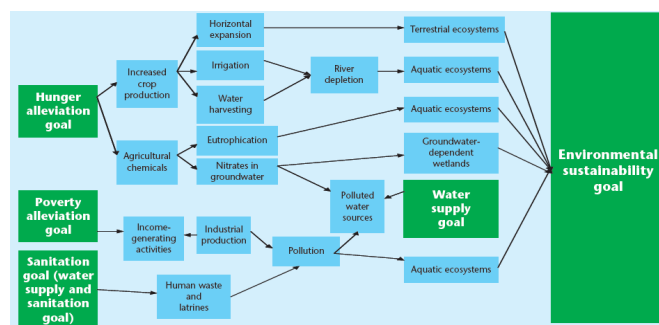


Figure 2: Some ways in which the subject of water forges linkages between the Millennium Development Goals (based on Cosgrove 2006)



Financing ecosystem restoration and biodiversity conservation

Large financial investments in water infrastructure are required and are already being made, in part in response to climate concerns. In the United States, for example, one estimate is that bringing water supply and sewerage infrastructure up to required standards will cost more than \$1 trillion over the next 20 years, with hundreds of billions more required for dams, dykes and waterway maintenance (ASCE 2008). The World Business Council for Sustainable Development estimates that the total costs of replacing aging water supply and sanitation infrastructure in industrial countries alone may be as high as \$200 billion a year (WBCSD 2005). Meanwhile, estimates of global investment requirements in water by 2030 reach \$22 trillion, about the same as that required for energy. This represents a trillion dollars a year. Much of this financing could be redirected to using ecosystem-based approaches, saving money in the process and delivering many other benefits. Even a small percentage used in this way would represent a major source of biodiversity and environment financing.

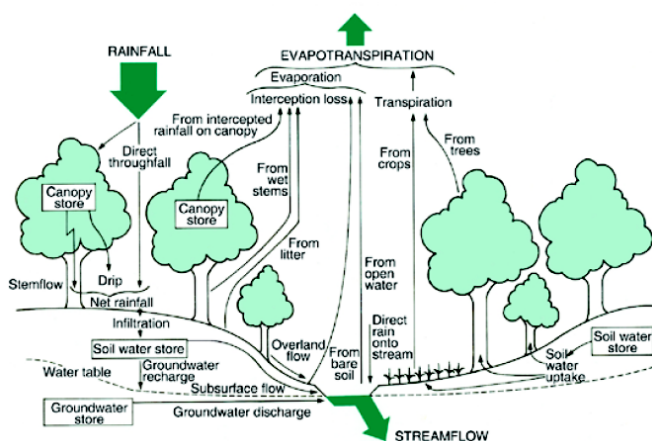


Figure 3: The role of ecosystems and biodiversity in the water cycle (from Hamilton 2008)

Source: L. S. Hamilton. *Forests and Water*. FAO Forestry Paper 155, Rome, FAO, 2008.

Box 3: Working with nature—not against it

Across many parts of the developing world, losses associated with disasters are of a sufficient scale to undermine development and poverty reduction goals. Disasters, most of which are water-related (droughts and floods), cause a sustained 14 per cent reduction in the average GDP of low-income countries. During the decade from 1992 to 2001 floods accounted for 43 per cent of all recorded disasters and affected more than 1.2 billion people (Dilley et al. 2005).

A community-led initiative to mitigate water-related disasters in Nepal

The community of Madhumalla in Morang district employed bioengineering techniques, planting a greenbelt along the river bank, to successfully reduce threats posed by unpredictable and devastating floods. The approach became a model that was replicated by others, including in nearby refugee camps. The project was funded mainly through local resources and received a donor grant of only about \$40,000. The resulting plantation area is expected to generate hundreds of thousand of dollars in income in only a few years. Such initiatives turn risks into rewards (Dinesh L. Shrestha and Tako Ganai, cited in *The United Nations World Water Development Report 3: Water in a Changing World*. World Water Assessment Programme. 2009. Paris, United Nations Educational, Scientific and Cultural Organization, and London, Earthscan).

Restoring and protecting mangroves in Viet Nam

Potential damage from storms, coastal and inland flooding and landslides can be reduced considerably by a combination of careful land-use planning and maintenance or restoration of ecosystems to enhance their buffering capacity. Planting and protecting nearly 12,000 hectares of mangroves in Viet Nam cost \$1.1 million but saved annual expenditures on dyke maintenance of \$7.3 million (De Groot et al. 2006).

Economic benefits of wetland restoration

A recent study in the United States values the extreme-weather mitigation service (risk reduction) provided by wetlands at \$33,000 per hectare for a single storm event, not including the value of other services (Costanza et al. 2008). In the Netherlands, there is a long tradition of converting wetlands and replacing them with dykes to control flooding. Large investments are now concentrated in former wetlands, and the cost of a flood in these areas is very high. Climate change is changing the risks, however, through increases in sea level and extreme river discharges. This has led to a shift in the way people view the costs and benefits of dykes. In some areas it is now recognized that it is more cost effective to restore wetland services through a programme of river restoration, including broadening floodplains, creating or restoring water retention areas in natural depressions and opening or restoring secondary river channels (Stuip et al. 2002). Many countries are similarly re-examining their wetland policies in the light of increased awareness of their values and the risks posed by climate change.



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