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POSITION PAPER – Extended Summary

Climate Change Impacts and Adaptation in Water and Land Context

Zbigniew W. Kundzewicz

Day 1 | Climate Change

Climate Change Impacts and Adaptation in Water and Land Context

Zbigniew W. Kundzewicz

Institute for Agricultural and Forest Environment, Polish Academy of Sciences, Poznań, Poland and *Potsdam Institute for Climate Impact Research, Potsdam, Germany*

Summary

The Earth – land, water, and atmosphere, have warmed, the cryosphere has shrunk, and the sea level has risen. Changes in many extreme weather and climate events have been observed, e.g. the frequency and intensity of heavy precipitation events have likely increased over many areas.

However, the precipitation statistics are strongly influenced by natural inter-annual and inter-decadal variability. Observed precipitation trends are often weak and statistically insignificant. Streamflow generation integrates influences of climatic and non-climatic factors. In addition to climatic influences, the freshwater resources and water fluxes have been controlled by direct anthropogenic drivers corresponding to population changes and economic development, therein massive manipulations of both land and freshwater resources. Variations in streamflow reflect variations in atmospheric conditions—primarily, changes in precipitation (volume, timing, and phase) and changes in evapotranspiration (dependent on atmospheric CO_2 concentration, temperature, energy availability, atmospheric humidity, and wind speed), changes in land use (urbanization, deforestation or afforestation, development of agriculture), and more direct human regulations of the water cycle (dike and dam building, irrigation and drainage). Humans attempt to smoothen the spatial-temporal variability of river flow via storage reservoirs and water transfer schemes. Irrigation is by far the most important water use and the global irrigated area has been increasing.

Impacts from recent climate-related extremes, such as heat waves, droughts, floods, and wildfires, reveal significant vulnerability and exposure to current climate variability. Climate-related hazards may exacerbate other stressors, with negative outcomes for livelihoods, especially for people living in poverty.

The global water system is very complex, so that it is difficult to disentangle individual contributions of various factors to changes in freshwater variables. Among the main force of changes in global river discharge have been variations in precipitation, temperature effects on evapotranspiration and partly compensating effects of rising atmospheric CO_2 concentration on the physiology and abundance of vegetation (the physiological and the structural effects).

Models indicate that continued emissions of greenhouse gases will cause further warming and corresponding changes in all components of the climate system. Substantial and sustained reductions of greenhouse gas emissions will be required to curb the climate change.

Projected changes in the global water cycle are not uniform. The contrast in precipitation between wet and dry regions and between wet and dry seasons will likely increase. Wet regions will likely become wetter and dry regions – drier, with increase of flood and drought hazards in many areas. Renewable water resources (defined as long-term average annual streamflow) are likely to increase at high latitudes as well as in some currently water-stressed areas in India and China. However, annual streamflow increases may not alleviate water stress if they are caused by

increases during the wet (monsoon) season or if no infrastructure is available to capture the additional volume of water. The fraction of the global population experiencing water scarcity and the fraction affected by major river floods is projected to increase with the level of warming. Extreme precipitation events are projected to become more intense and more frequent in many parts of the world, which may lead to more floods, landslides, and soil erosion.

A review of impacts and key risks is provided, spanning sectors and regions. Risks of climate change impacts on water and land, have already affected natural and human systems and are projected to increase significantly in the future.

Many key risks constitute tough challenges for less developed countries and vulnerable communities, given their limited ability to cope. Climate-change impacts are projected to slow down economic growth, make poverty reduction more difficult, and further erode food security.

To support water management under changing climate, it is necessary to evaluate potential freshwater-related impacts of climate change in a quantitative way. This involves the application of a chain of methods or models, generating significant uncertainty. In high latitudes and parts of the tropics, climate models are consistent in projecting future precipitation increase, while in some subtropical and lower mid-latitude regions, they are consistent in projecting precipitation decrease. Between these areas of robust increase and decrease in model projections, there are areas with high uncertainty. Quantitative projections of changes in streamflow at the basin scale, relevant to water management, remain largely uncertain.

Water, soil, and waste management decisions have always been made on the basis of uncertain information. Yet, changes in climatic, terrestrial, and socio-economic systems challenge the existing management practices by adding uncertainties and novel risks – often outside the range of experience.

Climate change will affect current water management practices that are very likely to be inadequate to overcome the negative impacts of climate change on water. Climate change has introduced large uncertainties into the estimation of future freshwater resources, with implications for adaptation practices. Due to uncertainty, water managers should no longer base their decisions on crisp estimates of future hydrological conditions and their impacts but consider instead future freshwater hazards and risks. This means that a broad range of possible future hydrological changes should be considered, taking into account a number of emissions and socioeconomic scenarios. It is difficult to assess water-related consequences of climate policies and emission pathways with high credibility and accuracy.

There are two approaches to choosing between alternative courses of action under uncertainty – the precautionary principle and adaptive management. The precautionary principle (resilient or "no-regrets" approach) corresponding to the min-max concept – to choose the approach which minimises the worst outcome. An alternative approach is adaptive management and the use of scenarios, learning from experience, and the development of flexible and low-regret solutions that work satisfactorily within the range of plausible climate futures.

There are some intervention options which perform well under any of the alternative futures and others which perform extremely well in some futures but not in others. Some adaptation measures can be virtually no-regret (doing things that make sense anyway) or low-regret but other measures may entail significant costs. Planning horizons and life times for some adaptation options (e.g., dams) are up to many decades, during which information is expected to change. There is an opportunity cost of failure to act early *vs* value of delay and waiting for the range of uncertainty to become narrower.

Long-lasting and costly efforts of redesigning and building higher levees and larger storage volumes are needed in some areas to accommodate larger future flood waves if the same (or higher) safety standards have to be reached. Water quality systems need to cope with lower self-purification in warmer water, and increased turbidity and pollution may increase significantly the costs and challenges of treating water to potable standards. The stake is high, as annual global investments in water infrastructure can easily reach hundreds of billions of US$.

Adaptation is highly place- and context-specific, with no single approach appropriate across all settings. Adaptation involves reducing risk and vulnerability; seeking opportunities; and building the capacity to cope with climate impacts, as well as mobilizing that capacity by implementing decisions and actions. Adaptation needs can be categorized as biophysical and environmental needs, information, capacity, societal, financial, institutional, and technological needs.

Among categories and examples of adaptation options are: structural / physical (engineered and built environment, technology, ecosystem services), social (educational, informational, behavioral) and institutional (economic laws and regulations, government policies, and programs). There is an opportunity to align adaptation measures across multiple water-dependent sectors. Adaptation in as agriculture, forestry and industry has impacts on the freshwater system, and freshwater resources management is clearly linked to other policy areas (e.g., sustainable development, energy, nature conservation, disaster risk prevention). Adaptation to climate change should also include reduction of the multiple non-climate-related pressures on freshwater resources.

Governments at all levels start to develop adaptation plans and policies, and to integrate climate-change considerations into broader development plans. Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments. Local government and the private sector are critical to progress in adaptation. National governments can coordinate adaptation by local and subnational governments, creating legal frameworks, protecting vulnerable groups, and providing information, policy frameworks, and financial support. As national governments decide many of the funding priorities and tradeoffs, develop regulations, promote institutional structures, and provide policy direction to district, state, and local governments, they are essential in advancing an adaptation agenda. National governments assume a coordinating role of adaptation actions in subnational and local levels of government, including the provision of information and policy frameworks, creating legal frameworks, actions to protect vulnerable groups, and, in some cases, providing financial support.

Available strategies and actions can increase resilience across a range of possible future climates while helping to improve human livelihoods, social and economic well-being, and environmental quality. Integration of adaptation into planning and decision-making can promote synergies with sustainable development. Adaptation can generate larger benefits when connected with development activities and disaster risk reduction.

Global adaptation cost estimates are substantially greater than current adaptation funding and investment, particularly in developing countries, suggesting a funding gap and a growing adaptation deficit.

Climate change is only one of the multiple interacting stressors of freshwater systems, all of which have to be managed jointly. Reduction of risks caused by non-climatic drivers like human water demand and pollutant emissions can reduce climate-related risks. In this way, managing the risks of climate change may at the same time contribute to reducing risks caused by non-climatic factors.

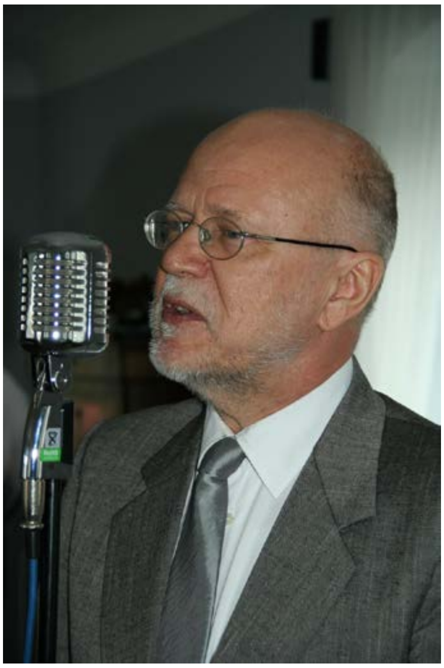
We can influence the risk of anthropogenic climate change by adaptation to climate change impacts (treating symptoms of a problem) or by mitigation of climate change (an indirect option with high inertia - treating sources of a problem) and its adverse impacts. The likelihood of deleterious impacts, as well as the cost and difficulty of adaptation, are expected to increase with magnitude and speed of the global climate change. Greater rates and magnitude of climate change increase the likelihood of exceeding adaptation limits - for a strong climate change, satisfactory adaptation would be much costlier and difficult, if not impossible.

Hence, effective mitigation of climate change is necessary to reduce the adverse climate change impacts. However, we are already committed to further warming and corresponding impacts, hence it is absolutely crucial to adapt to climate change and its impacts.

There is a complex interplay between adaptation to, and mitigation of, climate change, with significant co-benefits, synergies, and tradeoffs. Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, particularly at the intersections among water, energy, land use, and biodiversity. In general, mitigation policies reduce the impacts and need for adaptation to climate change but some mitigation measures may constrain adaptation options and even consume freshwater resources that could alternatively be used for crop irrigation or other purposes.

The notion of governance of climate change adaptation and disaster risk reduction denotes exercise of political, administrative, and economic, authorities to manage adaptation and risk reduction. The formal governance structure can be seen as a multi-dimensional figure of actors and such constructs as power and resources, the capacity to induce or resist change; discourses and rules. Risks associated with climate change are not caused by anthropogenic climate change alone but also by climate variability and by socioeconomic conditions and processes. The climate change is not the only risk; nonetheless, it is a significant risk. As example of risk management, flood risk reduction strategies and governance arrangements are discussed.

There is no doubt that better accommodation of extremes of present climate variability augurs better for the future climate, subject to change. Reducing present vulnerability and exposure to existing climate variability should be at the agenda for the nearest future, independently of the projections. Strategies include actions with co-benefits for other objectives. Adaptation planning and implementation are contingent on societal values, objectives, and risk perceptions.



Zbigniew W. Kundzewicz is Professor of Earth Sciences and Corresponding Member of the Polish Academy of Sciences. He holds doctorate and habilitation in hydrology from the Institute of Geophysics, Polish Academy of Sciences, Warsaw, Poland. He has led the Climate and Water Department in the Institute for Agricultural and Forest Environment, Polish Academy of Sciences in Poznan, Poland (since 1990) and has been a Senior Scientist in the Potsdam Institute for Climate Impact Research (PIK) in Potsdam, Germany (part time, since 2001). His main scientific contributions have been in the areas of extreme hydrological events (and floods in particular) and climate change impacts on water resources. He has been a four-fold Coordinating Lead Author of publications of the Intergovernmental Panel on Climate Change (IPCC). He was a Member of the Advisory Group on Environment (including Climate) for 7th Framework Programme of the European Commission. He was an Alexander von Humboldt-Foundation Research Fellow at the University of Karlsruhe and a Scientific Officer at the World Meteorological Organization in Geneva. He has been Editor and Co-Editor of scientific periodical *Hydrological Sciences Journal* and member of editorial boards of several scientific journals. He has published over 400 scientific publications, therein 124 articles in ISI-rated journals. His H-index after Web of Science is equal to 24. He has received Polish state orders: Golden Cross of Merit and Knight's Cross of Polonia Restituta, a Great Golden Seal of the City of Poznań (Poland), a Tison Award of the International Association of Hydrological Sciences (IAHS), and two awards of the Polish Academy of Sciences. He is a Polish citizen.