



THE ROLE OF WETLAND ECOSYSTEMS IN ADDRESSING WATER SCARCITY IN INDIA

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Abstract: Access to adequate and clean water is one of the most crucial prerequisites for human survival. Water scarcity is one of the critical challenges facing the world today. With 2.4 percent of the world's land area, India is home to more than 16 percent of the human population. The quantity of freshwater available for such a large population is limited, resulting in a per capita availability of water far below the world average. Water is a key resource necessary for national agricultural production. Growing industries, infrastructure, and urbanization require a tremendous amount of water. However, increasing population and fast-growing urban development are putting immense pressure on water resources, resulting in high levels of water stress for many coastal and river basin states in India. The role of wetlands in addressing the water scarcity issue is critical and of great significance because they can store surface and groundwater, reduce runoff, purify water, and improve groundwater recharge. However, the nation's wetlands have been reduced to one-third. The wetlands have seen a decline of 70%, whereas urban wetlands have been reduced due to encroachment and improper utilization. This Research Paper is a humble attempt to analyze the role of wetlands in addressing water scarcity and suggest certain solutions to conserve these wetlands.

Index Terms: Water Scarcity, Wetlands, Role of Wetlands, Water Management, Challenges

I. INTRODUCTION

Water accessibility, alongside water purity, forms the basic requirement needed for human survival. The world faces a serious water scarcity problem in modern times. A landmass representing 2.4 percent of the Earth's surface contains more than 16 percent of the world's population. The scarce fresh water resources available to serve India's population base result in individual water availability that falls substantially below global norms. National agricultural output depends heavily on water as an essential resource. Water requirements for expanding industrial activities, infrastructure development, and urban expansion reach extreme levels. Water resources in India face tremendous pressure due to a growing population and rapid urban growth, resulting in excessive water stress levels in river basins and coastal states.¹

Droughts emerge from both abnormal rainfall patterns and the inability to produce rainfall within India. Floods are caused by excess rain. Heavy rains can create floods, while siltation, sedimentation, and pollution can cause the accelerated depletion of water bodies. The complex combination of climatic conditions and human-induced land use changes, including urban growth and human activities, is harming natural drainage functions, thereby deforming stormwater flows during flooding events. Wetland ecosystems function as important components because they absorb excessive floodwater and replenish aquifers, while sustaining water quality and supporting nutrient cycles and biodiversity.² Indian water management systems suffer from inadequate policies that overlook the crucial role of wetlands in these water management operations. A national-scale assessment must define policy frameworks that optimize water resource management and wetland ecosystem operations.³

II. UNDERSTANDING WATER SCARCITY IN INDIA

The problem of insufficient water resources is increasingly understood to be a water-quality crisis. Water scarcity represents the minimum level of available water needed to fulfill diverse regional water requirements, including drinking water supply, sanitation and hygiene, agriculture, industry, hydropower generation, and transportation, alongside socio-ecological necessities. The quantity of water scarcity represents how much internal water reservoirs at infrastructure supply levels fall below the domestic, agricultural, industrial, and socio-ecological water requirements across cities and river basins, up to national and continental levels, to preserve minimum acceptable living conditions supported by hydrological systems. Public water supplies are likely to fail to meet current living standards and growth goals due to future river basin resource availability.⁴

¹ Rakesh Kumar Mishra, 'Fresh Water Availability and its Global Challenge' (2023) 4(3) British Journal of Multidisciplinary and Advanced Studies 1.

² Arunima Nayak and Brij Bhushan, 'Wetland Ecosystems and Their Relevance to the Environment,' *Practice, Progress, and Proficiency in Sustainability* (IGI Global 2022) <http://dx.doi.org/10.4018/978-1-7998-9498-8.ch001> accessed 9 September 2025.

³ Alan Dixon, Adrian Wood and Afework Hailu, 'Wetlands in Ethiopia: Lessons from 20 Years of Research, Policy and Practice' (2021) 41(2) Wetlands <http://dx.doi.org/10.1007/s13157-021-01420-x> accessed 9 September 2025.

⁴ Walter Leal Filho and others, 'Understanding Responses to Climate-Related Water Scarcity in Africa' (2022) 806 Science of the Total Environment 150420 <http://dx.doi.org/10.1016/j.scitotenv.2021.150420> accessed 9 September 2025.

A water scarcity condition exists in a basin when its actual internal water usage falls below the basin's necessary level. A basin's water scarcity comparison reveals which provinces have extra water reserves. Other regions that confront water scarcity often have abundant water for those regions located 'downstream.' A water scarcity region shows that an outside water supply is essential both within and across river basin boundaries. A water-surplus base or region must transfer its surplus water to water-scarce domains or maintain collaboration with additional parties for transboundary water basin co-management practices.⁵

The identification and understanding of water scarcity occurs through both technical water science approaches and non-water-focused institutions that operate across multiple socio-economic scales. The insufficiency of water resources to meet human needs for water accessibility defines water scarcity. External supply-side state-territorial discussions about human water-environment resource scarcity persist while new geographical disputes emerge from extreme climate change effects and intensified dams combined with agricultural expansion and modernization, and urbanization processes, which cause severe environmental consequences, leading to deaths and forced displacement and poverty, and social unrest.⁶

1. Definition and Types of Water Scarcity

A multi-dimensional water scarcity situation spreads across the entire globe. The term water scarcity represents any situation in which water use surpasses accessible freshwater supplies. The defined nature resource allocation problem fails to cover the diverse aspects of such issues. The lack of consensus regarding water scarcity exists across different areas of study. Economic and sustainability metrics reveal a water-scarce region as one where freshwater management exceeds availability or where pollution has reduced water quality to affect uses in the area.⁷

However, physically quantified definitions are more intuitive in that they centre around the raw ability of the natural water resources. After this, the terms "water stressed" and "water scarcity" are defined as the aggregate annual availability per capita of renewable water resources in a given area being less than 1700 m³/year and 1000 m³/year, respectively. In a purely hydrological sense, 62 countries are considered water-scarce. Yet, this raw physical definition is rather incoherent with what has been, is, and what will be. For instance, rejecting the consequence, Australia has plunged itself into the world of water scarcity in the modern world. Water-rich countries like Canada and Brazil also shudder at the threats to water security due to adverse climatic conditions. Therefore, the real manifestations of scarcity and the specific variables, indications, and mitigation means are dynamic and time-specific,

⁵ Liang Yuan and others, 'A System Dynamics Simulation Model for Water Conflicts in the Zhanghe River Basin, China' (2021) 39(6) *International Journal of Water Resources Development* 1039.

⁶ Hilla Shemer, Shlomo Wald and Raphael Semiat, 'Challenges and Solutions for Global Water Scarcity' (2023) 13(6) *Membranes* 612 <http://dx.doi.org/10.3390/membranes13060612> accessed 9 September 2025.

⁷ Qiujin Xu, 'Quality-Induced Water Scarcity and Countermeasures', *Water-Soil-Vegetation Nexus and Climate Change* (Elsevier 2024) <http://dx.doi.org/10.1016/b978-0-12-820106-0.00007-5> accessed 9 September 2025.

which should be evaluated precisely regarding particular characteristics and histories that prevail at different spatial, political, economic, institutional, and cultural scales.⁸

In the wake of the disastrous consequences of water sourcing strategies that were developed by developmental states in the past, there is an urgent need for a radical paradigm shift concerning the abatement of water scarcity. Such a shift in guiding principles is the catchment-based integrated conservation of existing freshwater ecosystems, including wetlands and watersheds, as well as the development of soil moisture conservation structures and the upgradation of conventional methods, such as rainwater harvesting and in situ soil moisture conservation. The renewable water resources available within the catchment should be utilized to meet the established demand through conjunctive use, rather than overexploiting watersheds outside the catchment and causing significant harm to nature. The deliverables of the wetlands-based policy framework in terms of the ecosystem services would here be outlined explicitly for the important inputs in developing such a policy framework.⁹

2. Current Statistics and Trends

The Natural Water Resources in India

Covering 328 million hectares, India is blessed with a massive natural water endowment. A total length of 2,400 km and 5,453 km of coastline, it has 11 major river basins, and 375 major and 14,000 minor tributaries. The basic inland freshwater resources amount to 1869 billion cubic meters/year. Water distribution is not uniform in either space or time. Water is a state matter, but the Central State deals with interstate water disputes. Water Management is the need of the hour.¹⁰

Coastal ecosystem, estuaries, deltaic ecosystem, lagoons, wetlands, coral reef, mangroves, shallow bathymetric zone, and pelagic zone are critical components of Indian marine water bodies. There are about 4,205 sq km (8 percent of the area of wetlands, which are very productive regions, have been declared as economic exclusion zones for exploitation other than fishing) of points of interest. Many of the marine islands are found on the eastern and western coasts. The Andaman and Nicobar Islands lie within the Indian geographic region, and the Lohachara island is in the Sundarbans.¹¹

The freshwater wetlands are the lakes, swamps, and marshes that rivers irrigate. Apart from these in-stream wetlands having a direct hydrological channel to a river, there are normally several off-stream wetlands, with no hydrological connection to the river. The off-stream wetlands include the large lakes and swamps of Wurli, Fatehsagar, Keola, Ballwala, and others.¹²

⁸ Ganesh Datt Bhatt and Deepali Rana, 'Water Security in North America and Europe' [2025] Water Scarcity Management 99.

⁹ Laurence B Couldrick, 'A Case Study of Payments for Ecosystem Services and the Need for Integrated Catchment Management: Experiences from the Westcountry Rivers Trust' (2024) 2 Cambridge Prisms: Water <https://doi.org/10.1017/wat.2024.10> accessed 9 September 2025.

¹⁰ Shahenaz Mulla and others, 'Climate Change Effect on Climate Parameters Like Temperature, Rainfall and Water Resources Sectors in India', *Earth and Environmental Sciences Library* (Springer International Publishing 2023) http://dx.doi.org/10.1007/978-3-031-42056-6_2 accessed 9 September 2025.

¹¹ Vandana Shan, SK Singh and AK Haritash, 'Present Status, Conservation, and Management of Wetlands in India', *Lecture Notes in Civil Engineering* (Springer Singapore 2021) http://dx.doi.org/10.1007/978-981-33-6695-4_22 accessed 9 September 2025.

¹² Arunima Nayak and Brij Bhushan, 'Wetland Ecosystems and Their Relevance to the Environment,' *Practice, Progress, and Proficiency in Sustainability* (IGI Global 2022) <http://dx.doi.org/10.4018/978-1-7998-9498-8.ch001> accessed 9 September 2025.

3. Factors contributing to Water Scarcity

Water is a renewable but finite resource that depends on the precise geo-climatic conditions. Water will still be moving back and forth between the atmosphere, land, and oceans for ages, but the amount and quality of that water are crucial to the success of human civilization. Due to its scarcity, water is considered a constraint for rural development in many countries, including India. The increased populations will likely mean increased economies, so that competition for scarce resources is bound to increase, leading to conflicts between the water users. Water as a resource is wasted or abused in many developing nation-states. Based on forecasts, the number of people inhabiting countries with absolute water scarcity, if existing trends in management and water use continue to prevail, will rise from 1.4 billion in 1995 to well over 3 billion by 2025.¹³

Water misuse is prevalent in many sectors and areas with water shortages. There is immense irrational overvaluation of groundwater, where, in some cases, more water is drawn than flows in. It is true at the same time that other parts are suffering from a water famine. In closed regional systems, hydraulic connections are forgotten. In many regions where the rate of drawdown of groundwater aquifers is alarming, the water levels continue to drop, and water outputs from wells are diminishing, while the quality of water is deteriorating, and the irrigation lands are being contaminated with salinity. Urbanization increases the demand for urban water supply and salination very quickly. Overexploitation of surface water quantity has led to dead lakes and other water bodies. Interactions with climatic forces are causing, thus the drying of many lakes and wetlands. Supply of adequate sanitation and waste management is poor, and urban wastewater is polluting surface water, as is groundwater. The rapid urbanization, planning, and strengthening of local water governance is seriously lagging urban supply system. Surface water quality in much of India has been reduced because of the presence of untreated urban and industrial wastes. Saltwater intrusion at the coast contaminates and irreversibly pollutes groundwater.¹⁴

III. WETLANDS: AN OVERVIEW

Wetlands are defined as areas that consist of marsh, fen, peatland, or natural or man-made, with static or flowing fresh, brackish, or marine water that does not exceed 6m depth at low tide. Wetlands occupy an intermediate niche between aquatic and terrestrial ecosystems, with the water level either equal to or slightly above the surface. Different wetland types are grouped based on attributes such as the type of climate they experience, size, vegetation, presence of wetlands, depth, and the method by which they developed.¹⁵

¹³ Pradeep Kumar and others, 'Prevalence and Predictors of Water-Borne Diseases Among Elderly People in India: Evidence From Longitudinal Ageing Study in India, 2017-18' (2022) 22(1) BMC Public Health <http://dx.doi.org/10.1186/s12889-022-13376-6> accessed 9 September 2025.

¹⁴ Khadeeja Priyan, 'Issues and Challenges of Groundwater and Surface Water Management in Semi-Arid Regions', *Groundwater Resources Development and Planning in the Semi-Arid Region* (Springer International Publishing 2021) http://dx.doi.org/10.1007/978-3-030-68124-1_1 accessed 9 September 2025.

¹⁵ Wahied Khawar Balwan and Sachdeep Kour, 'Wetland- An Ecological Boon for the Environment' (2021) 4(3) East African Scholars Journal of Agriculture and Life Sciences 38 <http://dx.doi.org/10.36349/easjals.2021.v04i03.001> accessed 9 September 2025.

Over the last century, approximately 30% of the world's wetlands have been lost. Asia leads the list in terms of wetland degradation, having lost around 80% of its wetlands. In some Indian states, the rate of wetland loss exceeds 80%, resulting in a dramatic and irreparable decrease in both the quantity and size of these ecosystems. Disruptions arising from artificial practices are the leading cause of water scarcity.¹⁶

1. Definition and Types of Wetlands

Wetlands are defined as lands that are transitional between terrestrial and aquatic systems, where the water level is usually at or near the land surface for a long enough period to develop wetlands and hydric soils.¹⁷

The Ramsar Convention has designated six main categories of wetlands-

1. Marshes (including wet grasslands)- Lands that are covered by water and have shallow bodies of water that go to a maximum depth of 2 metres and either are largely colonized by soft-stem plants or devoid of plants. This category encompasses reedlands, wet grasslands, and sedge bunds.
2. Swamps- Wetlands that are predominantly trees and/or shrubs with a supply of basic to moderately acidic surface and subsurface waters. Examples also include seasonally flooded forests, mangroves, and brackish-water swamps.
3. Bogs- Freshwater wetlands occur when peat is buried as a result of the accumulation of Sphagnum moss, acidic wood, shrub, and Sphagnum moss leaf litter; the continuous lack of oxygen within waterlogged situations and a reduced intake of nutrients from groundwater and surface water are responsible for the process.
4. Fens- Marshes receiving a good supply of basic to moderately medicated waters.
5. Shallow water bodies- Lakes and ponds that have still or slow-moving fresh or saline brackish water, whether temporary or permanent, with the deepest point not exceeding 6 meters.
6. Coastal and inland deltaic systems- Plants common to flooded flats, low-lying grounds of fields, and river banks.¹⁸

2. Wetlands in India- Distribution and Types

India became part of the Ramsar Convention, a global convention that seeks to protect wetlands and their resources, in 1991. Currently, India has 91 wetland sites and 1,359,434 hectares that have been identified as Ramsar sites of international significance, and it is an active party to the global Network of Wetlands. Wetlands are experiencing major transformation, driven by intensive agriculture, industrialization, and urban sprawl, without adequate or effective mechanisms to conserve them.

¹⁶ Susanta Kumar Chakraborty, Poulomi Sanyal and Ratnadeep Ray, 'Diversity and Classification of Wetlands in International and National Perspectives', *Wetlands Ecology* (Springer International Publishing 2023) http://dx.doi.org/10.1007/978-3-031-09253-4_3 accessed 9 September 2025.

¹⁷ Maryam Akram Butt and others, 'Wetland and Wetland Plants', *Wetland Plants* (Springer International Publishing 2021) http://dx.doi.org/10.1007/978-3-030-69258-2_1 accessed 9 September 2025.

¹⁸ Peter A Gell, C Max Finlayson and Nick C Davidson, 'An Introduction to the Ramsar Convention on Wetlands', *Ramsar Wetlands* (Elsevier 2023) <http://dx.doi.org/10.1016/b978-0-12-817803-4.00018-8> accessed 9 September 2025.

Determining where wetlands are located is central to devising long-term, effective wetland conservation strategies.

A wetland inventory was carried out and an assessment was done in southern Indian states such as Andhra Pradesh, Goa, Karnataka, Kerala, and Tamil Nadu, and northeastern regions (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura). This work constitutes the first effort to map and evaluate India's wetlands nationally to analyze their vulnerability and establish a baseline for monitoring wetland fill, loss, and degradation.¹⁹

IV. WETLANDS AND WATER MANAGEMENT

Due to the rapid spread of urbanization and overexploitation of water resources, the need for water, an important natural resource, is reduced. There are plans to implement international projects to solve and eliminate the socio-economic and environmental impact of this problem. It is well understood that natural resources must be exploited extensively to sustain high levels of water quality and availability. Approximately 1/5 of the world's surface area is made up of wetlands. Wetlands are defined as areas whose environment and life are in many ways dependent on water. These habitats are the most productive ecosystems in the entire world. They store water supplies, promote aquifer recharging, and contribute to cleaner water. Wetland habitats are home to a thriving flora and fauna, but they are also an important source of fodder and fuelwood to the people living in the rural regions. With their great ecological and economic value, wetlands are being lost more than any other ecosystem. Ecologically, India has approximately 4.5 million square km of wetland space, amounting to about 14% of its land area. Still, the Indian wetlands are under a burgeoning human pressure. The loss rate of global wetlands is at least three times higher than the loss of forests, causing massive socio-economic and environmental problems. Proper management of wetlands is crucial for conserving this important ecosystem and facilitating sustainable development in the country.²⁰

1. Role in Water Regulation

Wetlands are complex natural systems that can be incorporated into water and wastewater treatment systems. Regions popularly referred to as wetlands, which include periods where water covers the land, can function as natural filters between the land and the water and play different roles- water management, habitation of ecosystems, cleaning up water, water quality improvement, and water retention in nutrient storage. Wetlands have the potential to help mitigate global climate change by absorbing carbon, stabilizing coastlines, and fortifying shorelines from natural disasters due to rising human influences and weather patterns. They are considered Critical Ecosystem Service Areas (CESA) or important hydrology regulators. The enforcement of national and international water policies, state water policies, and international conventions is needed. Engineered wetlands can cover some or all of these issues as their capacity can rely on treatment standards, design specifics, practices

¹⁹ Shivam Singh, Manish Kumar Goyal and Erumalla Saikumar, 'Assessing Climate Vulnerability of Ramsar Wetlands Through CMIP6 Projections' [2024] Water Resources Management <http://dx.doi.org/10.1007/s11269-023-03726-3> accessed 9 September 2025.

²⁰ Vandana Shan, SK Singh and AK Haritash, 'Present Status, Conservation, and Management of Wetlands in India', *Lecture Notes in Civil Engineering* (Springer Singapore 2021) http://dx.doi.org/10.1007/978-981-33-6695-4_22 accessed 9 September 2025.

related to operation, and local conditions. In the range of the hydrological systems, wetlands include such moist zones as shallow water bodies, swamps, floodplains, reservoirs, and banks/riparian zones, where the primary productivity is usually dominated by herbaceous vegetation rather than woody vegetation. India has approximately 6.1 million hectares of wetlands, which is about 18% of the land surface. The fact that wetlands play a great role in maintaining the hydrological system is clear, and their influence extends to agricultural, national economy, ecological health, and biodiversity. Such features form a significant aspect of the landscape and provide many advantages for recreation, tourism, and aesthetic enjoyment. In the case of India, the immediacy of dealing with the pressures of swift urbanization and industrialization also makes wetlands very important. Consequently, meticulous studies of wetlands, including their location, identification, and assessment of their functions, are important.²¹

2. Groundwater Recharge Mechanisms

Wetlands promote a specific area of groundwater recharge because of their ability to trap water and control runoff through the use of vegetation. Groundwater recharge then occurs in moistened soils or sites designed to increase the groundwater table. Recharge of water in the ground has a direct effect on the filtration of both the aquifer as well as storage potential. Water from lakes, canals, and ponds reduces evaporation to keep up with rainfall, and wastage of water from these bodies also leads to aquifer leakage. Groundwater recharge rates in a basin are determined by various techniques, including both mathematical modeling and direct estimation.²²

3. Flood Mitigation and Drought Resilience

Flooding risks are one of the main ways wetlands manage flooding risks effectively from incoming water. The flood reduction benefits of wetlands have been known to people for thousands of years. Some protection of the swamps in the Nile's southern stretches benefited Ancient Egyptians, as it reduced the chances of flooding and provided better soil for their crops. This knowledge is now commonly accepted globally, and many examples show how either wetlands protect against flooding or, if destroyed, cause increased flood hazards. Wetlands are barriers to the movement of water: they retain water, some for a period, some releasing it at a slower rate. The approaches involve reducing the slope and introducing plant structures to the ecosystem. The lack of wetlands means that flooding can sluice through the landscape and towards urban areas more quickly and urgently.²³

Upland and lowland wetlands show markedly different patterns of causation and attenuation of floods. Water from off-land supplies renders upland wetlands typical contributors to flooding. The reason these zones get a considerable amount of water from rivers and estuaries renders the flooding almost unavoidable. The periodicity of flooding on upland wetlands will, throughout a landscape, be similar

²¹ Smrutisikha Mohanty and others, 'Wetlands Contribution and Linkage to Support SDGs, Its Indicators and Targets- a Critical Review' [2024] Sustainable Development <http://dx.doi.org/10.1002/sd.2948> accessed 9 September 2025.

²² Laura M Norman and others, 'Natural Infrastructure in Dryland Streams (NIDS) Can Establish Regenerative Wetland Sinks That Reverse Desertification and Strengthen Climate Resilience' [2022] Science of The Total Environment 157738 <http://dx.doi.org/10.1016/j.scitotenv.2022.157738> accessed 9 September 2025.

²³ Shivendra Srivastava, Andrea Basche, Elbert Traylor and Tirthankar Roy, 'The Efficacy of Conservation Practices in Reducing Floods and Improving Water Quality' (2023) 11 Frontiers in Environmental Science <http://dx.doi.org/10.3389/fenvs.2023.1136989> accessed 9 September 2025.

to the periodicity of flooding experienced by lowland wetlands from precipitation. Floodplain wetlands have greater flood mitigation capability when compared with upland wetlands. The highest flood control capability will typically be found in proximity to the confluences and junctions of lowland river systems, where floodplains have the tendency to generate large floods but continue to act to reduce flood potential on average. Major flood mitigation by upland wetlands takes place on lower stream systems.²⁴

V. CHALLENGES FACED BY WETLANDS

Wetlands show depletion, loss, and alteration, similar to what has been experienced within all altered landscapes by man. Anthropogenic activities have led to wetland degradation, which has had massive effects, including biodiversity loss and extinction, pollution, and problems of drought, flood, industrial and urban waste disposal, and limited financial and infrastructural resources. Climate change, in combination with these anthropogenic activities, pressures the ability of wetlands to provide ecosystem services, with urbanized wetlands being one of those that are especially affected.²⁵

1. Urbanization and Land Use Change

For cities that are rapidly urbanizing, urban expansion needs to be closely monitored, as it implies continuous development and potential challenges. Urban expansion development advances affect not only the city itself, but its natural environment and the ability to live in the city. The unending proliferation and convergence of cities across varying political jurisdictions are likely to lead to increased regional integration and urban sprawl. Various regional factors stimulate the emergence of large urban zones according to regional economic growth, ambitious government strategy for greater economic impact, strong infrastructural facilities, flawed urban planning processes, and strong socio-cultural elements. While much is changing rapidly concerning urban development, governments face tremendous challenges in ensuring the preservation of critical livability services. Urban expansions collectively cover a significant portion of city regions that are rapidly pushing into farmlands and water bodies, causing major disruptions to regional ecological, hydrological, and climatic systems.²⁶

2. Pollution and Water Quality Degradation

Over 600 million people in India face extremely high levels of water stress because of the variations in rainfall and dependence on snowmelt. The situation has further increased water insecurity fears and vulnerabilities in individuals, households, and communities, causing economic losses, health crises, harm to agriculture, and fewer environmentally beneficial outcomes. Pollution of over 600 important rivers, whose total length is about 14,500 km, adds further complexity to this water crisis. By 2030, it is estimated that 45% of the population will become water access challenged. The agricultural industry expects to take a portion of this growing demand, which is developing quickly. Assessments

²⁴ Carla S.S. Ferreira and others, 'Wetlands as Nature-Based Solutions for Water Management in Different Environments' (2023) 33 *Current Opinion in Environmental Science and Health* 100476 <http://dx.doi.org/10.1016/j.coesh.2023.100476> accessed 10 September 2025.

²⁵ Ying Xiong and others, 'Influence of Human Activities and Climate Change on Wetland Landscape Pattern- A Review' (2023) 879 *Science of The Total Environment* 163112 <http://dx.doi.org/10.1016/j.scitotenv.2023.163112> accessed 10 September 2025.

²⁶ Muhammad Rehan Anwar and Lintang Dwi Sakti, 'Integrating Artificial Intelligence and Environmental Science for Sustainable Urban Planning' (2024) 5(2) *IAIC Transactions on Sustainable Digital Innovation (ITSDI)* 179 <http://dx.doi.org/10.34306/itsdi.v5i2.666> accessed 10 September 2025.

show that 30% of all river reaches in the country are polluted, which is a critical risk to the sustainability of water management. The development of rivers and unprecedented freshwater consumption have further amplified the water resource situation, with the impending adoption of resource-intensive land and water management strategies.²⁷

The increased degradation of the quality of water, coupled with the impending loss of surface water, is an important challenge facing the 21st century. Water, singularly extraordinary, can solvate both ionic and covalent compounds. The necessity to control the shortage and contamination of fresh water, as well as degradation of surface and ground water, and loss of ecological health, must be treated with importance, in addition to the ever-increasing need for drinking water. Water quality problems are getting to a critical point with severe consequences to resource-rich highland regions.²⁸

VI. POLICY AND GOVERNANCE

India's system of water governance is deficient; consequently, a large portion of the country's population lacks access to safe drinking water. The haphazard pattern of groundwater investment results from a mismanagement of the watershed and river basin systems. In addition, the rivers have been degraded even more. There is a need to update current approaches to planning and implementing water projects. A Water Disputes Tribunal at the Centre to resolve disputes favorably and impartially is recommended. The state should also move from the "Service Provider" role to a regulator and facilitator, providing the development of institutions that manage Water resources, plants, and implement. The state should phase water-related services to communities or private interests incrementally, employing effective Public Private Partnership (PPP) structures.²⁹

With the State Water Policy already in place, it is important to develop a national water law that will act as a central framework for all State water legislation. A national legal framework on water at the level of the country is needed to help establish vital water governance legislation for each State. To achieve food security and sustainable development, such a law must treat water as a scarce good that must be managed under the principle of public trust. A law is required to permit the formation of basin authorities with the required powers for water resource management and regulation. Water must be regarded as a marketable good, but with special attention to meeting the basic needs of the economically deprived. Community participation in water management should be consolidated and formalized by law.³⁰

²⁷ Anupama Mahato, Saurabh Upadhyay and Damini Sharma, 'Global Water Scarcity Due to Climate Change and Its Conservation Strategies with Special Reference to India: A Review' [2022] Plant Archives 64 <http://dx.doi.org/10.51470/plantarchives.2022.v22.no1.009> accessed 10 September 2025.

²⁸ Anwesha Mukhopadhyay, Srimanti Duttgupta and Abhijit Mukherjee, 'Emerging Organic Contaminants in Global Community Drinking Water Sources and Supply: A Review of Occurrence, Processes and Remediation' (2022) 10(3) Journal of Environmental Chemical Engineering 107560 <http://dx.doi.org/10.1016/j.jece.2022.107560> accessed 10 September 2025.

²⁹ Xuanxuan Wang and others, 'The Growing Water Crisis in Central Asia and the Driving Forces Behind It' (2022) 378 Journal of Cleaner Production 134574 <http://dx.doi.org/10.1016/j.jclepro.2022.134574> accessed 10 September 2025.

³⁰ Sharad K. Jain and Vijay P. Singh, 'Water Resources Planning', *Water Resources Systems Planning and Management* (Elsevier 2024) 503 <http://dx.doi.org/10.1016/b978-0-12-821349-0.00005-8> accessed 10 September 2025.

1. National Wetland Conservation Programme

To safeguard and maintain wetlands across the country, the Ministry issued the Wetlands (Conservation and Management) Rules, 2017. A comprehensive national wetland inventory and assessment program, named the National Wetland Inventory and Assessment, has been initiated by the Ministry of Environment, Forests, and Climate Change. The approach incorporates satellite-based mapping of wetlands, distinction of wetland types, and in-depth field review to understand their biological and ecological features. There is a consensus to initiate wetland assessment in all States and Union Territories using the support of Regional Offices and State Wetland Cells.

In addition to inventory and assessment, supportive measures are being launched, such as training stakeholders for effective wetland management, including practical database validation out in the field. The purpose of the National Wetland Capacity Building Programme is to advance the capacities of those professionally engaged in wetland management. The programme includes a specially designed national-scale training initiative to boost the capacities of state officials, NGOs, researchers, and other stakeholders as they work to tackle wetland conservation challenges at all levels, from local to national.

2. Legal Framework and Policies

Wetland protection efforts include local communities' work in conjunction with government bodies and independent organizations. The Ramsar Convention on Wetlands exists to support the protection and wise use of these ecosystems. Taking effect in 1975, the Convention represented the beginning of international treaties directed solely toward conserving a type of ecosystem. Since 1982, India has been a party to the Ramsar Convention.

According to the Constitution of India, Article 48A promotes environmental protection, and Article 51A charges every citizen with the duty to preserve the environment. The Water (Prevention and Control of Pollution) Act, 1974, provides legislative support for the establishment of pollution control bodies throughout India. Central and State Pollution Control Boards were established through this Act to safeguard protected rivers, lakes, ponds, and water bodies throughout the country. Such laws become necessary for the conservation of both wetlands and the variety of life they support. The National Water Policy, issued in 2002, emphasizes the importance of conserving wetlands. The Wetlands (Conservation and Management) Rules, 2017, formulated by the Ministry of Environment and Forests, present a full framework for the preservation of wetlands.³¹

³¹ Shobha Poudel and others, 'The Status and Prospect on Nature-Based Solution in South Asia: A Policy-Based Analysis', (2024) 3(3) PLOS Climate <http://dx.doi.org/10.1371/journal.pclm.0000289> accessed 10 September 2025.

VII. INNOVATIVE SOLUTIONS AND BEST PRACTICES

1. Restoration and Rehabilitation of Wetlands

Wetlands help steady water movement during a storm by easing stormwater into nearby bodies of water. Water that passes through wetlands is cleansed of pollutants. The emergence of wetlands is associated with diversity in hydrological features, such as sinkholes, diversions, beaver ponds, and glacial formations. Indian wetlands are the main water source for irrigation, agriculture, and municipal use. They supply food, medicine, and provide animals with routes for travel. The process of urban growth in India results in wetlands being emptied for agricultural uses, filled for building projects, and engineered to prevent water buildup. The central issue under review concerns the protection or reclamation of wetlands. The growth of urban spaces generates non-point runoff that pollutes receiving waters and negatively impacts individuals accessing those systems. Water quality problems are seen in the form of flooding during years with excessive rainfall because the watershed cannot hold as much water, and in drought during dry periods, owing to more rapid loss due to evaporation and transpiration. Before recent times, wetlands were seen as valueless habitats overrun with mosquitoes, so they were drained. Scientific evidence now confirms that wetlands are vital to preserving biodiversity and perform functions that would otherwise call for major investments in infrastructure and regular maintenance. Although techniques for protecting wetlands exist in many places, few have been legally enacted. Lawmaking that works best involves setting up funds for targeted wetland safeguards, establishing official wetland descriptions, and introducing design and maintenance benchmarks.³²

2. Integrated Water Resource Management

The planet Earth's water is most valuable to people and we have ample water available in lakes, rivers, oceans, glaciers and polar ice caps. Oceans account for 97.22 percent of the world's water, which is more than double the amount held in ice glaciers and even greater than that held by lakes and rivers. Only 1 percent of all the water available is suitable for humans to use. Water resources are naturally arranged, but their use is greatly influenced by geography, physiography, and demography and the impacts of people and industry. So. Although water resources internationally seem adequate, some regions, such as India, continue to deal with water scarcity, both because of global warming and other reasons.³³

Since the UN General Assembly proclaimed the Decade for Water Development (1981-1990) and International Water Resources Conferences were held, the issue of water resources has grown into an international concern. ICWE concluded in 1992 that Dublin called on all to consider new approaches for water resource assessment and management. The ICWE set out a structure and advice for UNCED, which took place at Rio de Janeiro in June 1992. It is pointed out in the ICWE document that water is among the world's most critical, limited, and non-substitutable resources, and the three remaining

³² Soumi Datta and others, 'Water Pollution of Wetlands', *Practice, Progress, and Proficiency in Sustainability* (IGI Global 2022) 27 <http://dx.doi.org/10.4018/978-1-7998-9498-8.ch003> accessed 10 September 2025.

³³ Guilherme Baggio, Manzoor Qadir and Vladimir Smakhtin, 'Freshwater Availability Status Across Countries for Human and Ecosystem Needs' (2021) 792 *Science of The Total Environment* 148230 <http://dx.doi.org/10.1016/j.scitotenv.2021.148230> accessed 10 September 2025.

guiding principles: freshwater is a vulnerable resource. You are paying for it. Everyone deserves to be governed with good systems in place. Water is valuable in all ways it is used and should be seen as an economic good.³⁴

3. Public Awareness and Education Initiatives

Water conservation matters to people everywhere and also locally. A water conservation plan can only succeed if the community is informed. Simple local action begins at home by planting a tree, using less water and planting a garden. Trees block the sun which helps keep a house cool and insulated. They also help the area by collecting and storing carbon dioxide. Trees help stop soil from becoming loose and being swept away. Gardens give numerous plants and animals living in cities a safe place to live. You can get involved, no matter if your effort is big or small. Just one drop can save lives. The central Government of India has asked state governments to carry out what is required by Article 51(g) of the Constitution. In India, conclusive state of Odisha, Kerala, and Jammu and Kashmir have implemented several water conservation initiatives at the planning, lawmaking, and executive levels. The Mahatma Gandhi National Rural Employment Guarantee Act, 2005, identifies a few projects that the central government finances. We all need to find ways to save water to build a better tomorrow.³⁵

VIII CONCLUSION

There is a worldwide concern about water scarcity. There is enormous value in wetlands' role in addressing water scarcity as they can save and store water, keep surface and ground waters clean, reduce run-offs, and better the recharge of groundwater. Wetlands support and advance agriculture and irrigation. Still, only a third of America's wetlands remain. Wetlands have lost about 70% of their former area, while the urban wetlands have been affected by people invading and misusing them. Such risks have increased the likelihood of flooding in big cities. We need to give urgent attention and use different approaches to restore wetlands. As a result of rapid urban growth, unprotected urban wetlands are destroyed by concrete jungles, incorrect water management has led urban areas to come into contact with drainage lines, and citizens without easy access to existing urban wetlands have resulted in waste being dumped directly in nature. The introduction of waste from agriculture, horticulture, and fisheries into urban environments has rapidly become the newest danger to the health of city wetlands. It cuts off wide parts of the public from enjoying urban wetlands, and it can release harmful substances called fertilizers and pesticides into both surface waters and underground aquifers.³⁶

Restoration, conservation, and use of these water bodies depend greatly on what the community does. Nearby people must understand the economic and social importance of wetlands. Well-designed droplet technology and farmers cooperating would help keep this type of loss low. In addition, we need proper public spaces to help citizens become involved and aware, legal support for local and

³⁴ Kalomoira Zisopoulou and Dionysia Panagoulia, 'An In-Depth Analysis of Physical Blue and Green Water Scarcity in Agriculture in Terms of Causes and Events and Perceived Amenability to Economic Interpretation' (2021) 13(12) Water 1693 <http://dx.doi.org/10.3390/w13121693> accessed 10 September 2025.

³⁵ Vaibhav Chaturvedi and others, 'India's Pathway to Net Zero by 2070: Status, Challenges, and Way Forward' (2024) 19(11) Environmental Research Letters 112501 <http://dx.doi.org/10.1088/1748-9326/ad7749> accessed 10 September 2025.

³⁶ Junyu Zou and others, 'Rewetting Global Wetlands Effectively Reduces Major Greenhouse Gas Emissions' (2022) 15(8) Nature Geoscience 627 <http://dx.doi.org/10.1038/s41561-022-00989-0> accessed 10 September 2025.

community action, a push to end merchants' silence, and ongoing community support for beneficial action. Water management is better handled by resource-poor farmers personally than by sharing ideas and lessons with others. As a result, organizing youth clubs, religious groups, and self-help groups would work better than giving a public talk or organizing a workshop. With strong support by public support and proper management of resources, these projects would protect the wetlands and nicely boost the well-being of the community, yet if the wetlands vanished, the deterioration of the environment could not be fixed.³⁷



³⁷ Sara Lofqvist and others, 'How Social Considerations Improve the Equity and Effectiveness of Ecosystem Restoration' (2022) 73(2) BioScience 134 <http://dx.doi.org/10.1093/biosci/biac099> accessed 10 September 2025.