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International
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Programme

IHP-VIII

WATER SECURITY

Responses to local, regional, and global challenges
(2014-2021)

THEMES AND FOCAL AREAS



INTERNATIONAL HYDROLOGICAL PROGRAMME (IHP)

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TABLE OF CONTENTS

INTRODUCTION	2
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THE THEMES AND FOCAL AREAS OF IHP-VIII	4
THEME 1: WATER-RELATED DISASTERS AND HYDROLOGICAL CHANGE	6
THEME 2: GROUNDWATER IN A CHANGING ENVIRONMENT	9
THEME 3: ADDRESSING WATER SCARCITY AND QUALITY	12
THEME 4: WATER AND HUMAN SETTLEMENTS OF THE FUTURE	15
THEME 5: ECOHYDROLOGY: ENGINEERING HARMONY FOR A SUSTAINABLE FUTURE	18
THEME 6: WATER EDUCATION: KEY FOR WATER SECURITY	21

PUTTING SCIENCE INTO ACTION	25
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ANNEX 1: IHP INITIATIVES	26
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ANNEX 2: UNESCO WATER FAMILY	28
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INTRODUCTION

The International Hydrological Programme (IHP), implemented in programmatic phases and tailored to Member States' needs, is in its eighth phase in the 2014-2021 period. Since its inception in 1975, IHP has evolved from an internationally coordinated hydrological research programme into a holistic policy-oriented programme. IHP has three main objectives: to mobilize international cooperation to improve knowledge and innovation; to strengthen the science-policy interface; and to facilitate education and capacity development in order to enhance water resources management and governance.

The Eighth Phase of IHP (IHP-VIII) aims to improve water security in response to local, regional, and global challenges. For our purposes, water security has been defined by UNESCO's Member States as **the capacity of a population to safeguard access to adequate quantities of water of an 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 such as floods,**

landslides, land subsidence, and droughts. Given population growth, deteriorating water quality, the growing impact of floods and droughts and the other hydrological effects of global change, water security is a growing concern. It touches upon all aspects of life and requires a holistic approach, which actively integrates social, cultural and economic perspectives, scientific and technical solutions and attention to societal dynamics.

In response to the needs and priorities of Member States, IHP-VIII focuses on six knowledge areas which address issues related to water-related disaster and hydrological changes, groundwater sustainable management, addressing water scarcity and quality challenges, the provision of water for human settlements, the combined use of ecohydrology with engineering approaches and the change of the culture mindset through water education and awareness raising in order to attain water security.

THE THEMES AND FOCAL AREAS OF **IHP-VIII**





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THEME 1:

WATER-RELATED DISASTERS AND HYDROLOGICAL CHANGE

The number of fatalities and economic damage caused by water-related disasters, such as floods and droughts, landslides and land subsidence, is dramatically increasing worldwide, mainly as a result of more people living in areas vulnerable to water-related disasters. Land-use changes, urbanization, migration patterns, energy issues and food production are derived from population change and economic development, with climate change and variability likely to exacerbate the risk with more uncertainties. The great challenge for the hydrological community is to identify the impacts of such global changes on water resources and to appropriate and timely propose and implement adaptation measures in a continuously changing environment. We also need to ensure that policy makers have access to the best available knowledge when making decisions to develop and put in place relevant policies to address such challenges.

FOCAL AREA 1.1: RISK MANAGEMENT AS ADAPTATION TO GLOBAL CHANGES

With water-related risks likely to increase further, risk management needs to be improved. Poor water governance, coupled with lack of adequate emergency management institutions and infrastructure, reduce a society's capacity to cope with extreme events. We need to establish methodologies to assess risk, which take into account the hydro-climatological and social conditions of the area in question. Integrating pilot case studies on hazard-damage relationships on local/regional scales and developing hazard-damage relationships are essential to providing risk management tools for water managers and policy makers.

Risk communication and stakeholder participation have to be part of the strategies for managing water-related risks to reduce the exposure to risks and build resilience. There is also a need to implement early warning systems, develop risk mapping and strengthen land planning.

Objectives

- ▶ Improve understanding and promotion of an approach to flood risk management based on the idea of "living with floods" instead of "fighting floods" (International Flood Initiative).
- ▶ Further research and develop early warning systems that integrate enhanced monitoring capability and hydrological modelling of socio-ecological systems.
- ▶ Compile, share, and analyse data on socio-economic damages taking into consideration the magnitude of the hydrological hazard and social vulnerabilities.
- ▶ Support Member States in developing a culture of resilience to water-related disasters and risk treatment.
- ▶ Develop the knowledge (memory) of past disasters by improving communication and understanding of the changing nature of hazards.
- ▶ Support cooperation among Member States and international organizations in advancing vulnerability studies and adaptation actions related to climate change.

FOCAL AREA 1.2: UNDERSTANDING COUPLED HUMAN AND NATURAL PROCESSES

While there have been significant advances in coupling hydrologic and biogeophysical models over the past decade, these advances remain limited because of the need to better understand the coupled human-environment systems to properly manage the resource by decision-makers.

Objectives

- ▶ Implement integrated modelling of social ecological systems (SES) in water resources management decision-making processes.
- ▶ Improve understanding of the processes in coupled hydrological, biogeochemical, and anthropogenic systems across hydrological domains and social systems both in models and in water education.
- ▶ Promote innovative, holistic approaches to education and institutional and human resources capacity development.

FOCAL AREA 1.3: BENEFITING FROM GLOBAL AND LOCAL EARTH OBSERVATION SYSTEMS

Most of the world's river basins and aquifer systems are poorly gauged or completely ungauged. It is thus essential to strengthen existing hydrological monitoring networks by promoting the use of innovative tools. While existing large-scale river flow archives are crucial to advancing hydrological science and operational issues, more resources are needed to promote and implement open data sharing, such as is performed through the FRIEND-Water (Flow Regimes from International Experimental and Network Data) and ISARM (Internationally Shared Aquifer Resources Management) IHP research initiatives.

Objectives

- ▶ Adapt models to the continuously changing hydrology, remote sensing and in situ data availability, and to the different needs of water managers.
- ▶ Support actions aimed at increasing availability of hydrological data in near real-time coming from remote sensing and

in situ monitors to enable a more integrated approach to continuously calibrate/update models and water management.

- ▶ Develop new analytical methods, such as sequential processing of data and diagnostic evaluation of model consistency or data assimilation and other quality-assurance tests of real-time data.
- ▶ Share experiences with data platforms to facilitate more rapid model adaptation and increase monitoring in critical areas.

FOCAL AREA 1.4: ADDRESSING UNCERTAINTY AND IMPROVING ITS COMMUNICATION

There is increasing interest in assessing uncertainty in hydrology and analysing its possible effects on hydrological modelling and prediction. Yet environmental agencies, river basin authorities and engineering consultancies rarely apply recent advances in uncertainty analysis and probabilistic mapping of water-related hazards/risks. Once the uncertainty has been assessed, it is important to communicate it successfully to those who use the results of hydrologic modelling. IHP, with its ability to mobilize scientific expertise is assisting Member States on this.

Objectives

- ▶ Adopt consistent terminology and systematic approaches and guidelines for uncertainty estimation.
- ▶ Research how the uncertainties of water-related risk maps are understood, communicated, and then responded to in different institutional settings.
- ▶ Develop clear guidelines, aimed at water managers, for uncertainty estimation and probabilistic mapping of water-related risks.
- ▶ Encourage the application of recent advances in uncertainty analysis and probabilistic

mapping of water-related hazards and risks among government agencies, river basin authorities, and engineering consultancies.

- ▶ Encourage governmental flexibility in developing new standards and regulations in response to climate variability and changes.

FOCAL AREA 1.5: IMPROVE THE SCIENTIFIC BASIS FOR HYDROLOGY AND WATER SCIENCES FOR PREPARATION AND RESPONSE TO EXTREME HYDROLOGICAL EVENTS

Many people around the world are affected by water-related disasters every year. Flood frequency statistics have changed in recent years due to the variations in climate and land use changes. These need to be revised to raise the resilience of hydraulic structures during flood events. IHP-VIII encourages the development of the scientific and methodological basis for hydrology to prepare for and respond to extreme events, with research in river flow formation processes, methods of hydrological calculations and forecasting, mathematical and numerical modelling, and improvements to the theory of channel processes and sedimentation among the research topics to be addressed.

Objectives

- ▶ Support and expand scientific research and development of methodological basis for hydrology and water sciences.
- ▶ Document recent hazards induced by extreme hydrological events and share lessons learned with the water community.
- ▶ Promote the understanding of probabilistic and uncertainty analysis of extreme events among water professionals and managers.
- ▶ Reset design standards of hydraulic structures considering variations in climate and land use changes.



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THEME 2:

GROUNDWATER IN A CHANGING ENVIRONMENT

In nature, groundwater drives many geological and geochemical processes, sustaining various ecological functions and services. Groundwater is the largest store of freshwater and represents 98% of the Earth's unfrozen freshwater. Many people depend on groundwater for drinking water, food security and sustainable living in arid and semi-arid regions, small islands and emergency situations. Groundwater use has increased significantly over the past fifty years due to its good quality and widespread availability, even during droughts. Advances in hydrogeological knowledge have been made worldwide, many of them with the support of IHP; however, we still face many challenges such as improving knowledge of aquifer systems, the increasing global risk of groundwater depletion and pollution, the growing demand for groundwater and the potential influence of climate change. These challenges call for further research, the implementation of new science-based methodologies and the endorsement of principles for integrated management and environmentally-sound protection of groundwater.

FOCAL AREA 2.1: ENHANCING SUSTAINABLE GROUNDWATER RESOURCES MANAGEMENT

Sustainable groundwater development and resource management very much depend on knowledge of aquifer systems. Demographic changes and population growth and the related increase in groundwater demand for drinking and other uses, as well as the influence of changing climatic conditions are factors which need to be studied further. Sustainable groundwater management calls for holistic and multidisciplinary and environmentally-sound approaches and solutions provided through a participatory approach that encompasses policy-makers, water scientists and managers, planners, different user groups and the general public.

Objectives

- ▶ Develop methodologies for the sound development, exploitation and protection of groundwater resources to minimize social, economic and ecological side effects, and propose appropriate measures for the rehabilitation and replenishment of depleted aquifers.
- ▶ Develop new groundwater resource maps and visualizations at various scales, related guidelines and methods for the assessment, mapping and presentation of groundwater resources in areal extent and three-dimensional nature (World Hydrogeological Map, WHYMAP initiative).
- ▶ Strengthen groundwater governance policy in emergency situations (natural disasters, human-induced pollution events) and increase public awareness in the management of emergency groundwater resources based on historical experience and knowledge.

FOCAL AREA 2.2: ADDRESSING STRATEGIES FOR THE MANAGEMENT OF AQUIFER RECHARGE

IHP initiated the Strategies for Managed Aquifer Recharge (MAR) in semi-arid regions in 2002, in cooperation with the International Association of Hydrogeologists (IAH), with the aim to expand water resources and improve water quality. The MAR initiative can also help to create new water resources and thus secure drinking water supplies

under the increasing pressures of climate change and population growth.

Objectives

- ▶ Integrate managed aquifer recharge into IWRM to address effects of locally changing climate, population and food production.
- ▶ Develop and apply methods to assess the impact of recharge structures on water availability and quality, social and economic resilience and local ecosystems with a special focus on appropriate MAR methodologies and techniques for conservation and augmentation of safe drinking water supplies.
- ▶ Evaluate the risks and benefits of recycling appropriately treated wastewater and storm water for aquifer recharge to produce safe irrigation or drinking water supplies.
- ▶ Enhance governance capacities, and institutional and legal frameworks to aid effective MAR initiative implementation.

FOCAL AREA 2.3: ADAPTING TO THE IMPACTS OF CLIMATE CHANGE ON AQUIFER SYSTEMS

Few studies have been conducted on the impact of climate change on groundwater as it relates to surface water. The most important direct effect of climate change on groundwater is associated with recharge patterns, saline intrusion and a higher vulnerability to water security risks on the population.

Models for predicting and quantifying groundwater systems' response to the impact of climate change and the knowledge of the associated uncertainties are needed. The GRAPHIC initiative (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change) will analyse and quantify the potential impacts of climate change on groundwater quantity and quality in terms of their social, economic and environmental effects on and risks for population and groundwater dependent ecosystems.

Objectives

- ▶ Identify and evaluate the potential influence of climate change on different types of aquifers under various climatic, geographical and hydrogeological conditions.

- ▶ Increase public awareness of the importance and vulnerability of groundwater resources and propose adaptation measures.
- ▶ Promote the increase of groundwater storage in aquifers in view of potential climate change impact.
- ▶ Expand and integrate ground and satellite-based monitoring methods.
- ▶ Improve/develop appropriate methodologies and models for predicting and assessing climate change impact on groundwater resources at regional and small island scales.

FOCAL AREA 2.4: PROMOTING GROUNDWATER QUALITY PROTECTION

The establishment and operation of national groundwater quality monitoring networks is needed to support the sustainable management of aquifers; they provide valuable data for assessing the current state of and forecasting trends in groundwater quality, and help to clarify and analyse the extent of natural processes and human impacts on groundwater systems in time and space.

Objectives

- ▶ Propose basic principles for sustainable groundwater quality management and groundwater protection policies with a special focus on developing countries.
- ▶ Outline the basic criteria for the assessment of groundwater quality and vulnerability in regions repeatedly affected by climatic, hydrological and geological extremes (Groundwater for emergency situations – GWES).
- ▶ Strengthen national groundwater quality monitoring networks and site-specific monitoring systems around pollution sources, in public groundwater supply protection zones and in groundwater-dependent ecosystems.

FOCAL AREA 2.5: PROMOTING MANAGEMENT OF TRANSBOUNDARY AQUIFERS

Over half of the large continental aquifers are shared by two or more countries. In 2000, IHP established the ISARM initiative to compile a global inventory of transboundary aquifers and

to develop best practices and guidance tools on shared groundwater resources management.

IHP will work to strengthen groundwater monitoring activities of transboundary aquifers and fill data gaps.

Objectives

- ▶ Finalize assessment of transboundary aquifers around the world and develop global groundwater databases and knowledge-based systems.
- ▶ Implement the United Nations General Assembly Resolution on the Law of Transboundary Aquifers 63/124 and promote the principles of international water law as an instrument for cooperation.
- ▶ Map and evaluate the relation between international river systems and transboundary aquifers.



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THEME 3:

ADDRESSING WATER SCARCITY AND QUALITY

For many countries, water scarcity represents the most pressing challenge to socio-economic and human development at large. Furthermore, increasing human pressure threatens the ability to provide adequate water resources and functioning of ecosystem services in the arid and semi-arid regions and are particularly vulnerable to climate variability and changes.

Declining water quality has become a worldwide concern as human populations grow and economic activities expand. Poor water quality makes water unfit for use, has multiple health and environmental consequences, and further reduces water availability. Water pollution is becoming one of the greatest threats to freshwater availability. IHP aims to make a significant contribution to understanding and managing water quantity and quality worldwide, and especially in the developing world.

FOCAL AREA 3.1: IMPROVING GOVERNANCE, PLANNING, MANAGEMENT, ALLOCATION, AND EFFICIENT USE OF WATER RESOURCES

Increasing water scarcity worldwide calls for increased integration and cooperation to ensure sustainable, efficient and equitable management of scarce water resources, at international, regional, and local levels. Cooperating on transboundary river and aquifer water uses, and optimal allocation of water resources is an important element of water diplomacy.

Objectives

- ▶ Promote catchment-based water resources planning and decision-making, and promote a policy shift towards water demand management and its integration in the policies of all water sectors.
- ▶ Promote good water governance practice, including shared vision planning and adaptive management to enhance rational water allocation and implement water use policies and regulations.
- ▶ Promote sustainable conjunctive use of groundwater and surface water and implement adaptation measures to climate change.
- ▶ Understand and promote valuation and costing of water as a tool for cost-effective decision-making in water resources management.
- ▶ Promote water use efficiency in the various water use sectors through traditional and modern technologies.

FOCAL AREA 3.2: DEALING WITH PRESENT WATER SCARCITY AND DEVELOPING FORESIGHT TO PREVENT UNDESIRABLE TRENDS

Innovative policies and strategies are needed to manage freshwater sustainably. The goal is to find a balance between water for human and economic-based demands on the one hand, and water for maintaining ecosystem integrity and environmental sustainability on the other. This balance entails reconciling the seemingly disparate goals of socio-economic development and environmental protection and conservation.

Objectives

- ▶ Improve understanding of the special characteristics of hydrological systems and water management needs in water scarce regions and the broad dissemination of understanding to the user community and the public, especially as a basis for improved management.
- ▶ Promote better measurement and accounting for freshwater, develop and improve predictive water planning and management tools, enhance water management and sharing during scarcity periods, improve understanding of water-related services and ecosystem needs for water, improve valuation of water, design schemes in order to live with scarcity in view of climate change and explore new forms of resource management.
- ▶ Develop alternative environmentally and economically sound non-conventional water resources (e.g., desalination and treated wastewater) as well as conventional water augmentation techniques (water transfer, water reuse, water harvesting) through worldwide use of technologies and successful experiences for enhancing water supply.
- ▶ Develop and promote innovative water-saving technologies and tools and enhance their public acceptance as adaptation measures for scarcity.

FOCAL AREA 3.3: PROMOTING TOOLS FOR STAKEHOLDER INVOLVEMENT, AWARENESS AND CONFLICT RESOLUTION

Attaining water security requires addressing a range of issues from protection of the environment, coping with scarcity and climate change, and fair pricing of water services, to equitable distribution of water for irrigation, and industrial and household use. International organizations, governments, and local communities should all play a role. Improving the management of water resources and providing access to water for more people cannot be done without investing in water conservation and delivery systems, protecting the earth's ecosystems, conserving water and using water more efficiently. The involvement of stakeholders, an important component of good governance, is therefore necessary in achieving these targets.

Objectives

- ▶ Engage all stakeholders (NGOs, private sector, local communities, etc.) in sustainable water resources use and management.
- ▶ Train, communicate, and raise stakeholders' awareness of water security issues.
- ▶ Empower schools, universities and research institutes to address issues of water scarcity, including efficient water use and conservation.
- ▶ Strengthen education and training in interdisciplinary policy and decision-making for water professionals and decision-makers under scarcity conditions.
- ▶ Promote and support capacity development for decision-makers in managing conflicts over water use under scarcity conditions induced by human activities or climate change.

FOCAL AREA 3.4: ADDRESSING WATER QUALITY AND POLLUTION ISSUES WITHIN AN IWRM FRAMEWORK – IMPROVING LEGAL, POLICY, INSTITUTIONAL, AND HUMAN CAPACITY

Poor wastewater management, under-investment, inefficient allocation of water, land-use changes, and population growth are the main drivers of water pollution. Managing surface water and groundwater quality should be integrated with overall water quality management as part of integrated water resources management (IWRM). Effective water quality management, in the context of IWRM, requires an enabling environment in the form of policy, legal and institutional frameworks. Water and environmental laws and accompanying regulations such as those for wastewater discharge and environmental impact assessment are key legal and regulatory instruments for governing water allocation, environmental assessment and pollution control.

Objectives

- ▶ Improve understanding and knowledge of the quality of water resources for human well-being and ecosystems through strengthening the scientific knowledge base on monitoring and assessment of the quality of the world's freshwater resources and promoting better data management and information sharing.

- ▶ Assess the current knowledge base and information about water quality to establish management priorities.
- ▶ Promote integrated quality-quantity management through innovative approaches ('fit-for-purpose' water quality management, for instance) and science-based decision-making.
- ▶ Enhance legal, policy and institutional frameworks for water quality management by improving water pollution licensing and enforcement systems for sustainability.
- ▶ Build institutional and human capacity in water quality management and water pollution control.

FOCAL AREA 3.5: PROMOTING INNOVATIVE TOOLS FOR WATER SUPPLY SAFETY AND POLLUTION CONTROL

The development and promotion of innovative tools for improved water quality and pollution control for an integrated water quality management framework for sustainable livelihoods is needed through the promotion of scientific cooperation and joint research on specific water quality issues and challenges.

Objectives

- ▶ Develop and promote innovative tools for water quality management and pollution control.
- ▶ Promote scientific cooperation and joint research on specific water quality issues and challenges for improved understanding and scientific knowledge on new and emerging pollutants, water quality monitoring, risk assessment and regulations, and pollution control and attenuation.
- ▶ Promote integrated water pollution management through prevention, reduction and restoration of polluted water, improved wastewater management and effective management of impacts of land-use changes.
- ▶ Disseminate scientific knowledge and share research findings, facilitate the exchange of best practices and successful experiences in reducing pollution and restoring water quality.



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THEME 4:

WATER AND HUMAN SETTLEMENTS OF THE FUTURE

One of the major challenges we face is to provide safe drinking water and basic sanitation for all. At present close to 1 billion people lack access to improved water sources and over 2.6 billion people lack access to basic sanitation. Nearly all of these people live in cities in developing countries.

Cities all over the world are facing a range of pressures, from climate change and population growth, to deterioration of urban infrastructure systems and more. Cities of the future will thus have a hard time providing sufficient sanitation and managing scarcer and less reliable water resources efficiently. New approaches for urban water management will need to address these issues, and strategies to build resilient urban water systems must adopt a broad perspective that recognizes the interdependence of different water systems. The case of rural settlements and cities in developing countries merit a special emphasis, especially slums or peri-urban areas that are often the most deprived.

FOCAL AREA 4.1: GAME CHANGING APPROACHES AND TECHNOLOGIES

The business as usual approach will not adequately address the many challenges identified in urban centres. The use of innovative approaches and technologies in urban environments will ensure resource and cost optimization. By employing innovative technologies, reclaimed water can be reused multiple times, through cascading water use approaches for different purposes that require different water quality. Natural systems in an urban context can be used for treatment, resource recovery and buffering of the natural environment.

Objectives

- ▶ Manage urban water according to local context of city size and region, including long-term funding solutions to build and maintain water and wastewater infrastructure.
- ▶ Develop non-conventional sources of water and efficiency-enhancing means.
- ▶ Promote a fuller understanding of the role of urban groundwater – as a source of water but also as a site for intentional and non-intentional disposal for different type of discharges.
- ▶ Develop a systematic inventory of existing natural systems treatments, qualifying their performance and potential in the urban environment.
- ▶ Analyse the state-of-the-art in the design of smart networks applicable to urban water management.

FOCAL AREA 4.2: SYSTEM-WIDE CHANGES FOR INTEGRATED MANAGEMENT APPROACHES

Integrated urban water management (IUWM) incorporates all parts of the water cycle, and provides an opportunity to optimize the whole urban water system and to minimize water consumption, costs and energy. A better understanding of the interfaces and interconnections between the different resource streams in cities has to be developed, in particular in the water-energy-food nexus.

Objectives

- ▶ Study, develop and apply flexible and adaptive methods for the urban water management, considering diverse socio-economic, cultural and physical city environments, and consequences of global changes. Especially focus on slums and marginal peri-urban areas with their institutional, social and economic implications.
- ▶ Perform comparative studies of urban metabolism models with significance to urban water management and potential applicability.
- ▶ Compile and analyse cases where water sensitive urban design has been applied in the past 20 years, evaluate the state-of-the-art, including restoration of urban streams, and recommend relevant applications, particularly in cities in the developing world.
- ▶ Identify existing transition models: principles, objectives, scopes, and required information; select case studies with scenarios and evaluate results.
- ▶ Support regional activities and inter-regional cooperation involving relevant regional initiatives such as SWITCH-Asia, and regional and international water-related centres under the auspices of UNESCO.

FOCAL AREA 4.3: INSTITUTION AND LEADERSHIP FOR BENEFICIATION AND INTEGRATION

System-wide changes and game-changing technologies need to be coupled with governance and institutional structures that support their implementation. There is a need for innovative curriculum development to encourage systems thinking.

Objectives

- ▶ Examine the appropriate level of centralization of urban water management according to technical considerations, economies of scale, and necessary conditions of autonomy for the decentralized scheme in order to ensure viability and effectiveness.
- ▶ Develop a conceptual framework for institutional structures that leads to more effective management, innovative practices, and effective conflict resolution mechanisms.

- ▶ Investigate current and potential links of effective urban water management to generating green growth.
- ▶ Promote capacity development of a new generation of urban leaders with a wider vision of the role of city processes with the economy and the interaction between urban infrastructures.
- ▶ Carry out a survey of current participatory approaches in decision-making process applicable to urban water management.

FOCAL AREA 4.4: OPPORTUNITIES IN EMERGING CITIES IN DEVELOPING COUNTRIES

Urban settlements in developing countries are currently growing five times faster than those in developed countries. In Africa the population will soon pass 1 billion people and is expected to reach 2 billion people by 2050.

Since these emerging cities have immature institutions and infrastructures, there is an opportunity to do things differently for the urban management of water.

Objectives

- ▶ Perform a state-of-the-art review of existing urban water systems in developing countries, their evolution and constraints (physical, technical, institutional, financial, political, social); identify the responsible national institutions as well as relevant intervening international cooperation institutions, regional and intergovernmental organizations, and NGOs.
- ▶ Characterize a representative cross-section of cities regarding size, environmental, social, cultural, institutional and developmental conditions and aspects relevant to urban water management.
- ▶ Develop a set of criteria for identifying cities that may offer favourable conditions for rapid urban water development and leapfrogging to IUWM, and undertake pilot projects in cooperation with the relevant institutions and governments.
- ▶ Organize a series of well-designed events in target countries and sub-regions for capacity building sessions, closely coordinated with local authorities, regional organizations such as the African Minister's Council on Water

(AMCOW), the Asian Development Bank (ADB), the African Development Bank (AFDB), and UN organizations such as UN-Habitat.

FOCAL AREA 4.5: INTEGRATED DEVELOPMENT IN RURAL HUMAN SETTLEMENT

Water supply and sanitation support in rural areas is challenging since settlements can be in environmentally fragile areas. Rural populations depend on local water sources which are often contaminated. Scattered settlements, dominated by an agro-based economy and limited water resources give rise to challenges for infrastructure provision. Most of the existing water infrastructure is decentralized, and many of these infrastructure systems have fallen into disrepair due to technical, financial and managerial limitations.

Objectives

- ▶ Identify appropriate awareness raising initiatives for water security and safe sanitation that is suitable for the illiterate rural population.
- ▶ Identify appropriate technology for agriculture, water and sanitation services that can be accepted, developed, operated and maintained by local rural people.
- ▶ Propose a new business model specifically for the rural poor that ensures sustainable infrastructure development and operation, and efficient use and reuse of resources.
- ▶ Study new institutional frameworks that can address rural area issues in an integrated approach, and identify enabling institutional and governance structures (e.g. institution, decentralization and devolution, NGO participatory levels and community organization, policies and regulation, cost recovery and subsidies).



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THEME 5:

ECOHYDROLOGY: ENGINEERING HARMONY FOR A SUSTAINABLE WORLD

There is an urgent need to reverse the degradation of water resources and stop further decline in biodiversity. One way to reach this goal is to appreciate and optimize ecosystem services for society while also enhancing the resilience of river basins to climatic and anthropogenic stress.

FOCAL AREA 5.1: HYDROLOGICAL DIMENSION OF A CATCHMENT: IDENTIFICATION OF POTENTIAL THREATS AND OPPORTUNITIES FOR SUSTAINABLE DEVELOPMENT

The integration of information about hydrological cycle inputs and economic distribution provide a template to regulate processes towards sustainable water and ecosystem resource use. IHP will support research and capacity building initiatives aimed at improving the understanding of the inter-linkages of ecohydrological processes at the catchment scale with a special emphasis

on implementation at UNESCO ecohydrology demonstration sites.

Objectives

- ▶ Increase the knowledge base and further develop approaches to reduce threats, such as floods and droughts, by asserting the stochastic character of hydrological processes in catchments through the harmonization of hydrotechnical infrastructure with the distribution and management of water-retaining ecosystems.
- ▶ Support research and develop guidelines for the incorporation of an understanding of

the past in River Basin Management Plans (e.g. paleohydrology, ecological succession patterns, spatial-temporal dynamics of human settlement).

- ▶ Promote model development to reduce hydro-peaking by integrating specific environmental science knowledge (e.g. hydrogeology, soil, groundwater, plant cover) and floodplain characteristics.
- ▶ Develop catchment scale ecohydrological early warning systems (by integrating molecular biomonitoring, hydrochemistry, geomorphology, land cover and use in the geographic information system (GIS) framework).

FOCAL AREA 5.2: SHAPING OF THE CATCHMENT ECOLOGICAL STRUCTURE FOR ECOSYSTEM ENHANCEMENT POTENTIAL – BIOLOGICAL PRODUCTIVITY AND BIODIVERSITY

It is necessary to integrate the concept of enhanced ecosystem potential with ecohydrological strategies to achieve sustainability of ecosystems closely related with water to improve IWRM on specific areas. This is termed WBSR (water, biodiversity, ecosystem services, and resilience) containing the four elements that should be taken into consideration while trying to improve the ecosystems potential.

Objectives

- ▶ Improve the understanding of the role of different types of terrestrial and wetland ecosystems distributed in a catchment on water cycling processes.
- ▶ Support studies of the role of hydrodynamics and the biological structure of river basins in the reduction of various types of pollution in demonstration sites.
- ▶ Develop methods to mitigate the impact of the catchment’s demographic and socioeconomic structures effect on water balance nutrients and pollutants in river fluxes.
- ▶ Potentiate and share knowledge on the integration of ecohydrological technologies with good agriculture and environmental practices for the reduction of diffuse pollution from the landscape.

FOCAL AREA 5.3: ECOHYDROLOGY SYSTEM SOLUTION AND ECOLOGICAL ENGINEERING FOR THE ENHANCEMENT OF WATER AND ECOSYSTEM RESILIENCE, AND ECOSYSTEM SERVICES

The use of ecosystem properties as a management tool is related to ecological engineering, and is based on the first and the second principles of ecohydrology.

The identification and evaluation, as well as the functional incorporation of ecosystem services as integral elements of water management and economics, sustainable water supply and demand models is a necessity, given global changes and the increasing demand for more sustainable and efficient management focused on changing social needs and the global context. There is also a need to change the perception of ecological systems in economic models from “compulsory costs” to “potential benefits”. Ecohydrological biotechnologies (based on “dual regulation”) have to be developed in both agricultural landscapes and urban spaces to increase water availability, food and bioenergy productivity, reduce diffuse pollutant emission, enhance biodiversity and serve human health and quality of life through a systems approach towards regulating the complexity of interactions between the water cycle, ecosystems and societies.

Objectives

- ▶ Identify good practices for implementing “dual regulation” for the reduction of excess nutrients and pollutants by the regulation of the biota-hydrology interplay.
- ▶ Develop guidelines for the integration of various types of biological and hydrological regulations at the basin scale toward achieving synergy to improve water quality, biodiversity and freshwater resources, and optimize ecosystem services.
- ▶ Develop case studies focusing on the harmonization of ecohydrological measures with existing or planned hydrotechnical solutions (dams, irrigation systems, sewage treatment plants, etc.) for a reduction of toxic algae blooms and adaptation to climate instability.
- ▶ Promote ecohydrology low cost high-tech for IWRM, evaluation of ecosystem services in a catchment scale and development of tools

for their efficient incorporation into Basin Management Plans.

FOCAL AREA 5.4: URBAN ECOHYDROLOGY – STORM WATER PURIFICATION AND RETENTION IN THE CITY LANDSCAPE, POTENTIAL FOR HEALTH AND QUALITY OF LIFE IMPROVEMENT

One of the major causes of the world's water crisis is that urban populations place large demands on water resources and services. Since quality of life and human health are top priorities for sustainable city development, there is thus a need for a new paradigm of holistic city management.

Objectives

- ▶ Identify and promote good practices for the reduction of urban storm water hydro-peaking by developing systems for infiltration, purification and retention of storm water.
- ▶ Develop guidelines for sustainable urban planning, based on a combination of water sensitive urban design and ecohydrological biotechnologies for improving the quality of life and economics of urban systems and adaptation for global climate variations.
- ▶ Develop and strengthen frameworks and improve methodologies for cooperation in multi-stakeholder platforms and public participation for demand-driven research and the efficient application of recent achievements in ecohydrology for IUWM.

FOCAL AREA 5.5: ECOHYDROLOGICAL REGULATION FOR SUSTAINING AND RESTORING CONTINENTAL TO COASTAL CONNECTIVITY AND ECOSYSTEM FUNCTIONING

Human pressure on coastal areas is extremely high. Eighty percent of marine pollution comes from land-based sources and, in the developing world, more than 90% of sewage and 70% of industrial waste is untreated when dumped into surface waters where it pollutes water supplies and coastal waters with harmful consequences to human health, biodiversity, and coastal ecosystem services. An estimated 75% of the world's population – or 6.3 billion people – will live in coastal areas by 2025. This will further

increase pressure on water resources and reduce sustainability. Global change is also affecting coastal ecosystems both from land, through changes in hydrologic cycles and precipitation patterns, and from the ocean, through changes in the sea level. There is thus an urgent need to address these impacts and apply ecohydrological approaches in order to contribute to sustainable solutions.

Objectives

- ▶ Share and improve regional ecohydrological solutions to the impact of global change on hydrologic cycles and coastal ecosystems to address the increasing vulnerability of aquatic resources.
- ▶ Develop approaches and methods for dual management regulation – hydrology and biota – in river basins to improve water quality and biodiversity in coastal ecosystems.
- ▶ Improve the understanding of coastal ecosystems, as recipients of wastewater released from upstream sources, and develop case studies of how ecohydrology solutions may contribute to reducing the risk of diseases occurring in estuarine zones.



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THEME 6:

WATER EDUCATION – KEY FOR WATER SECURITY

To attain water security, water education at all levels will have to be enhanced along the lines of education for sustainable development. In this phase of IHP, water education includes a multidisciplinary and interdisciplinary approach aimed at advancing scientific knowledge through the training of scientists, and strengthening and enhancing the water sector through training and continuing education for water professionals and decision-makers. IHP will also involve working with mass and community media professionals to improve their capacities to communicate water issues accurately and effectively. This includes community education strategies to promote community-wide water conservation, and skills in local co-management of water resources.

The UNESCO water centres and the Chairs and the University Twinning and Networking Programme (UNITWIN) play a critical role to implement the water education component of the programme.

FOCAL AREA 6.1: ENHANCING TERTIARY WATER EDUCATION AND PROFESSIONAL CAPABILITIES IN THE WATER SECTOR

Human capacities and expertise of the water sector and related areas must be ensured to guarantee universal access to freshwater and address complex challenges linked to social, economic, climatic, and other factors at local, regional and global levels.

Objectives

- ▶ Support the enhancement of tertiary water education capacities, particularly in developing countries.
- ▶ Promote and assist the development of interdisciplinary and multidisciplinary curricula and research initiatives linked to water-related programmes in higher education and research institutions.
- ▶ Strengthen collaboration between the UNESCO Category 2 Water Centres and UNESCO water-related Chairs, other UN system agencies and programmes, and existing international water-related education programmes.
- ▶ Promote and support strategies and actions for continuous professional development of water scientists, engineers, managers and policy makers in the water sector.
- ▶ Develop interdisciplinary materials, such as guidelines, briefing papers, prototype professional development programmes and case studies connected with water education for water security, linked to the implementation of other IHP themes and initiatives.

FOCAL AREA 6.2: ADDRESSING VOCATIONAL EDUCATION AND TRAINING OF WATER TECHNICIANS

IHP will aim to maintain and expand the training of technicians in water-related fields, such as hydrometeorological monitoring, irrigation systems, sanitation, and water supply systems. An important component of this focal area will be to survey and prepare case studies with examples of leading practices in sustainable integrated water management for the training of water technicians.

Objectives

- ▶ Support specific initiatives in developing Member States to sustain and improve water-related vocational education.
- ▶ Survey, prepare and analyse case studies of examples of leading practices in sustainable water management in the training of water technicians and support the preparation of guidelines and briefing papers based on them.
- ▶ Develop efforts within UNESCO and in partnership with other UN system agencies and programmes to maintain and expand the training of technicians in water-related fields.

FOCAL AREA 6.3: WATER EDUCATION FOR CHILDREN AND YOUTH

Water education should be a significant component of the K-12 curriculum. Although formal education systems are the main focus here, other initiatives will be considered, such as the development of water-related activities in children's eco-clubs, sports clubs, and explorer groups. IHP will work closely with UNESCO's Education Sector, as well as with other partner organizations with a mission of enhancing water education in schools. The programme will also aim to improve the capacity of teachers and informal educators to better understand water issues at the local, regional and global scales, and to commit to a water ethic.

Objectives

- ▶ Develop capacity of teachers and informal educators on water issues at the local, regional and global scales.
- ▶ Support and guide the development of improved tools for the teaching of water issues in the K-12 curriculum.
- ▶ Guide and provide technical support to national/regional demonstration projects and the development of prototype materials at national/regional levels in select Member States/regions.
- ▶ Provide technical assistance for the development of interdisciplinary support materials, such as guidelines, briefing papers, and case studies on leading practices in K-12 water education, and curriculum development on water resources, in coordination with other UNESCO Sectors.

FOCAL AREA 6.4: PROMOTING AWARENESS OF WATER ISSUES THROUGH INFORMAL WATER EDUCATION

Communities need to have the appropriate knowledge and understanding of their watershed, the natural, social, cultural conditions, as well as policies and regulations, economic trends and development opportunities, to be involved in water management and conservation. They will also be more actively involved if they are organized. IHP will develop water education activities for communities and will partner with IHP National Committees.

Mass media professionals can play an important role in increasing awareness on water-related problems and issues. Yet limited efforts have been made to educate them on water issues, and so reports are mainly on extreme water-related situations, when preventive measures or actions relative to disasters, conflicts, contamination, loss of life and natural resources are no longer applicable.

If journalists, bloggers, radio, television, film, and other media professionals understand the importance of local, regional and global water issues, this will be an effective mechanism for increasing overall public awareness.

Objectives

- ▶ Develop and promote community education strategies related to water issues (state of the resource, conservation, co-management, among others).
- ▶ Provide technical assistance for the development of interdisciplinary support materials, such as guidelines, briefing papers, and case studies on leading practices in water education for communities.
- ▶ Provide technical assistance for the development of interdisciplinary support materials, such as guidelines, briefing papers, and case studies on leading practices in water education for mass and community media professionals.
- ▶ Engage leading mass media professionals in awareness raising campaigns and programmes.

FOCAL AREA 6.5: EDUCATION FOR TRANSBOUNDARY WATER COOPERATION AND GOVERNANCE

Since the majority of large basins and aquifers in the world are shared between two or more countries, the management and conservation of water resources needs to take place through negotiations and the establishment of agreements. However, very few institutions around the world have specialized courses or programmes on water negotiation for cooperation. IHP supports the development of educational initiatives that support transboundary water cooperation and negotiation. PCCP (From Potential Conflict to Cooperation Potential), is a long-term IHP initiative which aims to compile and develop wise practices and guidance tools on shared water resources management and negotiation. New capacity building tools, guidelines, curricula and case studies to support Member States in their ongoing transboundary management and negotiations will be developed in this phase.

Objectives

- ▶ Provide technical assistance for the development of interdisciplinary support materials, such as guidelines, briefing papers, and case studies on leading practices in education and capacity building for transboundary water cooperation.
- ▶ Improve Member States' cooperation and mutual understanding, strengthen capacities and develop agreements for the sustainable management of transboundary water through capacity building activities at all levels.
- ▶ Assist in the development of curricula and research on transboundary water cooperation in higher education institutions.



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PUTTING SCIENCE INTO ACTION

Building on the lessons learned and experience gained from previous phases, IHP-VIII will aim to produce policy-oriented results that translate into tangible benefits at the country level, with steps taken to ensure coordinated action on the ground with other organizations involved in water resources management. IHP-VIII will be implemented through an adaptive regional approach and strong coordination within the UNESCO Water Family. Special attention will be given to strengthening the involvement of all regional partners, including National Committees, centres, chairs, networks and programme committees.

Considering the magnitude of water-related issues in developing countries, and Africa in particular, UNESCO will continue to support African countries in furthering the role of water as a source of social, economic and political stability, with an emphasis on water, peace and security, building resilience to water-related disasters and capacity building. UNESCO will also promote gender mainstreaming in water resources management, as well as develop capacities on water-related issues and women's empowerment.

ANNEX 1.

IHP INITIATIVES

As a science and education programme at the global level, IHP covers a wide spectrum of initiatives. All IHP-related activities are endorsed, recommended and coordinated through the IHP Intergovernmental Council.

IHP's two cross-cutting initiatives, FRIEND-Water and HELP, interact with all IHP themes through their operational concepts. IHP's associated initiatives cover projects and activities that contribute to the development and implementation of IHP themes, and are often interlinked with joint and interagency programme components.

+ **FRIEND-Water** (Flow Regimes from International Experimental and Network Data)

An international research initiative that helps to set up regional networks for analysing hydrological data through the exchange of data, knowledge and techniques at the regional level.

+ **GRAPHIC** (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change)

A UNESCO-led project seeking to improve our understanding of how groundwater interacts within the global water cycle, how it supports human activity and ecosystems, and how it responds to the complex dual pressures of human activity and climate change.

+ **G-WADI** (Global Network on Water and Development Information in Arid Lands)

A global network on water resources management in arid and semi-arid zones whose primary aim is to build an effective global community to promote international and regional cooperation in the arid and semiarid areas.

+ **HELP** (Hydrology for the Environment, Life and Policy)

A new approach to integrated catchment management by building a framework for water law and policy experts, water resource managers and water scientists to work together on water-related problems.

+ **IDI** (International Drought Initiative)

A long-term initiative through which the research activities related to droughts as well as the development of capacities to address such events will be designed, coordinated and implemented.

+ **IFI** (International Flood Initiative)

An interagency initiative promoting an integrated approach to flood management which takes advantage of the benefits of floods and the use of flood plains, while reducing social, environmental and economic risks. Partners: the World Meteorological Organization (WMO), the United Nations University (UNU), the International Association of Hydrological Sciences (IAHS) and the International Strategy for Disaster Reduction (ISDR).

+ **IIWQ** (International Initiative on Water Quality)

An international platform to strengthen knowledge, research and policy, and develop innovative approaches to tackle water quality challenges.

+ **ISARM** (Internationally Shared Aquifer Resources Management)

An initiative to set up a network of specialists and experts to compile a world inventory of transboundary aquifers and to develop wise practices and guidance tools concerning shared groundwater resources management.

+ **ISI** (International Sediment Initiative)

An initiative to assess erosion and sediment transport to marine, lake or reservoir environments aimed at the creation of a holistic approach for the remediation and conservation of surface waters, closely linking science with policy and management needs.

+ **PCCP** (From Potential Conflict to Cooperation Potential)

A project facilitating multi-level and interdisciplinary dialogues in order to foster peace, cooperation and development related to the management of shared water resources.

+ **UWMP** (Urban Water Management Programme)

An initiative that generates approaches, tools and guidelines which will allow cities to improve their knowledge, as well as analysis of the urban water situation to draw up more effective urban water management strategies.

+ **WHYMAP** (World Hydrogeological Map)

An initiative to collect, collate and visualize hydrogeological information at the global scale to convey groundwater-related information in a way appropriate for global discussion on water issues.

ANNEX 2.

UNESCO WATER FAMILY

