summary

Global Warming: Water the Main Mediator

The climate change foreseen in the Intergovernmental Panel on Climate Change's Fourth Assessment has major implications for the water sector. In this article, a followup to our report in the April 2007 Water Front, a set of policy-relevant impacts of the warming on natural and human systems considered to be of key interest to the water community are presented.

Photo: SIWI

The assessment made by the Intergovernmental Panel on Climate Change reports current scientific understanding of impacts on natural, managed and human systems, the vulnerability of these systems and their capacity to adapt. Locations are shown where significant changes in physical and biological systems have been observed, based on 29,000 data series from 75 different studies. Although data and literature on observed changes are scarce in developing countries, IPCC stresses that it is very unlikely that the observed changes be the result of natural variability only.

There is observational evidence from all continents and most oceans that natural systems are being affected, particularly by temperature increases in terms of increased number of glacial lakes, increasing ground instability in permafrost regions, changes in both Arctic and Antarctic ecosystems, increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, warming of lakes in many regions, etc. Recent warming is already strongly affecting terrestrial biological systems with a trend towards earlier greening of vegetation in the spring in many regions.

Other changes are emerging but are difficult to discern due to adaptation and non-climate drivers. This includes among others agricultural and forestry management in the Northern Hemisphere and heat-related mortality in Europe. Expected impacts that have not yet become established trends include an enhanced risk to glacier outburst floods, a warmer and drier hydroclimate in the Sahelian region, and longer dry seasons and more uncertain rainfall in Southern Africa.

Water is mediating effects to human livelihoods

Many of the climate change impacts on economy, human health, hunger and diseases are mediated – transferred – to human livelihoods by temperature-driven alterations of the water cycle. These alterations are proceeding along two parallel branches:

1. Atmospheric warming that speeds up the water cycle, increasing precipitation and generating glacier melting, altered water availability and seasonality, and influencing both human livelihoods and ecosystems. Blue water (lakes, rivers, groundwater, etc.) dependent activities are influenced in both settlements and industrial areas. Also, green water (soil moisture) dependent societal sectors like food, fiber and forest production are also influenced.

2. Atmospheric warming that heats the sea, expanding its volume and causing sea level rise in coastal areas, exacerbated by melting snow and ice from the land, and influencing coastal settlements and small islands.

Impacts on natural systems

In terms of freshwater, annual average river runoff and water availability are projected to increase by 10-40% at high latitudes but decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics. Drought-affected areas will likely increase in extent. Heavy precipitation events are likely to increase in frequency, augmenting flood risks. Figure 1 shows the changes in annual runoff by 2060 under scenario A1B, which assumes very rapid economic growth, continued globalisation, and technological change in energy systems. It shows that large low- and mid-latitude areas will get up to 40% less runoff already some 40 years from now, while other low and high latitude areas will get up to 40% more runoff.

In the course of the century, glaciers and snow cover are projected to decline. This will reduce water availability in regions now dependent on meltwater from major mountain ranges, incorporating more than one-sixth of the world populations.

As for ecosystems, the resilience of many ecosystems to adjust to change and bounce back from shocks is likely to be exceeded during this century. This is foreseen as a result of an unprecedented combination of climate change and associated disturbances like flooding, drought, wildfire, insects, etc., and other drivers like land use change, pollution and

overexploitation of resources. If warming exceeds 1.5-2.5 degrees centigrade, major ecosystem changes are projected with mainly negetative consequences for biodiversity.

Globally, crop productivity may in fact increase slightly in mid- and high latitudes when temperature rise remains in the interval 1-3 degrees centigrade, but decrease for an even larger warming. However, in subsistence sectors in low latitudes, increased frequency of droughts and floods may affect local crop production negatively.

Human system impacts

For industry, settlements and society, the net effects will tend to be more negative the larger the climate change. Most vulnerable are industries and settlements in coastal and river flood plains. Especially vulnerable will be poor communities since they are more dependent on climate-sensitive resources.

The health status of millions of people, particularly those who are already socio-economically and geographically vulnterable, is likely to be affected by increases in malnutrition, heat waves, diarrhoeal disease, cardio-respiratory diseases and altered spatial distribution of some infectious diseases.

Regional projections

In terms of regional projections, IPCC now reports that new studies have confirmed that Africa is one of the continents most vulnerable because of multiple stresses and low adaptive capacity. Agricultural production is projected to be severely compromised in many regions by climate variability and change. The projections suggest increasing challenges in terms of increased water stress and adverse effects on food production as areas suitable for agriculture along the margins of semiarid and arid areas are expected to decrease. Although some adaptation to current climate variability is taking place, it may be insufficent for future climate changes.

Turning focus to Asia, one of their main headaches will be long-term problems linked to glacial melt in the Himalayas, affecting water resources first by increasing flooding, and later followed by decreased riverflows as the glaciers recede. The dense populations in the mega-delta regions in South, East and Southeast Asia will be at great risk from sea-level rise. These different difficulties in the mentioned regions may keep hunger risks very high in several developing countries in Asia.

In Australia, reduced precipitation and increased evaporation will intensify water security problems by 2030. IPCC also foresees a decline in agriculture and forestry production, and biodiversity will suffer.

In Latin America, decreases in green water (soil moisture) are projected to lead to a dramatic gradual replacement of tropical forest by savanna in eastern Amazonia, where significant biodiversity loss is also foreseen. In drier areas of the continent, salinisation and degradation of agricultural land may be expected. Also on this continent, glaciers can be foreseen to disappear.

North America will be suffering decreased snow pack, more winter flooding and reduced summer flows, exacerbating today's problems of over-allocated water resources. In the early decades, rainfed agriculture may in fact increase in yields. The rising value of infrastructure in coastal areas tends to increase vulnerability to climate variability and change in regions where the intensity of tropical storm increases.

In Europe, finally, a multitude of wide ranging impacts have already been documented: retreating glaciers, longer growing seasons, shifts of species ranges and health impacts due to heat waves. Nearly all regions are anticipated to be negatively affected by some future impact, posing challenges on many economic sectors. The great majority of organisms and ecosystems are thought to have difficulties adapting to climate change. Worst affected will be Southern Europe, with higher temperatures and increasing drought, increasing heat waves and more frequent wildfires. Reduced runoff will be impacting not only water availability, but also hydropower potential, summer tourism and crop productivity.

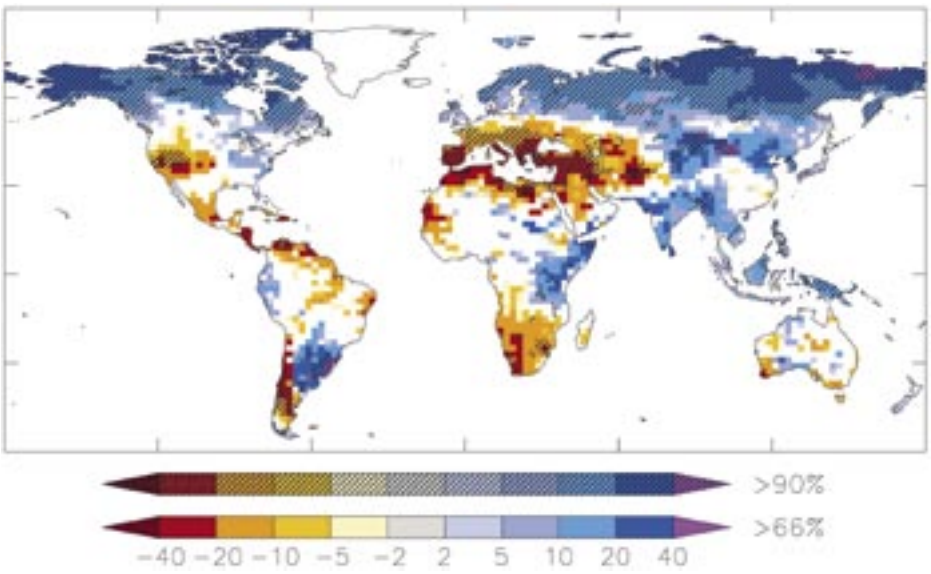
Vulnerability and adaptation needs

The IPCC studies have also made clear that the projected impacts of climate change can vary greatly with the development pathway assumed in their projections. Moreover, vulnerability can be exacerbated by other stresses. Thus, multiple stresses may arise from current climate hazards, poverty and unequal access to resources, food insecurity, globalisation trends, conflicts and incidence of disease such as HIV/AIDS.

Even if the output of greenhouse gases would remain at the present level, a warming of some 0.6 degrees centigrade (beyond 1980-99) will be unavoidable, for which adaptation is the only available and appropriate response. As climate warming increases, there are several options.

The array of adaptation options is very large, however, ranging from purely technological measures like sea defences, through behavioural adaptation such as altered food choices, to managerial adaptation such as altered farm practices, to policy like planning regulations. For developing countries, availability of resources and adaptive capacity-building are particularly important.

As a general conclusion, climate change can be foreseen to bring considerable changes for the water community to find out how to manage. Predicted impacts have to be introduced into development planning in the future, including land use planning and infrastructure design, and measures to reduce vulnerability in disaster reduction strategies.



Multimodel mean changes in annual runoff by 2060, in percent, indicating also degree of agreement between the 12 models used Scenario A1B, i.e. very rapid economic growth, convergence among regions and technological change in energy systems. Illustration from Milly et al 2005.

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For more information, visit www.ipcc.ch. The third volume of the report entitled "Impacts, Adaptation and Vulnerability" was launched May 3 in Brussels.