ARYAVART SHODH VIKAS PATRIKA
RNI TITLED NO. UPBIL04292
RNI REG. NO. UPBIL/2014/66218 **PP. No.- 178-186**

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

Hydrological Bankruptcy in India : An Integrated Approach to Ecological Restoration, Pond Rejuvenation, Rainwater Harvesting, Landscape Planning, and Sustainable Water Management

Ar. Rajesh Kumar,
2. Co. Ar. Piyush Prakash,
3. Co. Ar. Prashant Kumar

School of Architecture & Planning, Dayalbagh Educational Institute (Deemed to be University), Agra (U.P.) India

Received-27.04.2026, Revised-05.05.2026, Accepted-12.05.2026, E-mail:rajeshkumar@dei.ac.in

Abstract: ***"रहिमन पानी राखिए, बिन पानी सब सून। पानी गए न ऊबरे, मोती, मानुष, चून" रहीम दास जी***

Indians face an unprecedented scenario as far as the scarcity of water is concerned because all the water resources in India are facing quality issues due to the drying up of the ground water resources, shrinking of wetlands and ponds, and climate change impacts.The problem of hydrological bankruptcy is becoming more pronounced in India, including problems with depleted groundwaters, degradation of wetlands, disappearance of ponds, unhealthy rivers, water pollution, and climate change-related water scarcity. Hydrological bankruptcy refers to the situation when there arises a point in time when the demand for water exceeds the abilities of water ecosystems and aquifers to regenerate themselves. The failure of water systems has immediate consequences including decrease in agricultural productivity, disruption in energy generation, increase in health hazards, loss of liveability of cities, loss of livelihood, migration, and risk to the very survival of peace and security.

Our planet has now reached the age of Global Water Bankruptcy, where almost three-quarters of the population live in water-insecure or critically water-insecure countries. 2.2 billion people do not have safely managed water sources, 3.5 billion do not have safely managed sanitation facilities, and 4 billion people experience severe water scarcity for at least a month a year. Failure in the provision of water can lead to numerous consequences, including crop failures, disruption of energy supply, deterioration of public health, poor living conditions in cities, loss of livelihood, community displacement, and conflicts. The present research article shall look at the idea of hydrological bankruptcy in India and shall analyze how ecological regeneration, the construction of biodiversity parks, pond recharging, rainwater harvesting, and land management can be employed to restore balance in hydrology. Drawing from a review of recent cases of water crises in India, this paper shall present some examples of successful wetland restoration, sponge landscape practices, community-driven water conservation programs, and reforms in water governance. Emphasis will be laid on pond restoration initiatives and decentralized rainwater harvesting techniques.

Besides, it is also important to mention the vision that has been put forward by Dr. A.P.J. Abdul Kalam regarding the adoption of the approach of Integrated Water Resource Management and the conservation of every drop of rainwater. It further mentions that the biodiversity parks can be seen as an important part of the ecological infrastructure because habitat protection, stormwater management, groundwater recharge, carbon storage, and environmental education can be carried out through the process. The example of the Sikandra-Kakraita Biodiversity Park in Agra has been taken for illustrating the same point. As per the study, pond restoration, wetland conservation, practice of rainwater harvesting, and establishment of biodiversity parks can play an important role in providing better hydrological security and water security in India in addition to fulfilling the SDG objectives.

Key words: Hydrological Bankruptcy, Water Security, Pond Rejuvenation, Rainwater Harvesting .

Introduction- Water is an integral part of sustainable development and well-being. The survival of civilizations in India has always been dependent on water. Ancient settlements thrived along rivers, lakes, tanks, ponds, step-wells, and traditional water harvesting structures, which were carefully planned to be in harmony with the surrounding landscape. This way, besides the availability of water, these structures provided ecological balance, biodiversity, and improved the resilience of local communities.

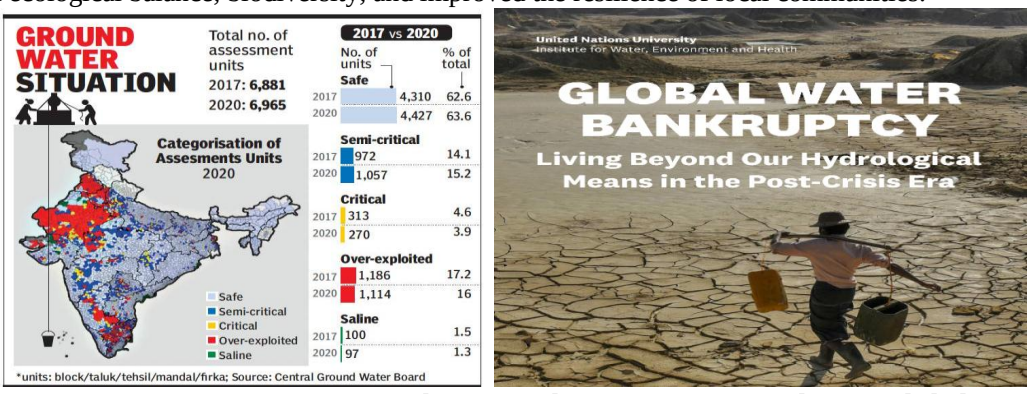


Figure 1. Burning Issue: Groundwater Depletion situation in India – Civilsdaily

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

Over half of the large lakes in the world have seen reduced water volumes since the beginning of the 1990s, depriving a quarter of the planet's population of access to lake waters. At present, half of the domestic water requirement is met by groundwater sources worldwide, while the same accounts for more than 40% of irrigation requirements. Consequently, food safety and availability of potable water become closely linked with the rapidly depleting freshwater resources. In addition, over seventy percent of major aquifers in the world experience a decline in water supply. As a result of groundwater extraction, almost 6 million square kilometers, or 5% of the Earth's surface, experienced land subsidence.

The world has seen the depletion of more than 30% of glacier mass in various parts since the year 1970. However, the equation between India and water has been taking a drastic turn recently. Urbanization, industrialization, population growth, and agriculture have exerted immense pressure on nature's water resources. Besides, the impacts of global warming have led to variation in rainfall, resulting in some areas experiencing droughts and floods..Indian cities now face the irony of having to deal with both floods during the rainy season and water shortage during summer months. Over 1.8 billion people were facing drought situations in 2022-2023. Damages due to drought have reached US$307 billion yearly due to the combination of factors such as land degradation, declining groundwater, and climate change, and not just lack of rainfall.

The theory of hydrological bankruptcy can be helpful in explaining this scenario. As in the case of financial bankruptcy where withdrawals keep exceeding the financial ability of an ecosystem to repay back loans, hydrological bankruptcy means that withdrawal of water exceeds the ecosystem's ability to recharge. India is increasingly witnessing signs of hydrological bankruptcy, making sustainable water management one of the most important environmental challenges of the twenty-first century.

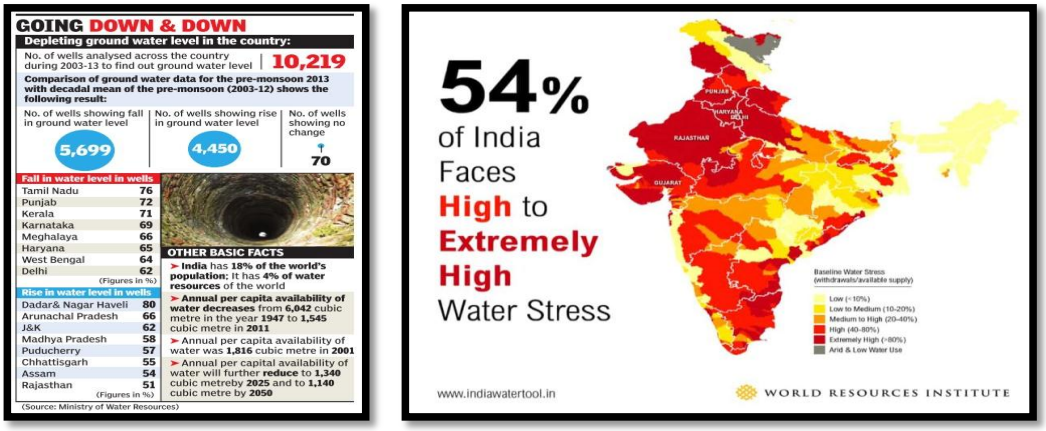


Figure 2. Burning Issue: Groundwater Depletion Level &water stress in India – Civilsdaily

Understanding Hydrological Bankruptcy- Hydrological bankruptcy is defined as a situation in which an area has exceeded its available water supplies, leaving no potential to recharge the system. Hydrological bankruptcy occurs as a result of excessive water abstraction from rivers and over-extraction of groundwater during a specified timeframe. As opposed to short-term deficits caused by seasonal drought conditions, hydrological bankruptcy represents a long-term structural failure and represents the loss of decades and light years worth of hydrological resources.

Figure 3. Burning Issue: Groundwater Depletion in India – Civilsdaily

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

Examples of this problem include:

- The decline in groundwater tables.
- Emptying of lakes and ponds.
- The drop in river flow.
- Wetland degradation.
- The lowering of water quality.
- Severe urban flooding and water shortage simultaneously.

In India, several basins and aquifers have reached or are about to reach a situation wherein restoration might be extremely challenging.

Drivers of India's Water Crisis-

Groundwater Overexploitation: Over-exploitation of Groundwater Resources:

Groundwater is one of the most important sources of supply for satisfying both agriculture, home, and industry uses across India. Unfortunately, due to the excessive use of water resources, many areas have seen large declines in groundwater levels, particularly in the states of Punjab; Haryana; Rajasthan; Uttar Pradesh; Gujarat; Karnataka; Tamil Nadu.

Boreholes and tubewells have greatly increased the use of groundwater by withdrawing it at a rate much higher than the rate at which it can be replenished naturally.

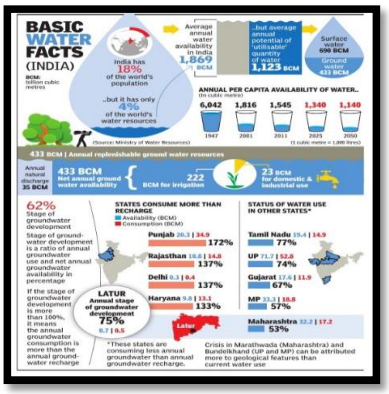
Figure 4. Composite Water Management Index- NITI AAYOG

Urbanization and Land Use Change- Rapid urban expansion has transformed natural landscapes into impermeable surfaces. Roads, buildings, parking lots, and paved areas prevent rainwater infiltration and reduce groundwater recharge.

The loss of open spaces, wetlands, and natural drainage channels has disrupted hydrological cycles and increased both flooding and water scarcity.

Wetland and Pond Degradation- India's ponds, lakes, and wetlands historically functioned as natural water storage and recharge systems. However, many have been encroached upon, polluted, or converted for development purposes.

The disappearance of these water bodies has significantly reduced the landscape's capacity to store water and regulate floods.



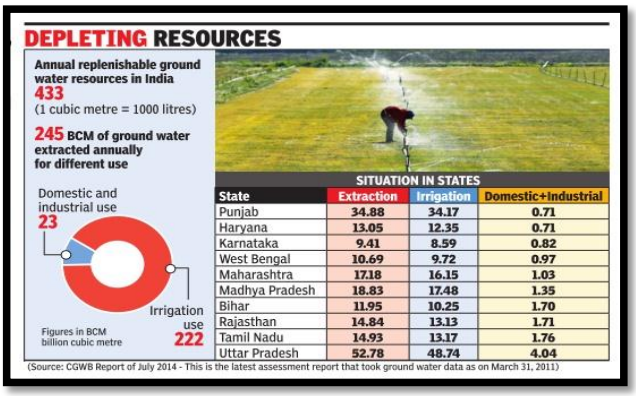


Figure 5. Annual_per_capita_availability_of_water_1947-2050_estimated

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

Climate Change- Climate change is intensifying hydrological uncertainty. Extreme rainfall events, prolonged dry spells, heat waves, and changing monsoon patterns are increasing pressure on already stressed water systems.

The challenge is not merely a lack of rainfall but the inability of degraded landscapes to capture, store, and utilize available water effectively.

Water Crisis Case Studies in India (2025–2026)- Several recent initiatives demonstrate both the severity of India's water crisis and the potential for recovery through ecological restoration.

Rajasthan: Community-Based Water Conservation- The Vande Ganga Jal Sanrakshan Jan Abhiyan focused on restoring traditional water bodies, desilting reservoirs, and strengthening rainwater harvesting infrastructure. This initiative highlighted the importance of community participation in restoring hydrological systems and increasing water storage capacity before monsoon seasons.

Maharashtra: Water Accounting Innovation- Maharashtra introduced a Water 7/12 system that scientifically records water availability, recharge, consumption, and watershed conditions. This innovative approach supports evidence-based water governance and promotes sustainable water budgeting.

Chennai: Sponge Parks and Pond Restoration- Chennai has emerged as an important example of urban ecological restoration. The city has restored numerous ponds and developed sponge parks designed to absorb stormwater, reduce flooding, and recharge groundwater. These projects demonstrate how urban landscapes can be redesigned to function as water-sensitive systems.

Urban Wetland Restoration- Across several Indian cities, efforts to revive wetlands and urban lakes are helping improve groundwater recharge, biodiversity conservation, and climate resilience. These initiatives demonstrate that ecological restoration can produce significant hydrological benefits.

Biodiversity Parks as Ecological Infrastructure- Conventional parks are often viewed primarily as recreational spaces. Biodiversity parks, however, perform multiple ecological functions and can serve as critical water infrastructure.

Projects such as the proposed **Sikandra–Kakraita Biodiversity Park in Agra** illustrate how degraded landscapes can be transformed into multifunctional ecological systems.

The benefits of biodiversity parks include:

- Groundwater recharge.
- Stormwater management.
- Wetland restoration.
- Carbon sequestration.
- Habitat creation.
- Soil stabilization.
- Biodiversity conservation.
- Urban heat reduction.

By restoring ecological processes, biodiversity parks improve hydrological performance while enhancing environmental quality.

Integrating Traditional Water Systems with Ecological Restoration- India has a long-standing history of water management systems made up of many different kinds of bodies of water such as ponds, tanks, johads, baolis, step wells, and village lakes which were traditionally employed for the purposes of rainwater harvesting, groundwater recharge, and community support.

Figure 6. Integrated Framework for Addressing Hydrological Bankruptcy in India through Ecological Restoration and Nature-Based Solutions.

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

However, with the rapid growth of cities and the modernization of society many of these systems are in a state of disrepair and have been abandoned.

Restoring these traditional bodies of water is one way to address the issue of aquifer depletion; restored ponds can also double as decentralized recharge systems that capture stormwater, recharge aquifers, create microclimate regulation, and support biodiversity.

When combined with biodiversity parks and wetlands, ponds will help create blue-green infrastructure networks that will positively impact both water security and ecological resiliency.

Rainwater Harvesting as a Foundation for Water Security-

Rainwater harvesting represents one of the simplest and most effective approaches to restoring hydrological balance.

India receives substantial annual rainfall, yet much of it is lost as surface runoff. Capturing even a fraction of this water can significantly improve groundwater recharge and reduce dependence on external water sources.

Effective rainwater harvesting strategies include:

- Rooftop rainwater harvesting.
- Recharge wells.
- Percolation tanks.
- Infiltration trenches.
- Retention ponds.
- Bio swales.
- Recharge basins.

In biodiversity parks and public landscapes, rainwater harvesting systems can be integrated with ecological restoration efforts to create self-sustaining hydrological systems.

Dr. A.P.J. Abdul Kalam's Vision for Water Security- Dr. A.P.J. Abdul Kalam consistently emphasized the importance of integrated water resource management. He believed that every drop of rainwater should be conserved and utilized effectively.

His vision highlighted:

- Rainwater harvesting.
- Watershed development.
- Restoration of traditional water bodies.
- Community participation.
- Sustainable environmental management.

Dr. Kalam advocated decentralized water management systems capable of creating self-reliant communities. His philosophy aligns closely with contemporary concepts of ecological restoration, nature-based solutions, and blue-green infrastructure.

The proposed Sikandra–Kakraita Biodiversity Park reflects many of these principles through its emphasis on wetland restoration, recharge ponds, native vegetation, and sustainable water management.

Landscape Planning and Nature-Based Solutions- Landscape planning provides a holistic framework for addressing hydrological bankruptcy because it recognizes the interconnected relationship between land, water, ecology, and human activity.

Key strategies include:

Watershed-Based Planning: Managing landscapes at the watershed scale helps protect recharge zones, floodplains, and river corridors while maintaining hydrological connectivity.

Blue-Green Infrastructure: Blue-green infrastructure combines vegetation and water systems to enhance environmental performance. Examples include:

- Rain gardens.
- Bio swales.
- Urban wetlands.
- Green corridors.
- Permeable surfaces.
- Retention ponds.

Water-Sensitive Urban Design- Water-sensitive urban design promotes infiltration, storage, reuse, and recycling of water through decentralized systems integrated within urban environments.

Nature-Based Solutions- Nature-based solutions include:

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

- Constructed wetlands.
- Urban forests.
- Floodplain restoration.
- Wetland rehabilitation.
- Native vegetation restoration.
- River restoration projects.

These approaches provide ecological, economic, and social benefits while enhancing hydrological resilience.

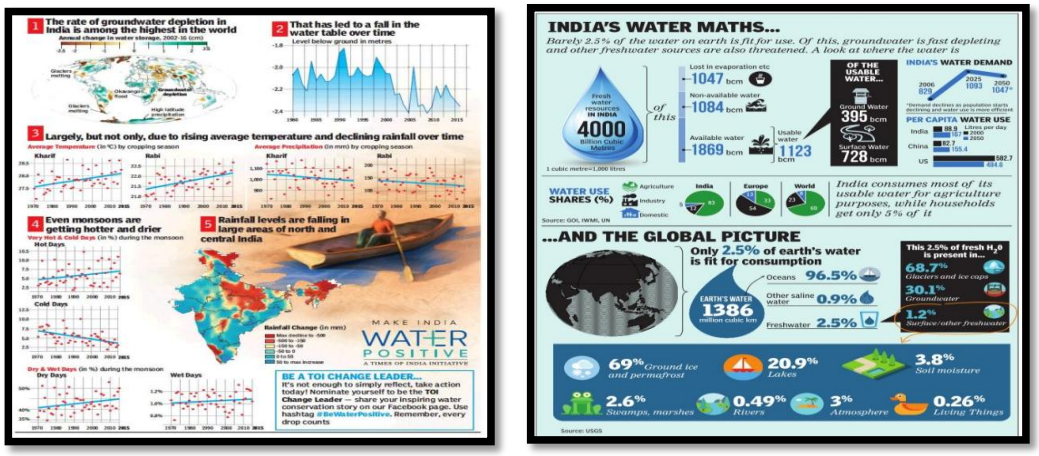


Figure 7. Groundwater_depletion_in_India_vis-a-vis_other_countries_2002-16.

Hydrological Bankruptcy and the Sustainable Development Goals (SDGs)- Addressing hydrological bankruptcy directly contributes to several United Nations Sustainable Development Goals. Water is explicitly addressed in Sustainable Development Goal 6, which commits the international community to ensure the availability and sustainable management of water and sanitation for all. At the same time, progress across almost every other Sustainable Development Goal depends directly or indirectly on the stability and integrity of water systems.

SDG 6: Clean Water and Sanitation: Pond rejuvenation, groundwater recharge, wetland restoration, and rainwater harvesting improve water availability and quality.

SDG 11: Sustainable Cities and Communities: Biodiversity parks and blue-green infrastructure create resilient urban environments capable of adapting to water-related challenges.

SDG 13: Climate Action: Ecological restoration enhances climate adaptation, flood mitigation, drought resilience, and carbon sequestration.

SDG 15: Life on Land: Restoration of wetlands, river corridors, and native vegetation supports biodiversity conservation and ecosystem recovery.

SDG 2: Zero Hunger: Improved groundwater recharge contributes to agricultural productivity and food security.

SDG 3: Good Health and Well-Being: Healthy ecosystems improve water quality, environmental conditions, and public health outcomes.

SDG 17: Partnerships for the Goals: Effective water management requires collaboration among governments, communities, planners, scientists, and environmental organizations.

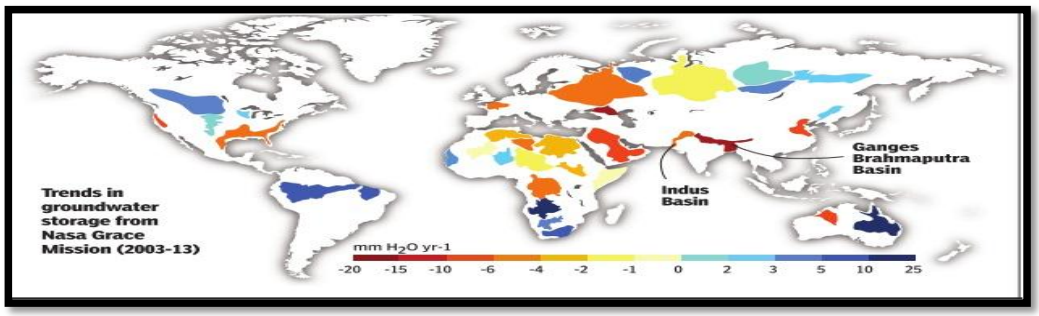


Figure 8. Integrated Framework

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

Contribution of the Sikandra–Kakraita Biodiversity Park- The proposed Sikandra–Kakraita Biodiversity Park demonstrates how a single landscape intervention can address multiple environmental challenges simultaneously.

The project integrates:

- Pond rejuvenation.
- Wetland restoration.
- Rainwater harvesting.
- Groundwater recharge.
- Native vegetation restoration.
- Habitat conservation.
- Environmental education.

As a result, the park contributes directly to SDGs 2, 3, 6, 11, 13, 15, and 17 while serving as a model for sustainable urban ecological restoration.

Conclusion- Hydrological bankruptcy is becoming one of the most pressing environmental issues for India. Natural hydrological cycles in India have been disrupted due to excessive extraction of groundwater, urban development, degradation of wetlands, climate change, and the abandonment of traditional water systems.

Restoration of hydrology requires both engineering interventions and ecological restoration through sustainable landscaping. Restoring ponds, restoring wetlands, implementing rainwater catchment systems, and developing biodiversity parks will help improve hydrological resilience.

In Rajasthan, Maharashtra, Tamil Nadu and many other places, there are numerous examples of successful ecological restoration that provide water security while enhancing biodiversity and climate resilience. The vision of Dr. A.P.J. Abdul Kalam emphasizes that it is critical to conserve millions of drops of water through community engagement, scientifically driven planning process, and stewardship of the environment.

The proposed Sikandra-Kakraita Biodiversity Park provides an example of integrating biodiversity, water management, and sustainable urban development. By utilising the knowledge of traditional water management combined with the modern principles of ecological planning and development India can achieve hydrological resilience rather than hydrological bankruptcy.

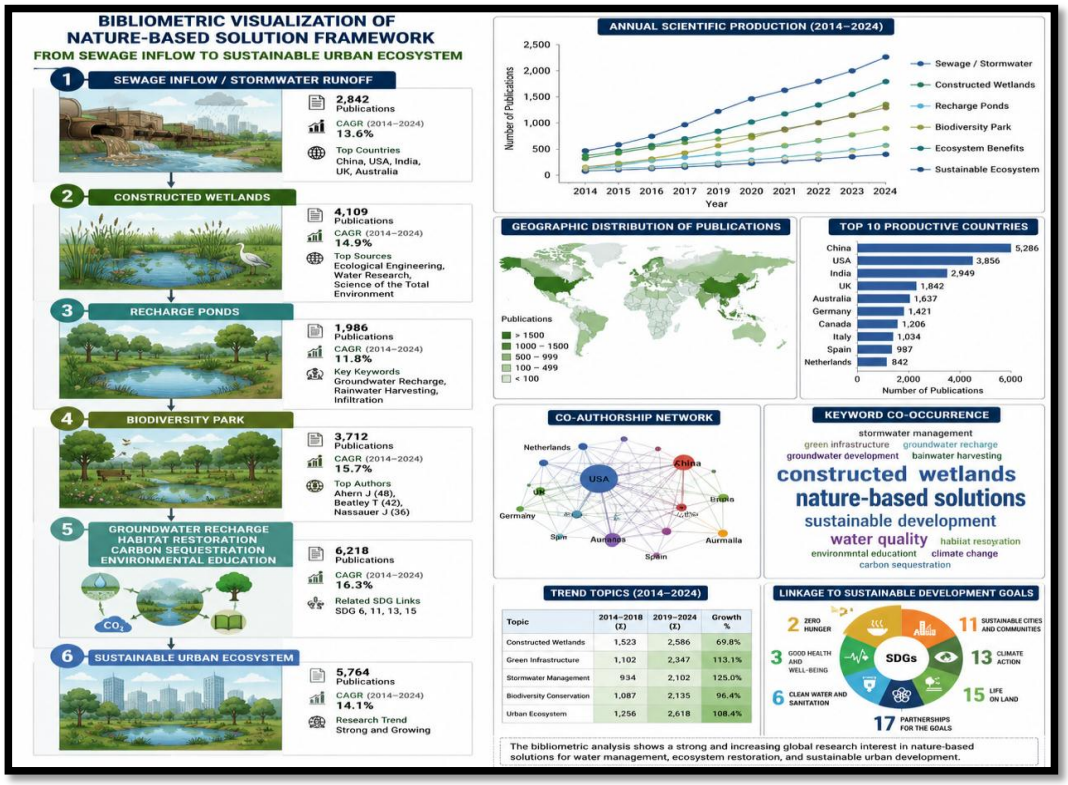


Figure 9. Biodiversity Park-Based Water Management Model.

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

The future of water security in India will rely heavily on the restoration of ecological connections between land, water, and communities. Using interdisciplinary planning approaches in conjunction with pond revitalisation, rainwater harvesting, biodiversity conservation, and nature-based solutions, we are building a sustainable and resilient water future for India.

REFERENCES/Bibliography

1. Agarwal, A., & Narain, S. (1997). Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems. Centre for Science and Environment, New Delhi.
2. Central Ground Water Board (CGWB). (2024). National Compilation on Dynamic Ground Water Resources of India. Ministry of Jal Shakti, Government of India.
3. Centre for Science and Environment (CSE). (2023). State of India's Environment Report 2023. New Delhi: CSE Publications.
4. Government of India. (2023). Jal Shakti Abhiyan: Catch the Rain Campaign Report. Ministry of Jal Shakti, New Delhi.
5. Government of India. (2024). National Water Policy and Sustainable Water Resource Management Framework. Ministry of Water Resources, River Development and Ganga Rejuvenation.
6. Intergovernmental Panel on Climate Change (IPCC). (2023). Climate Change 2023: Impacts, Adaptation and Vulnerability. Geneva: IPCC.
7. Kalam, A. P. J. Abdul, & Rajan, Y. S. (2002). India 2020: A Vision for the New Millennium. New Delhi: Penguin Books India.
8. Kalam, A. P. J. Abdul. (2015). Transcendence: My Spiritual Experiences with Pramukh Swamiji. HarperCollins India.
9. Mishra, A. (2001). The Radiant Raindrops of Rajasthan. Gandhi Peace Foundation and Centre for Science and Environment.
10. NITI Aayog. (2018). Composite Water Management Index: A Tool for Water Management. Government of India, New Delhi. NITI Aayog
11. Ramaswami, A., Russell, A. G., Culligan, P. J., Sharma, K. R., & Kumar, E. (2016). Meta-principles for developing smart, sustainable, and healthy cities. Science, 352(6288), 940–943.
12. Singh, R., & Sharma, K. D. (2022). Sustainable groundwater management and water security in India. Journal of Water Resource Management, 36(8), 2751–2768.
13. UNESCO. (2024). United Nations World Water Development Report 2024: Water for Prosperity and Peace. Paris: UNESCO Publishing.
14. United Nations Environment Programme (UNEP). (2023). Nature-Based Solutions for Climate and Water Resilience. Nairobi: UNEP.
15. United Nations University Institute for Water, Environment and Health (UNU-INWEH). (2026). Global Water Bankruptcy and Hydrological Sustainability Report. Hamilton, Canada.
16. United Nations University Institute for Water, Environment, and Health (UNU-INWEH) Richmond Hill, Ontario, Canada, 2026
17. United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. New York: United Nations.
18. World Bank. (2023). India's Water Security and Climate Adaptation Report. Washington, D.C.: World Bank Publications.
19. World Resources Institute (WRI). (2024). Aqueduct Water Risk Atlas: India Water Stress Assessment. Washington, D.C.: WRI.

Web References

1. India Water Portal. Water Governance and Water Security Resources. Available at:
2. India Water Portal
3. Ministry of Jal Shakti, Government of India. Available at:
4. Ministry of Jal Shakti
5. NITI Aayog Water Reports. Available at:
6. NITI Aayog Official Website
7. UN Sustainable Development Goals Knowledge Platform. Available at:
8. United Nations SDGs
9. United Nations University Institute for Water, Environment and Health (UNU-INWEH). Global Water Bankruptcy Report. Available at: UNU-INWEH Official Website

I S S N NO. - 2347 – 2944 (Print)
e–I S S N NO.- 2582 – 2454 (Online)
Vol.-20, No.- II, Issues-40, YEAR- April-June 2026

10. https://www.civilsdaily.com/burning-issue-groundwater-depletion-in-india/ Written byStaff @CD in Burning Issues

Suggested Citation for the Article

Rajesh Kumar., Piyush Prakash,[11] (2026). *Hydrological Bankruptcy in India: An Integrated Approach to Ecological Restoration, Pond Rejuvenation, Rainwater Harvesting, Landscape Planning, and Sustainable Water Management.*

*****