SDC Network **Climate, DRR & Environment**

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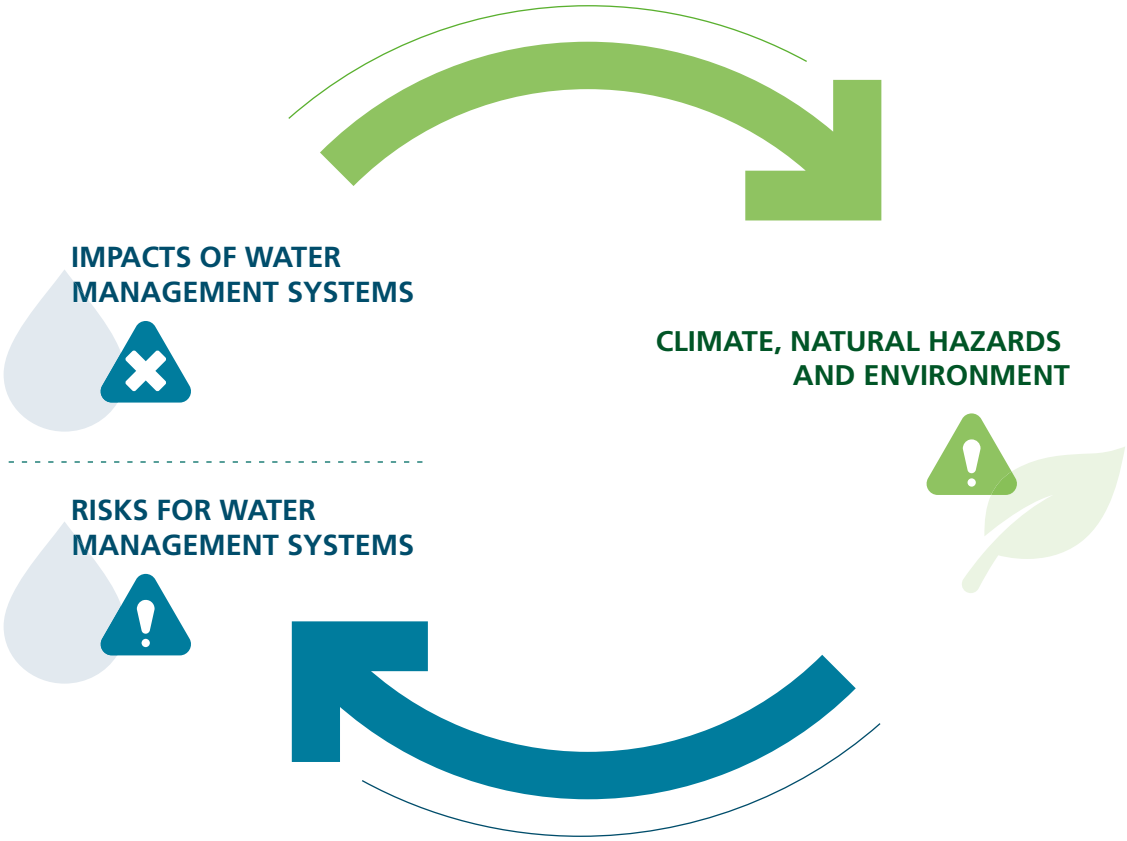
Thematic Integration Brief (TIB)

Climate, DRR & Environment …and **Water Management Systems**



Climate change is disrupting water supply for human, agriculture, industrial purposes including energy production. Human-caused environmental degradation and natural hazards further exacerbate the strain on water resources and infrastructure. And water management practices can have both positive and negative influences on the climate, disaster risks, and the environment. An understanding of the relationships among water management, climate, hazards, and the environment can inform development efforts in identifying and exploiting potential co-benefits to be found in development activities.

This Thematic Integration Brief (TIB) provides a comprehensive but non-exhaustive overview of the interconnections between water management systems and climate (C), disaster risks (D), and the environment (E). The brief aims to:

- *enhance the understanding of potential C/D/E risks for water management systems*
- *highlight both the positive and negative impacts of water management systems on C/D/E*
- *offer practical advice on integrating C/D/E considerations into water management systems to ensure added value, greening, and risk-proofing.*

This brief fosters systemic thinking, addresses root causes, and provides practical guidance for project interventions and strategic planning for durable solutions.

SDC's Climate, DRR and Environment, and Water sections welcome feedback to continuously improve this Thematic Integration Brief (TIB).

Interconnections at a Glance

Adapted from: Capacity4dev, 2017

Risks for water management systems[1] from climate change, natural hazards, and the environment

Climate change profoundly affects water, increasing in particular unpredictability in the water cycle through extreme weather, or affecting water demand, availability, and quality. Natural hazards and environmental degradation further strain water resources. The following is a non-exhaustive list of risks:

- Vulnerability of water and wastewater treatment infrastructure to extreme weather events and other effects of climate change including the increased risk of overload – exacerbating the risks already associated with environmental degradation.
- Changes in the availability and quality of water resources due to climate change, including increased variability of precipitation, glacial retreat affecting river flows, more frequent and severe floods or droughts, temporarily increased runoff and seawater intrusion into coastal aquifers, compounded by ecosystem degradation.
- Water scarcity associated with climate change and environmental degradation leading to inequitable access to water supply and an emergence or aggravation of tensions and conflicts among different users or user groups.
- Increased demand for water associated with warming trends concurrent with implementation of climate change adaptation and mitigation measures such as irrigation development, evaporative cooling of buildings, afforestation and reforestation, bioenergy crops, and hydropower development.
- Decreasing capacity of degraded water bodies and natural ecosystems, particularly wetlands, to receive and decompose waste, increasing the need for wastewater treatment and re-use infrastructure.

Adverse impacts of water management systems on climate, natural hazards, and environmental degradation

While the impacts from water management systems on C/D/E can be both positive and negative, the following is a non-exhaustive list of negative impacts:

- Enhanced access to water supply leading to increased water use and over-extraction, which in turn can lead to depletion of surface and groundwater resources, land subsidence, and seawater intrusion.
- Water pollution, environmental degradation and increased incidence of waterborne diseases resulting from the discharge of quantities beyond the capacity of sanitation and wastewater treatment infrastructure.
- Flaws in the design and/or maintenance of wastewater collection and treatment systems leading to the concentration of waste in some places, such as low-lying areas of urban settlements, with adverse impacts on the environment and human health.
- Increased greenhouse gas emissions resulting from reliance on fossil fuels for powering water supply and treatment infrastructure.
- Groundwater pollution and greenhouse gas emissions caused by pit latrines or improper sludge disposal from wastewater treatment plants .
- Deterioration in ecosystems, biodiversity, and ecosystem-dependent livelihoods caused by water diversions for productive purposes.

1 The term water management systems in this TIB covers water supply, water resources, sanitation, and wastewater.

1. Interactions between Water Management Systems and Climate, Disaster Risks and the Environment

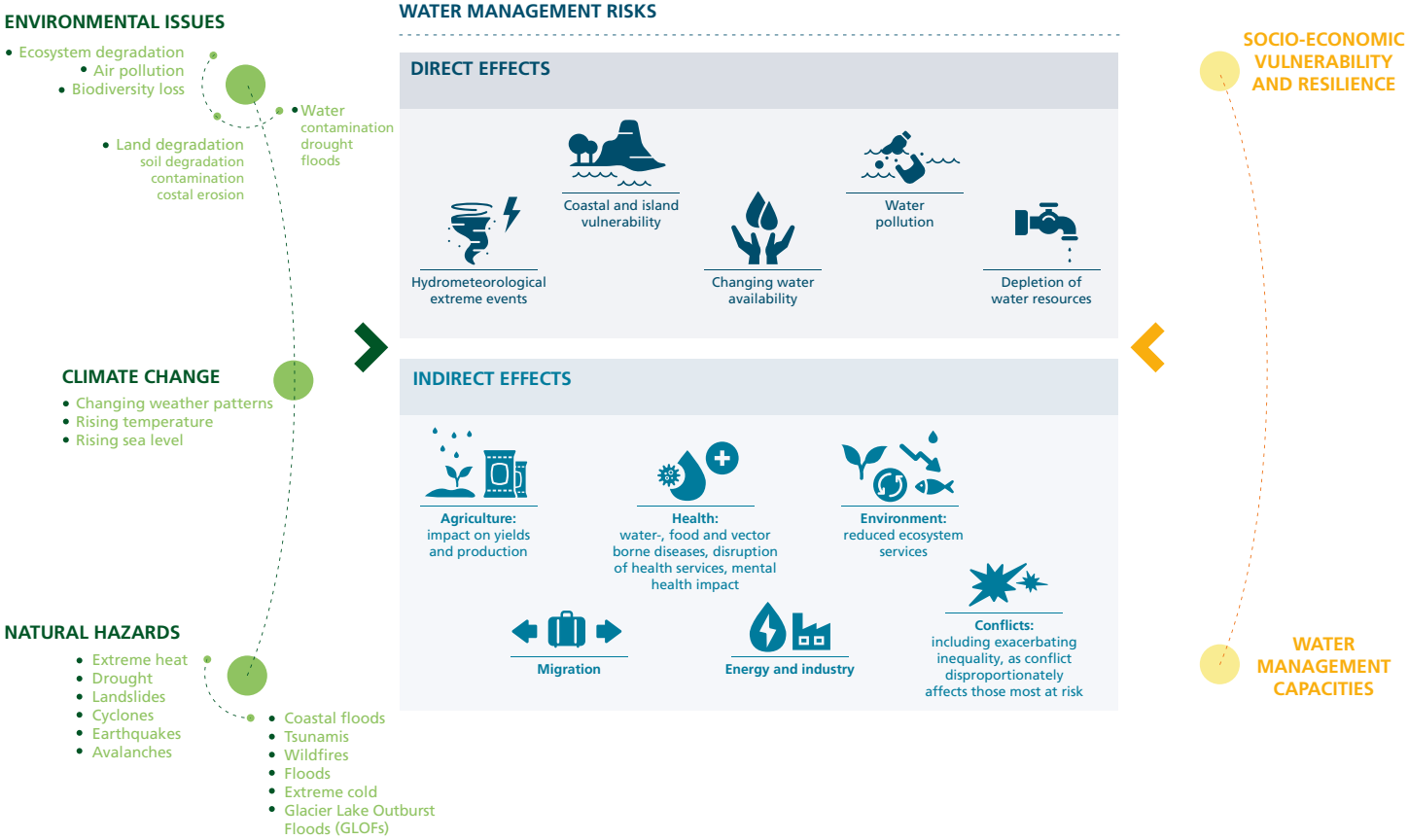
Climate change, natural hazards, and environmental degradation have significant, interrelated impacts on water resources, directly affecting human health and sectors dependent on water, such as agriculture, energy, and industry. Climate change will affect the availability, quality and quantity of water for basic human needs, threatening the effective enjoyment of the human rights to water and sanitation for potentially billions of people (UNESCO, 2020). Existing water-related challenges are likely to be exacerbated by impacts from climate change, natural hazards, and the environment.

At the same time, water management systems can have adverse impacts on the climate, disaster risks, and the environment. Climate change can intensify natural hazards, leading to more frequent and severe floods, droughts, hurricanes, and wildfires. These intensified events compromise both the availability and quality of water, creating a vicious cycle of resource scarcity and environmental degradation.

Man-made crises – such as conflicts or unsustainable development practices – can amplify the effects of climate change and natural hazards on water availability and quality. Conversely, climate change-induced water stress and environmental degradation can worsen the impacts of these human-driven challenges.

This chapter explores the interactions between water management systems, climate change, disaster risks, and the environment, emphasizing the importance of avoiding or at least reducing exposure to such risks.

Risks related to climate change, natural hazards and environmental degradation on water management systems



Direct effects occur when exposure to natural hazards directly affects parts of water management systems.

Extreme hydrometeorological events and changing water availability:

- Increased flooding[2] can damage drinking water sources and lead to contamination from livestock waste, human sewage, chemicals, and other impurities.
- Increased frequency and magnitude of extreme events – including unprecedented rainfalls, droughts, and floods – as well as slow-onset events such as sea-level rise, can affect the availability and distribution of surface water and groundwater resources.
- Other natural hazards such as wildfires, hurricanes, tornadoes, earthquakes and tsunamis can disrupt water supply and sanitation systems and contaminate water bodies, requiring an ever-increasing need for adaptation measures.
- Higher temperatures and changes in snowfall frequency and intensity in the cryosphere can alter freshwater availability in mountainous areas and downstream regions.

Changes to freshwater ecosystems:

- Higher temperatures reduce dissolved oxygen and heavy rainfalls increase the sediment, nutrient, and pollutant loads in freshwater. Droughts reduce the self-purifying capacity of water bodies, and floods disrupt treatment facilities. Altered streamflow and reduced water quality ensue.

Coastal and island vulnerability:

- Small islands, low-lying coastal areas, and deltas face heightened vulnerability to sea-level rise, leading to the loss of arable land and saltwater intrusion into freshwater systems.

Resource depletion and pollution:

- Excessive water use in agriculture, industry, power generation, and domestic consumption deplets freshwater resources (both surface waters and groundwater).
- Untreated wastewater and improper disposal of hazardous waste cause water pollution.

Indirect effects occur when the direct effects of C/D/E on water management systems subsequently affect related sectors.

Agriculture and food:

- The altered frequency and intensity of rainfall, floods, and droughts can cause significant impacts on agriculture and food production.
- Environmental degradation, such as water shortages or water and soil contamination, reduces agricultural production and can harm not yet exploited relevant ecosystems.
- Disasters such as floods and tsunamis can destroy crop yields and cause erosion of fertile soil.[3]

Health:

- Water-related health impacts of climate change are primarily food-, water- and vector-borne diseases (diarrhoea, hepatitis A, typhoid fever and cholera), and deaths and injuries associated with extreme weather events.
- Disruption of access to health services due to flooding will disproportionately affect people with limited financial resources and already poor health conditions such as people with disabilities, elderly people, children and other groups excluded on the basis of gender or social and cultural discrimination.
- Impacts associated with adverse events may include mental health challenges, economic losses, and displacements; these impacts may be substantial and long lasting.
- Extreme weather and disasters can lead to a spread of contaminated water from agricultural runoff, flood waters and sewage treatment systems, with negative impacts on human health, especially for those who already have limited access to water.
- Reduction of agricultural productivity negatively influences nutrition and increases the spread of food-borne illnesses.
- Environmental degradation can result in water pollution with negative consequences for the quality of drinking water, especially for those who are at risk of being excluded or are already excluded from full social and economic participation.

2 Since the 1970s, 44% of all disaster events have been flood-related (IPCC, 2022).

3 Such disasters can, however, have positive effects for agriculture, such as the enhancement of soil fertility.

Energy and industry:

- The increase of hydrological variability can have consequences on the energy sector and other industries, as most energy generation and industrial processes require significant water resources.
- Extreme weather events and disasters can destroy energy and industrial infrastructure.

Ecosystems:

- Floods, saltwater intrusion and droughts can destroy ecosystems with negative consequences on biodiversity.
- Environmental degradation and climate change can cause salinisation with negative consequences on plant growth and yields, damage to infrastructure, and reduction of water quality.
- Climate change, natural hazards, and environmental degradation can affect the provision of water-related ecosystem services such as water purification and natural flood protection.

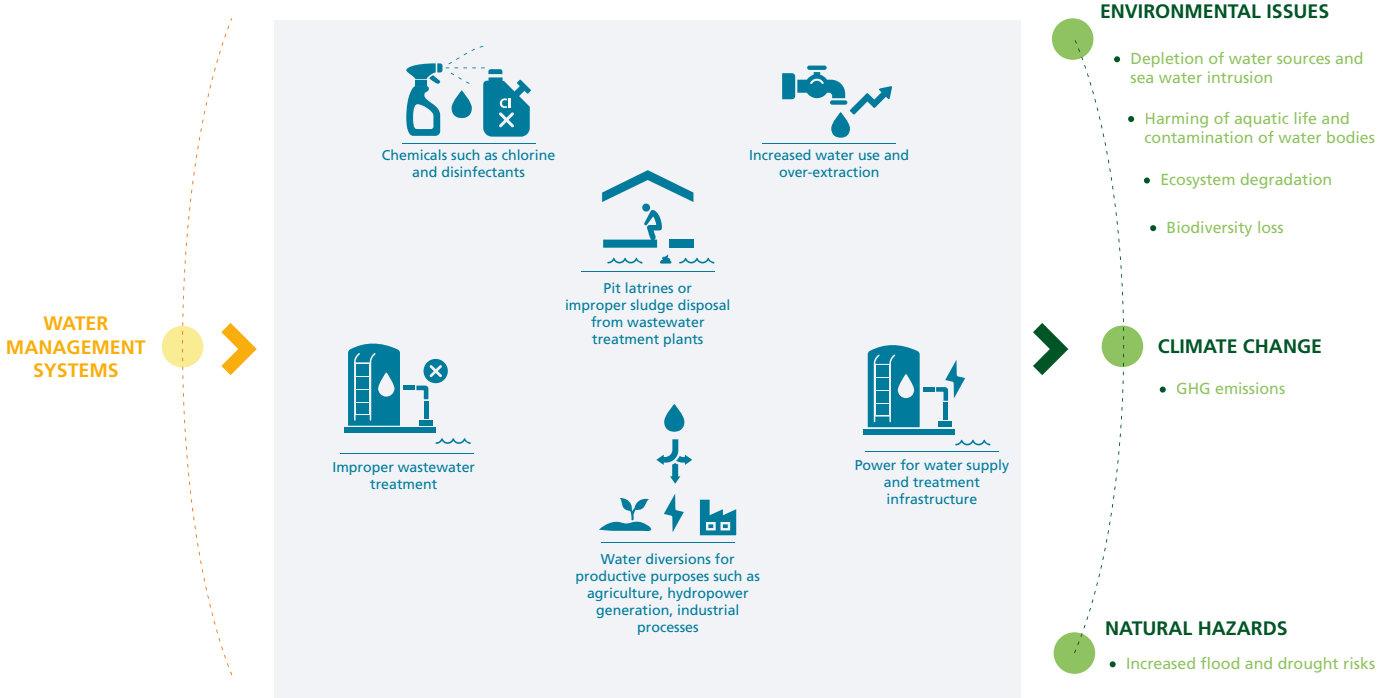
Migration:

Climate change and global environmental changes affect migration but are not their sole drivers. Many drivers of migration are however climate sensitive, but the potential for migration is determined by the context where these changes occur. The effects of gradual changes such as increased water shortages are likely to have a greater impact on the movement of people than sudden-onset disasters such as floods, storms and earthquakes.

Conflicts:

Water challenges can compound existing and emerging instabilities and contribute to unrest and conflict. Failure to address water challenges can have significant negative spillover effects beyond specific regions and countries.

Impacts of water management systems on climate, natural hazards and environmental degradation



Positive impacts occur when water management systems have positive effects on C/D/E.

Climate resilience and disaster reduction:

- Sustainable water supply can help manage and conserve water resources, ensuring a more reliable supply in the face of climate-induced droughts and shifting precipitation patterns. In regions with uneven rainfall distribution, rainwater collection is particularly useful in building resilience to shocks and in ensuring supplies for dry periods.
- Well-designed sanitation and drainage systems mitigate urban flooding in high-risk areas during extreme weather such as heavy rainfall or storm surges – events that disproportionally affect poor households and communities located in risk areas.
- Improved access to clean water and sanitation reduces waterborne diseases during disasters, safeguarding public health in emergencies.
- Proper water management and well-maintained infrastructure can help enable communities to respond effectively during periods of water scarcity and to adapt to changing climatic conditions.
- Access to clean water and sanitation boosts public health and fosters resilience to climate-related health threats and disasters. Specific barriers for excluded groups must be identified and removed in order to avoid harmful impacts of water management (following the do no harm and leave no one behind principles).

Environmental benefits and a circular economy:

- Properly planned water management systems can help preserve ecosystems by avoiding excessive water extraction and habitat disruption.
- Adequate sanitation can prevent the contamination of water bodies, enhancing water quality and protecting aquatic ecosystems.
- The valorisation and reuse of resources such as grey water or faecal sludge promotes resource reuse and recycling, contributing to the concept of a circular economy within the water sector.
- Safely managed wastewater serves as an affordable and sustainable source of water, energy, nutrients, and other recoverable materials.

Reduction of carbon emissions:

- Transitioning water and sanitation facilities to renewable energy sources reduces their carbon footprint.
- Advanced wastewater treatment facilities capture methane as an energy source, mitigating carbon emissions.
- Healthy aquatic ecosystems and improved water management can lower greenhouse gas emissions and provide protection against climate hazards through enhanced absorption capacity.

Negative impacts occur when water management systems adversely impact C/D/E.

Increased greenhouse gas emissions and disaster risks:

- Water and sanitation facilities consume significant energy for treatment and distribution, resulting in higher greenhouse gas emissions.
- Diverting rivers and streams for water supply disrupts the hydrological cycle, increasing floods and drought risks downstream and harming ecosystems.

Environmental impacts:

- Constructing large water and sanitation infrastructure such as dams, canals, and reservoirs disrupts habitats, leading to biodiversity loss and fragmented landscapes.
- Over-extraction of groundwater depletes aquifers, reducing water availability, causing sea water intrusion and increasing disaster risks such as sinkholes and flooding.
- Certain chemicals, such as chlorine and disinfectants, can harm aquatic life and contaminate water bodies.

2. Integrating C/D/E and Water Management Systems: Key Areas for Action

Addressing the risks and impacts in a meaningful manner calls for a comprehensive systemic approach that acknowledges root causes and strives for durable solutions that will ultimately contribute to systemic change and societal transformation. These proposed actions (adapted from Capacity4dev 2021) are meant to contribute to such systemic thinking from the planning stage to the implementation of projects and programmes.

Adding value to water management systems by reducing risk and environmental impact

Hazard and risk assessment, preparedness, and early warning systems

- Undertake thorough regional or country-specific assessments that consider climate, disaster, and environmental risks, along with impacts and forecasting (scenarios). CEDRIG can serve as an initial screening tool for risks and impacts, and may be complemented by more in-depth assessments.
- Deploy and implement preparedness measures, early warning systems and early action approaches to anticipate and mitigate potential threats to water resources and sectors reliant on water.
- Utilise existing resources from the IPCC, UNDRR, or the World Bank Climate Change Knowledge Portal to bolster the accuracy and effectiveness of risk assessments and preparedness strategies.

Awareness and community engagement

- Enhance awareness of and commitment to mainstream climate and environmental agendas, integrating them into local action plans and communication strategies. Use existing resources such as the WRG communications toolkit. Make sure that the awareness and communication efforts are accessible to everyone by using the United Nation's Disability-Inclusive Communications Guidelines.
- Initiate communication and behaviour change campaigns focused on education and involving diverse stakeholders to emphasise WASH benefits for both environmental conservation and public health. Take a participatory approach to understanding stakeholders' motivations and the barriers that might prevent them from adopting the practices.
- Educate and engage local communities in comprehending climate risks, and involve them in integrated water resource management throughstakeholder participation that empowers them to adapt to evolving conditions. Ensure the legally binding, meaningful participation of all members of the community – women, men and children with disabilities, elderly people, poor people and other groups excluded on the basis of gender or social and cultural discrimination.
- Encourage and involve youth in educational initiatives, fostering active participation in understanding and addressing climate-related risks and water resource management.

Water conservation and a circular economy

- Promote effective and efficient water usage by advocating for the adoption of low-flow plumbing devices,[4] waterless sanitation solutions such as ecological sanitation systems,[5] and rainwater harvesting systems.
- Mitigate water wastage in piped supply systems by addressing leaks and renewing infrastructure.
- Support the safe reuse of water and treated wastewater in agriculture and industry to foster a circular economy approach.
- Explore opportunities for nutrient recovery in wastewater treatment from polluting industries.
- Integrate solar and biogas energy generation into wastewater treatment plant operations to promote sustainable energy practices.

4 See WaterSense (US EPA) for water conservation technologies.

5 See Compendium of Sanitation Systems (Eawag) for sanitation solutions.

Resilience of infrastructure

- Strengthen the resilience of water and sanitation systems to withstand disasters and climate-induced impacts, ensuring continuous service based on accurate hazard and risk assessment.
- Reduce the overflow risk of sewerage systems and wastewater treatment plants by climate-resilient siting practices (steering clear of flood-prone areas) and robust design, coupled with routine maintenance protocols.
- Utilise established resources such as Lifelines: Water Infrastructure Resilience and Infrastructure for climate action to guide efforts in bolstering infrastructure resilience.

Renewable energy and efficiency

- Conduct energy audits and implement equipment upgrades to enhance energy efficiency within water supply and sanitation facilities.
- Promote the use of renewable energy sources within water and sanitation infrastructure.
- Use available resources offered by organisations such as the International Renewable Energy Agency.

Ecosystem protection

- Implement ecosystem-based approaches in land-use planning to manage land cover effectively, considering the impact of sealing practices on water absorption and other ecological processes such as Ecosystem-based Adaptation (EbA).
- Establish and implement watershed protection initiatives aimed at protecting headwaters and recharge areas vital for the health of ecosystems. Utilise established resources such as the Guidelines for applying protected management categories.
- In sensitive regions and ecosystems, prioritise the placement and design of wastewater treatment plants to minimise potential adverse impacts.

Alignment with global commitments

- Ensure coherence between water and sanitation policies and commitments such as the Sustainable Development Goals, the Paris Agreement and the Sendai Framework for Disaster Risk Reduction, which promotes all-of-society engagement and partnership as a principle.

Enhancing stakeholder engagement, cross-sectoral collaboration and capacities

- Support and promote an Integrated Water Resources Management (IWRM) approach across all levels of engagement and among all stakeholders and actors.
- Foster collaborative efforts across diverse sectors – including land use and urban planning, health, agriculture, energy, and environmental conservation – to take a holistic approach in addressing complex challenges impacting water management systems. This collaboration spans strategising, planning, implementation and monitoring.
- Ensure meaningful participation of diverse groups of stakeholders and community representatives through universal design, accessible communication, physical accessibility to meetings, reasonable accommodation, and the involvement of civil society organisations, including Organisations of Persons with Disabilities (OPD).
- Use established tools and procedures such as environmental impact assessment (EU and CH), Climate Risk Assessments (EU and GIZ), CEDRIG, or The World Bank's Climate and Disaster Risk Screening to identify and address risks effectively.
- Strengthen institutional capacities and advocate for policies that integrate climate adaptation, DRR, and environmental protection into water sector planning and governance.

Further reading

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