

WATER SUSTAINABILITY FRAMEWORKS FOR SOCIO-ECONOMIC AND ENVIRONMENTAL RESILIENCE

ANUJ KUMAR SINGH¹

Department of Botany, K.P.M Govt. Girls Degree College, Aurai, Bhadohi, U.P., India

ABSTRACT

Water is fundamental to ecological stability, economic productivity, and human well being. Water has proved role in our future perspective. It is most important source of life on Earth because we need water to fulfill all the activities of life like drinking, eating, bathing, making clothes and producing crops. For a better and sustainable future we people should apply several strategies to save and recycle the wastage of water, a precious natural resources and also gift of our nature. Sustainable water governance therefore demands integrated frameworks capable of balancing environmental protection with socio-economic development. Water conservation includes all the several policies, strategies and activities to sustainably manage the natural resources of fresh water, to protect the hydrosphere, and to meet the current and future human demand. Reducing water use through waterless toilets, water efficient appliances, and water quantity monitoring, is an important part of sustainability for domestic water supply. Sustainable water management means using water in a way that meets current, ecological, social and economic needs without compromising the ability to meet those needs in the future. It also concludes that adaptive, inclusive, and ecosystem- centred water management systems are essentials to achieving long-term environmental sustainability and socio-economic stability. This paper concludes that effective water conservation requires multi-level governance, stakeholder participation, and the integration of environmental protection with economic development

KEYWORDS: Water Sustainability, Water-Recycle, Integrated Water Resource Management (IWSM), Natural Resource, Socio-eco Monitoring

Water is definitely the most important natural resources. Nature has gifted us some precious and valuable resources. It is earth's most plentiful natural resource. Our planet, Earth, has three-fourths of its surface area covered with water and only one-fourth has land masses. Despite its critical importance, global water resources are increasingly threatened by over exploitation, pollution, climate change, and uneven distribution. In our country, nearly 70% part of the available water is polluted. According to the quality of water, we are at the place of 120th in total of 122 country. In their report of "NITI Aayog" they warns that the demand of water would double than availability of it, till 2020. Water is transparent, tasteless, odourless and colourless chemical liquid. The main constituent of earth streams, lakes, oceans and the fluids of most living organism. It is vital for all known form of life, even though it provides no calories or organic nutrients. Amongst most of the water, 97% is found in oceans and seas. The remaining, about 3% is found in rivers, lakes, ponds, streams, etc. Water has properties of fluidity and solubility. These properties make it useful in the process of digestion, blood circulation and excretion. Water also helps in regulation of our body temperature by the process of sweating. Water is basic necessity of life not only for people but for all living things need water for their survival. Water is used for variety of purposes, including drinking, food preparation, Irrigation and manufacturing.

Water security has emerged as a major burning issue towards fulfillment of sustainable

development goals (SDG's) our country. In a recent study (Varies *et al.*, 2017), water security is defined in four dimensions, each consisting of two complementary aspects: direct-indirect, macro-micro, technical-political, and peace conflict. It's essential for basic health and hygiene, and it drives society's most essential industries: agriculture, energy and transportation. Without water security there can be no national security. Infact, water is essential to the stability of every country on the planet.

SOURCES OF WATER

Amongst most of the water, 97% found in the Oceans and Seas. The remaining about 3% is found in river, lake, pond etc. Some sources of water are obvious, like lakes and rivers, while others like glaciers are a bit more removed from everyday experiences. With so many people living near water, it sometimes seems unlikely that water shortages could be a serious problem. Understanding the sources of water available for human use reveals how limited fresh water actually is despite the overwhelming amount of water on earth. Very little of it is suitable for consumption.

Water resources are natural resources of water that are potentially useful. Freshwater is a renewable resource, yet the world's supply of ground water is steadily decreasing, with depletion occurring most prominently in Asia, South America and North America, although it is still unclear how much natural renewal balances this usage, and whether Ecosystems are threatened. The framework for allocating water resources

¹Corresponding author

to water users (where such a framework exists) is known as Water rights.

Water Sustainability and Socio-Economic Resilience

Socio-economic resilience refers to the ability of societies and economies to withstand and adapt to environmental and resource-related disruptions. Water plays a central role in building such resilience because it directly affects food production, public health, energy systems, and economic stability.

Water and Economic Stability

Agriculture is the largest consumer of freshwater globally. Reliable water supplies support crop productivity, livestock farming, and rural livelihoods. Water shortages or poor water management can therefore threaten food security and economic development. Water also supports industrial processes, energy generation, and urban infrastructure. Sustainable water governance helps maintain economic productivity while preventing resource depletion.

Water and Social Well-being

Access to safe drinking water is a fundamental human need. Adequate water supply improves sanitation, reduces disease transmission, and enhances public health. Water scarcity often disproportionately affects vulnerable populations, highlighting the importance of equitable water governance.

Climate Adaptation and Resilience

Climate change is intensifying hydrological variability, causing more frequent droughts, floods, and extreme weather events. Adaptive water management strategies—such as improved storage systems, efficient irrigation technologies, and watershed protection—can reduce vulnerability to climate impacts.

TYPES OF WATER SOURCES

There are different types of Water sources-

Ground Water Sources

Ground water refers to any source of water that lies beneath the soil layer. Ground water can exist in the soil itself or between rocks and other materials. Most communities obtain their water from underground aquifers, or rock formations capable of holding large amounts of fresh water. Only 3% of the water on earth is considered fresh water, with a mere 30% of that small amount being found as ground water. Pollution, sea water contamination and over use threaten this valuable resource.

Surface Water Sources

Surface of surface water can include any above-ground collection of water such as rivers, lakes, ponds and oceans. Some surface of surface water are also fed by under ground aquifers. Surface water accounts for 80% of the water humans use.

Although the only natural input to any surface water system precipitation within its water shed. The total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial reservoirs the permeability of the soil beneath these storage bodies. Human activities can have a large and sometimes devastating impact on these factors. Human often increase storage capacity by constructing reservoirs and decrease it by draining wetlands.

Ocean Water

Although ocean water makes up nearly 97% of all water on earth. It is not a viable source of potable water unless salt & other impurities are removed. Desalination, the process by which salt is removed from water is a rapidly growing practice, While salt and other microscopic entities can be removed from water in a variety of ways. The most promising method is through reverse osmosis. This process forces salt water through filters with microscopic pores that removed salt and other microbes. Reverse osmosis requires large amounts of energy, making it a very expensive process.

Ice Caps and Glacial Melting

Of the 3% earth's water considered fresh water, 70% of that small amount is currently locked in glaciers and ice caps. In theory, frozen glacial and ice cap water could be melted and used but the amount of energy needed to melt and transport vast quantities of ice caps also play vitally important roles in the regulation of Earth's climates and global temperatures.

Water, Sustainable development, the MDGs and the SDGs

The Millennium Development Goals (MDGs)

The Millennium Development Goals (MDGs), agreed in 2000, aim to halve the proportion of people without sustainable access to safe and drinking water and basic sanitation between 1990 and 2015.

A total of 748 million people still do not have access to an improved drinking water source and existing indicators do not address the safety and reliability of water supplies. To reach the requirements of the right to access to safe drinking water requires real improvements for several billions of people. The MDG target for

sanitation is an even more pressing challenge, with 2.5 billion people currently lacking access to improved sanitation and over one billion still practicing open defecation. At current rates of progress, the sanitation target will be missed by over half a billion people. These global aggregates also mask disparities between nations and regions, rich and poor, between rural and urban populations, as well as between disadvantaged groups and the general population.

There is currently no global target to improve hygiene, despite this being one of the single most cost-effective public health intervention.

Frameworks for Water Sustainability

Integrated Water Resources Management (IWRM)

Integrated water resources management is one of the most widely adopted frameworks for sustainable water governance. It emphasizes the coordinated development and management of water, land, and related resources to maximize social and economic welfare while protecting ecosystems.

UNEP - UN Environment Programme

Key principles include

- Cross- sectoral coordination
- Stakeholder participation
- Basin-level planning
- Equitable water allocation
- Adaptive management

By integrating social, environmental, and economic considerations, this framework helps reduce conflicts among water users and promotes sustainable resource use.

Water-Sensitive Urban Planning

Rapid urbanization has increased pressure on urban water systems. Sustainable urban water frameworks integrate stormwater management, wastewater reuse, and groundwater protection into city planning.

Approaches such as Water-Sensitive Urban Design promote the collection, reuse, and treatment of urban water to minimize environmental impacts and improve water efficiency.

These strategies help cities manage flooding, reduce water demand, and enhance urban ecosystem health.

Ecosystem-Based Water Management (EBWM)

Ecosystem-based management focuses on protecting natural hydrological processes. This approach includes:

- Watershed conservation
- Wetland restoration
- Sustainable groundwater management
- Pollution reduction strategies

Natural ecosystems can regulate water flows, filter pollutants, and mitigate climate impacts, making them essential components of sustainable water systems.

Technological and Digital Innovations

Technological advancements are increasingly transforming water management practices. Examples include:

- Smart water monitoring systems
- Remote sensing and hydrological modelling
- Wastewater recycling technologies
- Efficient irrigation systems

Modern water infrastructure also incorporates real-time data analysis and automated control systems to improve efficiency and reduce water losses. These innovations support adaptive water governance and enhance system resilience.

Conservation of Water

Conservation of water means a careful and economical use of water. Water conservation includes all the policies, strategies, planning movement and activities to sustainably manage the natural resources of fresh water, to protect the hydrosphere which are going to be limited in coming days, to meet the current and future human demand. For sustainable development this has to be managed in coming future perspective. We should conserve water as it is a precious natural resource. It can happen in the following ways-

- (a) Afforestation can help water to penetrate in to the soil and replenish the water table.
- (b) Use of efficient watering systems such as drip irrigation and sprinklers to reduce water consumption by plants and helps in conservation of water.
- (c) Building dams and hydropower projects which help in checking flood and regulating the supply of water to agriculture.
- (d) Irrigation hours and frequency can be reduced.
- (e) Treatment of industrial and domestic wastewater in sewage plants before its disposal in water bodies help in conservation of water. It reduces the water pollution.

Goals of water conservation efforts include

- (1) To ensure availability of water for future generations.
- (2) Energy conservation as water pumping, waste water treatment facilities etc.

- (3) Habitat conservation especially for local wildlife and migrating waterfowl etc.

Strategies

- (a) Activities regarding reduction in Run-off water losses- By using terrace farming, water spreading system, contour cultivation methods, use of some chemical like Gypsum & HPAN (Hydrolyzed Polyacrylonitrile) and improved water storage system.
- (b) Avoiding any damage to water quality by using different techniques.
- (c) Improving water management practices like Rain water harvesting system, Afforestation ,Agroforestry and water shed management system

Importance of Water conservation and Sustainability

Fresh, clean water is a limited resources. While most of the planet is covered in water, it is salt water that can only be consumed by and other species after undergoing desalination .Which is an expensive process. Occurences such as droughts further limits access to clean and fresh water. In some areas of the world, access to water is limited due to contamination. People who have access to fresh water can take effective steps to limit their use of water to avoid wastage.

Water is at core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself. Water conservation ultimately reduces much of the energy use and can even save households many things.

Challenges in Achieving Water Sustainability

Despite progress in water governance, several challenges remain:

1-Population growth and urbanization increasing water demand.

2-Climate change altering precipitation patterns and hydrological cycles.

3-Pollution from agricultural, industrial, and domestic sources.

4-Institutional fragmentation and weak governance structures.

5-Technological and financial constraints in developing regions.

Addressing these challenges requires integrated strategies that combine policy reform, technological innovation, and community engagement.

CONCLUSION

Earth has a finite amount of fresh usable water. Fortunately, water is naturally recycled, humans have developed various technologies to speed the process. Conservation of water can ensure that supplies of fresh water will be available for everyone, today and tomorrow's daily life. Water conservation involves changing habits. People able to take some more advanced steps to reduce water consumption and move one step forward towards sustainable life. An individual may simply use less water. People can shorten their shower time or reduce the amount of water they use when bathing. Other conservation methods initially require more effort and funds.

The increasing decline in the level of ground water, in many parts of the country, is leading to a lot of insustainability. Lack of proper waste water treatment from industrial, mining and domestic sources leading to potential threats to humans as well as the ecosystem.

Water is crucial resources for the country today. Due to the growing population, increasing industrialisation and escalating agricultural scenario, the demand for water has clearly increased over the years. Thus water conservation is essentially and evidently the need of the hour is that every individual uses water economically and judiciously for sustainable future. Although still several efforts are being made at Governmental & Inter governmental level by building dams, wells and reservoirs, there is still a long way to go. We have to motivate our living communities to adopt different water conservation practices, such as Rain water harvesting system, Water shed management practices and many more other conventional practices to save more water in our daily routine life and also make a remarkable step or we can say that certainly it can proved to be a milestone towards a Sustainable future.

REFERENCES

- Biswas Aset K., 1998. Water Resources, Tata McGraw-Hill Publishing Company, New Delhi.
- Geerts S. and Raes D., 2009. Deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas. *Agric. Water Manage.*, **96(9)**:1275-1284.
- Kurunthachalam S.K., 2014. Water conservation and sustainability: An Utmost Importance. *Hydrol Current Res.*, **5(2)**: 1000e117.
- UNEP, 2011. Towards a green Economy: Pathways to sustainable development and poverty eradication, www.unep.org/greeneconomy

SINGH: WATER SUSTAINABILITY FRAMEWORKS FOR SOCIO-ECONOMIC AND ENVIRONMENTAL RESILIENCE

- Vickers and Amy, 2002. Water use and conservation. amherst, MA: water plow Press.p.434 ISBN 978-1-9315-79-07-0
- Water conservation. *defra.gov.uk*, 2013. Retrieved january 24, 2013
- Water waste. *Lvvwd.com*. Retrieved 2017-07-11
- Water-Use It wisely. U.S. multi-city public outreach program. Park & Co., Phoenix, AZ. Accessed 2010-02-02
- United Nations, 1987. Our Common Future, Report of the World Commission on Environment and Development.
- UNDESA, 2012. Sustainable Development for the 21st Century Back to our Common Future (2012) UNDESA.