Responding to the Challenges of Water Security: 
the VIII Phase of the International Hydrological Programme 2014-2021

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Water Security: key challenges of the 21st Century

Recalling some facts:

- 85% of the world’s human population live in the drier half of the Earth; for 2030, half of the world population will be living in areas of high water stress.

- 6-8 million human beings are killed each year from water-related disasters and diseases.

- Between 1970 and 2000, populations of freshwater species declined by 50%.

- 750 million people are without access to safe water (many billions still with not a reliable service), near 2.5 billion without access to adequate sanitation.

- Almost 85% of the world’s total wastewater is discharged without adequate or any treatment.

- 145 nations have transboundary river basin and there are 445* transboundary aquifers shared by 2-4 countries.

*Inventoried by UNESCO-IHP
(“Traditional”) Drivers

- Socio-economic development
  - GDP, population, ...

- Land Use, Land Cover Changes
  - urbanization, forest, ...

- Water Demand Changes
  - municipal, industrial, energy, agricultural

Impacts and Risks
  - for humans
  - for freshwater ecosystems
Climatic and non-climatic drivers have changed natural freshwater systems and are expected to continue to do so. (IPCC AR5, WGII Chap 3, 2014)
General:

- Freshwater-related risks increase significantly with increasing greenhouse gas emissions.

- Each degree of warming is projected to decrease renewable water resources by at least 20% for an additional 7% of the global population.
Permafrost and Glaciers

- **Evident changes** consistent with warming in northern regions.
- **The area of permafrost is projected to continue to decline** over the first half of the 21st century in all emissions scenarios.
- Glaciers/snow packs capacity to store will be lost in many regions.
- Decreasing snowfall may lead to lower rivers and groundwater recharge even if precipitation remains constant.
- **Higher erosion** is expected in areas where snow melt is occurring and permafrost is being lost.
Floods

By the end of the 21st century, the number of people exposed annually to a 20th-century 100-year flood is projected to be three times greater for very high emissions (RCP8.5) than for very low emissions (RCP2.6).

Droughts

It is expected to increase the frequency of short hydrological droughts (less surface water and groundwater), notably in the Mediterranean, central Europe, central North America and southern Africa regions.
The projections show:

- A significant reduction of renewable water in most dry subtropical regions
- An increase in water demand

Leading to:

- An exacerbated competition for water among all uses and users, affecting regional water, energy and food securities
Under high competition scenarios, water for ecosystems are those more limited.

Except in areas with intensive irrigation, the impacts on the ecological flow are expected to be stronger than historical impacts due to anthropogenic causes.
By the 2050s, climate change is projected to impact river flow characteristics more strongly than dam construction and water withdrawals have done up to around the year 2000.
Few studies on observations

The land area affected by decreases of groundwater resources increases linearly with global mean temperature rise between 0°C and 3°C.

For each degree of temperature rise, an additional 4% of the global land area is projected to suffer a groundwater resources decrease of more than 30%.

Human vulnerability to climate-change related to renewable groundwater resources by the 2050s. (Döll, 2009, Figure 3-7, IPCC AR5)
Water Quality

- Climate change is projected to reduce raw water quality, posing risks to the quality of drinking water even with conventional treatment.
- More water pollution episodes in water sources due to higher temperature (eutrophication), heavy rainfall (sweeping pollutants from soil to water courses) or droughts (reduced dilution), or in water supply because of the disruption of treatment facilities during floods.
- The sources of the risks are different (for instance, sediments, nutrients, pathogens, heavy metals, emerging pollutants etc.).
Vulnerabilities and Risks: Water Uses – ex. Municipal Services

With more than half of the world population living in cities under conditions of climate change, water utilities are confronted with:

- **Less natural storage of water** (ice melting and higher evapotranspiration)
- **Higher water availability variation** and shift in timing of river flows
- **Higher water demand** due to higher ambient and water temperatures
- **Higher competition** for the resource
- **Higher pollution** problems of eutrophication (higher water temperatures) and pollution (increased runoff sweeping pollutants from soil to water courses)
- **Insufficient treatment capacity** to deal with increased pollution problems
Projected Impacts, Water Nexus: Energy and Food Security

- Hydroelectric and thermal power plants, and the irrigation of bioenergy crops, require large amounts of water.
- Water for irrigation (availability, demand and competition)
- Demand depends on type and the efficiency of management procedures
- But also on climate (both supply and demand side)

AR5 IPCC (2014) Key risks at the global scale
AR5 IPCC (2014)

- There are bad news and also good news
- Good news often are ambiguous.
  - In many rivers fed by glaciers, there will be a “meltwater dividend” during some part of the 21st century but the continued shrinkage of the glaciers means that after several decades the total amount of meltwater that they yield will begin to decrease
  - Higher biological treatment efficiencies
- Impacts do not become “good news” unless measures are taken to take advantage from them
- Managing Risks and Benefits
Objective: Water Security
Defined by UNESCO as:

“the capacity of a population to safeguard access to adequate quantities of water of acceptable quality for sustaining human and ecosystem health on a watershed basis, and to ensure efficient protection of life and property against water related hazards — floods, landslides, land subsidence and droughts.”
Axis 1: Mobilizing international cooperation to improve knowledge and innovation to address water security challenges.

Axis 2: Developing institutional and human capacities for water sustainability innovation.

Axis 3: Enhancing policy advice to reach water security at local, national, regional, and global levels.

IHP-VIII Responses: 6 Themes, 3 Axes 2014-2021
Theme 1: Water-related Disasters and Hydrological Change

1.1 Risk management as adaptation to global changes
1.2 Understanding coupled human and natural processes
1.3 Benefiting from remote sensing data and ground truth
1.4 Addressing uncertainty and improving its communication

Victims: more than 25,000
Refugees: over 20 million
Destroyed homes: 2 million
Theme 2: Groundwater in a changing environment

2.1 Enhancing sustainable groundwater resources management
2.2 Addressing strategies for management of aquifers recharge
2.3 Adapting to the impacts of climate change on aquifer systems
2.4 Promoting groundwater quality protection
2.5 Promoting management of transboundary aquifers
Theme 3: Addressing Water Scarcity and Quality

3.1 Improving management, allocation, and efficient use of water resources

3.2 Dealing with present water scarcity and developing foresight to prevent undesirable trends

3.3 Promoting tools for stakeholders involvement and awareness, and conflict resolution

3.4 Addressing water quality and pollution issues within an IWRM framework (legal, policy, institutional and human capacity)

3.5 Promoting innovative tools for safety of water supplies and controlling pollution
Theme 4: Water and human settlements of the future

4.1 Game changing approaches and technologies
4.2 System wide changes for integrated management approaches
4.3 Institution and leadership for beneficiation and integration
4.4 Opportunities in emerging cities in developing countries
4.5 Integrated development in rural human settlement
Increasing climate instability, demographic growth and human migrations

- Global economy (food prices growth and intensified environmental impact)
- Most of the global landscape has been converted into agricultural land with spots of highly modified urban areas.
- The over-engineering of urban and agricultural landscapes results in a reduction of biomass and organic matter, leading to a modification of the water cycle and ecosystems in general

Need to reverse degradation of water resources and stop further decline in biodiversity.
Appreciation and optimization of ecosystem services

Ecohydrology concept in the perspective of evolution of relations between man and environment (Zalewski, 2011)
The two-steps strategy to be elaborated and implemented to reverse the negative processes

- The first proposed step should be based on von Weizsäcker’s reduction of energy and matter use per GDP.

- The second proposed step is based on Ecohydrology theory to regulate hydrological and nutrients’ cycles in “novel ecosystems” (agricultural and urban) towards the enhancement of carrying capacity of the global ecosystem.

Carrying capacity enhancement is understood as the enhancement related to water resources, biodiversity, ecosystem services for societies and the resilience to increasing various forms of impact.
Theme 5: Ecohydrology, engineering harmony for a sustainable world

5.1 Hydrological dimension of a catchment (threats and opportunities for a sustainable development)

5.2 Shaping of the catchment ecological structure for ecosystem potential enhancement — biological productivity and biodiversity.

5.3 Ecohydrology system solution and ecological engineering for the enhancement of water and ecosystem resilience and ecosystem services

5.4 Urban Ecohydrology – storm water purification and retention in the city landscape, potential for improvement of health and quality of life.

5.5 Ecohydrological regulation for sustaining and restoring continental to coastal connectivity and ecosystem functioning
Theme 6: Water education, key for water security

6.1 Enhancing tertiary water education and professional capabilities in the water sector

6.2 Addressing vocational education and training of water technicians

6.3 Water education for children and youth

6.4 Promoting awareness of water issues through informal water education

6.5 Education for transboundary water cooperation
“UNESCO Water Family”
Cross-cutting programmes and initiatives

Hydrology for the Environment, Life, and Policy (HELP)
Flow Regimes from International Experimental and Network Data (FRIEND)
Groundwater Resources Assessment under the Pressures of Humanity and Climate Change (GRAPHIC)
Global Network on Water and Development Information in Arid Lands (G-WADI)
International Drought Initiative (IDI)
International Flood Initiative (IFI)
Internationally Shared Aquifer Resources Management (ISARM)
International Sediment Initiative (ISI)
UNESCO-IAEA Joint International Isotope Hydrology Programme (JIIHP)
Water for Peace: From Potential Conflicts to Cooperation Potential (PCCP)
Urban Water Management Programme (UWMP)
International Knowledge, Research, and Policy Initiative on Water Quality
World Hydrogeological Map (WHYMAP)
Challenges must be opportunities to:

- **Transform** unsustainable water systems into sustainable ones.
- **Develop** flexible and resilient technologies.
- **Perform** strategic planning processes incorporating IWRM principle into management practical aspects.
- **Integrate** the challenges into emerging economic development, (emerging urban centres and green economies).
- **Create** a culture of water cooperation among science, technology innovators, economy, civil society and governments at all levels.