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COMPENDIUM

SUSTAINABLE WATER GOVERNANCE IN ASIA AND THE PACIFIC:

UNESCO SITES FOR WATER SECURITY TOWARDS THE 2030 AGENDA

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SHORT SUMMARY

Sustainable Water Governance for the Sustainable Development Goals

This document is a comprehensive Compendium of the findings and featuring a collection of case stories and articles related to water governance implementation within Asia and the Pacific between 2019 and 2022.

The Compendium is based on presentations, discussions, findings, regional and sub-regional reports based on various research and capacity building activities within Asia and the Pacific region coordinated by the UNESCO Jakarta Regional Sciences Bureau for Asia and the Pacific in the period between 2019 and 2022. It is funded by the Japanese Funds-in-Trust (JFIT) project: Good Governance for the Sustainable Development Goals: mobilising UNESCO's water and environmental science networks for the 2030 Agenda.

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"Since wars begin in the minds of men and women it is in the minds of men and women that the defences of peace must be constructed"

Foreword

Mohamed Djelid
Director and UNESCO Representative for Brunei Darussalam, Indonesia, Malaysia, the Philippines and Timor-Leste
Jakarta, Indonesia

It is my pleasure to present this Compendium of Sustainable Water Governance in Asia and the Pacific: UNESCO sites for water security towards the 2030 Agenda. This Compendium summarize various activities conducted to supports the supports the advancement and implementation of good governance of water management in Asia and the Pacific.

During the period of 2019 – 2022, we witness the continued fight against many global crises. As we endeavor to end the ongoing pandemic, the decisions we make will reshape human, economic and environmental wellbeing for future generations. We need more urgent and ambitious actions in our society to end the pandemic, to secure an equitable and green recovery, and to speed up the implementation of the Sustainable Development Goals (SDGs).

The compendium you are about to read disseminate scientific results, best practices, and consider a variety of tailored and targeted methods, such as events, campaigns, and media engagement to enrich the toolbox on water education, as well as policy instruments, tools, decisions, and actions on water (surface and groundwater). Therefore, this Compendium serves as a demonstration of good practices and innovative approaches helping to advance effective.

The main priority on the UNESCO-IHP in the Asia-Pacific region is to improve water system resilience to avert water related disasters and to prepare for climate and other global changes by turning previous disaster lessons into better practices for tomorrow by using nature-based solutions. Therefore, activities of the UNESCO IHP Programme are focused on

mainstreaming the establishment and maintenance of a virtuous system of good governance, which calls for effective water-related organisations to provide coherent policies, evaluate progress, and take action when necessary, all while interacting transparently with stakeholders.

The development of this Compendium was made possible through support from Japan Funds-in-Trust towards the "Good Governance for the Sustainable Development Goals: mobilizing UNESCO's water and environmental science networks for the 2030 Agenda" project – representing a continuation of the steadfast and invaluable support towards regional engagement in UNESCO's natural sciences programmes provided by the Government of Japan over the past two decades.

While the content of this Compendium was developed specifically for Asia and Pacific context, we hope that this Compendium can be a reference to support management of natural sites across the world and enhance their contribution to the Sustainable Development Goals.

Participating Countries:

Afghanistan

Australia

People's Republic of China

Fiji

India

Indonesia

Iran

Japan

Kazakhstan

Republic of Korea

Lao People's Democratic Republic

Malaysia

Mongolia

Republic of the Union of Myanmar

Nepal

New Zealand

Pakistan

Philippines

Solomon Islands

Thailand

Timor-Leste

Uzbekistan

Viet Nam

Executive summary

There will be significant shifts in water availability and variability in the Asia-Pacific area due to climate change. While higher expectations for and more resources to deliver on water security are created by societal progress, the development may also raise water consumption and pollution, lowering water security. Water security may rise or fall in importance in the political context, and governments may pay less consideration to water security's environmental aspects as a result.

Asia and the Pacific is home to sixty percent of the world's population but has only thirty-six percent of the world's water resources, resulting in the lowest per capita water availability in the world (APWF, 2009).

Due to population expansion, urbanisation, and rising industrialisation, water rivalry amongst sectors in the region has intensified, endangering agricultural productivity and food security and compromising water quality. Seven of the world's 15 largest groundwater abstractors are located in Asia and the Pacific (UNESCAP/UNESCO/ILO/UN Environment, 2018 cited in the UN World Water Development Report, 2021, p. 116).

The Compendium on "Sustainable Water Governance In Asia And The Pacific: UNESCO Sites For Water Security Towards The 2030 Agenda" is aimed to provide a situational analysis of current UNESCO Asia-Pacific initiatives and recognize the involvement and contribution of the UNESCO members in the implementation of the IHP-IX Strategic Plan 2022-2029 (Science for a Water Secure World in a Changing Environment, 2021).

In the recent years, the UNESCO family in Asia-Pacific developed several effective projects on water education and awareness-raising regarding the climatic impacts on water sector in the region. Strategies and contributions included in this Compendium s disseminate scientific results, best practices, and consider a variety of tailored and targeted methods, such as events (conferences, virtual field trips, study curriculums, etc.), campaigns, and media engagement to enrich the toolbox on water education, as well as policy instruments, tools, decisions, and actions on water (surface and groundwater). Therefore, this Compendium serves as a demonstration of good practices and innovative approaches helping to advance effective

water governance and the UNESCO IHP Programme as a whole throughout Asia and the Pacific.

Because of the wide variety of impacts from climate change, experts agree that evaluation on a finer geographical and temporal scale is necessary for developing more effective adaptation measures. Better protection and the growth of resistant and resilient communities in the Asia-Pacific area are possible with more information about likely impacts and their repercussions (Islam & Kieu, 2021, p. 48). The main priority on the UNESCO-IHP in the Asia-Pacific region is to improve water system resilience to avert water-related disasters and to prepare for climate and other global changes by turning previous disaster lessons into better practices for tomorrow by using nature-based solutions. Therefore, activities of the IHP UNESCO are focused on mainstreaming the establishment and maintenance of a virtuous system of good governance, which calls for effective water-related organisations to provide coherent policies, evaluate progress, and take action when necessary, all while interacting transparently with stakeholders.

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Acronyms

ADB	:	Asian Development Bank
APWF	:	Asia-Pacific Water Forum
AWDO	:	Asian Water Development Outlook
CACENA	:	Central Asia and Caucasus
CHA	:	Catalogue of Hydrological Analysis
COVID-19	:	Coronavirus disease 2019
DDR	:	Disaster Risk Reduction
FAO	:	Food and Agriculture Organization of the United Nations
FIT	:	Funds-In-Trust
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
ICOLD	:	International Commission on Large Dams
ICT	:	*Information and Communications Technology*
IHP	:	International Hydrological Programme
IWRM	:	Integrated Water Resources Management
I-WSSM	:	UNESCO International Centre for Water Security & Sustainable Management
NbS	:	Nature-based solution

OECD	:	Organisation for Economic Co-operation and Development
PIC	:	Pacific Island Countries
PMP	:	Probable Maximum Precipitation
PMF	:	Probable Maximum Flood
RIDM	:	Risk-informed decision making
SDG	:	Sustainable Development Goal
UNECE	:	United Nations Economic Commission for Europe
UNEP	:	United Nations Environment Programme
UNESCAP	:	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
USLE	:	Universal Soil Loss Equation
VFT	:	Virtual Field Trip
WASH	:	water, sanitation, and hygiene
WBL	:	Work-Based Learning
WSI	:	Water Security Index

Introduction

The strategic importance of water, combined with increasing pressures on its availability and connected social and political constrictions makes water security research today more relevant than ever (Bréthaut et al., 2022, p. 466). The last Intergovernmental Panel on Climate Change (IPCC) report also highlighted "the centrality of water security in light of climate change" (IPCC, 2022, p. 8), which is exacerbated in Asia-Pacific region. Problems related to water access, water depletion and pollution, sanitation conditions, and disasters in the Asia-Pacific region continue to grow, often along with many other problems that exist in a given country. The many water-related problems mentioned above are various components of water security. A country facing any combination of these problems is highly vulnerable to water scarcity, which can undermine efforts to implement its development agenda.

As a contribution to implementing the good practices bringing water security to be more highlighted in the region, the UNESCO Office in Jakarta decided to develop a practical tool that would provide examples and guidance for bringing water security in knowledge and experience exchange, as well as education. The result is this Compendium - a collection of more than 30 good practices from UNESCO sites in Asia and the Pacific region, which aims to become a resource for practitioners and policymakers as well as a platform for exchange among institutions and individuals.

This Compendium starts with a brief introduction of the water security concept and its relevance in Asia-Pacific, as well as a general overview of water security issues in the context of UNESCO IHP Programme in Asia and the Pacific. The second chapter is dedicated to the best practices of ensuring physical water security in Asia-Pacific region through disaster risk assessment and management, with the best practice examples collected from Indonesia, Japan, Republic of Korea, Malaysia, Myanmar and the Philippines.

The best practices and tools of ensuring water security through multipurpose dam reservoir operations are supported by the expertise from China, Indonesia, Japan, Republic of Korea, Malaysia, Mongolia, Philippines, Viet Nam.

The third part of the Compendium is devoted to the regional platform activities on water security. Namely, it enlarges on the 4th Asia-Pacific Water Summit, Regional IHP Steering Committee meetings for Asia and the Pacific, and assessments of National Committees and Focal Points in Asia Pacific.

The forth chapter is dedicated to the best practices and innovative tools for bringing water security at the forefront of the education. Here, the reader can learn more on the introduction of the regional ready-t-use curriculum on water security in Asia-Pacific, the success stories of Water Resilience Challenges for raising awareness among the youth water leaders, and interactive virtual trips.

The fifth chapter is devoted to response strategies to the COVID-19 crisis in Asia-Pacific. The Compendium ends with the conclusion and future avenues for common actions.

1. Water security as an area for policy action

Water fits in this broader notion of security, which includes political, socioeconomic, individual, and broader environmental considerations, and serves as a connecting point amongst them (UNESCO i-WSSM, 2019, p. 24). In this light, it is not surprising that in the last decades, the political and academic interest in water security crystalized across many disciplines (Waterbury, 1979; Turton, 2002; Cook & Bakker, 2012; Lautze & Manthrithilake, 2012). This interest was caused due to changes in global and local water availability, growing water demand in light of growth of demography and industrial advancements.

The definition of water security acknowledged by the United Nations (UN) is “the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socioeconomic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability” (UN Water, 2013, p. 1 cited in IPCC, 2022, p. 621). At the risk of becoming porous, this definition attempts to encompass all water-related aspects of economic,

political, societal, individual and environmental security and, as Lautze and Manthrithilake highlighted, make it relevant for national security and sovereignty calculations (Lautze & Manthrithilake, 2014, cited in Wegerich, 2015, p. 4660). Nonetheless, what defines "sufficient" water security and the ways of its estimation are still contested (Young et al. 2021, cited in Wutich et al. 2022).

Individual and household water security is defined as "having physical and economic access to water that is sufficient and safe (in quantity and quality) for drinking, cooking, bathing, and cleaning needs" (Bacon et al., 2022, p. 17). The human dimension of water security, namely, the diversity and power disparities within different segments of water users, which shape their access to water is widely recognized in the most recent water security literature in the Asia Pacific region. Namely, Asian Development Bank (ADB) has released Asian Water Development Outlook (AWDO), which is a methodology and approach for evaluating the state of key components of water security. Taking into consideration not just water quantity but also time, place, quality, and consumption, this index produces a whole-of-society value for water, which may help policymakers ensure that no one is left behind (AWDO, 2020, p. xiii). There, five key dimensions (Rural Household Water Security, Economic Water Security, Urban Water Security, Environmental Water Security, Water-Related Disaster Security) were aligned with actionable indicators (AWDO, 2020).

From the industrial era water was resources were controlled from a technical or engineering standpoint, with water being gathered, stored, and dispersed to suit human requirements. Concerns about water quality also frequently center on institutional tools or source-level actions. This strategy has produced "over-engineered" landscapes and waterways in a variety of contexts, which eventually has an effect on ecosystems. To address environmental degradation brought on by multiple pressures, such as but not limited to, climate variability and change, human population growth, rising water abstractions, and poor water quality, a broader, more holistic approach to managing water resources has emerged over the last few decades. People can grasp the importance of water in maintaining life due to its capacity to operate as a transport medium, a solvent and a coolant, as well as due to its role in several biogeochemical reactions, by acquiring

an awareness of the complexity of guaranteeing water security. Building a solid knowledge base and comprehending how technical methods to water management have significantly changed landscapes is increasingly important for environmental management today. The effects of climate change on the global supply, demand, and quality of water resources are added to the rising human need for water. Extreme climate events including tropical cyclones, droughts, and floods are predicted to become more frequent and more powerful as a result of climate change (UNESCO Curriculum, 2021, p. 30).

Therefore, in this Compendium, we aim to connect different views on water to be able to comprehend and alleviate all types of water-related insecurities in the Asia-Pacific Region.

For individual report for each activity present in this Compendium, please follow this link: https://msteams.link/4OQI

1. 2. Water Stresses in Asia and the Pacific

People living in Asia and the Pacific region, share the increase of urgency and complexity of water and other climate-related problems.

Developing countries in Asia and the Pacific have experienced rapid economic growth in recent years, exploiting the opportunities presented by globalization and the export-led growth model. This economic growth comes at the costs of increasing pressure on natural systems, which also affects the water sector. Just as rising energy demand affects food production, rising water demand may have a similar impact if current trends continue. Notably, the Asia-Pacific region has the lowest per capita water availability, yet it has the highest share of water consumption from available renewable sources. The region is also one of the most vulnerable to climate-related disasters: The floods, which affected 33 million people in Pakistan, were caused by strong monsoon rains that began in mid-July 2022. With climate change posing such a significant danger, disruptive and destructive extreme weather situations like this and worse will become more often. These catastrophes not only demolish houses and cause immediate fatalities, but they also constitute a public health risk: the stagnant water around displaced families'

camps and settlements serves as a breeding ground for vector-borne (e.g., malaria and dengue) and water-borne (e.g., cholera) illnesses that damage people's health and capacity to use food correctly (IPCC 2007 cited in Islam & Kieu, 2021, p. 28, also in Bhamani, 2022).

Water scarcity affects food security by reducing water availability for irrigation, and hygiene by failing to dispose of domestic waste, which in turn leads to contamination of water sources and the spread of aquatic pathogens and undermines environmental sustainability as countries deplete their water resources.

Despite some progress in improving access to sanitation in rural areas of the region, more than half of the rural population in many member countries still does not have access to improved sanitation. In addition, 80-90 per cent of all liquid waste produced in developing countries is dumped directly into open water bodies without any treatment. Poor sanitation and wastewater management in developing countries contaminate freshwater sources, a major cause of illness and death and impact negatively on ecosystems.

The Asia-Pacific region is also one of the world's most disaster-prone regions. Natural disasters such as cyclones (typhoons), rainstorms, floods, landslides, and tsunamis triggered by earthquakes and volcanic eruptions beneath the sea have a negative impact. These natural disasters cause major disasters in all nations in the region, which has the most dynamic social development in terms of population and economic growth in the globe.

Eastern and South-Eastern Asia with 2.3 billion people (29 percent of the global population) and Central and Southern Asia with 2.1 billion people were the two most populated regions in 2022. (26 per cent). With almost 1.4 billion people each, China and India accounted for the majority of the population in these two regions (World Population Prospects, 2022). By 2025, the total number of megacities worldwide is expected to increase to 37, with 23 of them in Asia. Thus, meeting the needs of medium-sized cities is critical to development. In addition, 99 of the top 100 riskiest cities in the world, including 37 in China and 43 in India, are located in Asia when exposure to a variety of environmental and climate-related dangers is taken into account. Eight of the world's top ten most pharmaceutically contaminated rivers - the Citarum, Yangtze, Indus, Hai He, Yellow, Ganges, Zhu Jiang, Amur, and Mekong Rivers - are located in Asia (Wilkinson et al., 2022).

Population growth, high rates of urbanization and the impacts of climate change will further exacerbate water supply problems, especially as many densely populated areas in Asia are located in very high and high-risk areas, such as flood-prone areas, river deltas and coastal areas. Extreme weather also has an impact on the Asia-Pacific area. Hazards and calamities frequently disproportionately affect vulnerable people. The risk of flooding will continue to outstrip both structural and non-structural mitigation efforts as cities expand to occupy more areas of the world's flood plains, riversides, and shorelines.

Growth in this region, however, has not resulted in advancements in disaster risk management. The situation is worse as infrastructural development cannot keep pace with expansion. Policies to reduce and alleviate poverty are insufficient, and the gap between rich and poor is growing.

1. 3. General Policies Regarding the Global Water Security in Asia Pacific Region

Nearly every nation faces challenges related to water shortage and security as a result of climate change and harsh weather. The Sendai Framework for Disaster Risk Reduction (2015-2030) lays out a plan to make communities everywhere safer and more resilient against natural disasters, and it places a strong emphasis on ensuring access to clean water.

Reports and standards for assessing WSI have been used to evaluate nations internationally.

In 2014, the Global Water Partnership (GWP) published the proceedings of a workshop titled "Assessing Water Security with Appropriate Indicators," wherein it was reported that a framework based on the following five components had been developed for assessing water security in various Asia and the Pacific countries (APC):

A: Basic household needs;
B: Food production;
C: Environmental flows;
D: Risk management;
E: Independence (GWP, 2014).

There are many ways of making WSI assessment more precise. Namely, these ways are the following:

- Reliable data (on required spatial and temporal scales);
- Simple yet robust methodology and computing devices;
- Skilled workforce to conduct WSI assessment;
- Sensitized and committed authority at the governance level (e.g., bureaucracy, organisation leaders) to inject the launch and continuation of this activity.

In addition to ignorance and apathy, many nations have problems with one or more of the foregoing components, resulting in a poor position on the global water security index (Goyal, 2020).

Given the importance of WSI assessment in the next years, especially in light of the effects of climate change, natural catastrophes, and pandemics, it is essential that APC work together to provide a valid WSI assessment by learning from each other's strengths and flaws. Therefore, it is recommended to launch WSI assessment group activities among IHP RSC-AP nations. The activities under this initiative shall include the formation of a Group on WSI assessment for APC (GoWSIA-APC), focused group discussions (FGDs) among GoWSIA-APC members to share the available WSI frameworks and discuss adaptation and implementation issues, devise innovative ways of procuring the required data, organise training courses for the practitioners/ implementers and awareness programmes for the major stakeholders, and share results among the group members to delineate the way forward. As the majority of the aforementioned activities may be conducted using virtual platforms/webinars, less financial resources (other than the time of the resource participants) will be required (Goyal, 2020).

These needs were formulated at the 4th APWF, where the aim to achieve water security is formulated as "the realization of quality growth through the deployment of sustainable and quality water infrastructure, where everyone can have clean water and sanitation, be resilient to all disasters, while safe and environmentally-friendly" , what will lead towards the achievement of water-related SDGs, resilience to all disasters, a safe, secure and sustainable future, in which no one will be left behind" (Asayama, 2020).

1. 4. Synergies with other global water security policies

Nowadays, water security became an integral part of the following global policies, resolutions ad recommendations:

- the Sustainable Development Goals (SDG) framework and its 2030 Agenda (SDG6 on ensuring availability and sustainable management of water and sanitation for all and its connecting role to all the other SDGs);
- the High-Level Political Forum on Sustainable Development and updated monitoring of progress towards SDG targets;
- the SDG6 Global Accelerator Framework;
- the Paris Agreement within the UN Framework Convention on Climate Change;
- the Sendai Framework for Disaster Risk Reduction;
- the Addis Ababa Action Agenda for Financing Development;
- the New Urban Agenda;
- the Human Rights Framework with reference to the human rights to safe drinking water and sanitation (UNGA Resolution A/RES/64/292 and A/RES/70/169) and the Global Strategic Framework for Food Security and Nutrition;
- the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki 1992);
- the Convention on the Law of the Non-navigational Uses of International Watercourses (New York, 1997);
- the Resolution A/RES/68/118 on the Law of Transboundary Aquifers.

Other important frameworks include the UNGA declaration on the Water Action Decade 2018-2028 and the Decade of Action to Deliver SDGs by 2030, the UN Decade on Ecosystem Restoration (2021-2030), the Decade of Ocean Science for Sustainable Development (2021-2030), the Global Commission on Adaptation's Year of Action, and the outcome document of the Small Island Developing States Accelerated Modalities of Action (SAMOA) Pathway (Arifin, 2021).

IHP, in turn, aligned the upcoming Strategy with giving the water security a central role and connecting it to the global challenges and existing global frameworks:

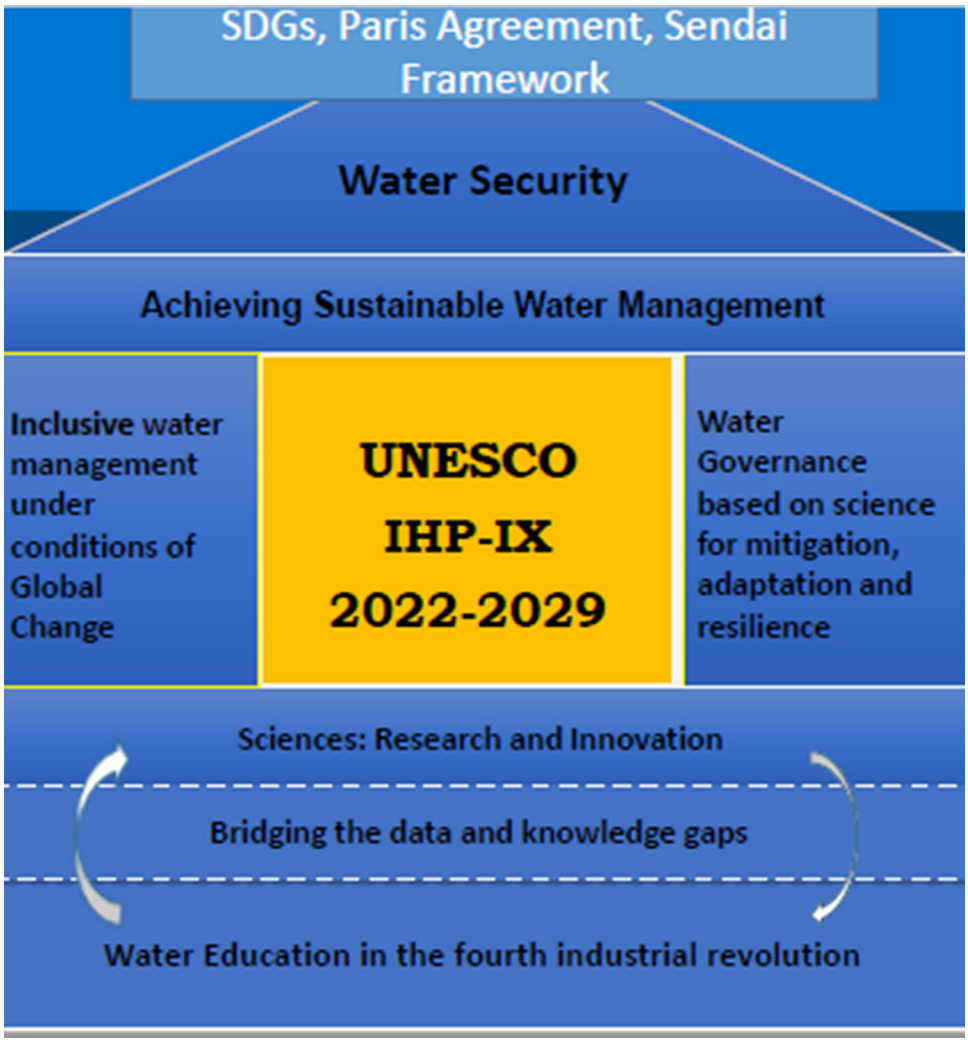

Image 1. Preparation of the Strategic Plan for IHP-IX (2022-2029)

Science for a Water Secure World in a Changing Environment is the topic of the Strategic Plan for the ninth phase of the Intergovernmental Hydrological Programme (IHP-IX). It spans the years 2022 to 2029 and outlines important water priority areas to assist Member States in achieving Agenda 2030, the Sustainable Development Goals (SDGs), and other global water-related objectives.

This IHP IX strategic plan is intended to provide a compelling and strategic focus for the IHP Programme for the period 2022-2029. The proposed approach and prioritisation are in line with UNESCO's primary mandates in the Sciences and Education, and are intended to be responsive to the needs of Member States and assist them in capitalising on scientific and technological advances in order to address global water-related challenges. The NCs should support and concur that the IHP-IX strategic plan is positioned within the global framework of water-related policy in order to create chances for alignment with other efforts and for contributing to their success.

Several of the active National Committees significantly contributed to the creation of the IHP IX initiatives. In different consultation phases, regional experts, the IHP Bureau and Council members, the UNESCO Water Family, partner organisations, and UN agencies, whose opinions were substantial and relevant, contributed to the preparation of the strategic plan.

Strategic objective 1: Improve evidence-based water management and governance;
Strategic objective 2: Enhance resilience of societies under global change including climate change.

Outcomes:

- Enhanced capacity development and public awareness towards a sustainable water culture and water management;
- Water-related data and knowledge gaps bridged by enhancing scientific research and cooperation;
- Enhanced evidence-based water decisions for resilient societies by reinforcing the science policy interface;
- Strengthening the capacities of, cooperation and partnerships with UNESCO Water Family members and in particular the National IHP committees and focal persons.

Priority Areas

i. Scientific research and innovation;
ii. Water Education in the Fourth Industrial Revolution;
iii. Bridging the data knowledge gap;
iv. Inclusive water management under conditions of global change;
v. Water Governance based on science for mitigation, adaptation and resilience;
vi. Strengthening the capacities of UNESCO Water Family members (From the outcomes of the IHP RCS Reports, 26 October, 2020).

1. 5. General overview of water security issues in the context of UNESCO IHP Programme in Asia and the Pacific

The Covid-19 epidemic has reaffirmed the urgent need to ensure that everyone has access to safe drinking water, sanitation facilities, and hygiene education, with particular focus on those who are marginalised and at risk of disease.

The SDGs and other global commitments made by the international community, including the Paris Climate Agreement and associated Nationally Determined Contributions, and the Sendai Framework for Disaster Risk Reduction, have positioned water security at the centre of sustainable and resilient development in the Asia-Pacific region.

Therefore, water is essential for the achievement of Intergovernmental Hydrological Programme for the period 2022-2029, which has goals in line with significant global commitments and serves as a foundation for social and economic growth. Intergovernmental Hydrological Programme for the period 2022-2029 intends to continue the organization's work to bring scientific and technological advances in addressing global water-related challenges while also advancing the goal of making Asia and the Pacific region more wealthy, inclusive, resilient, and sustainable. Recognizing the importance of a differentiated approach and considering the needs of societies at different stages of development and with varying endowments of human and natural resources, this strategy provides a framework for the next decade through a set of operational priorities and delivery mechanisms.

Closing the data gaps, recognising the potential of gender balance in access to resources, enhancing governance arrangements to deliver services, constructing resilience and reducing exposure to disasters, protecting the natural environment, and encouraging cooperation across borders are all central tenets of IHP-IX strategic plan. Achieving greater water security for all people should be a top priority in all operations.

For this reason, investments in water security and related capacity building and policies within a more integrated approach with other sectors are necessary to achieve the aims of IHP-IX strategic plan and the thematic emphasis of its operational priorities.

The aim for the IHP Programme from 2022–2029 requires a strong integration, where design complementarity and process inclusivity will assist achieve the required regional development results.

The importance of water is evident in the fact that it contributes to all three outcomes concerning the enhancement of the environment, climate resilience, and disaster management in the region, all of which fall under operational priority 2 (enhancing resilience of societies under global change including climate change). Productivity improvement and inclusive growth initiatives might benefit from expenditures on the provision of water, sanitation, and hygiene (WASH) services, as well as education and awareness-raising on IWRM.

Unrealized prosperity and inclusivity, as well as a lack of sustainability and resilience in the face of environmental, social, and economic shocks, may emerge from a failure to deploy creative and integrated measures. Therefore, bridging knowledge and ability gaps is essential for tackling dynamic development concerns like water security (AWDO, 2020, p. 64-65).

2. Ensuring water security through disaster risk assessment and management

2. 1. Flood Hazard Mapping

An effective and economical way to reduce vulnerability to water-related disasters is an integrated flood risk management, which includes flood risk mapping, land use planning standards (restrictions on land development in flood plains), and early warning systems. It is critical to implement a comprehensive strategy that includes early warning systems and residual risk instruments in addition to structural approaches and remedies based on nature (AWDO, 2020, p. 50).

The Asia and the Pacific area is vulnerable to hydrometeorological risks that are frequently connected with severe occurrences due to its diverse climatic characteristics. Climate change additionally affects hydrological and climatological patterns, which frequently result in extreme flooding (Sutapa, 2013, p. 188).

Therefore, the Catalogue of Hydrologic Analysis (CHA) for Asia and the Pacific was developed to focus on flood hazard mapping in Asia and the Pacific and released in 2019 for increasing the hydro-hazard resilience of Asia-Pacific region. The first volume of this Catalogue is the latest product of international cooperation between countries that make up the Regional Steering Committee for Asia and the Pacific (RSC) under the auspices of the UNESCO International Hydrological Program Phase VIII (IHP-VIII, 2014-2021).

The publishing of the Catalogue of Hydrologic Analysis has the following goals:

- To increase mutual knowledge of the hydrology and water resources of the region and its surrounding nations;
- To encourage information interchange between various groups in each nation;
- Share information about water-related topics in Asia and the Pacific, such as disaster preparedness, water environment protection, and water resources management (Kobayashi et al., 2019a, p. 5).

Rainfall-runoff forecasting, flood inundation mapping, and other uses have all benefited from the use of diverse hydrologic analytic methodologies across the Asia and the Pacific area. Climate, geography, and catchment development history are only a few of the ways in which these hydrologic analytic approaches and experiences vary. If researchers and engineers in particular nations and industries in the region could get together to share their experiences and understanding of hydrologic analysis methodologies, it would greatly enhance their capacity to estimate risks and mitigate water-related hazard damage.

The purpose of the flood hazard map as one of the nonstructural flood mitigation strategies is to overcome the structural measures' limitations. The goal of a flood hazard map is to give regional governments and related agencies with some of the essential information on probable flooding areas in the form of maps for effective disaster prevention such as evacuation, flood insurance, land use regulation, etc. (Joo-Heon Lee at al., 2019, p. 39).

The first Volume enlarges on the submissions from from Indonesia, Japan, Republic of Korea, Malaysia, Myanmar and Philippines.

Indonesia: "Flood Risk Assessment with High Spatial Resolution for Flood Disaster Mitigation with Climate Change Scenario"

Geographically and hydrographically, Indonesia is very prone to the occurrence of a wide variety of natural catastrophes, particularly those involving water-related issues such as floods, droughts, and landslides. There are roughly 5,590 rivers in Indonesia, of which 600 have a high potential for flooding. Indonesia has rich water resources. Approximately 1.4 million hectares are comprised of flood-prone zones along the main river. National Disaster Management Agency (BNPB) estimates that the number, location, frequency, and intensity of flood occurrences, as well as the value of flood-related losses, have continued to rise over the past 50 years, with the highest number of flood and landslide incidents occurring in 2010 (1,433 incidents).

Numerous investigations have shown that there are two primary causes of floods. First, natural phenomena such as excessive precipitation (weather extremes) and sea level rise. This problem is compounded by the fact that a large number of people reside in areas with topographic characteristics that are lower than river water levels or below sea level. As an illustration, flooding that occurred in certain regions of the province of DKI Jakarta as a result of excessive groundwater extraction and consequent land subsidence. Second, human activities that impose undue pressure on land use needs, resulting in subsequent changes in ecosystem function and environmental deterioration.

It is hypothesised that changes in climate and land use, which will become more intense in the future, will continue to contribute to the increase of flood hazard and its risk, particularly in river basins with national strategic value, if there are no further integrated and mitigation efforts based on societal participation. In response to climate change, it is necessary to immediately construct a river basin-scale adaptation programme that includes catastrophe mitigation. In this context, risk quantification with a solid scientific foundation and greater geographical resolution and precision are required. In Indonesia, projection studies of climate change's

effects on flood risk are still restricted, despite the fact that climate change-related research is currently ongoing. Apip and Fakhrudin created the idea of geographic quantification of flood risk on river basin scale with high precision by taking climate change and human variables into account.:

"One of the outputs of this research is spatial-temporal information of flood risk. Mathematically, it is formulated as a function of several components, namely: flood flow discharge (q), flood depth (h), flood inundation extent (a), flood duration (t), and economic losses value, which are quantified in the form of damage costs (θ). The q, h, A, and t variables are the three variables that naturally (due to extreme rainfall) affect the flood hazard. Furthermore, the magnitude θ is very influenced by high flood hazard and conditions of vulnerability and resilience of existing biophysical conditions within the watershed, in particular the condition of the community and infrastructure facilities of flood control (exposure & vulnerability components) (Apip & Fakhrudin, 2019, p. 12).

Incorporating components of climate change and anthropogenic influences, the concept of spatial risk formulation was developed and implemented in the Batanghari River basin and 13 river basins that run through the city of Jakarta. The rainfall-runoff-inundation model, a physically-based distributed hydrological modelling system, was employed as the primary tool for assessing flood danger dimensions (q, h, A, t) (Apip & Fakhrudin, 2019, p. 16).

Japan: Flood Hazard Mapping

The Infrastructure Development Institute of Japan and Japan River Association estimate that around 49% of Japan's population and 75% of its real estate are situated on alluvial plains vulnerable to floods (Udmale et al., 2019, p. 17). Since 1982, the risk of floods has been successfully managed by flood damage prevention devices such as enlarged channels and embankments, detention basins, floodways, and dams, among others.

However, the ongoing rise of population and general assets, as well as the expansion of urbanisation and suburbanization, is increasing the risk of flooding in places. To minimise future flood damages of various types,

it is vital to comprehend the causes of the flood risk and to prepare flood management techniques in advance to avert expected damages.

The case study flood risk models developed for Yodogawa River Basin in Osaka and Kyoto Prefecture Omihachiman City in Shiga Prefecture forecast rainfall runoff, channel flows, overland flow, and plain flow when topping or breaching processes are considered Udmale et al., 2019, p. 29). The new mapping systems have a better geographic resolution (mesh grid of 25 m x 25 m) and includes different rainfall scenarios and levee breach situations. In addition to flood inundation, the newest inundation area estimates offer inundation duration time and home collapse danger zones, which are important for constructing the flood hazard map (especially identifying the locations where early evacuation is required and the establishment of evacuation shelters) (Udmale et al., 2019, p. 34), which is important for providing the population with accurate information on evacuation routes and shelters in times of need.

Republic of Korea: Flood Hazard Map

Year after year, South Korea has endured flooding, strong rainstorms, and typhoons despite all investments and attempts for flood prevention or mitigation. Han River Watershed has sustained the most flood damage over the past decade, followed by Nakdong River, Geum River, Seomjin River, and Yeongsan River.

The authors provide a methodology of three flood hazard mapping scenarios to find the optimal circumstances for maximum inundation or floods in the target locations:

- Watershed scenario is used for mapping general conditions that affect flooding, such as land cover, land user plans, and flood mitigation measures;
- Flood magnitude scenario, which calculates flows for each return period, which is the same for urban flood inundation analysis considering river flows;

- Flood inundation scenario, which consist of river flood inundation (external causes) and urban flood inundation (internal causes). Depending on the goal of the flood hazard map, this scenario design incorporates all conceivable variables that might result in prospective flooding, not only a simulation of prior floods. In addition, the scenario intends to identify flood-prone low land regions in consideration of various flooding circumstances (Joo-Heon Lee et al., 2019, p. 43).

The flood hazard map can help to the improvement of the flood forecasting system by spatially displaying the real-time flood area prediction generated by the spatial flood forecasting system. Spatial flood forecasting may be subdivided into static spatial flood forecasting and dynamic spatial flood forecasting based on real-time flooding analysis. Because the generation of flood danger maps is based on a scenario-based method, they can help to the improvement of scenario-based spatial flood forecasting. The database created for the flood danger map may be utilised immediately to enhance the spatial flood forecasting based on scenarios.

In addition, long-term flood simulation and analysis in real time can provide geographic flood predictions in real time. However, present processing capacity restricts the implementation of real-time flood simulation due to the lengthy simulation period, which degrades three aspects of flood forecasting: precision, timeliness, and dependability. It is anticipated that large amounts of technological progress and infrastructure will be required to accomplish this.

The scenario-based spatial forecasting system, in conjunction with river flood hazard maps and urban flood risk maps, is now recognised as the greatest option for enhancing the flood forecasting system. With technological advancements, a real-time dynamic spatial flood forecasting system is anticipated to be feasible in the near future ((Joo-Heon Lee et al., 2019, p. 52).

Malaysia: Flood Hazard Mapping in Malaysia: Case Study Sg. Kelantan river basin

Malaysia is no exception to the rule that floods are one of the most common and potentially deadly natural disasters worldwide (Maqtan et al., 2022). The cost of floods in terms of property damage, human lives lost, and economic stagnation is rising quickly.

Those living in low-lying parts of Malaysia are particularly at risk of flooding. These floods, which happen every year during the northeast monsoon season (November–March), are considered to be "normal." Rising sea levels, more frequent severe weather events, and more rainfall due to climate change all contribute to this frightening prospect (Sanders, 2007).

The developed case study for Kelantan river basin, which covers an area of about 13,000 km2 together with its other tributaries, namely Sg. Lebir, Sg. Galas, Sg. Pergau and Sg. Nenggiri, is based on hydrological modeling was completed by utilizing the InfoWorks ICM Software, using SCS Synthetic Unit Hydrograph Method.

Using this formula to approximate the possibility of flooding:

$$R = \sum_{l=1}^{n} \frac{1}{i} D_i$$

Where,

R = Flood Risk
i = Return Period (2-, 5-, 10-, 20-, 50-, and 100-year ARIs)
D_i = Damage for Return Period i

The authors developed a scale for classifying the flood risk classification applicable for Malaysia:

Table 2.3: Flood risk classification

Risk Class	Index Range	Representative Description of Typical Areas
Very Low	<50	• Oil palm or rubber land that are infrequently and less severely flooded • Any type of land use with very low probability of occurence and very low damage
Low	51-1,000	• Rice fields or sparsely populated rural areas that may be subjected to frequent, but low severity flood • Any type of land use with potentially moderate damage when flood occurs
Moderate	1,001-5,000	• Moderately dense rural residential areas with good infrastructure that are subjected to frequent floods • Any type of land use with potentially moderate damage when flood occurs
High	5,001-25,000	• Densely populated areas with good infrastructures that are subjected to frquent floods • Any built up area with potentially high damage when flood occurs
Very High	>25,000	• Densely populated urban areas with plenty of commercial/industrial establishments and served by extensive infrastructure with frequent flooding of various magnitude and occasionally very severe flood • Any built up area with potentially very high damage when flood occurs

This gradual classification can be used in the regions with similar geographical characteristics. Similarly, the developed map of evacuation zones the use of emergency services and the population in making evacuation plans.

Myanmar: Flood Hazard Mapping at the Bago City in the Bago River Basin

The effects of climate change, altered land use, and altered river morphology have combined to make floods and inundations the most common natural catastrophes in Myanmar.

In this case study, the flood hazard map was generated by using HEC-RAS, HEC-GeoRAS, and Arc GIS. The government, non-governmental organisations (NGOs), international non-governmental organisations (INGOs), civil society organisations (CSOs), and community-based organisations (CBOs) in Myanmar have been working together to develop an effective flood response mechanism and map out flood disaster management activities since the nation-wide devastating flooding caused by Cyclone Komen in 2015. The widespread flooding that hit the country in 2015 was a valuable learning experience, and this level of societal unity is an example of the lessons that were learned (Myo Tun Oo & Thet Htoo Naing, 2019).

Philippines: Flood Mitigation Planning and Hazard Mapping for Cagayan de Oro River in Mindanao

Cagayan de Oro City in the Philippines was devastated by Typhoon Sendong in the middle of December 2011, prompting the need for flood mitigation planning and related flood hazard mapping. Typhoon Sendong made landfall in the Cagayan de Oro River (CDOR) Basin in Mindanao, Philippines.

Both the flood danger maps and the suggested flood mitigation strategy derived from this research can be used for flood control purposes. Involvement of stakeholders in all stages of a flood study, from initial planning to final plan selection and recommendation, is emphasised. Hydraulic modelling research makes use of a 2D flood inundation model (Tabios, 2008).

The flood risk map created as part of this research, and especially the flood mitigation strategy that was suggested, can be put to use in flood management. For instance, flood hazard maps may be used to locate potential no-build zones and flood staging and evacuation sites. To restate, this research emphasises the significance of including stakeholders at every stage of the flood study process to ensure adequate assessment, development, and ultimately, selection and recommendation of the optimal flood mitigation plan.

2. 2. Dam reservoir operation for addressing water related disasters, water scarcity and quality

In order to support the ever-increasing population and fulfil the water and energy needs of the fast expanding economy, the majority of the great rivers draining the East, Southern, and Southeast Asia (ESSE) area have been managed over their entire lengths during the past few decades. ESSE Asian nations (China, Taiwan, Vietnam, Myanmar, Thailand, India, Pakistan, and Bangladesh) hold over 250 mega dams and tens of thousands of big and minor reservoirs (Gupta et al., 2012).

Overall, climate change is anticipated to have a considerable influence on the major rivers of East, Southern, and Southeast (ESSE) Asia, since flow regimes are projected to become more erratic and intense. The repercussions of climate change will be felt at all levels and ignore national borders. Consequently, successful adaptation and mitigation will necessitate regional multilateral governance. However, climate change issues at the transboundary level are very recent. Many water agreements and institutions were built with minimal need for such issues; thus, they must be added retroactively, which will be politically problematic because such changes frequently need shifts in decision-making authority and resources (Williams, 2019).

Dam reservoirs have been used to secure water resources for living and agricultural development since prehistoric times in the East, Southern, and Southeast Asia. Since then, industrial usage and hydroelectric power generation have been added, as has safeguarding the water ecosystem

and preventing flood damage (Kobayashi et al., 2021, p. 3). Nowadays, dam reservoir operation is becoming more sophisticated as the demand for efficiencies in water and power continually increases, while maintaining and safety of dams remain of paramount importance.

The second volume of the hydrological analysis is focused on the major multipurpose dams in the Asia-Pacific region to illustrate their unique features and implications to reservoir operations under normal conditions and emergency operations. Multipurpose dams have the ability to store water for irrigation and electricity, as well as to manage floods and improve water quality by trapping sediments to reduce turbidity in irrigation water flows. However, there may be inconsistencies in meeting competing goals with multi-use reservoirs. When operating a reservoir, it can be difficult to strike a balance between competing priorities, such as those of different stakeholders that have a stake in the water supply. These disagreements may be broken down into three potential sources of contention:

1. daily discharge with downstream;
2. conflicts in the release time to fulfil requirement;
3. conflicts in the limited storage of reservoirs to serve various uses (Thi Lan Huong Huynh et al,, 2021, p. 103).

The following steps can be suggested to enhance the sustainable dam safety programmes and dam engineering and safety capacity building:

- To develop dam engineering capacity building (public-private-academia) in accordance with ICOLD and other internationally recognised dam societies;
- To develop the capacity building (public-private-academia) for dam engineering, involving parties that have interests in dam engineering and dam safety;
- In order to guarantee that dams are constructed and managed in a way that is safe, efficient, economically viable, ecologically responsible, and socially equitable, it is necessary to create standards for cutting-edge dam engineering and safety in the form of guidelines and bulletins;
- To increase participation in national conferences, short courses, and workshops on dam and reservoir design, development, maintenance, and operation;

- To encourage stakeholders to submit best practices and national concerns, so dam safety will be in line with ICOLD and other international recognised dam societies;
- Emergency Action Plan (EAP) adoption, compliance, and exercise should be encouraged for all dams with high and considerable hazard potential;
- Awareness-raising on the dam's potential benefits and dangers through education and outreach (Lariyah et al, 2021, p. 87).

China: The operation of Three Gorges Reservoir at Yangtze River basin in China - system dynamics

The history of reservoir operation shows a trend away from maximising operational advantages and toward balancing economic and environmental issues. A multi-purpose reservoir operating system is a complex, interconnected system that encompasses both socioeconomic and eco-environmental subsystems, often with competing goals (Jiang et al. 2021).

Currently, practically all research tries to reduce environmental consequences, with each study focused on a single part of the research goal, such as incorporating environmental flow into existing reservoir operation guidelines. The study of Haiyan Jiang, Zhongbo Yu, and Slobodan Simonovic (Jiang et al., 2021) investigates on Three Gorges Reservoir (TGR), located in the middle reach of the Yangtze river in China, develops a simulation model based on system dynamics to establish an ecologically friendly operation of the Reservoir. Its goals include restoring a healthy downstream riverine environment, maintaining a stable reservoir riverbank system, and ensuring the reservoir's long-term usage (sediment evacuation).

This study is novel in that it takes into account the interactions and feedback between power generation, environmental discharge, sediment flushing, and reservoir-induced landslides.

The SDSA TGR specifically takes into account the interactions between the TGR system's components, such as power generation, sediment flushing, landslide stability, and downstream flow regime. Four operational scenarios were developed to evaluate the synergies and tradeoffs between electricity generation and the mitigation of reservoir environmental consequences.

The main findings of our research are as follows:

1. ensuring landslide stability can generate the most energy production during the first 50 years of operation;
2. allowing sediment flushing to evacuate reservoir sediment may come at a high cost; and
3. releasing an extra amount of water to meet the sturgeon spawning flow significantly improves flow conditions for sturgeon spawning, but at a high cost of reduced electricity generation.

Developed System Dynamics-based Simulation Approach (SDSA TGR) addresses the restoration of a healthy downstream riverine ecosystem, the maintenance of a stable reservoir riverbank system, and the sustainable water use of the reservoir itself - sediment evacuation. These findings can help with the environmentally friendly functioning of the TGR system. This study also made some suggestions for the TGR operation (Jiang et al., 2021).

Saguling Reservoir operation at Citarum River basin in West Java – Indonesia: opportunities and challenges

Saguling reservoir is one of three huge cascade reservoirs developed along the Citarum river basin in in West Java – Indonesia. These reservoirs and river basins serve crucial roles in providing water for agriculture irrigation, residential, hydropower plant, and industrial operations in the provinces of West Java and DKI Jakarta. This region has experienced an upsurge in a number of environmental issues over the past two decades, including flooding, soil erosion, land use change, water pollution, and water supply changes. In terms of environmental deterioration, the Saguling reservoir endured similar sedimentation and water pollution conditions. Despite technology, tools, and previous attempts, this dam's capacity and potential functions have decreased. The Universal Soil Loss Equation (USLE) technique was used to evaluate the amount of erosion around the reservoir catchment regions of Saguling (Sutapa, 2021, p. 12).

In the past two decades, several environmental challenges of Saguling Dam operation have garnered public attention, including deteriorating water quality, flooding, soil erosion, land use change, and climate change. Saguling

is one of the reservoirs experiencing environmental degradation due mostly to sedimentation and water contamination. These primary issues tend to reduce the reservoir's service life (Wardhani et al., 2018; Sutapa et al., 2019). According to Wardani et al., the water quality in Saguling reservoir decreased dramatically owing to pollutants from household, industrial, and agricultural operations, silting due to aquatic plants blooming Wardhani et al., 2018).

The USLE methodology, which is applied on the basis of ecohydrology application. may be utilised to repair and construct wetlands, mangroves, salt marshes, and mudflats due to their capacity to trap pollutants and sediment and provide homes for demersal and pelagic species. Utilizing the natural capacity afforded by ecohydrology, this low-cost technology provides an option for anthropogenic impact reduction on river basins throughout coastal zones.

Current status and new challenges in the operation of reservoir systems in Japan

It is worrying that climate change might exacerbate both floods and droughts in Japan's river basins. Some studies have shown that the frequency and severity of droughts may rise in Japanese river basins by the end of the 21st century, and that the existing reservoir storage capacity is inadequate to manage such extreme droughts (Nohara, 2021). In such a circumstance, reservoir enhancements such as the expansion of storage capacity by building dams can be a viable adaptation strategy to hydrological changes resulting from a changing climate (Nohara, 2021, p. 38).

The reservoir management procedures in the Yoshino River basin are an example of multifunctional dam design. In the Yoshino River watershed, in addition to hydroelectric dam reservoirs, five important multipurpose reservoirs are managed for flood control, water supply, power generation, and environmental flow: Sameura, Tomisato, Yanase, Shingu, and Ikeda Reservoirs.

Reservoir control offices are outfitted with reservoir operation support systems and hydrological information systems in order to facilitate reservoir operation, a complex decision-making process that must take into account reservoir states and hydrological conditions at various locations in the river basin, as well as water demands and other constraints. These methods are essential for the effective operation of reservoir systems. Observation data on rainfall, river water level, and reservoir statuses are also essential for river basin stakeholders such as water users, inhabitants, and riparian towns. For transparent reservoir and water resources management, river authorities or reservoir managers consequently publish data on reservoir states and basin hydrological conditions via their websites (Nohara, 2021, p. 38).

In addition to hydrological observation data, real-time hydrological forecasts are required for the proper management of reservoirs, particularly for flood control. Observed rainfall data are frequently used to forecast future reservoir levels and river flows for the purpose of real-time prediction of reservoir inflow or river discharge. However, the majority of reservoirs in Japan are situated in upstream mountainous regions with steep rivers and slopes. Due to the rapid runoff from the steep slopes, the river flow rises very quickly, frequently within a few hours of a downpour. Consideration of real-time precipitation forecasts is crucial for the functioning of flood control reservoirs in Japan.

In order to prevent sedimentation from diminishing the storage capacity of reservoirs in Japan, a number of sediment control strategies have been used in some reservoirs. These techniques include silt removal, sediment sluicing, sediment flushing, and sediment bypassing. One of the promising measures for sustainable sediment management is the installation of sediment bypass tunnels (SBTs) for sediment bypassing, which can divert inflowing turbid

water with a high concentration of sediments directly to the downstream of the dam reservoir without storing it in the reservoir. This strategy is anticipated to be not only a sustainable sediment management method for reservoirs, but also an effective means of enhancing the river ecology by delivering silt to downstream river channels (Nohara, 2021, p. 37).

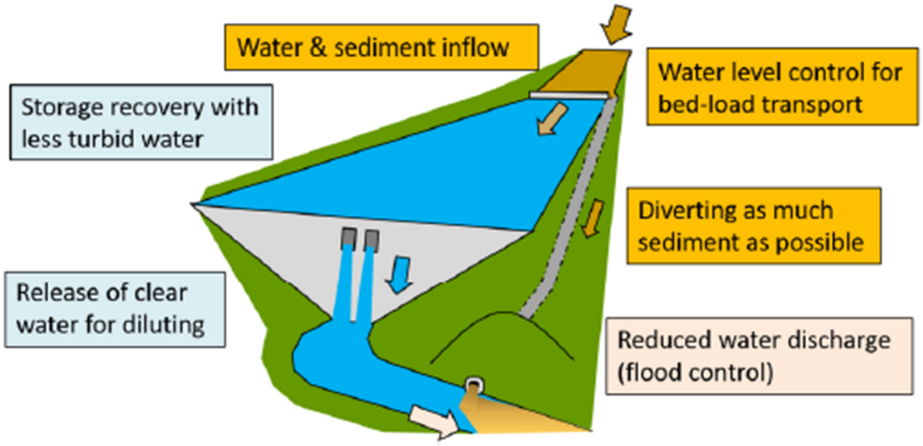

Image 2. Integrated operation of reservoir and sediment bypass tunnel for effective water and sediment management (Nohara, 2021, p. 38).

Multi-purpose reservoirs in the Sameura Reservoir allow to regulating water saving and water release from the reservoir system to the downstream, mitigating both the risks of flood inundation and droughts.

The operation of reservoir systems in Japan is meticulously designed to strike a balance between diverse and competing demands from multiple operating goals, such as flood control, water supply, electricity production, and river environment. Utilizing real-time hydrological projections for a more adaptable water resources management, these reservoirs are controlled so to optimise their capacity. Consequently, reservoirs have lessened the effects of catastrophic floods and droughts throughout history. Climate change will need a more coordinated operation of reservoir systems to account for future hydrological shifts. Effective measures against this challenge include:

- more adaptive and flexible reservoir operation considering advanced hydrological predictions to improve Water-Food-Energy-Environment Nexus;
- structural measures such as dam upgrading for enlarged reservoir capability for more robust flood and drought management under a changing climate;
- integrated sediment management for sustainability of reservoirs and downstream river environment;
- To optimise the impacts of reservoir management for a more sustainable and resilient society, reservoir managers must maintain close contact with stakeholders or locals regarding risk (Nohara, 2021, p. 48).

Dam reservoir operation in the Republic of Korea

Technologies, techniques, and systems in the Republic of Korea's dam reservoir operations that have played an important role in managing floods and droughts. The effective functioning of over 18,000 dams has contributed to water supply for household, industrial, and agricultural reasons, flood and drought control, ecosystem preservation, and recreational places in Korea. Administrative and legislative frameworks have assisted critical water facilities, i.e. multifunctional dams, by introducing and developing advanced ICT technologies for dam operation in accordance with applicable processes and rules.

Examining the functioning of the Namgang Dam during the 2012 flood events demonstrate the mix of structural and non-structural measures in dam reservoir management has reduced potential damage caused by strong typhoons. Based on its expertise in dam technologies and systems, the nation should seek to implement an integrated method for coping with floods and droughts in the period of climate change. The case study of the Namgang Dam in relation to heavy flooding in 2012 demonstrates the preparation of Korea against floods produced by typhoons.

For the purpose of avoiding floods and droughts, a range of technological equipment and facilities are established. These include stage gauges, rain gauges, warning stations, CCTV, and meteorological radar, which provide data and information in real time to the K-water Water Resources

Operation Centre. The centre acts as an important knowledge and decision support hub that helps central and local water management to determine dam reservoir operation, especially in the face of floods or droughts (Lee et al, 2021, p. 54).

The expansion of detention storage through the building of dams or reservoirs is a crucial structural countermeasure against floods and droughts. Two actions are critical for the reduction of flood damage:

1. delaying flood discharge as much as feasible to reduce peak flow;
2. redirecting major portions of flood discharge in rivers and streams to the ocean. Dams are erected to improve flood retention, although river management is necessary to provide flood protection.

In the Republic of Korea, dam operations are always supported by cutting-edge technology, equipment, facilities, and systems. In contrast, ICT industries and non-structural and structural systems have been well prepared to deal with climatological and hydrological uncertainties connected to the occurrence of severe floods and drought events.

The extraordinary economic growth, social well-being, and environmental sustainability of Korea are largely attributable to the effective management of water resources, particularly in regards to the functioning of outstanding dam reservoir systems. On the basis of river basin management, it is anticipated that the water sector reform that began in 2018 will deliver broader advantages to the Korean society. One of the major questions of the reform is whether this new campaign for enhancing water resources management can provide water security for the entire community, which is directly tied to the effective operation of dam reservoirs in each river basin.

The management of water resources was accompanied with uncertainties and hazards as a result of climate change. It presents us with severe challenges to address heavy rainfall, frequent typhoons, flash floods, extreme heat waves, and protracted droughts, as well as a window of opportunity to create imaginative new concepts.

In the period of climate change, the Korean government must make substantial expenditures in water infrastructures such as dams as well as non-structural solutions, such as economic instruments and governance mechanisms. On the basis of a high degree of technological development in dam reservoir operations, the nation should prioritise the implementation of an integrated approach to running dam reservoirs (Lee et al., 2021, p. 70-71).

Dam reservoir operation for safe communities at the Perak River basin in Malaysia

To guarantee comprehensive and long-term dam safety management, especially in regards to operational decision making, the government of Malaysia has appropriately instituted a national dam safety management guideline. The government of Malaysia backs TNB and GenCO's efforts to use the MyDAMS Guidelines for their hydropower dams. Due to a shortage of dam knowledge, Malaysia has to interact within transdisciplinary in order to take action. Dam engineering is an area where Malaysia has to make strides in catching up to other countries. Through a platform for interrelated activities, we must establish a systematic plan for disseminating information and facilitating the exchange of expertise in the service of growing local and global capability. This work is essential for bringing Sustainable Development Goal 6 (SDG 6) back on track with the UNESCO Global Agenda by the year 2030.

Risk assessment and risk-informed decision making (RIDM) may be used to drive the decision process for dams priority to take action on risk reduction. Many nations utilise these methods to assess their current infrastructure. Economic viability, societal safety, and the order of priority for dam repair may all be considered using a risk-based methodology. The innovation here is to create a statistical framework within the AI that takes into account potential risk variables, different failure scenarios, and damage costs when modelling dam risk. The use of a comprehensive probabilistic dam risk analysis strategy receives much attention (Mohd Sidek, 2021, p. 87).

The Philippines

In case of the Philippines, three largest multipurpose dams were selected to showcase the flood risk mitigation:

1. Angat Reservoir as a multipurpose reservoir and its competing water uses by virtue of its physical or design configuration and water rights allocation;
2. San Roque Dam flood operations during Typhoon Parma in 2009;
3. Pulangi Hydropower IV Dam.

These cases demonstrated that having effective sediment management is essential for constructing sustainable multifunctional reservoirs that can be exploited as a renewable resource with a potentially endless lifespan (i.e., reducing watershed sediment yield; rerouting sediments; sediment removal by dredging or hydraulic flushing). In order to preserve the river's biological balance, it is important to ensure that the river downstream is not deprived of sediment supply (carrying nutrients to maintain flora/fauna). Because of this, a life cycle management strategy should be used in the planning and execution of the reservoir (Tabios III, 2021, p. 101).

Viet Nam

It is obvious that Viet Nam's irrigation and hydroelectric reservoirs have played an important role in the country's creation and development over the last decades, helping to advance the growth of the country's natural resources, clean energy, and socioeconomic standing. But in the current operation, in flood season operation, most reservoirs keep a constant volume of flood reduction throughout the whole flood season or across several flood periods (early flood, main flood, and late flood season). Considering the effects of climate change and unusual shifts in the hydrometeorological features, this resulted in a waste of water resources. Improvements in the ability to predict rainfall and river flows are expected to help resolve this problem.

Furthermore, tensions have been rising between water-dependent industries including agriculture, hydropower, and flood management. When industries like agriculture have a high water need but a low electricity demand, the efficiency of the energy production system suffers. Studies that are both simultaneous and cross-disciplinary are essential. In addition, optimization is seen as one of the most efficient approaches to resolving issues connected to reservoir functioning ((Thi Lan Huong Huynh, 2021, 2021, p. 112).

3. Regional perspectives for water security in Asia and the Pacific

3. 1. Regional cooperation tools

The 4th Asia-Pacific Water Summit: Water for Sustainable Development: Best Practices and the Next Generation

The Asia-Pacific Water Forum is one of the big-scale platforms of the region, and a global network comprised of several organisations addressing water concerns in Asia and the Pacific. This platform aspires to contribute to the Asia-sustainable Pacific's social and economic development from a water viewpoint. The network raises the priority of addressing water security issues highlighted in the development agenda throughout the region and

the world in order to solve them by collecting and sharing good practices and knowledge on water issues in the region and by promoting the solutions to severe water-related problems.

Key member organizations of the APWF are Asian Development Bank (ADB), UNESCO, UNESCAP, FAO, UN HABITAT, EC IFAS, Freshwater Action Partnership for South Asia, Global Water Institute UNSW, Global Water Partnership, GWP China, GWP CACENA, GWP South Asia, GWP Southeast Asia, ICHARM, ICIMOD, IUCN Asia, IWMI, International WaterCentre, Japan Sanitation Consortium, NARBO/JWA, Korea Water Forum, Secretariat of Pacific Community, Singapore PUB, World Toilet Organization, AIT, WaterEd Australia, Alliance for Water Stewardship Asia Pacific, Water Integrity Network, EBRD Representative Office Japan.

On April 23-24, 2022, APWF successfully organized the 4th Asia-Pacific Water Summit (APWS) with the subject "Water for Sustainable Development: best practices and the next generation" that gathered heads of states and governments of 49 countries of Asia and the Pacific.

The mission of the 4th APWF is to address lingering critical concerns in order to organise more concerted activities for transformative change and strengthen pledges to speed deployment of solutions and how to pass them on to the next generation by 2050. Namely, water infrastructure and service financing lags behind actual demand. It is necessary to develop finance solutions to address the enormous financial gap in developing high-quality infrastructure. Governance must be reinforced by including diverse stakeholders in the decision-making process and enhancing their competence and understanding, especially among the younger generations. Moreover, the role of the present technological revolution and science has not been effectively grasped owing to a lack of talent and experience, necessitating immediate action from all sectors to engage in talent development via partnerships for cooperation and collaboration.

Regional Steering Committee meetings for Asia and the Pacific

The UNESCO-IHP Regional Steering Committee Meetings for Asia and the Pacific provide a platform to report on, analyse, and review different activities carried out under the scope of IHP, as well as to propose new ones.

For instance, the 27th UNESCO-IHP Regional Steering Committee Meeting for Asia and the Pacific welcomed two new UNESCO Chairs from Central Asia subregions: Kazakhstan and Uzbekistan and resulted in concluding the Strategic Plan for IHP IX (2022-2029).

Assessment of National Committees and Focal Points in Asia and the Pacific

The periodic reporting system of the IHP Committees and UNESCO member state focal points is an effective tool for collecting data and preparation of the up-to date situational analysis in the sub-region.

The harmonized methodology consisting of primary data collection (interviews and questionnaires with respective national committees and focal points) and secondary data collection (desk study on the country datasets) allowed to develop a database on key people, institutions, regulations, policies, development goals and plans, frameworks for water research and capacity development, and water data and information system capabilities.

The national waterscapes monitoring reports from 25 countries were summarized and connected with the regional assessment by Arifin in East Asia, South Asia, Southeast Asia, West Asia and connected in the Baseline Review of the Current Status of Intergovernmental Hydrological Programme (IHP) in Member States of Sub-Regions in Asia by Prof. Dr. Zainal Arifin (Arifin, 2021).

The baseline information aimed to cover the following sections:

A. Policy and Legal Framework for Water Resources;
B. National Institutional Water Framework;
C. Transboundary Water Legal and Institutional Framework;
D. Water Research and Capacity Development;
E. Water related Data and Information Systems;
F. Key Water Stakeholders at National and Regional Levels;
G. Perspectives on Gender, Indigenous Peoples, Youth, and Disabled People in Water Management.

East Asia: China, Japan, Democratic People's Republic of Korea (DPRK), Republic of Korea, Mongolia.

South Asia: Afghanistan, Bangladesh, Bhutan, India, Maldives, Pakistan, Nepal, Sri Lanka.

Southeast Asia: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand, Timor-Leste, Viet Nam.

West Asia: Iran.

Central Asia and Caucasus: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan (together referred as "CACENA countries").

Dr. Dinara Ziganshina (Ziganshina, 2021) conducted the monitoring for the countries of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and Caucasus (Armenia, Azerbaijan and Georgia).

Capabilities of various Member States to monitor hydrological processes, organise, store, and analyse data and information, and eventually build and deploy models, are quite disparate. Ensuring that data information and knowledge interchange across governments and regions is trustworthy so that it may be considered in decision-making remains a significant problem. In addition, the development of coordinated strategies for the management of water data by scientific organisations, UN agencies, Member States, and other stakeholders is crucial. Despite this, the development and deployment of novel monitoring tools, in particular remotely sensed data, are enabling the observation of hydrological processes across a wide range of temporal and geographical scales. Similarly, global-scale modelling presents exciting potential for getting a more thorough knowledge and mapping of the availability of water resources and identifying water dangers.

This IHP-Water Information Network System (IHP-WINS) is unfamiliar to a small number of nations. In other words, whereas the IHP-WINS has been extensively acknowledged by certain nations, some nations still had not received any information on the platform at the moment of the assessment. Through IHP-WINS, efforts could be made to integrate the data-related platforms of all IHP flagships and programmes, as well as other important water data platforms.

Transparency and data accessibility are two of the primary pillars that support the development of open science. Hydrological measures are vital for decision-making and sustainable management of water resources. In the lack of or inability to obtain comprehensive or long-term data on water quantity, quality, distribution, access, hazards, usage, etc., management and investments are frequently insufficient or ineffective. Therefore, both enough data and its accessibility must be assured and, in many instances, enhanced (Arifin, 2021, p. 66).

There is a list of recommendations made for the region:

- In some countries there are no non-governmental sources of funding for Commissions work, and the operations of the NC are supported by the zeal of its members. Therefore, relations with UNESCO Family should be strengthened in all NCs under review. Most NCs have close links with their respective National Commissions for UNESCO but less so with the UNESCO IHP programme as such. For certain member states, lack of financing assistance from relevant ministries/agencies to implement the programme might be a major concern. The budgetary and personnel limitations hinder the potential of NCs to organise its activities;

- Despite the system of biannual national reporting to the IHP Council is an efficient tool to receive the updates of the NCs and FCs consistently, there are little incentives for them to provide them on time and in a rigorous manner. Therefore, there is a need in UNESCO field offices to attend and participate in regional activities to connect them better with the network and motivate to maintain consistent reporting;

- Efforts should be made to contribute to water management and governance by bridging data and knowledge gaps via enhanced science and collaboration. The Water Family must enhance its insertion and contribution in the debate and proposals with Member States, as well as in other globally approved documents such as Agenda 2030, the Sendai Framework, the Paris Agreement, and the New Urban Agenda, as well as other pertinent initiatives. This indicates the Water Family's contribution to the subsequent implementation of IHP IX (Arifin, 2021, p. 70);

- Spreading the awareness on the IHP-Water Information Network System WINS (https://en.unesco.org/ihp-wins) among the NCs and focal points would be a step for harmonizing their involvement in the UNESCO IHP activities;

- Improvement of the means of communication and information dissemination, including development of a webpage dedicated to the activities of the country NCs and FPs would help to engage with the audience and strengthen the digital presence of the UNESCO family;

- Depending on the individual conditions of each country, it is vital to cultivate a new generation of specialists and strengthen ties with diverse professionals and policymakers. Therefore, the NCs and FPs shall provide incentives for youth to participate in the implementation of the IHP program and the activities of the National Commitees (Ziganshina, 2021, p. 87).

4. Water education as a solution to regional water security challenges

Since its beginning in 1975, UNESCO's Intergovernmental Hydrological Programme has prioritised water education as a means of attaining water security. However, throughout most of Asia and the Pacific, the concept of water security is still does not become a substantial part of policies closely interrelated with water. A deeper understanding, acceptance, and internalisation of fundamental water science principles and concepts among experts and masses is necessary to ensure water security in the region. This calls for more and improved water education initiatives.

Water education will lead to responsible decision-making in the future by encouraging the general public, particularly the young, to understand the complexities of today's water concerns. Furthermore, the process of developing consensus among young professionals on solutions to water difficulties will undoubtedly make a significant contribution to future water problem addressing. Along with this water education for the young, water education research will generate information and standards that will meet

the demands of developing and transitional nations in terms of water-related capacity building.

The Korea Water Forum, as an Asia-Pacific regional water educational channel, has worked to develop national and international public and expert water education programmes through a variety of initiatives (Takara, 2013, p. 111).

4. 1. A regional curriculum for water education for climate resilience in APC

The regional curriculum "Water Education for climate resilience in Asia and the Pacific" out in 2021, is the product of a multi-year project called "International Hydrological Programme Water Informatics for Sustainability and Enhanced Resilience in Asia and the Pacific," funded by the Government of Japan through UNESCO Funds-in-Trust. It is prepared by Sara Beavis, Australian National University Fenner School of Environment and Society, for UNESCO Office Jakarta.

UNESCO is leading the Global Education 2030 Agenda through SDG 4: Quality Education to 'ensure inclusive and quality education for all and promote lifelong learning.' The objectives of this curriculum has particular relevance to SDG 4 Target 4.3: Equal access to affordable technical, vocational and tertiary education and SDG 4 Target 4.7: Education for sustainable development and global citizenship.

UNESCO IHP is aligned with the SDGs, leading research agendas in developing knowledge relating to water and sustainability from a systems perspective. The eighth phase as IHP-VIII 2014–2021, was focused on water security, including the theme of 'water education, key to water security.' In 2017, UNESCO supported the development of a comprehensive, three-volume water management curriculum, titled "Water management curricula using ecohydrology and integrated water resources management" (Regional Humid Tropical Hydrology and Water Resources Centre for South-east Asia and the Pacific, 2017).

Furthermore, significant suggestions from the 7th World Water Forum on Water Education and Capacity Building indicated the following potential for tertiary-level water education curriculum development:

a. Incorporating water curriculum into non-water programmes;
b. The use of information technology to pique students' attention and engagements;
c. Fieldwork as an important component of the curriculum.

Academic studies in the Asia-Pacific region show that water-related topics are still most typically found within engineering degree programmes. This demonstrates that the study of water as an engineering subject is motivated by the need to catch, impound, divert, and distribute water to maintain not just population growth but also urbanisation, food and water security, and energy production (UNESCO Water Curriculum, 2021, p.). This raises new concerns and confirms previous ones about how well the next generation of water specialists is being trained. This curriculum was developed to assist fill the current information gap about climate change resilience, adaptation, and capacity building.

Therefore, the developed Curriculum is a response to the need to train young talents in the hydrlogical system, universities and scientific research institutions through various channels, and draws on recent advances in the fields of ecohydrology, integrated water resources management (IWRM), and sustainability science.

It is intended that students participating in a wide variety of degree programmes will take modules from this curriculum; nevertheless, it is considered that students enrolled in the latter years of a Bachelor's degree programme (or equivalent) or Masters by coursework will take these courses. The programme format is modular and meant for advanced undergraduates and graduate students. This approach takes into consideration the vast range of users, including educators and students, as well as their respective contexts of use. Assumptions are made about the prior knowledge of the student groups we aim to target with respect to the hydrological cycle, the water balance, and freshwater systems (rivers, lakes, groundwater).

Modules can vary greatly in form and function. Students have the option of taking the first unit as either a self-paced reading unit where they determine their own learning goals and pace, or as a series of instructor-led tutorials. All of these options were created with students' various levels of English ability in mind. The other courses mainly revolve on the ideas of student-teacher partnerships (Healey et al., 2014) and the flipped classroom model (Sharples et al., 2014), in which students take the lead in their own education under the guidance of instructors.

Modules are designed to provide a framework for the creation of several lectures and to provide the lecturer with vital suggestive content that may act as "springboards" for student reading, research, and in-class debate. Experiential learning possibilities such as discussion, hands-on exercises, and site visits can be taken advantage of in conjunction with the provided additional resources.

Six learning modules provide crucial information to support student-centered instruction:

1. Understanding the Great Acceleration and the Anthropocene;
2. Climate change;
3. Ecohydrology and water sustainability;
4. Ecohydrology and the water plant nexus;
5. Integrated water resource management;
6. Water ethics.

Work-integrated learning (WIL) is a core tenet of the curriculum since it increases students' marketability upon graduation by teaching them skills relevant to the workplace (Cooper et al., 2010; HEQCO, 2016). Work-integrated learning (WIL) is based on the idea that students will be better prepared for the workforce if they acquire a variety of literacies and engage in real-world learning activities before graduating from college. These skills can be gained through collaborative efforts between educational institutions, government agencies, NGOs, corporations, and community groups to conduct research-led or project-focused learning. The connection between the educational institution and the host organisation should be beneficial for both parties and built on a foundation of mutual trust.

5. Best practices and innovative approaches in water education for active learning / capacity building

5.1. UNESCO Water Resilience Challenges

It is imperative that Indonesia invests in the education of future water and climate leaders in light of the growing urgency and complexity of water and other climate-related concerns in the Asia-Pacific Region. The best approach to achieve this is to expose young people to real-world water issues, to encourage them to consider multiple perspectives on water management, to provide them with opportunities to provide their own ideas and solutions, and to provide them with access to mentorship from seasoned experts.

UNESCO Water Resilience Challenge 2021: selected biosphere reserves in Southeast Asia

The UNESCO Water Resilience Challenge 2021 is an innovative capacity-building programme that also serves as a platform, a stage, for youth to express their ideas on how to achieve water resilience and sustainable development. It was conducted in Indonesia, and the Sembalun District of West Nusa Tenggara, located close to the Rinjani–Lombok Biosphere Reserve and UGGp, was chosen as the case study region for this challenge due to the wide variety of water-related problems that exist there.

In particular, the river basin is home to a wide array of water-related problems, the severity of which may be exacerbated by the impact of climate change. Lombok Island's water resilience may be at risk due to these problems, especially in the Sembalun District, where water shortage is particularly acute.

25 Young Water Leaders were selected, mentored, and tasked with learning about all aspects of the reserve area and watershed, analysing the critical issues, and developing their own unique concepts to address these in just four weeks.

In order to address the current water problems caused by natural disasters and climate change, participants are encouraged to focus on the following three areas:

- Water for Food, to guarantee water availability for food production and how to be more responsible in water consumption;
- Water for Living, to address challenges on clean water and sanitation for daily use;
- Water and Safety, to respond to these issues.

Mentors from AWS Indonesia, ICLEI Indonesia, Nazava, Resilience BV, and the Urban+ Institute are on hand to offer advice and assistance to the teams during the Challenge.

Due to the current Covid-19 epidemic crisis in Indonesia, the Challenge was held entirely online to safeguard the safety of all participants, maintain the momentum of the learning process, and provide inspiration to as many people as possible. Each week, participants met with their mentors and presented their progress using a variety of online meeting platforms, including Google Meet, Zoom, and Microsoft Teams, and utilised online communication services to brainstorm and develop their concepts (Mural, Miro).

The participants identified Sembalun District's water concerns, contacted experts, and were inspired by virtual field trips during Phase I in early October. Phase II's four-week online mentoring session with experienced national and international mentors helped teams turn their strategy into concept solutions.

Phase III saw participants pitch their Sembalun District water resilience solutions to judges and stakeholders. The winning team presented their concepts at the 13th Southeast Asian Biosphere Reserve Network (SeaBRnet) conference on 16 November 2021.

The Challenge has piqued the interest of renowned universities and young professionals throughout the years and is a much-anticipated programme.

Twenty-five university students and young professionals who took part in the UNESCO Water Resilience Challenge 2021 learnt about integrated and resilient water development from a variety of national and international specialists. Participants were also urged to improve their significant abilities in the following areas: presentation, communication, perseverance, confidence, negotiation and persuasion, teamwork with a varied team, critical and systematic thinking.

The initiative demonstrates the possibility for incorporating creative concepts into other UNESCO Biosphere Reserves in order to benefit from a more inclusive engagement with youth in accomplishing other SDGs, particularly SDG 4: Quality Education and SDG 6: Clean Water and Sanitation (UNESCO Water Resilience Challenge Program Report, 2021).

UNESCO Water Resilience Challenge 2022: Groundwater: Making the invisible visible

The UNESCO Water Resilience Challenge of 2022 uses groundwater as focus for the challenge for participants, align with 2022 World Water Day:

Groundwater provides 30% of the world's freshwater, and the rising population requires more clean water every year.

Many Asian nations cannot withstand uncontrolled groundwater irrigation growth. Groundwater pumping has become a viable irrigation alternative for millions of farmers across Asia because to cheap and subsidised power (Shah, 2010). While this has had a significant impact on food security and poverty alleviation, it has also resulted in extensive groundwater depletion. The Indian subcontinent has some of the world's greatest rates of groundwater depletion, with at least half of the subcontinent's groundwater

being drained faster than it is restored (Wada, 2014). Responding to Asia's groundwater problem is critical to ensuring the region's irrigation and agricultural production sustainability. Among other things, this will entail lowering perverse subsidies for groundwater pumping and establishing institutional incentives for the sustainable and conjunctive use of surface and groundwater resources (AIIB, 2019 cited in Leckie et al., 2021 p. 45).

Groundwater supply is diminishing, causing groundwater issues in several Indonesian and Vietnamese biosphere reserves.

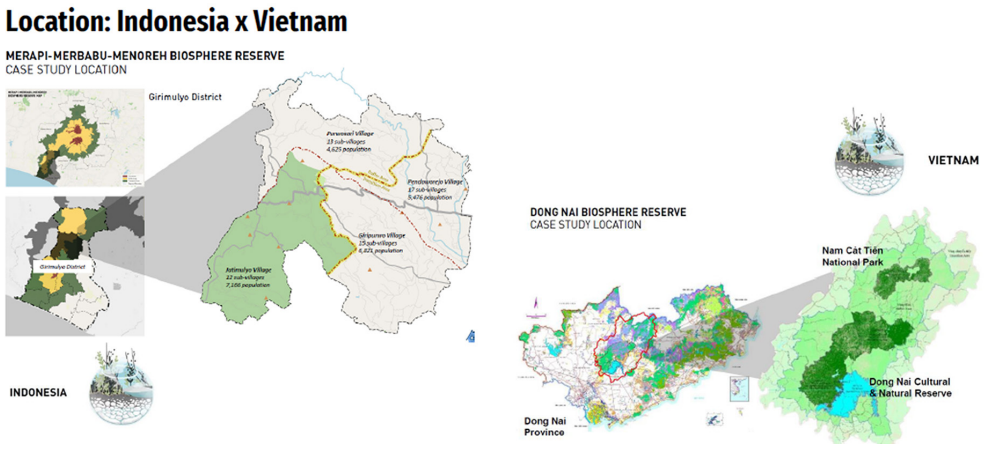

Image 3. Location of the UNESCO Water Resilience Challenge case studies. Source: UNESCO 2022 Water Resilience Challenge Report, 2022.

Indonesia and Vietnam have the most UNESCO-designated biosphere reserves in Southeast Asia, demonstrating the significance and ambition of preserving these unique habitats for local biodiversity and livelihood. The biosphere reserves region is a unique environment split into three zones: the core area, buffer zones, and transition zone.

This site is home to a wide range of living organisms. Water in the biosphere reserves serves as a source of life for both upstream and downstream organisms. As a result, groundwater management and the water cycle must be linked with ecosystem and watershed planning and conservation. Biosphere reserves are not immune to groundwater issues in certain

locations of Indonesia and Vietnam. Long-term groundwater extraction without conservation, however, may cause land subsidence above the threshold and saltwater intrusion into groundwater.

Thus, the UNESCO 2022 Challenge had these objectives:

1. Promote local inter- and transdisciplinary approaches to good governance and sustainable natural resource management, supported and enhanced by UNESCO designated site networks' regional and global knowledge sharing. In biosphere reserves, where water sustains life upstream and downstream, water is a cross-cutting issue. Indonesian and Vietnamese biosphere reserves must manage groundwater issues locally. Peer-to-peer learning and information exchange are used to find solutions across the two nations.
2. Inform young leaders on groundwater issues. Groundwater is hidden from most people, including the youth. Asian families and businesses typically use groundwater from medium to deep wells, although this activity is poorly regulated. Raising awareness of something we cannot see is tough, but if nothing is done, the next generation, who are currently children, will face this challenge.
3. Train future water and climate leaders (UNESCO Groundwater Challenge Technical Proposal, 2020, p. 10).

Following the three-week online phase of the UNESCO Water Resilience Challenge, the offline phase in Indonesia and Vietnam began on Monday, September 19, 2022. The selected participants of the Challenge visited Dong Nai Biosphere Reserve and Merapi-Merbabu-Menoreh Biosphere Reserve, as well as interact with inhabitants in the area to better understand the underlying issue.

Dong Nai Biosphere Reserve is unusual in that it is covered by rainforest, protecting the province's water supply. However, there has been a lot of large-scale agricultural production in recent years, which has altered the quality of groundwater. As a result, participants are motivated to think outside the box about how to conserve groundwater while still preserving the biosphere reserve.

Participants learnt about the Merapi-Merbabu-Menoreh Biosphere Reserve's unequal water distribution and how this led to numerous families relying on groundwater for everyday usage. Tourism operations in another village have prompted the local community, notably Kelompok Hutan Tani (KTH) WanapaksiJatimulyo, to educate and promote awareness through stakeholders and community participation for preserving Menoreh's natural beauty and promoting bird biodiversity.

The teams were prepared for the Final Presentation after weeks of study and site visits. Stages had been set up for the teams to offer their perspectives on making the unseen visible. The presentation was done in live hybrid style to facilitate knowledge sharing between nations, with Vietnamese participants from Dong Nai and Indonesian participants from Yogyakarta.

Youth participation is becoming increasingly crucial in raising awareness of water challenges and preparing the next generation of leaders. Giving them a platform to be educated, providing a safe area to study and talk, and challenging them to confront the issue will result in a more aware young network, who will one day lead their country via their efforts.

This Challenge emphasises and demonstrates that resolving groundwater issues requires collaboration among many experts, including engineers, planners, architects, local communities, government, and other groups. The UNESCO Water Resilience Challenge is an example of local collaboration that may be used to enhance local capacity to address the groundwater issue (Viet Nam Water Portal, 2022).

5.2. Interactive virtual field trips

Dr. Sara Beavis' pedagogic framework for Virtual Field Trips to Support Active Learning in Water Management was circulated to UNESCO Centres and Chairs in the region considered to align thematically with the proposed field trips.

'The field' can give numerous possibilities for students studying water science and management to explore aquatic landscapes, gather samples, take measurements, create and test hypotheses, and analyse processes

and reactions at various scales. Despite their significance, however, there are a number of practical restrictions that might limit their incorporation in college curriculum. Time, cost, class size, safety and liability, and proper resourcing are examples of such restrictions. Access, equality, and inclusion concerns may arise for some students owing to disability or socioeconomic position, or a lack of involvement due to social anxiety. This set of restrictions has resulted in the creation of virtual field trips (VFTs) during the last two decades. This was only achievable with the development of appropriate software for producing digital pictures with interactive capabilities.

Virtual field excursions are online, interactive teaching/learning methodologies that transport students to remote areas for in-depth study. Students are directed through a succession of pre-filmed and organised facts that offer a systematic, highly organised online learning experience using multi-media. While there are several advantages to such a teaching/learning methodology, virtual field excursions do have several significant drawbacks. They often rely on autonomous, lonely desktop study, thus the social contacts that characterise true field visits are lacking. Furthermore, there is a substantial, at times sole, dependence on visualisation, whereas genuine field excursions include a complex interplay between experience and emotional learning that informs and reinforces cognitive learning through the use of all senses (Hurst, 1998; Dolphin et al., 2019). There is also the possibility that virtual field excursions may be restricted to 'watch and listen' activities. Being aware of these constraints can help educators create chances for collaborative student activities. Furthermore, the notion of a virtual field trip may be broadened so that it is utilised as a demonstration from which students can jump into their own geographically situated research rather than just viewing a location online. As a result, the virtual field trip serves as a platform for the learning experience to include all three domains: cognitive, emotive, and experiential.

The emergence of COVID-19 in 2020 caused severe disruptions in university education, resulting in campus closures and a shift from face-to-face to online teaching/learning. As a result, virtual field trips are increasingly recognised as a necessity to fill this hole. However, such field excursions must go beyond what is now available, with numerous design alternatives that recognise the diverse sets of settings in which teaching and learning occur.

This framework addresses the need for the creation of pedagogically sound virtual field excursions. It also offers a variety of possibilities for enriched learning in both resource-rich and resource-limited contexts, as well as for educators and students with varied degrees of mobility and access. This supports the idea that virtual field excursions may be structured to meet course requirements and learning goals while also assuring active learning for a wide range of needs and circumstances.

The primary purpose of this framework is to offer tertiary water educators with a toolkit for designing virtual field excursions that are accessible to tertiary students worldwide (covering hydrology, ecohydrology, water resources management, freshwater ecology, and WASH).

The purpose and goal of VFTs are to give students with chances to access and participate in virtual fieldwork, as well as to learn skills in field-based observation, monitoring, measurement, and analysis (Beaves, 2020).

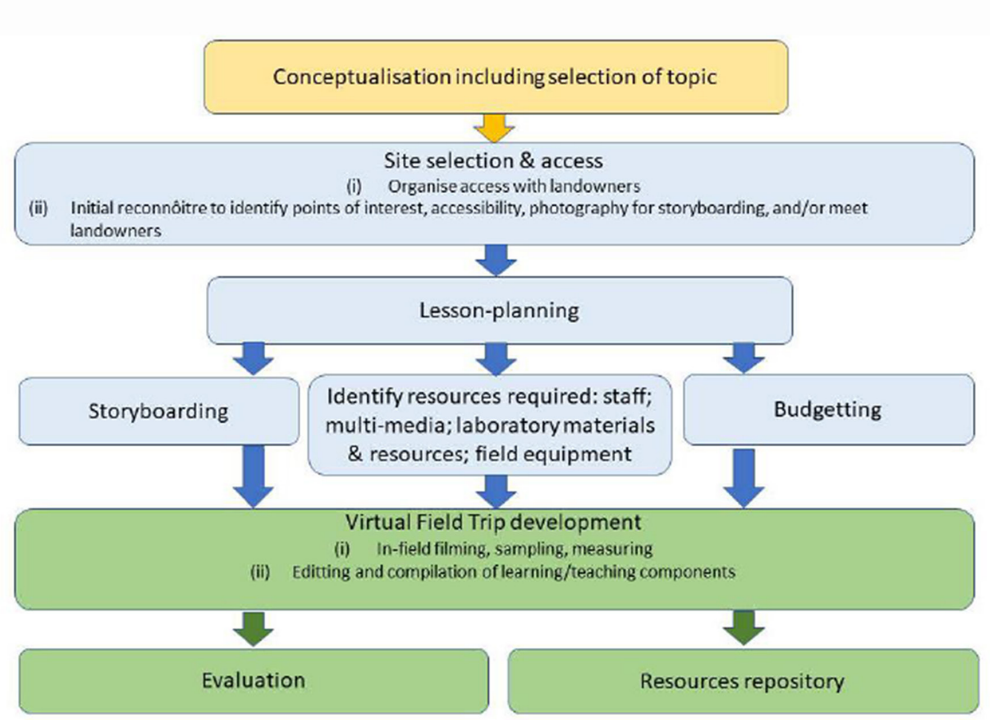

Image 4. Essential steps for VFT planning. Source: A Pedagogic Framework for Virtual Field Trips to Support Active Learning in Water Management (Beavis, 2020).

The UNESCO office in Jakarta provided support for development of VFT in Kazakhstan, Iran and Malaysia. Additionally, Republic of Korea (i-WSSM) and Japan (ICARM) developed VFTs based on the provided pedagogic guidance independently. Considering the benefits of this educational activity, in the future, UNESCO could develop a regional compendium of virtual field visits for delivering experiential online water education learning.

Virtual field excursions developed by the UNESCO are a full, ready-to-use resource.

Tragedy Of The Aral Sea: Consequences Of Anthropological Activities And Restoration Measures

One of Central Asia's most vulnerable places is the Aral Sea region. Climate change stresses the environment, economy, social sector, and infrastructure, and it will almost likely have an influence on both individuals and the region as a whole. This VFT's field lectures are devoted to broadcasting the region's present state, including historical facts and statistics, catastrophic social, economic, and environmental repercussions, restoration activities, and future estimates to the global audience (Aral Sea VFT Report, 2021).

From September 1st to September 10th, 2021, the film team travelled approximately 1000 kilometres between nine important areas of the project. The film crew included a group leader and two helpers (a cameraman and a driver/assistant). The VFT covers 10 locations in the Aral Sea basin, which are covering a wide array of topics, starting from the impact of the Aral Sea tragedy on social-economic state and infrastructure, the city of Aralsk in present time desertification, dust storms and restoration measures (phytomelioration) (Aralkum project area), hydroacoustic fish protection plant (Kokaral Dam).

The VFT is filmed and narrated by:

- Almas Kitapbayev, Expert on the Aral Sea issues at Kazakh-German University His background is GIS, physical geography, geomorphology and hydrology. Started his career as junior researcher as junior researcher at laboratory of GIS and geomorphology of the Institute of

Geography of Kazakhstan. For the last 7 years involved in projects in the field of desertification, natural resources management and organizing of educational and research expeditions for students in the region of Aral.

- Dr. Bolat Bekniyaz – Doctor in Geography, Head of the Kazakhstan office of the International Fund for Saving the Aral Sea. Dr. Bolat Bekniyaz has a strong expertise in hydrogeology, geology, hydrology and ecology. Started his career at the Institute of Hydrogeology of Kazakhstan as a junior researcher, during his career as a researcher took part in many projects and expeditions focusing on water resources in the region of Aral. In different years, he held high-ranking positions in state agencies dealing with environmental and water resources problems.
- Dr. Zauresh Alimbetova – Doctor in biology, Head of the "Barsakelmes" State reserve and Chair of the "Barsakelmes" UNESCO biosphere reserve. Dr. Zauresh Alimbetova has a strong expertise in biology ecology and biodiversity of the region of Aral. She started her career as a junior officer at the Barsakelmes reserve.

River Of Life (RoL) Kuala Lumpur, Malaysia

River of Life (RoL), also known as Sungai Nadi Kehidupan, is one of the government's Entry Point Projects (EPP) selected for Greater Kuala Lumpur / Klang Valley (KL / KV) as part of the National Key Economic Areas (NKEA), Economic Transformation Program (ETP). This project intends to make the Klang River into an iconic river for the vibrant and quickly rising metropolis of Kuala Lumpur, as well as to provide great economic value to the country. In order to achieve this aim, three components of the transformation programme for Sg. Klang and the main tributaries in the RoL region have been designed: river cleaning, river beautification, and property development. River of Life (RoL) initiatives began in 2010 and are projected to be completed by 2024.

The water quality of the Klang River has deteriorated as a result of potential pollution sources such as sewerage effluent, industrial effluent, untreated discharge from restaurants, wastes and effluent from wet markets and commercial outlets, and large amounts of solid waste (litter and rubbish), among others. Since it is in metropolitan areas every day, the quality of

Klang river water is deteriorating significantly and has become one of the key challenges. As a result, the Malaysian government began a river cleaning initiative known as the River of Life (ROL) project. The Klang River is being rehabilitated and restored as part of this project.

The developed VFT is, therefore, an essential practical tool to cover such topics, as the ongoing river revitalization process, covering such locations as the functioning of Wastewater treatment Plant (WWTP), and Sullage Water Treatment Plant (SWTP) (River of Life VFT Detailed Work Plan Report, 2020).

Virtual Field Visit: Tehran City

The VFT dedicated to Tehran River Restoration and Improvement Master Plan is mainly focused on presenting the information on sustainable river restoration. The slides present success factors and technical issues of river restoration, which can be used as a study material. The case study cover successful river restoration in Laojie River, Taoyuan City, Taiwan.

Such innovative concepts as basin-connected cities, low impact development (LID), Blue-Green infrastructure (BGI), and Ecological Buffer Zone, are innovative and practically applicable in Tehran.

In this regard, the project "Nature Oriented Tehran River Restoration: A Symphony of River, City, and Citizens" arose from close collaboration between Tehran Municipality and the Ministry of Energy (MOE) on urban flood control. The overall project goal was to create and promote connectivity and attractiveness of Tehran Rivers, City, and Citizens on various scales ranging from local urban design to the city's overall spatial development, which will construct linear parks, landscape, and waterfront design along the urban rivers (Sustainable Urban River Management. Virtual Field Visit: Tehran City, 2020).

Active Learning in Water Management - i-WSSM Online Water Education

i-WSSM Online Water Education in an online interactive platform dedicated to e-Learning on three thematic modules:

- Groundwater;
- Integrated Real-time Discharge Measurement System;
- Nature-based solutions.

i-WSSM Online Water Education platform presents a selection of the virtual field trips (VFT) to several water bodies in the Republic of Korea. The lecturer team consisting of Yongcheol Kim, Sanguk Cho, Leehyung Kim combines the virtual learning trip destinations with the thematic areas. Namely:

- Virtual Field Trip to Jeju Hancheon Managed Aquifer Recharge Site;
- Virtual Field Trip to Jeju Hancheon Waterfalls (Groundwater);
- Virtual Field Trip to Cheongju National Groundwater Management Monitoring Site (Groundwater);
- Integrated Real-time Discharge Measurement System;
- Gwangju City Hall (Nature-Based Solutions).

Academic sessions will cover the following topics: water security, water challenges, and water and gender.

The Water and Gender module is based on the i-WSSM's Water and Gender Expert Forum, which was conducted on September 4, 2020, in the Republic of Korea.

The event attracted nine specialists from the Korean Ministry of Foreign Affairs as the first conference in Korea to discuss the specific topic of water and gender. Korea International Cooperation Agency (KOICA), Korean National Commission for UNESCO, Korea Women Development Institute, Korea University, and the Korean Institute for Gender Equality Promotion and Education are among the organisations involved. The experts agreed on the significance of promoting gender awareness and incorporating gender problems into the water industry.

The section of other learning resources include informative sections on Questions and answers, and Card news, which shed light on Capacity building Program on Hydrological Survey and Data Management for Cambodia in response to climate change (VFT to Cheongju National Groundwater Management Monitoring Site, 2021.).

6. Water in the COVID-19 crisis: response, recovery, and resilience in Asia Pacific

COVID brought new challenges in water sector and reaffirmed the Sustainable Development Goal 6.1 commitment of "access to properly regulated drinking water supply at the doorstep." This pa\ndemic has identified the most susceptible community segments, such as the handicapped, elderly, children, peri-urban and slum populations, rural and indigenous groups, and others. Water at urban scale must be continually recycled and reused to guarantee sustainable availability of water Water allocation for home use must be reconsidered. A water metering system must be established in urban areas to monitor the supply of water filtration units at the community level (Faizan ul Hasan, 2020).

Although there are no published scientific figures on the shifting pattern of water consumption during the COVID epidemic, the following patterns have been observed:

1. Rise in home water usage for drinking, sanitation, and hygiene;
2. Reduced water use in commercial and social businesses (mosques, educational institutions, hotels, restaurants, banquet halls, and tourist locations);
3. Increased danger of pandemic transmission owing to frequent visits to community-level drinking water filtration units.

Therefore, the IHP organized a meeting in the theme "Science to Enable and Empower Asia Pacific for COVID-19 response (19 May 2020). The event organized by the support of JFIT and MFIT designed to assess the impact of the pandemic on UNESCO's regional science networks and to present and discuss solutions to the issues it presents. It also examined and

reaffirmed the importance of science and technology during and after the epidemic. It was well-attended by UNESCO Centres, Chairs, Field Offices, and Headquarters, as well as a sizeable contingent from the Water Family (Thulstrup, 2020).

7. Conclusion and future avenues for common actions

The collected data in this Compendium, shared best practices and creative techniques reveal that the IHP members take action to improve their water security through technology, education and more efficient management of their water resources. However, external conditions can change, posing a danger to water security, as, for instance, climate change is modifying water availability and unpredictability in the region. Socioeconomic growth might lead to increased water demand and pollution, lowering water security.

Political contexts could also alter, resulting in higher or lower prioritising of water security and diminished attention governments devote to the environmental component of water security. Then the COVID-19 epidemic offers a range of direct and indirect concerns to water security.

The success of the IHP IX strategic plan relies on the development and implementation of locally relevant solutions across Asia and the Pacific. Approaches that take into consideration land and water management and temporal variability are necessary, especially when trying to account for the complex and unknown implications of climate change (AWDO, 2020, p. 67).

Several locally-sensitive methods for reducing flood risks are proposed in the Catalogues on hydrologic analysis, including:

- reducing exposure to flooding through flood risk mapping and land use planning (such as restricting areas to build or designating water catchment areas in high risk areas);
- investing in structural protection, such as the construction and maintenance of multipurpose dams and dykes;
- the expenses of monitoring and showing compliance with rules and managing water supply systems can be reduced thanks to optimization of monitoring systems made possible by advances in data management. Flow, pollutant, and water quality information will be more easily accessible online and in real time.
- additionally, nature-based solutions, such reclaimed floodplains, sustainable urban drainage systems, and artificial wetlands, can also provide various advantages and are frequently less expensive to run and maintain than their designed counterparts (Leckie et al., 2021, p. 48).

For more effective catastrophe risk management, it is necessary to enhance data gathering and related systems. Understanding disaster risk is a top objective in the Sendai Framework for DRR. However, there is always a problem with having enough data to make an informed assessment of risk. Governments in the Asia-Pacific region could strive for integrated, transboundary reliable statistics to assess the scope of the issue so they can establish effective response systems and properly budget for catastrophe risk. In order to replace ineffective methods based on responding to disasters

with a proactive strategy, agencies need to be equipped with contemporary database and data gathering technologies. Satellite technology offers potent resources for filling the informational void cheaply and effectively (AWDO, 2020, p. 72). Therefore, the Strategic Plan for IHP-IX (2022-2029) sets relevant objectives to overcome the difficulties in acquiring ecohydrology data in the region and the coordination of national responses to water-related risks.

Using the existing themed regional platforms, more cooperation may be proposed (the Asia Pacific Water Forum, the UNESCO IHP Steering Meetings and regional assessments).

Support for policy making and the design of water governance that is up to the challenge and customised to regional and country needs would be greatly enhanced by more coordinated efforts to promote and deliver water education on the (sub-)regional level. It is the responsibility of the National Committees to collect data related to the various initiatives.

Developed Water Education Curriculum, virtual field trips and Water Challenges are designed to make the youth aware of the ramifications of inactivity regarding water and sanitation, both to people's health and to the environment. These educational materials are ready to use and disseminate in the region, and they can be easily integrated in the educational curricula in the region. As a step forward, these experiences can be replicated for other case studies with the increase of citizen participation in the data collection and knowledge creation.

With these constraints in mind, the Compendium provides data and insights that countries may build upon to improve water security across Asia and the Pacific.

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