UN WATER

Policy Brief

Climate Change Adaptation:
The Pivotal Role of Water

Executive Summary

Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of societies. Higher temperatures and changes in extreme weather conditions are projected to affect availability and distribution of rainfall, snowmelt, river flows and groundwater, and further deteriorate water quality. The poor, who are the most vulnerable, are likely to be adversely affected.

Water stress is already high, particularly in many developing countries; improved management is critical to ensure sustainable development. Water resources management affects almost all aspects of the economy, in particular health, food production and security; domestic water supply and sanitation; energy and industry; and environmental sustainability. If addressed inadequately, management of water resources will jeopardize progress on poverty reduction targets and sustainable development in all economic, social and environmental dimensions.

Adaptation to climate change is closely linked to water and its role in sustainable development. To recognize this reality and to respond accordingly presents development opportunities. Various necessary adaptation measures that deal with climate variability and build upon existing land and water management practices have the potential to create resilience to climate change and to enhance water security and thus directly contribute to development. Innovative technological practices and implementation of strategies are also needed at the appropriate levels for adaptation as well as for mitigation.

Adaptation to climate change is urgent. Water plays a pivotal role in it, but the political world has yet to recognize this notion. As a consequence, adaptation measures in water management are often underrepresented in national plans or in international investment portfolios. Therefore, significant investments and policy shifts are needed. These should be guided by the following principles:

- Mainstream adaptations within the broader development context;
- Strengthen governance and improve water management;
- Improve and share knowledge and information on climate and adaptation measures, and invest in data collection;
- Build long-term resilience through stronger institutions, and invest in infrastructure and in well-functioning ecosystems;
- Invest in cost-effective and adaptive water management as well as technology transfer;
- Leverage additional funds through both increased national budgetary allocations and innovative funding mechanisms for adaptation in water management.

Application of these principles would require joint efforts and local-to-global collaboration among sectoral, multisectoral as well as multidisciplinary institutions.

Responding to the challenges of climate change impacts on water resources requires adaptation strategies at the local, regional, national and global levels. Countries are being urged to improve and consolidate their water resources management systems and to identify and implement "no regrets" strategies, which have positive development outcomes that are resilient to climate change.

Introduction

Water is the lifeblood of the planet, and the state of this resource affects all natural, social and economic systems. Water serves as the fundamental link between the climate system, human society and the environment. Climate change is severely impacting the hydrological cycle and consequently, water management. This will in turn have significant effects on human development and security (1).

Climate change has substantial impacts on both water resources demand and availability. It is critical to understand the processes driving these changes, the sequences of the changes and their manifestation at different spatial and temporal levels. These changes are likely to be an increasingly powerful driver of water availability, acting with other drivers that are already having a serious impact on its quality and availability. Increased water-related risks associated with the changes in frequency and intensity of extreme events, such as droughts, floods, storm surges, and landslides, will put additional strain on water resources management and increase uncertainty about quantity and quality of water supplies. These risks will continue regardless of mitigation measures applied over the coming decades. Society needs to find ways to adapt to the changes that are expected and to render its water infrastructure and services more resilient in coping with new conditions and extreme weather patterns.

Climate change is a complex problem that has increased the need for an integrated, multi-sectoral and multidisciplinary response. Apart from the normal water domain, decision-makers in other spheres (finance, trade, energy, housing, regional planning, agriculture) must use and consume water efficiently. Sustainable management and development of water resources will play a pivotal role in preparing societies' ability to adapt to climate change in order to increase resilience and achieve development goals - this calls for policy and governance shifts, investments and changes in the way water concerns are addressed in development strategies and budgets.

This policy paper is the product of the joint efforts of members and partners of UN-Water, and is addressed to practitioners and policymakers of water resources management, sectoral decision-makers as well as those who shape policy regarding climate change. The paper aims to draw attention to the critical importance of better water resources management in adapting to climate change and gives reasons why it should be systematically integrated into national plans and international investment portfolios.

Climate Change Impacts

Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of societies. Global warming is likely to intensify, accelerate or enhance the global hydrological cycle (2). Changes in precipitation, which higher average temperatures and temperature extremes are projected to cause, will affect water resources availability through changes in form, frequency, intensity and distribution of precipitation, soil moisture, glacier- and ice/snowmelt, river and groundwater flows, and lead to further deterioration of water quality. There is increasing evidence that this is already happening in many regions. The global picture, however, is complicated and uneven, with different regions, river basins and localities being affected in different degrees and in a variety of ways.

From the supply side, climate change affects the water cycle directly and, through it, the quantity and quality of water resources available to meet the needs of societies and ecosystems. Climate change can result in an increased intensity in precipitation, causing greater peak runoffs but less groundwater recharge. Receding glaciers, melting permafrost and changes in precipitation from snow to rain are likely to affect seasonal flows. Longer dry periods are likely to reduce groundwater recharge, lower minimum flows in rivers and affect water availability, agriculture, drinking water supply, manufacturing and energy production, thermal plant cooling and navigation. Increased intensity in rainfall, melting glacial ice and large-scale deforestation is already increasing soil erosion and depriving the topsoil of nutrients. Changes to the proper functioning of ecosystems will increase the loss of biodiversity and damage ecosystem services.

Rising sea levels will have serious effects on coastal aquifers, which supply substantial water to many cities and other users (3). This phenomenon will also have severe impacts on food production in major delta regions, which are the food bowl of many countries. Coastal ecosystems would also be profoundly affected, including loss in estuary productivity, changes in barrier islands, loss of wetland, and increased vulnerability to coastal erosion and flooding.

Global warming will impact water temperatures, which are expected to have substantial effects on energy flow and on the recycling of matter. This in turn may result in algal bloom, an increase in toxic cyanobacteria bloom and diminished biodiversity. The composition and **quality** of water in rivers and lakes is likely to be affected owing to changing precipitation and temperature resulting from climate change. At the same time, changes in precipitation intensity and frequency influence non-point source pollution, making the management of wastewater and water pollution more demanding and urgent.

Climate change will directly affect the demand for water; for instance, changes in demands will derive from industrial and household use, or from irrigation. **Water demand** for irrigation may increase as transpiration increases owing to higher temperatures. Depending on future trends in water use efficiency and the development of new power plants, the demand for water in thermal energy generation could either increase or decrease.

Extreme weather events have become more frequent and intense in many regions, resulting in a substantial increase of water-related hazards. At the same time, demographic changes are exposing more people to increased flooding, cyclones and droughts. The impacts of recent major flooding, which have resulted in many deaths and cost billions of dollars in damages, is an indication of what could lie ahead from increased climate variability (4). At the opposite end, the more intense droughts experienced in the past decade, which have affected an increasing number of people, have been linked to higher temperatures and decreased precipitation. Moreover, in its Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) has concluded that there is a 90 per cent probability that the extent of drought-affected areas will increase (5).

Water Resources Management and Climate Change

The management of water resources impacts almost all aspects of society and the economy, including food production and security, domestic water supply and sanitation, health, energy, tourism, industry and the functioning of ecosystems. Under present climate variability, water stress is already high, particularly in many developing countries (6). Managing water has always implied that societies deal with natural variability in the water supply and its effect on competing uses. Climate change threatens to increase this variability, shifting and intensifying extreme weather patterns, and introducing greater uncertainty in the quantity and quality of water supply over the long term. Adaptation to the current climate variability, while having direct benefits, can also help society to better prepare for the increased variability expected in the future.

Climate change is one of the main driving forces of change for water resources management, together with demographic, economic, environmental, social and technological forces (7). If conceived in isolation, solutions to the major challenges that these driving forces create may become self-defeating. Decision-makers and policymakers in other disciplines have the solution to many water management problems. They need to recognize that all major decisions should take into account the potential impact on water, recognizing water as the lifeblood. While tackling these issues, decision-makers should think beyond their own sectors and consider the wider ramifications of their decisions on water availability and the forces affecting it, and should adopt a balanced, integrated and coherent approach (8).

In a context dominated by worsening food security and malnutrition, increased energy shortages, spread of diseases, humanitarian emergencies, growing migration, increased risk of conflict over scarce land and water; and escalating ecosystem degradation, improved and integrated management of water and land resources becomes critical to sustainable development. Considering the increasing strain that water scarcity will place on the environment and the importance of water in development, mitigation of impacts of water management on the environment will become increasingly difficult. Country-specific solutions may include the creation of new decision-making mechanisms that take into account climate change impacts. Therefore, the establishment of new institutions, networks, and better coordination and exchange of information will be necessary.

Climate change impacts on water resources management issues have to be addressed urgently and adequately. Otherwise, progress towards achieving poverty reduction targets, the Millennium Development Goals, and sustainable development in all their economic, social and environmental dimensions will be jeopardized.

Adapting to Climate Change

Thus far, policy response to climate change has been dominated by the need for mitigation. Although these measures can slow down climate change, they will not halt or reverse it. Because the effects of climate change are inevitable in the short and medium term, adaptation needs to be addressed with the same urgency as mitigation. Adaptation, as integrated into the Nairobi Work Programme of the United Nations Framework Convention on Climate Change (UNFCCC), relies on better understanding of the effects of climate change and on making informed decisions on how to cope with it. Water management, based on integrated and system-wide approaches, is the key to climate change adaptation.

Adaptation planning and practices need to be comprehensive and flexible. When developing cross-sectoral national climate change adaptation plans, proper attention should be given to water management. At the same time, adaptation requirements have to be considered in the climate risk management framework to ensure sustainable interventions (9). Water-related disaster risk reduction (DRR) and its strategies should be considered as tools in climate change adaptation, with greater integration of water-related adaptation.

Long-term, sustainable adaptation to climate change will require the integration of infrastructure, policy and economic instruments, as well as behavioural changes into national development strategies. Adaptation programmes should consider structural and non-structural measures as well as the potential offered by natural and physical infrastructure and "soft" programmes that comprise incentives and sanctions. These measures should also be evaluated from the mitigation perspective. Efforts must be made to evaluate adaptation strategies for their likely impact on the ecosystem and on human health. Adaptation measures should be built on learning-by-doing principles, particularly those being introduced locally, which draw upon traditional and indigenous know-how that could enrich and widen scientific knowledge.

Adaptation measures can be categorized in the following five ways, which water managers have of adapting to contemporary climate variability and that could ultimately serve as the foundation for adapting to climate change (10):

1. Planning and applying **new investments** (for example, reservoirs, irrigation systems, capacity expansions, levees, water supply, wastewater treatments, ecosystem restoration).
2. Adjusting **operation, monitoring and regulation practices** of existing systems to accommodate new uses or conditions (for example, ecology, pollution control, climate change, population growth).
3. Working on **maintenance, major rehabilitation and re-engineering** of existing systems (for example, dams, barrages, irrigation systems, canals, pumps, rivers, wetlands).
4. Making modifications to **processes and demands** for existing systems and water users (for example, rainwater harvesting, water conservation, pricing, regulation, legislation, basin planning, funding for ecosystem services, stakeholder participation, consumer education and awareness).
5. Introducing new **efficient technologies** (for example, desalination, biotechnology, drip irrigation, wastewater reuse, recycling, solar panels).

Managing Uncertainty

Uncertainty should not be a reason for inaction. Adaptive management overcomes the challenges presented by uncertainties in various inputs to water management decision-making, including long-term climate projections. Adaptive management allows for adjustments, as additional and better information becomes available. For infrastructure, a pragmatic and "proactive adaptive management" approach – similar to the "no regrets"' philosophy of climate change adaptation (11) – should be based on the development of a new generation of risk-based design standards that take into account climate uncertainties. Many non-structural measures are flexible and therefore more suitable for adapting to greater uncertainty in both the supply and demand side, and should thus be integrated into every adaptation strategy. Adaptive management requires continuous feedback and adjustments based on the information provided by monitoring networks.

Managing Increasing Variability

Greater climatic variability and short-term uncertainty is likely to be superimposed on any long-term trend, thereby increasing the frequency of extreme events. This variability calls for comprehensive risk management planning, including disaster risk reduction at various levels and adopting new technologies to develop improved early warning systems for better reservoir and emergency operations. Water operators will need to consider climate change predictions and uncertainties, and prepare for the risks of more intense droughts and floods. Likewise, communities will need contingency plans for rapid and coordinated responses to these phenomena. Demand management in the major user sectors can also improve resilience.

Creating the infrastructure for water resources development and distribution has shown high human and macroeconomic benefits; conversely, countries lacking this capability have suffered damaging shocks from droughts and floods (12). More water storage is required to manage increased variability of water resources. Some storage can be **natural** – enhancing groundwater recharge through rainwater harvesting, sustainably managing aquifers and nourishing wetlands. Other methods of storage, such as small, medium or large reservoirs, can be constructed subject to safeguards for the environment and for communities. Both kinds of storage will be required in many regions to guard against droughts and floods and to provide regular multi-purpose benefits.

Drinking Water Supply and Sanitation

The world is on track in meeting the Millennium Development Goal (MDG) targets for drinking water, but not for sanitation (13). At the moment, water is increasingly under strain from competing demands and climate change, affecting both quality and quantity. Adaptation calls for coherent measures to address water security for all major users with priority given to the basic needs of human hygiene, consumption and subsistence, which are defined as a basic human right (14, 15). Increasing population and migration, and rising living standards will increase the demand for water services. The existing water supply and sanitation infrastructure was previously designed for different resource availability and water use. Such historical infrastructure will likely come under greater pressure owing to hydraulic changes and warmer temperatures. To upgrade or expand the availability of water supply and sanitation infrastructure is an urgent concern that will facilitate adaptation to climate change. **Stormwater and wastewater infrastructures** will have to include provisions for climate change effects in their design; they will also need to be evaluated to improve performance under conditions caused by changing water availability, water demand and water quality. A recent study of water supply and sanitation services shows that many are not resilient to climate change impacts (16).

Agriculture

Climate change is expected to impact both rainfed and irrigated agriculture, including feed and fodder for livestock. Climate change will alter the distribution of agriculture across the globe, shifting potential to high latitude areas, whereas in low latitudes, more frequent and severe droughts and floods will hurt subsistence agriculture in the semi-arid zones. This shift will worsen the living conditions of rural populations who live in fragile environments and depend on agriculture for their livelihood. These communities face an immediate and increasing risk of crop failure or loss of livestock and fertile topsoil owing to greater erosion. The challenge is to increase the ability of rural populations to cope with climate change impacts through enhanced resilience and preparedness, including diversification into non-farm-based activities.

Several densely populated farming systems in developing countries are at risk from the impacts of climate change. Severe reductions in river runoff and aquifer recharge are expected in the Mediterranean basin and in the semi-arid areas of the Americas, Australia and Southern Africa, affecting water availability and quality in already stressed regions. The large contiguous areas of irrigated land associated with river deltas are also at risk – from a combination of reduced inflows, change in annual flood cycles, increased salinity and rising sea levels. In irrigation systems that rely on high mountain glaciers for water, high runoff periods will advance earlier in the spring, when irrigation water demand is still low. In addition, rising temperatures will increase crop water demand. To address water shortages, more needs to be done, especially for rural women and youth who bear most of the brunt. Other than water-related land use and tenure changes, tasks could include integrated supply and demand management of water resources, increased water storage infrastructure (surface water and groundwater), watershed development, rainwater harvesting, water conservation and community initiatives that better integrate land and water management (17).

Water and Health

Climate change will influence human health through water-related impacts of various kinds (18). Changes in the composition of aquatic ecosystems will impact the nutritional status, exposure to health risks and access to health services for communities whose livelihoods are closely linked to such ecosystems. The occurrence of opportunistic invaders in particular, such as cyanobacteria in lakes and reservoirs, will pose new challenges for water service companies. There has been a resurgence of water-related vector-borne diseases in areas where eradication programmes had previously been successful, and emergence of new vector-borne diseases in areas where they were previously unknown (for example, transmission of the Chikungunya virus in Italy, and the continuing spread of dengue fever in northern Argentina, northern Australia and in southern China). Although it is difficult to identify the different driving forces, climate change cannot be excluded. Reduced nutrition and access to safe water for human consumption and personal hygiene may compromise basic human health and in particular affect the health burden caused by diarrhoeal diseases. Malnutrition owing to water shortages and limited safe drinking water during flooding may induce outbreaks of water-related diseases. New breeding places for mosquitoes and other disease-transmitting insects may also develop. Groundwater resources may also need improved protection against contamination from extreme rainfall and floods.

Nevertheless, climate change brings opportunities to improve community health. These health benefits could offset some of the costs of climate change mitigation and adaptation. It is important to raise stakeholders' awareness of the nature and scope of these health benefits (19).

Ecosystems

Services provided by ecosystems support livelihoods and economic development. The impacts of climate change on water will aggravate drivers of ecosystem degradation, thereby reducing the benefits obtained from them, such as clean water supply, and fisheries and coastal defences. The impacts of climate change on ecosystems will increase the vulnerability of communities. Thus, actions to reduce and restore ecosystems and their services are needed to help reduce vulnerability and build resilience at the community and national levels. Such actions include upper watershed management to maintain water storage; allocation of water to ecosystems through the application of environmental flows; and restoration of flood plains and mangroves. To maximize benefits for resilience, adaptive institutions should complement these actions by implementing effective and participatory water governance.

Water-related Hazards

Society needs to adapt to the full range of water-related hazards that will accompany climate change. These hazards can result from too much water (causing floods, erosion, landslides mudslides, and the like, in land-degraded areas) or too little water (causing droughts, forest fires, loss of wetlands or other habitats, saline encroachment, and the like) and from the effects of chemical and biological pollution on water quality and in-stream ecosystems. Approaches – such as Integrated Flood Management (20) – that are robust and adaptive should be adopted to manage floods. Flood risk assessments, which form an essential element in such approaches, should incorporate climate change effects on the magnitude of floods and the vulnerability of populations (21). Especially for the large regions of rainfed agriculture, early warning for droughts is essential.

With the above concerns in mind, The Hyogo Framework for Action (22) provides an internationally agreed framework for reducing disaster risks, and is an important tool for adaptation to climate change.

Guiding Principles

Mainstreaming Adaptation within the Broader Development Context

Adaptation must be addressed in a broad development context, recognizing climate change as an added challenge to reducing poverty, hunger, diseases and reversing environmental degradation. For adaptation measures to be effective, they must be integrated into national development plans, as the poor and marginalized groups are most vulnerable to the effects of climate change and suffer the most from accelerating water scarcity, water quality degradation, droughts and floods, and rising sea levels. Policy changes need to be identified and implemented for promoting synergies between adaptation and existing development challenges such as food and energy security, poverty reduction, disaster risk reduction and environmental protection, which are closely linked to effective water management. Effective adaptation not only requires that water is at the heart of national climate change adaptation strategies, but also that climate change adaptation is mainstreamed into existing national water policies, plans and funds.

Managing the competing demands for water from various sectors will become more onerous in conditions of water scarcity and drought. Different interests (with regard to water supply, sanitation, agriculture, irrigation, hydropower, navigation/transportation and environment) shape these sectors' management principles, rules and incentives, which often conflict with one another. Cross-sectoral, integrated and system-wide approaches to climate change adaptation must be developed, placing water management at the centre of any development plan.

Strengthening Water Governance and the Integration of Land and Water Management

Effective adaptation for water requires different approaches within a comprehensive, integrated framework. A combination of bottom-up and top-down decision-making, where all major players – at community, national and regional levels – can agree, should be envisaged. Water and climate do not respect borders, and many adaptation measures will have effects on neighbouring countries. This fact calls for cooperative solutions that help prevent the negative effects of unilaterally taken adaptation measures and identify more comprehensive solutions. Many countries have embarked on water sector reforms based on the Integrated Water Resources Management (IWRM) approach (23), employing a variety of tools based on multidisciplinary inputs, public participation, and regulatory, financial and political incentives. Well-functioning institutions are therefore needed to effectively administer this array of fairly complex management measures.

To incorporate climate change adaptation within the governance of water resources, mandates and management functions may need to be clarified and institutions strengthened at various levels. Adaptive water governance will call for more intersectoral planning and links between institutions responsible for agriculture, land tenure and use, forestry, energy, environment and water (24). The role of water in climate change adaptation should be mainstreamed into the work of all ministries (25). To avoid maladaptation, all development projects need to be resilient and all adaptation measures assessed for inadvertent adverse effects on the environment and on human health,

For effective adaptation, institutions should be strengthened and capacities built for holistic land and water management – building on the principles of participation of civil society, equality and decentralization (26, 27). This will require the creation of authorities based on hydrological rather than political boundaries; more effective regional water institutions; and improved transboundary cooperation (28). The stronger and more accountable institutions are, the better able they will be to plan and adjust to changes in water availability and extreme water events.

Despite the considerable uncertainty and large range of local climate change predictions, deliberate and constructive decisions can still be made. Lessons can be learned from drought and flood experiences of the past to reduce vulnerability of newly affected areas in the future.

Strengthening resilience and the capacity to manage today's climate is often an appropriate response to future climate change threats.

Improving and Sharing Knowledge and Information

Sound water management is built on long-term hydrological and climate data, gathered from monitoring networks that are accurate, timely and consistent. Sound principles of water management are also enshrined in many indigenous and cultural value systems. Meeting the challenge of climate change becomes more daunting for decision-makers, because information is often limited on the status of availability and use of water, and on the potential impact of climate change. Hydrological monitoring networks are declining (29) and as a result, hydrological information is often incomplete, unreliable, inaccessible or simply lacking at the global, regional, national and local levels. Even existing data are not used efficiently. There is little sharing of hydrologic data, owing mainly to limited physical access, policy and security concerns, lack of accepted protocols and often commercial considerations.

Transboundary cooperation in developing adaptation strategies can bring mutual benefit for all riparian parties – for example, it reduces uncertainty through exchange of data and information. This cooperation can also widen the knowledge and information base, increasing the set of options available for prevention, preparedness and recovery, and thereby helping to find better and more cost-effective solutions (30).

It is difficult for a single water management agency and affiliated research institute to develop new principles and tools that water managers and design engineers can use effectively to adapt to climate change. Internationally coordinated, collaborative applied research and development efforts need to be made that routinely deal with practical implementation issues for water management (31).

Better access to information, and transparency of its use, promotes more rational decision-making. As most decisions on water would have to be made at the basin and local levels, accurate, consistent, timely and relevant information about water and climate needs to be widely available. Information and knowledge for local adaptation must be improved and considered a public good to be shared at all levels. Better information, communication and public awareness – reinforced by the right incentives and sanctions – are required to produce changes in the behaviour of water users and consumers.

Building Long-term Resilience

Owing to future uncertainties, the key to adaptation must be resilience – managing risks and building capacity to deal with unpredictable events, especially of the most vulnerable rural and urban poor. To build resilience to ongoing and future climate change calls for immediate adaptation. First, existing problems in land and water management need to be addressed; and second, because climate change impacts are already being felt, we need to act today to prepare for the future through context-specific adaptation measures.

Water management options – including changes in operations, demand management and infrastructure – facilitate adaptation to climate change. Decision-making frameworks that use robust solutions should be encouraged. Multidisciplinary, multisectoral collaboration and adaptive management require institutional and human capacity-building at various levels. Planning and designing of new hydraulic infrastructure, and the development of new hydrologic tools, calls for a new socio-economic decision-making framework.

While climate change poses serious threats to our societies, there may be overall benefits to health and development in adapting to climate change. There is a high adaptive capacity in many water and sanitation services, but this potential is rarely fully achieved. Systematic assessments of climate change resilience of all utilities, including rural water and sanitation programmes, are needed (32). Urgent action is required to transform the potential adaptive capacity of many utility-managed water supplies to actual resilience to climate change.

Focusing on the adaptive capacity for livelihoods and ecosystem maintenance, and building on integrated land and water resources management approaches, "no regrets" investment schemes are needed for both "hard" adaptation measures such as infrastructure and "soft" adaptation measures such as incentives and demand management (33, 34).

Cost-effective, Adaptive Water Management and Technology Transfer

Infrastructure must be designed to cope with climate uncertainty. Climate adaptation is value for money in economic terms (that is, in damages avoided). Furthermore, natural infrastructure, such as watershed and wetlands, should be assessed as viable alternatives to the built environment, such as dams and canals.

Cost-benefit analysis of adaptation measures should consider all potential benefits, especially those related to health. Experience in the area of drinking-water supply and human health has shown that a narrow perspective – such as that adopted in the early 1980s for selective Primary Health Care – fails to support a long-term goal. Recent studies conducted by the World Health Organization (WHO) have demonstrated that taking all co-benefits into account (through social cost-benefit analysis), returns of up to US$34 can be attained for every US$1 invested in drinking-water supply (35). Similar analyses, including health co-benefit studies, should be carried out on adaptation measures aimed at strengthening the resilience of the hydraulic infrastructure.

Technological advances for improving irrigation efficiency, use of lower quality water (including reclaimed wastewater), reduction of system losses from water systems and other developments indicate considerable potential for conserving existing water supplies and for making better use of what is available. These technologies, appropriately adapted to local conditions, must be facilitated, and the capacity to implement and operate them supported.

Additional and Innovative Funding

The cost of inaction and the economic and social benefits of adaptation require increased and innovative investment and financing. Improving adaptive capacity calls for more intelligent use of existing financing, targeted towards the most vulnerable groups. The full range of financing options needs to be used, including innovative financing mechanisms, private sources and public funding from developed countries.

Developing countries currently have limited access to effective funding mechanisms to support adaptation to climate change. More funding must be made available for adaptation strategies to become sustainable. Increased support is needed for adaptation actions through targeted financing and improved aid effectiveness. As such, any adaptation funds must be incremental and must supplement climate change-dedicated Official Development Assistance (ODA) funds, in view of the compensatory nature of such funds (36). All sectors concerned should have access to existing funds to improve their adaptation strategies in an holistic way. Sound land and water management practices that provide mitigation and adaptation benefits should be eligible for such funding. Climate change adaptation should be integrated into existing funding for water management, and adaptive water management should be considered a funding priority for other water-reliant sectors.

Development budgets are already under high pressure as a result of the global finance crisis. Future financing mechanisms are needed to generate sufficient resources and deliver them in an efficient and effective manner, supporting the integration of adaptation concerns into the broader development agenda.

Conclusions and Recommendations

Climate change manifests itself through water resources. Management of these resources affects almost all aspects of society and the economy. Water-related climate change adaptation has a pivotal role in achieving sustainable development.

Adaptation to climate change is urgent. Water plays a pivotal role in it, but the political world has yet to recognize this notion. As a consequence, adaptation measures in water management are often underrepresented in national plans or in international investment portfolios. Therefore, significant investments and policy shifts are needed. These should be guided by the following principles:

- Mainstream adaptations within the broader development context;
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- Leverage additional funds through both increased national budgetary allocations and innovative funding mechanisms for adaptation in water management.

Application of these principles would require joint efforts and local-to-global collaboration among sectoral, multisectoral as well as multidisciplinary institutions.

Responding to the challenges of climate change impacts on water resources also requires the development of deliberate and context specific adaptation strategies. Countries are urged to improve and consolidate their water resources management systems and to identify and implement “no regrets” strategies, which have positive development outcomes that are resilient to climate change.

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UN-Water Members

UN Secretariat
United Nations Department of Economic and Social Affairs (UNDESA)
United Nations International Strategy for Disaster Reduction (UNISDR)

Programmes and funds
United Nations Children's Fund (UNICEF)
United Nations Conference on Trade and Development (UNCTAD)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations High Commissioner for Refugees (UNHCR)
United Nations Human Settlements Programme (UN-HABITAT)

Regional commissions
United Nations Economic Commission for Europe (UNECE)
United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
United Nations Economic Commission for Latin America and the Caribbean (UNECLAC)
United Nations Economic and Social Commission for Western Asia (UNESCWA)
United Nations Economic Commission for Africa (UNECA)

Specialized agencies
Food and Agriculture Organization of the United Nations (FAO)
International Fund for Agricultural Development (IFAD)
International Labour Organization (ILO)
United Nations Educational, Scientific and Cultural Organization (UNESCO)
United Nations Industrial Development Organization (UNIDO)
The World Bank Group (WB)
World Health Organization (WHO)
World Meteorological Organization (WMO)
World Tourism Organisation (UNWTO)

United Nations related organizations
International Atomic Energy Agency (IAEA)

Conventions
Secretariat of the United Nations Convention on Biological Diversity (UNCBD)
Secretariat of the United Nations Convention to Combat Desertification (UNCCD)
Secretariat of United Nations Framework Convention on Climate Change (UNFCCC)

Other Entities
United Nations University

UN-Water Partners

Aquafed
Gender and Water Alliance (GWA)
Global Water Partnership (GWP)
International Association of Hydrogeologists (IAH)
International Association of Hydrological Sciences (IAHS)
International Commission on Irrigation and Drainage (ICID)
International Hydropower Association (IHA)
International Water Association (IWA)
International Water Management Institute (IWMI)
Public Services International (PSI)
RAMSAR – Convention on Wetlands
Stakeholder Forum for a Sustainable Future
Stockholm International Water Institute (SIWI)
The World Conservation Union (IUCN)
United Nations Secretary General Advisory Board on Water and Sanitation (UNSGAB)
WaterAid
Water Supply and Sanitation Collaborative Council (WSSCC)
Women for Water Partnership (WfWP)
World Business Council on Sustainable Development (WBCSD)
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