The United Nations World Water Development Report 4

Introduction

- The uninterrupted water supplies anywhere in the world cannot be guaranteed to water users.
- The factors such as socio-economic-environment and water are interdependent on each other.
- All of the activities that drive development also shape important political and economic decisions and has substantial impacts on quantity and quality of the water available. Thus, all of these sectors are interlinked through water.
- As water demand and availability become more uncertain, all societies become more vulnerable to risks such as, hunger and thirst, high rates of disease and death, lost productivity and economic crises, and degraded ecosystems. These impacts elevate water to a crisis of global concern.
- This fourth edition of the World Water Development Report (WWDR4) point that all water users are **change agents** who affect and are affected by the water cycle.

Recognizing the Centrality of Water and its Global Dimensions

Beyond the Concept of Water as a Sector:

- Water is understood as a 'sector' but it is beyond that. As water cuts across all social, economic and environmental activities its governance requires cooperation and coordination.
- Furthermore, the hydrological cycle, is influenced by multiple factors, trends and uncertainties that extend beyond a narrow sectoral focus.
- Addressing water challenges necessitates interventions across an entire economy by strong institutions rather than a reactive role in water management.
- The importance of political leadership in establishing, reviewing and maintaining the frameworks cannot be understated.
- **Irrigation and food production:**
  - It is difficult to predict the future water availability due to evolving diet patterns, technological change and climate change.
- **Ecosystems:**
  - Ecosystem is vital part of water and water is vital part of the ecosystem. For example, products such as food, timber, medicines and fibre, regulating climate, supporting

nutrient cycling, soil formation and deposition.
    - The stability of ecosystems is a under increasing threat from unsustainable patterns of human consumption, development, and climate change across the globe.
- **Hazards:**
  Water management plays a central role in reducing the risks of natural disasters. Water storage (via reservoirs, aquifer recharge or other means) is vital to combating the effects of drought and managing floods.
- **Green economy:**
  Investment in protection and sustainable management of water resources across society as a whole allow significant steps to be made towards achieving a green economy that advances long-term human well-being within ecological limits.
- **Equity:** In addition to addressing inequities in global demand and consumption, it is also critical to address inequities at the local and national level as many regional water sources might be insufficient to distribute equitably to its inhabitants.

Beyond the basin: The international and global dimensions of water governance:

- Although water is distributed unevenly across the planet, it forms part of global water cycle which is influenced by actions and phenomena that take place beyond the nation state.
- Hence, global cooperation is required on a climate change and it is obligatory for developed countries to assist developing countries in managing these impacts and efforts to improve water governance for climate change adaptation.
- Climate change mitigation and adaptation responses are related because the carbon and water cycles are interdependent.

Recognizing water in global policy:

Global Policies:

- The MDGs provides for well establish access to water which improves education outcomes (Goal 2).
- The UNFCCC through its Cancun Adaptation Framework it emphasises upon water and related extreme events.
- The UNCSD (Rio+20) has laid emphasis on the success of green economy which depends on sustainable management of water resources and on safe and sustainable provisioning of water supply and adequate sanitation services.

Water Demand: What drives the consumption?

Food and agriculture

- The link between water and food is a simple one. Crops and livestock need water to grow, and other agricultural activities too need water.
- Agriculture accounts for 70% of all water withdrawn by the agricultural, municipal and industrial (including energy) sectors. Water is the key to food security.
- There are large areas of absolute water scarcity which affects billions of poor and disadvantaged people.
- Major changes in policy and management, across the entire agricultural production chain, are needed to ensure best use of available water resources in meeting growing demands for food and other agricultural products.

1. Water use in agriculture

- The booming demand for livestock products in particular is increasing the demand for water, while it is also affecting water quality, which in turn reduces availability.
- Globally, irrigated crop yields are about 2.7 times those of rainfed farming, hence irrigation

will continue to play an important role in food production.

2. Expected growth in demand

- The world population is predicted to grow from 6.9 billion in 2010 to 8.3 billion in 2030 and 9.1 billion in 2050 (UNDESA, 2009).
- By 2030, food demand is predicted to increase by 50%, while energy demand from hydropower and other renewable energy resources will rise by 60%.

3. Agriculture's impact on water and ecosystems

Water management for agriculture has changed the physical and chemical characteristics of freshwater and coastal wetlands and the quality and quantity of water, as well as direct and indirect biological changes in terrestrial ecosystems.

4. Pressures from population growth and changing diets

- The growing population (9.1 billion by 2050, as per study) is increasing the pressures on land and water. At the same time, economic growth and individual wealth are shifting diets from predominantly starch based to meat and dairy, which require more water.
- Demand for livestock products is closely linked to economic growth- Livestock contributes less than 2% of global gross domestic product (GDP), yet produces some 18% of greenhouse gases (GHGs).
- The livestock production and processing also causes water pollution.

5. Other pressures on water resources in the agriculture sector

- The climate change-induced hydrological changes such as, severe and frequent droughts and floods, are likely to affect irrigated and rainfed agriculture worldwide.
- Agriculture contributes to climate change through its share of GHG emissions, which in turn affect the planet's water cycle.
- The food price crisis, Land acquisitions and land-use and the demand for biofuels also add to the strains on local hydrological systems and GHG emissions.

6. Waste in the food chain

Food can be wasted at every step along the value chain, which means that the water used to produce it is also wasted.

7. 'Water-smart' food production

- Innovative technologies will be needed that can improve crop yields and create more sustainable livestock and marine production.
- Agricultural development in Least Developed Countries (LDCs) lies mainly in the hands of smallholders, a large majority of whom are women. Women have only limited access to a wide range of physical assets and lack the skills to deploy them. Human capacities and institutions are the assets and major changes in policy and management will be needed.
- Water recycling at all stages of the value chain can help secure environmental water

requirements.
- Virtual water may play an increasing role as water-rich countries export water embedded in food to water short countries.

8. Water for energy

- EIA (2010) estimates that global energy consumption will increase by around 49% from 2007 to 2035. This increase in energy consumption will be higher in non-OECD countries than in OECD countries.
- All forms of energy require water at some stage of their life cycle, which includes production, conversion, distribution and use.
- Energy for water: Energy is needed for extraction (surface water, groundwater), transformation (treatment to drinking water standards, desalination), water resource delivery (municipal, industrial and agricultural supply), reconditioning (wastewater treatment) and release. However, few countries currently research and report on energy requirements for water.

9. Drivers, challenges and responses to the water-energy nexus:

- The main challenge with regard to water and energy will be the provision of water resources to ensure that the increased energy needs can be supplied.
- This need requires policy-makers to promote more efficient and integrated water uses for energy and vice versa.
- Thermal, chemical, radioactive or biological pollution can have direct impacts on downstream ecosystems.
- Similarly, where water scarcity obliges nations to use non-traditional sources of water (e.g. desalination, brackish water), choices will need to be sensitive to the water and environmental impacts of the required electricity.

10. Industry

- Industry's total water withdrawal from surface water and groundwater is usually much greater than the quantity of water it actually consumes.
- Improved water management is generally reflected in overall decreased industrial water withdrawals or increased wastewater treatment, highlighting the connection between higher productivity and lower consumption and effluent discharges and reduced pollution.
- Industry is strongly influenced by external drivers such as, International trade, environmental management systems (EMS), corporate social responsibility (CSR), Basel Conventions etc that, indirectly, can add complexity and uncertainty to industry water needs.
- Undoubtedly, business and industry can play a leading role in sustainable water practices adaptation and mitigation technologies.
- For example, establishing water accounting techniques and measuring water impacts can allow an industry to more readily identify potential areas of increased water use efficiency.

Inter-relationship of water risks among business, government and society

11. Human settlements

- Urbanization and population trends: Population growth is projected to increase by 2.9 billion, from 3.4 billion in 2009 to 6.3 billion in 2050 (UN-Habitat, 2006).
- Population growth and rapid urbanization will create an even greater demand for water while decreasing the ability of ecosystems to provide more regular and cleaner supplies.
- Water supply and sanitation coverage: Pressure from urban areas on water such as water withdrawals, pollution and wastewater management would continue to challenge present water resources.
- Water management in urban areas:
    - It can be benefited from more comprehensive urban planning through integrated urban water management (IUWM).
    - The IUWM involves managing freshwater, wastewater and storm water.
    - Urban and peri-urban agriculture (UPA) is the safe production of agriculture and cattle products in and around cities. It can also solve several urbanization problems by enhancing food availability, greening cities and also recycling wastes etc.

12. Ecosystems

> Ecosystems underpin the availability of water, including its extremes of drought and flood, and its quality. Water management often involves trade-offs and often the transfer of risks between ecosystem services.

Water and ecosystem services: Ecosystem services (benefits for people) can be grouped in various ways. The Millennium Ecosystem Assessment has provided the most comprehensive assessment of the state of the global environment to date, and has classified ecosystem services as follows:

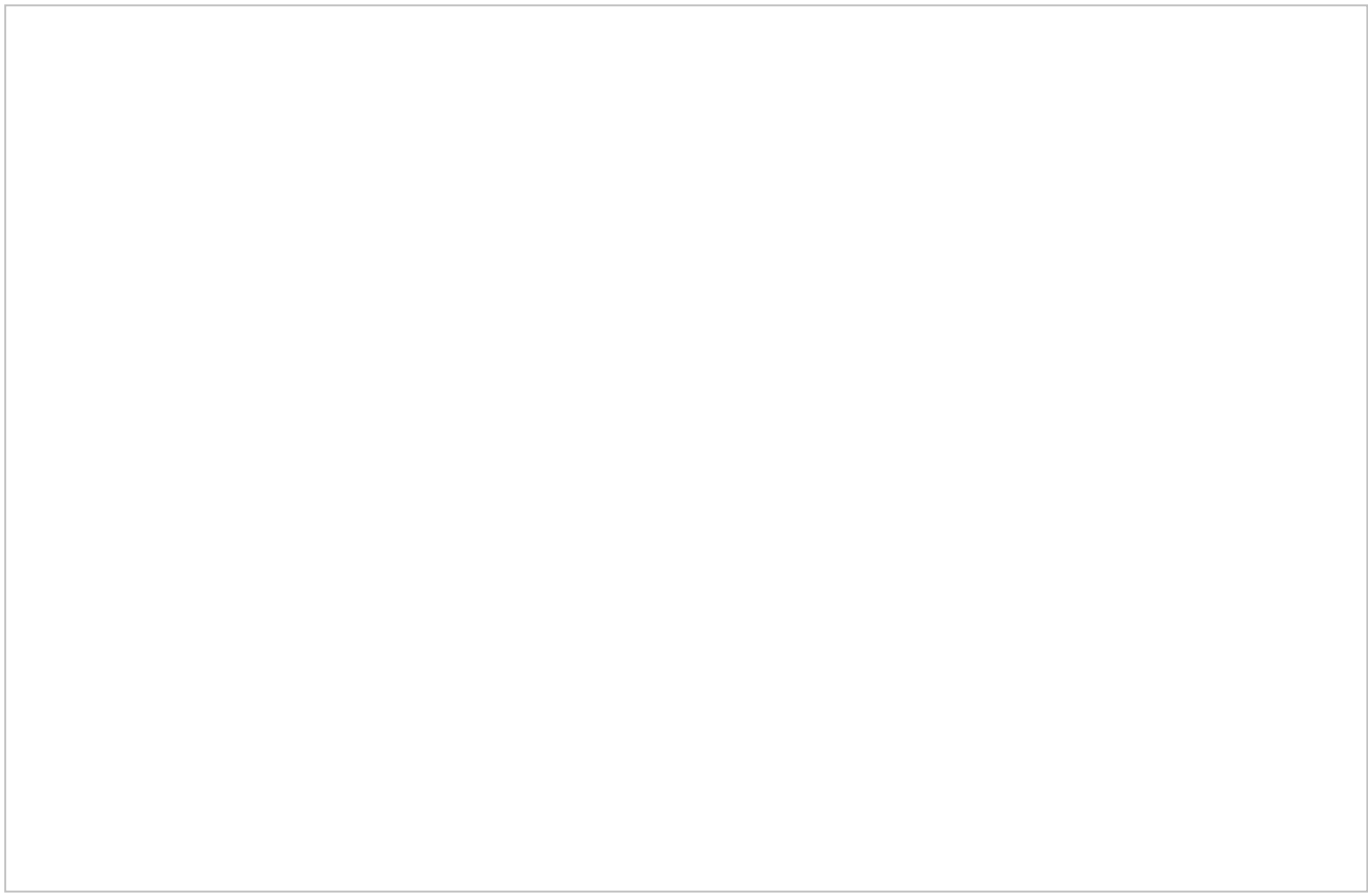
- **Supporting services:** The services necessary for the production of all other ecosystem services. Supporting services include soil formation, photosynthesis, primary production, nutrient cycling and water cycling.
- **Provisioning services:** The products obtained from ecosystems, including food, fibre, fuel, genetic resources, biochemicals, natural medicines, pharmaceuticals, ornamental resources and freshwater.
- **Regulating services:** The benefits obtained from the regulation of ecosystem processes,

including air quality regulation, climate regulation, water regulation, erosion regulation, water purification, disease regulation, pest regulation, pollination and natural hazard regulation (including extremes in water availability).

- **Cultural services:** The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences, thereby taking account of landscape (including waterscape) values.
- **Water is multi-dimensional** in the context of ecosystem services. Its availability and quality are products (services) provided by ecosystems. But water also influences how ecosystems can function and therefore underpins all other ecosystem services. This gives water paramount importance in managing ecosystems so as to deliver benefits to people.
- **The Millennium Ecosystem Assessment** (study by US) concluded that human development had tended to promote certain services (especially provisioning services) at the expense of others. This has led to an imbalance in services and indicates a path towards decreasing sustainability.

Understanding uncertainty and risks associated with key drivers: Drivers that directly impinge upon water stress and sustainability are the ecosystem, agriculture, infrastructure, technology, demographics and economy.

The ultimate drivers, governance, politics, ethics and society (values and equity), climate change and security exert their effect mostly through their impacts upon the proximate drivers.



The water resource: Variability, vulnerability and uncertainty

The hydrological cycle, external stressors on water resources, and sources of uncertainty

- Precipitation delivers water unevenly over the planet from one year to the next. There can be considerable variability between arid and humid climates and wet and dry seasons. As a result, distribution of freshwater supplies can be erratic with different countries and regions receiving different quantities of water over any given year.
- The state of water resources is one of constant change, resulting from the natural variability of the earth's climate system and the anthropogenic alteration of that system and the land surface through which the hydrological cycle is modulated.
- Specific changes to water resources and the hydrological cycle include changes in mean surface flows, increased flood potential due to climate change, decreasing snow and permafrost, soil moisture etc.

Drivers of global climate and hydrological variability

- The drivers such as, El Niño-Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), the North Atlantic Oscillation (NAO) and the Atlantic Multidecadal Oscillation (AMO) does affect global climate and hydrological variability.
- The **El Niño-Southern Oscillation** is a coupled ocean atmospheric phenomenon in the tropical Pacific Ocean and the dominant driver of global climate at seasonal to interannual time scales.
- There has been extensive documentation of ENSO impacts on precipitation, temperature, hurricanes and tropical cyclones, ecosystems, agriculture, water resources and public health around the world, especially from the tropical countries where most of the world's population reside.
- The **Pacific Decadal Oscillation (PDO)** is manifested in the large-scale sea surface temperature pattern predominant in the Northern Pacific region, but also includes participation from the tropical Pacific.
- The **North Atlantic Oscillation (NAO)** is a climate driver in the North Atlantic region and functions as an atmospheric feature mainly in the winter season.
- **NAO** is characterized by the location and strength of subtropical high-pressure and subpolar low-pressure centres in the North Atlantic. The location and strength of these pressure centres steer the jet stream and the storm tracks and consequently the regional climate and hydrology.

The vulnerability of natural long-term storage: Groundwater and glaciers

- The changing role of groundwater in the world unlike surface water, which has been intensively developed in many parts of the world. The twentieth century, observed unprecedented 'silent revolution' in groundwater abstraction across the globe.
- The use of groundwater has also considerably modified local and global water cycles, environmental conditions and ecosystems.

1. Groundwater: A resilient resource in transition

- Groundwater is now a significant source of water for human consumption and around 43% of

all water is effectively consumed in irrigation.
- Due to the relatively large volumes of water stored underground, most aquifers have a considerable buffer capacity, which keeps their water available for withdrawal even during very long periods without rainfall.
- This enables people to have reliable access to water in regions that would otherwise be too dry if their water supply depended only on precipitation or surface water.
- Therefore, any significant changes in the state of groundwater systems such as, inflows and outflows, the volume of water stored, water quality, are key characteristics of the state of any groundwater system.
- Steadily increasing rates of groundwater abstraction and other human interactions with groundwater, such as those produced by changing land use and emission of polluting substances, all affect the state of groundwater systems.

2. Groundwater: Cause for concern or opportunity?

- The global groundwater abstraction rate has at least tripled over the past 50 years.
- Groundwater systems around the world are coming under increasing stress from various anthropogenic and natural factors.

3. Glaciers The role of glaciers within mountain hydrology

- The glaciers are the 'water towers' of the world, receiving much more precipitation than the surrounding lowlands.
- Their contribution to water supply is of particular significance where the lowlands are arid.
- Mountain stream flow is composed of three major elements: **rainfall, snow melt and water from glacier melt**.
- The relative importance of these elements, varying through time and with elevation, is largely controlled by temperature and seasonality of precipitation.
- Examples of Glacial melt from the Himalayan region are:
    - The basins of the Brahmaputra, Ganges and Indus which encompasses the Himalaya and Karakoram.
    - Many people dependent on these stream flows for water supply and are at risk from glacier-related floods.
- The significance of glacier melt contribution to stream flow may be divided into two components:
    - In the eastern Himalaya glacier, ice melt is completely overshadowed by monsoon rainfall and snow melt, with the ice melt contributing less than 3% of annual stream flow.
    - In the Karakoram, the glacier melt contribution is much more significant, reaching more than 20% of annual flow in some years during late summer.
    - The contribution is also derived from shrinkage of the glacier mass due to global warming.
- Glacier-related floods:
    - The risks from such floods are increasing, a sudden release can result from the collapse of the retaining moraine or as a result of landslides into the lake with sudden displacement of the waters.
    - To deal with uncertainty and risk related to glaciers in the Himalayan region, policy

options such as, such as installing pumps to reduce lake levels and introducing early warning systems to alert downstream populations, etc is required.

4. Water quality

- The ‘quality’ of water is a relative term. ‘Pure’ water does not exist in nature but only in the laboratory, and all substances may be pollutants depending on their concentration in water.
- This is one of the reasons health professionals often prefer to use the term ‘safe’ water rather than 'clean' water.
- Appropriate quality of water is a key ingredient in human health, ecosystems and for socio-economic development.
- Water quality is becoming a global concern of increasing significance, as risks of degradation translate directly into social economic impacts.
- The quality can be affected through increased concentrations of naturally occurring compounds such as fluorides and increasing salinity levels, eg. saltwater intrusion into coastal aquifers.
- Policy-makers with the support of the research community can help to better quantify the problems, as well as develop remedial solutions.
- Development of clean technology, cost-efficient treatment options and a global water quality assessment framework is necessary.

Beyond demand: Water’s social and environmental benefits

Water and human health

Improving water resource management, increasing access to safe drinking water and basic sanitation, and promoting hygiene (WaSH) have the potential to improve the quality of life of billions of individuals. The global importance of water, sanitation and hygiene for improving health is reflected in the United Nations Millennium Development Goals (MDGs), explicitly, Goal 7.

1. Drivers

The global drivers predicted to have the greatest effect on human health via the water environment, these drivers are:

- **Population -** through increasing water demands and increasing water pollution.
- **Agriculture -** by increasing water withdrawals for irrigation, changing water regimes in agro-ecosystems, and increasing water pollution.
- **Infrastructure -** including dams and irrigation projects if not appropriately designed and managed, it can create breeding grounds for the black flies that spread onchocerciasis and the mosquitoes that spread.
- **Climate change -** is expected to exacerbate current stresses on water resources from population growth and land use, and also to increase the frequency and severity of extreme weather and hydrological event

2. Options and consequences

- The global drivers are predicted to have the greatest effect on disease rates via water-environment nexus.
- Protection of human health requires collaboration among multiple sectors, including actors and stakeholders in non-water and non-health sectors.

Five key conclusions are:

- Climate change is widely perceived as a threat rather than an opportunity. There may be significant overall benefits to health and development in adapting to climate change.
- Major changes in policy and planning are needed if ongoing and future investments are not to be wasted.
- Potential adaptive capacity is high but rarely achieved. Resilience needs to be integrated into drinking water and sanitation management to cope with present climate variability. It will be critical in controlling adverse impacts of future variability.
- Although some of the climate trends at regional levels are uncertain, there is sufficient knowledge to inform urgent and prudent changes in policy and planning in most regions.
- There are important gaps in our knowledge that already or soon will impede effective action. Targeted research is urgently needed to fill gaps in technology and basic information, to develop simple tools, and to provide regional information on climate change.

Water and gender

- Rural women often rely upon common water resources such as small water bodies, ponds and streams to meet their water needs, but in many regions these sources have been eroded or have disappeared due to changes in land use, or have been appropriated by the state or industry for development needs or to supply water to urban areas.
- By working together in partnership with these sectors, decision-makers in government bodies, private sector and civil society can understand and address the potential synergies and trade-offs that occur when providing access to different groups of men and women in local communities.
- By developing women's capacities to manage water interventions, and providing them with opportunities to play leadership roles and improve their economic conditions. However, these successes are often limited to the local context, as the larger issues, such as providing water rights to women.

Ecosystem health

- Ecosystems deliver multiple benefits, many of these key services are derived directly from water, and trends in ecosystem health, therefore, indicate trends in the delivery of these overall benefit.
- Natural hazards caused by water are floods, mudslides, storms, droughts etc. these hazards furthered cause more hazards such as breakage of levees and dams, as well as glacier lake outbursts, coastal flooding etc, thereby aggravating water risk and uncertainty.

Desertification, land degradation and drought (DLDD)

- Those affected by DLDD include the world's poorest, most marginalized and politically weak

citizens. India alone accounts for 26% of this population.
- Combating DLDD measures such as, terracing to restrain water erosion, no-till and minimum tillage in agriculture.

Water stress and water scarcity

- It is defined as an area experiencing water stress when annual water supplies drop below 1,700 m3 per person.
- When annual water supplies drop below 1,000 m3 per person, the population faces water scarcity, and below 500 m3 “absolute scarcity”.
- Several researchers and agencies have computed the water stress of watershed and grid scales by incorporating domestic, industrial and agricultural water consumption, against renewable supplies of water from precipitation, rivers and groundwater.
- Various approaches to international governance have failed to recognize the central role of water. Because water is considered to be part of the overall policy reform and no separate water policy are made.
- Therefore, a draft water-policy or ‘water-policy reforms’ would actually work.

Water management, institutions and capacity development

What is water management

It covers managing of water resource, water services and managing the trade-offs needed to balance supply and demand.

- **Water resource management** is about managing water found in rivers, lakes and groundwater. This includes water allocation, assessment and pollution control.
- **Water service management consists** of managing reticulation systems from the bulk water supply up to the end users and again capturing the waste back to a wastewater treatment plant for safe onward discharge.
- **Management of trade-offs** concerns a range of administrative activities that meet allocation and entitlement agreements across a wide spectrum of socio-economic interests.
- **Other ways of Water management:**
    - Innovative storage infrastructure, ‘green’ infrastructure (such as wetlands), less intrusive dams, waste water management for agriculture, urban or industrial waste.
    - Proper public education and awareness, by recognizing women’s needs and their potentials in contribution.
    - **Integrated water resources management (IWRM)** it is as a process that ‘promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.
    - **Water management through demands and changes** such as, Hydro-climatological information about precipitation and runoff etc. and population growth, migration.
    - **Adaptive management,** is a process for improving management policies and practices by learning from the outcomes of best practices.

The importance of water institutions for sustainable development

- Institutions constitute the 'rules of the game', defining roles and procedures for people and determining what is appropriate, legitimate and proper.
- Water-related institutions do matter because they function at different scales ranging from the local community to the transnational level, and oversee the allocation, distribution, management, planning, protection and regulation of water resources and services.
- Effective institutions can reduce natural, economic, technical and social uncertainties but due to a lack of appropriate institutions there has been 'institutional resistance to change' for managing and securing resources.
- Coordination between institutions is necessary to achieve water resource management goals,
- An awareness-raising and education for all stakeholder groups, from local communities to politicians is required.
- An example of an institution:
    - Social learning and adaptive water resources management practiced in Lower Bhavani Project (Tamil Nadu), have provided a platform to farmers for learning best practices.
    - Basin management committees, followed in other countries have provided a forum where stakeholder groups can communicate.
    - Forum for integrated resource management (FIRM) is another example from rural Namibia.

From raw data to informed decisions

Why we need effective data?

- The absence of systematic data collection impedes regular reporting on water resources and water-use trends.
- Quantitative indicators make it possible to spot problems, track trends, identify leaders and laggards, and highlight best management practices.
- Data constraints are limiting the programme's ability in effective water management.
- Hence there is need improved data availability and quality, more structured and better information about water.
- The Joint Monitoring Programme (JMP) for Water Supply and Sanitation (WHO/UNICEF) is the official UN mechanism tasked with monitoring progress.

Why there are constraints on better monitoring and reporting?

- Many institutional and political spheres face constraints because of the relatively low value and wide distribution of water and its use, also because the production of water is a natural rather than a man-made process.
- Additionally, water resources are often shared between a number of different political jurisdictions and there are conflicts between upstream and downstream jurisdiction in sharing of information.
- A further constraint on improved monitoring and reporting is the lack of agreement on what should actually be monitored. There are also substantial technical and financial constraints.

Improving the flow of data and information

- The initiatives of the **UN System of Environmental-Economic Accounting for Water** (SEEAW) and **Eurostat** are particularly significant in this regard.
- There are many other initiatives such as,
    - The **World Business Council on Sustainable Development** (WBCSD) has produced a 'water tool' to help business to monitor its use of and impact on water more systematically.
    - The **Water Footprint Network** similarly encourages businesses, their customers and other stakeholders to become more aware of the water content of their products and operations.
    - Total Actual Renewable Water Resources (TARWRs), a pilot initiative of WWAP is the fundamental measure of water resource availability (in a country, river basin or region).

Regional challenges, global impacts

The regional reports cover, Europe and North America, Asia and the Pacific, Latin America and the Caribbean, Africa, Arab and Western Asia region, which describes how actions in one part of the world can create negative impacts, as well as opportunities, in others.

- **Sub-Saharan Africa:** The region uses barely 5% of its annual renewable freshwater. Yet access to improved water supplies, in both urban and rural contexts, is still the lowest in the world.
- High population growth, poverty and underdevelopment are key drivers affecting how water is managed.
- About 66% of Africa is arid or semi-arid and more than 300 of the 800 million people in sub-Saharan Africa live in a water-scarce environment.
- Measures: African Ministers' Council on Water (AMCOW), the African Water Facility, the African Development Bank (ADB) and the Rural Water and Sanitation etc.
- **Europe and North America:** The over water abstraction, seasonal migration of people, the dependence on agriculture, mining and other export commodities, high use of chemical fertilizers and discharge of untreated wastewaters continue to exert pressures.
- Measures: Passing of regulations such as the Clean Water Act and the Safe Drinking Water Act in the USA, the EU Water Framework Directive (WFD) in the Danube and Rhine basins.
- **Asia-Pacific:** The region is home to 60% of the world's population but it has only 36% of its water resources.
- Water availability, allocation and quality remain major issues. Irrigated agriculture is the biggest water user.
- The driving forces and pressures on water resources are rapid urbanization, economic growth, industrialization, and extensive agricultural development.
- Risk such as water tables in Punjab, India, are falling by 2 m to 3 m a year. The Pacific's small Island Developing States (SIDS) are vulnerable to disasters like tropical cyclones, typhoons and earthquakes.
- Measures: The policies, strategies, plans and legal frameworks for water resources management such as, India's Sanitation Programme- Swachh Bharat, Namami Gange,

Integrated River Water Management Projects etc. are few examples of measures taken in India.
- **Latin America and the Caribbean:** Extreme climatic events, especially hurricanes in the Caribbean, have long had a negative influence on water management. Also demographic change, Economic development exert pressure on water resource.
- Measures: The region has taken steps to improve overall governance, new water legislation, creation of water authorities etc.
- **Arab and Western Asia region:** Regional conflicts and displaced persons has strained water resources and services, nearly all Arab countries suffer from water scarcity, saltwater intrusion from over-pumping groundwater, increased soil temperatures and aridity, shifts in seasonal rainfall patterns etc.
- Measures: The adoption of Arab Water Security Strategy in the Arab Region, capacity building and awareness programmes.

Linking the regional to the global

- It is necessary to examine how regional challenges are linked to global water problems.
- Water challenges do not occur in a vacuum, through a series of interconnected webs they affect diverse countries and communities in many ways.
- The negative effects of the environmental degradation of water supply and excessive water withdrawals are borne not just by the regions in which such activities occur their impact can be felt worldwide.

Working under uncertainty and managing risk

- Risk and uncertainty characterize much of what water managers and socio-economic policy-makers must deal with. The more they understand these uncertainties and risks, the more effectively they can plan, design and manage water systems to reduce them.
- **How uncertainty and risk affect decision-making:**
    - For example, a farmer must make planting decisions without knowing how much rain will be available, and its distribution over the growing season. The outcome of his planting decisions will be unknown until the time of harvest.
    - Alternatively, an expanding firm wants to construct a new building and must choose a location.
    - Managers do not always consider the risks as inherent to the situation and so there are more catastrophic consequences of making the wrong decision.
- **Approaches to inform decision-making under risk and uncertainty:**
    - Examination of economic benefits of rehabilitation of the levees along various rivers and lakes, taking into account uncertainties of storms, river or lake stages and levee performances.
    - Comparison of alternative rehabilitation plans for hydropower generators/turbines, making use of probabilities of failure of generators and turbines.
    - Examination and improvement in navigation system of water, such as the Gulf Intracoastal Waterway, which it has minimized traffic and uncertainty in tow trips and travel time.
    - Flood Damage Assessments by using a software system.

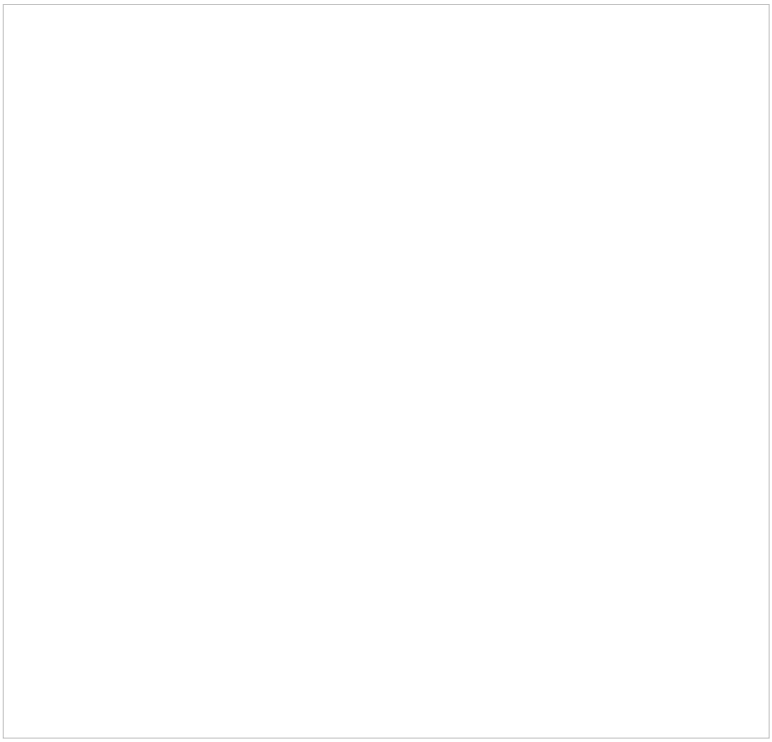
- Techniques such as ‘Scenario analysis’ to test uncertainty, ‘Backcasting’ for the exploration of alternative futures, ‘Institutional decision-making’, ‘Behavioural decision making’ includes multi-actors of the state such as the government, private sector and civil society organization.
- Ecosystems approach, it is used to create ecosystem resilience, reduce pressure on ecosystem, manage risk, increased benefits from water security and water quality enhancement, recreation, wildlife and flood control management.

New paradigms for water management

Unvalued water leads to an uncertain future

Why investment in water is necessary?

- Water infrastructure acts as a catalyst for **economic growth,** it promotes the growth of national income example construction of large dams.
- Security **against fluctuations in the availability of water** (mitigating both floods and droughts) and promotion of long-term climate resilience.
- It will open up new economic activity and benefit **economically productive sectors** such as agriculture, industry, hydropower, navigation, recreation and tourism, and households.
- Water also constitutes a vital input to **ecosystems** and all aquatic habitats, which in turn provide essential life support in addition to services with an economic value.
- It acts as a buffer against **climatic fluctuations** and is a key to climate resilience.
- The benefits of water-cycle:



Valuing water

- Benefits of water is essential for improving the decisions of governments, international organizations, the donor community, civil society and other stakeholders.
- If water is not valued properly it leads to insufficient appreciation of the importance of water, poor investment in water infrastructure and the low priority to water policy in development programmes.
- Valuation of water is a diverse process with different techniques and policy.
- However, different groups of people value water in different ways.
- These can lead to polarization that blocks dialogue and prevents reasonable governance solutions.
- **Example:**
    - Irrigation water use can be valued as farm output or surplus.
    - Whereas, industrial water valuation poses a greater problem, as water constitutes a small part of their total costs.
    - The value of water for navigation is quantified through cheapness of transportation. Water ways are cheaper than railways.
    - Household values are relatively high, as household waters are used for truly essential needs such as drinking.
- Failure to account for these benefits in water valuation can result in inefficient water allocation decisions.
- Benefits of valuation of water are, to allow for and regulate water trading and It will add an economic dimension to the social, ethical, public health and equity dimensions of allocating water.
- There are four main aspects of a water allocation system: **Water entitlements, Water allocation, Water service delivery and Water use**.

Transforming water management institutions to deal with change

- In order to meet the goals, set by decision-makers, water management must deal with the uncertainty.
- Adaptive management is a process that promotes flexible decision-making in the face of uncertainties.
- Adaptive strategies such as, use computer-aided processes, better information etc are used in water management.
- Assessment of vulnerability is essential in order to estimate, Reliability for successful outcomes, Robustness of performance of a system and to create Resilience strategy.
- Adaptive management approaches are, strengthened emergency management and preparedness plans, risk-based planning, increased inspections, oversighting and regulation of infrastructure.

Why Improving institutions is needed?

- Without institutions capable of accommodating uncertainty, climate and other external changes will impose significant costs on water users and water dependent communities.
- Improving institutions entails strengthening institutional capacity, creating learning-oriented institutional processes, tackling institutional deficits, and incorporating informal institutions into water management.
- **Conventional water planning** tends to be rigid and water institutions are typically poorly linked to other institutions.
- Corruption is a symptom of a governance crisis that increases transaction costs hence there is need for, water integrity and accountability.
- Many water institutions in developing countries are plagued by **under-financing** and capacity deficits.
- A **responsible institutional** setup in areas for water quality and groundwater management is often very limited.
- **Communicating risk** and uncertainty in order to make appropriate decisions and have to be clearly understood by the people.

Improving institutions includes

- The alignment and integration of policies within the formal and informal institutions.
- For example, the European Union (EU) Common Agricultural Policy (CAP) plays a beneficial role in achieving the goals of the EU Water Framework Directive (WFD).
- Adequate financing and appropriate staffing are required for effective and efficient delivery of water services.
- Developments in technology and infrastructure, as well as the availability of financial resources.
- Through free-riding process, where Water Resource Institutions determine who can use what water, how, at what time and for how much; they also set management responsibilities, tariffs and collect fees.
- A collaborative governance where a joint effort of government, society and technical institutions are present.

- Targeted communication, for more easy understandings the audience can be separated into target groups and tailoring the communication to each.
- Also, through Institutional reform, fostering dialogue and consensus at the national level, addressing institutional deficits.

Investment and financing in water for a more sustainable future

Why Investment and Financing in water is important?

- All countries, at every level of development, face heavy cost in creating a water infrastructure that is 'fit for purpose' which can address the water challenges.
- According to a recent World Bank Study, the global financial crisis has negatively impacted progress towards fulfilling the MDGs.
- A rethinking in financing strategies is therefore required to ensure that improvement in public expenditure efficiency results in additional resources.

How Financing can be improved in water management areas?

- The first step should be to minimise the financial requirements through, better collection of water dues, adjustments, technological infusion etc.
- The second step is to improve the rate of sustainable cost recovery by raising tariff revenues, budgetary allocations etc.
- The third step is to use these revenues to attract repayable sources of funds such as, loans, bonds and equity in water investments.
- Another potential source of finance would be improving the rate of collection of water bills, it will increase water revenues without raising tariffs.
- To generate more internal revenues from tariffs, and to rely as much as possible on local financial and capital markets.

How the management of risks and uncertainties outside of the 'water box' can also have benefits for water management.

- By reducing poverty and greening economies, responding to climate change, through better integrated urban planning and better decisions in business and private which are related to water.
- Managing sectoral risks to generate benefits to water such as the transport sector, health risks, the energy sector etc. Once these sectors are made sustainable it indirectly benefits water management.
- Mitigating risks and uncertainties through, insurance, treaties and agreements and through multi-sectoral cooperation at national and global level.