

# Wetland Degradation and Its Environmental Consequences

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**Abstract**—Wetlands are among the most productive and ecologically important ecosystems, providing critical services such as biodiversity support, water purification, flood control, and climate regulation. However, rapid urbanization, industrialization, agricultural expansion, pollution, and climate change are causing widespread wetland degradation. This paper examines the causes of wetland degradation, including over-extraction of water, invasive species, and unsustainable resource use, and analyzes their environmental and socio-economic consequences. These include loss of biodiversity, reduced water quality, increased flooding, declining livelihoods, and climate change impacts. The paper also explores the role of wetlands in sustainable development, emphasizing their importance in water management, disaster risk reduction, and carbon sequestration. Furthermore, it reviews government initiatives and policies at national and international levels, such as the National Wetland Conservation Programme and the Ramsar Convention, and identifies future challenges in balancing development with wetland conservation. The study highlights the urgent need for integrated management strategies, scientific monitoring, community participation, and policy enforcement to ensure the long-term preservation of wetlands and their ecosystem services.

## I. INTRODUCTION

Wetlands are ecologically significant ecosystems where land is permanently or seasonally saturated with water. They include lakes, marshes, swamps, floodplains, mangroves, and estuaries. Wetlands play a crucial role in maintaining environmental balance by supporting rich biodiversity, regulating the hydrological cycle, recharging groundwater, and acting as natural filters that improve water quality. Despite their importance, wetlands across the world are rapidly degrading due to human activities such as urbanization, industrial expansion, agricultural intensification, and climate change. In India, a large

number of wetlands have been lost or severely degraded because of encroachment, pollution, and unplanned development. This degradation has resulted in serious environmental consequences including loss of biodiversity, increased flooding, water scarcity, and climate instability. Therefore, understanding wetland degradation and its environmental impacts is essential for sustainable development and effective environmental management.

## II. TYPES OF WETLANDS

Wetlands are diverse ecosystems and are classified on the basis of water source, salinity, vegetation, and geographical location. Each type performs unique ecological functions and supports different forms of life.

### 1. Freshwater Wetlands

Freshwater wetlands are located inland and contain low salinity water. They are mainly fed by rainfall, rivers, lakes, and groundwater. These wetlands play a vital role in groundwater recharge, flood control, and biodiversity conservation. They provide habitat for fish, amphibians, aquatic plants, and migratory birds.

Examples: Wular Lake (Jammu & Kashmir), Loktak Lake (Manipur), Keoladeo National Park (Rajasthan), river floodplains of the Ganga and Brahmaputra.

### 2. Coastal Wetlands

Coastal wetlands are found along sea coasts and are influenced by tidal action and saline or brackish water. These wetlands act as natural barriers against cyclones, storms, and coastal erosion and are highly productive ecosystems. Mangroves also serve as important breeding grounds for fish and crustaceans.

Examples: Sundarbans Mangrove Forest (West Bengal), Chilika Lake (Odisha), Pulicat Lake (Tamil Nadu– Andhra Pradesh), Bhitarkanika mangroves (Odisha).

### 3. Man-made (Artificial) Wetlands

Man-made wetlands are created due to human activities such as dam construction, irrigation systems, and agriculture. Although artificial, they support rich biodiversity and help in water storage, irrigation, and wastewater treatment.

Examples: Ujani Dam backwaters (Maharashtra), village tanks of South India, reservoirs like Hirakud and Bhakra, paddy fields which support birds and aquatic organisms.

### 4. Seasonal and Temporary Wetlands

These wetlands hold water only during the monsoon or wet season. Despite their temporary nature, they are ecologically important for breeding of amphibians, insects, and migratory birds.

Examples: Vernal pools, seasonal ponds in Deccan Plateau and semi-arid regions of India. Importance of Classification: Understanding different types of wetlands is essential for effective conservation and management, as degradation impacts each type differently. Protection strategies must therefore be ecosystem-specific.

## III. CAUSES OF WETLAND DEGRADATION (DETAILED EXPLANATION)

Wetland degradation occurs due to a combination of anthropogenic and climatic factors, which alter the physical, chemical, and biological characteristics of wetland ecosystems.

### 1. Urbanization and Encroachment

Rapid urban expansion leads to large-scale conversion of wetlands into residential colonies, roads, and commercial complexes. Wetlands are often used as dumping grounds for construction debris and solid waste. Encroachment disrupts natural drainage systems, reduces flood absorption capacity, and fragments wetland habitats, leading to long-term ecological imbalance.

### 2. Industrial Pollution

Industries located near wetlands discharge effluents containing heavy metals (lead, mercury), hydrocarbons, dyes, and acids. These pollutants accumulate in sediments and enter the food chain through bioaccumulation and biomagnification. Industrial pollution reduces dissolved oxygen levels, causes fish mortality, and degrades water quality.

### 3. Agricultural Activities

Intensive agriculture around wetlands contributes to runoff rich in nitrogen and phosphorus from fertilizers. This accelerates eutrophication, resulting in excessive growth of algae and aquatic weeds. Pesticides also harm nontarget organisms, including fish, amphibians, and beneficial microorganisms, reducing ecological productivity.

### 4. Over-extraction of Water

Wetlands depend on a stable water regime. Excessive withdrawal of surface and groundwater for irrigation, urban water supply, and industrial use lowers water tables. Reduced inflow leads to drying of wetlands, conversion into wastelands, and loss of species that depend on permanent water bodies.

### 5. Climate Change

Climate change alters temperature and precipitation patterns, affecting wetland hydrology. Increased frequency of droughts reduces freshwater wetland extent, while intense rainfall events cause sedimentation and pollution loading. Rising sea levels increase salinity in coastal wetlands, leading to mangrove dieback and loss of estuarine biodiversity.

### 6. Invasive Species

Invasive plants such as water hyacinth grow rapidly in nutrient-rich wetlands, blocking sunlight and reducing oxygen availability. They alter habitat structure, restrict water flow, and suppress native plant species. Invasive animals also compete with native fauna for food and space, causing ecological imbalance.

### 7. Unsustainable Resource Exploitation

Unregulated fishing, excessive harvesting of reeds and aquatic plants, sand mining, and clay extraction disturb wetland substrates. These activities damage breeding grounds, reduce species populations, and weaken the natural regeneration capacity of wetlands.

### Overall Impact

The combined effect of these factors results in loss of wetland area, decline in biodiversity, reduced ecosystem services, and increased vulnerability to natural disasters. Addressing these causes requires integrated planning, strict regulation, and community participation.

Wetlands are among the most productive ecosystems on Earth. Their degradation leads to multiple, interlinked environmental consequences that extend far beyond the wetland boundary.

## IV. ENVIRONMENTAL CONSEQUENCES OF WETLAND DEGRADATION

### 1. Loss of Biodiversity

Wetlands provide breeding, nesting, and feeding habitats for aquatic plants, fish, amphibians, reptiles, birds, and microorganisms. Degradation causes habitat fragmentation, altered water regimes, and pollution stress, leading to decline in species richness and abundance. Migratory birds lose stopover and wintering sites, while endemic and specialist species face local extinction. Genetic diversity also declines, reducing ecosystem resilience.

### 2. Decline in Water Quality

Wetlands naturally remove excess nutrients, sediments, and pollutants through physical, chemical, and biological processes. When wetlands are degraded, these purification functions are weakened. As a result, nutrient loading increases, promoting eutrophication and harmful algal blooms. Contaminants such as heavy metals and pesticides persist in water bodies, posing risks to aquatic life and human health.

### 3. Increased Flooding and Reduced Flood Regulation

Healthy wetlands act as natural sponges by storing excess rainwater and releasing it slowly. Degraded wetlands lose this buffering capacity due to drainage, encroachment, or sedimentation. This results in higher surface runoff, increased flood frequency, and greater flood intensity, especially in urban and riverine regions.

### 4. Reduced Groundwater Recharge and Water Availability

Wetlands facilitate infiltration of surface water into underground aquifers. Degradation disrupts this

process by reducing wetland area and altering soil permeability. Declining groundwater recharge leads to falling water tables, drying of wells, reduced base flow in rivers, and long-term water scarcity.

### 5. Climate Change Feedbacks

Wetlands store large amounts of carbon in vegetation and waterlogged soils. When degraded or drained, stored carbon is oxidized and released as carbon dioxide and methane, enhancing greenhouse gas emissions. Loss of coastal wetlands such as mangroves also reduces protection against sea-level rise, storm surges, and extreme climatic events.

### 6. Soil Erosion, Sedimentation, and Land Degradation

Wetland vegetation stabilizes soil and traps sediments. Degradation exposes soil to erosion by wind and water, leading to sedimentation of rivers and reservoirs. Increased sediment load reduces water-holding capacity and affects aquatic habitats. In coastal and irrigated regions, salinization of soil further reduces land productivity.

### 7. Disruption of Ecological Processes and Nutrient Cycles

Wetlands regulate nutrient cycling, decomposition, and energy flow within ecosystems. Degradation alters these processes, leading to nutrient imbalance and dominance of invasive species. The breakdown of ecological interactions affects food webs and reduces the overall functional efficiency of ecosystems.

## V. SOCIO-ECONOMIC IMPACTS OF WETLAND DEGRADATION

Wetlands support the livelihoods and well-being of millions of people. Their degradation directly affects local communities and the broader economy.

### 1. Loss of Livelihoods

Many communities depend on wetlands for fishing, agriculture, livestock grazing, and collection of reeds and aquatic plants. Degradation reduces fish stocks, agricultural productivity, and availability of natural resources, leading to unemployment and income loss, especially among rural and marginal populations.

### 2. Impact on Agriculture and Food Security

Wetlands help maintain soil moisture and fertility.

Their degradation results in reduced crop yields due to water scarcity, soil salinization, and increased flooding. Declining agricultural output threatens food security and increases dependence on external food sources.

### 3. Increased Disaster-Related Economic Losses

Healthy wetlands reduce the impact of floods, droughts, and cyclones. Degraded wetlands fail to provide this natural protection, leading to increased damage to property, infrastructure, and crops. Governments and communities face higher costs for disaster relief and reconstruction.

### 4. Decline in Fisheries and Aquatic Resources

Wetlands serve as breeding and nursery grounds for fish and other aquatic organisms. Degradation disrupts reproductive cycles, causing a decline in fish catch. This affects local economies, nutrition, and traditional fishing practices.

### 5. Loss of Tourism and Recreation Opportunities

Wetlands attract tourists for bird-watching, boating, and nature tourism. Degradation reduces aesthetic value and biodiversity, leading to a decline in tourism revenue and associated employment opportunities.

### 6. Increased Cost of Water Treatment and Supply

Wetlands naturally purify water. When degraded, polluted water requires expensive treatment for drinking and industrial use. This increases financial burden on municipalities and reduces access to safe water.

### 7. Social Inequality and Community Displacement

Wetland degradation disproportionately affects poor and vulnerable communities who rely directly on natural resources. Loss of livelihoods and frequent disasters may force migration, increasing social inequality and urban pressure.

## VI. ROLE OF WETLANDS IN SUSTAINABLE DEVELOPMENT

Wetlands play a crucial role in achieving sustainable development by balancing environmental protection, economic growth, and social well-being. They provide essential ecosystem services that support both present and future generations.

### 1. Water Resource Management

Wetlands regulate the hydrological cycle by storing rainwater, reducing surface runoff, and recharging groundwater aquifers. They help maintain river flow during dry seasons and reduce water scarcity. This sustainable water management supports agriculture, drinking water supply, and industrial needs.

### 2. Biodiversity Conservation

Wetlands are biodiversity hotspots that provide habitat for a wide range of plant and animal species, including endangered and migratory species. Conserving wetlands ensures long-term survival of biodiversity, maintains ecological balance, and strengthens ecosystem resilience against environmental changes.

### 3. Climate Change Mitigation and Adaptation

Wetlands act as natural carbon sinks by storing large amounts of carbon in vegetation and soils. By absorbing carbon dioxide and methane, they help mitigate climate change. Coastal wetlands such as mangroves protect communities from sea-level rise, cyclones, and storm surges, aiding climate adaptation.

### 4. Sustainable Livelihoods and Economic Benefits

Wetlands support livelihoods through fishing, agriculture, aquaculture, tourism, and harvesting of natural resources. Sustainable use of wetlands provides long-term income opportunities while preventing overexploitation, thus contributing to poverty reduction and rural development.

### 5. Natural Disaster Risk Reduction

Wetlands function as natural buffers against floods, droughts, and coastal erosion. Floodplains absorb excess water during heavy rainfall, while mangroves reduce wave energy during storms. This reduces dependence on costly artificial infrastructure and promotes sustainable disaster management.

### 6. Water Purification and Public Health

Wetlands naturally filter pollutants, sediments, and excess nutrients from water. This improves water quality, reduces waterborne diseases, and lowers the cost of water treatment. Clean water contributes directly to public health and sustainable urban development.

### 7. Support to Agriculture and Food Security

Wetlands enhance soil fertility through nutrient cycling and moisture retention. They support rice cultivation, fisheries, and livestock grazing, ensuring food security. Sustainable wetland management helps maintain long-term agricultural productivity.

8. Contribution to Sustainable Development Goals (SDGs) Wetland conservation supports several UN SDGs, including:

SDG 6: Clean Water and Sanitation SDG 13: Climate Action

SDG 14 & 15: Life Below Water and Life on Land  
SDG 1 & 2: No Poverty and Zero Hunger

## VII. CONSERVATION AND MANAGEMENT STRATEGIES

### Wetland Protection

Legal protection of wetlands through designation as protected areas or eco-sensitive zones helps prevent encroachment, land reclamation, and unplanned urban development. Clear boundary demarcation and strict enforcement of environmental laws are essential to safeguard wetland ecosystems.

### Restoration and Rehabilitation

Degraded wetlands can be restored by removing accumulated silt, controlling invasive species, and reintroducing native plant species. Restoring natural water inflow and connectivity with rivers improves ecological functioning and biodiversity.

### Pollution Control

Effective treatment of domestic sewage, industrial effluents, and agricultural runoff before they enter wetlands is crucial. Establishing buffer zones around wetlands helps reduce nutrient loading and chemical contamination.

### Sustainable Water Management

Regulating surface and groundwater extraction ensures sufficient water availability for wetland survival.

Maintaining natural flow regimes and seasonal water fluctuations supports breeding cycles of aquatic organisms. Community Participation

Involving local communities in conservation planning

promotes sustainable use of wetland resources.

Traditional knowledge, when combined with scientific management, enhances conservation outcomes and ensures long-term protection.

### Scientific Monitoring

Regular monitoring using GIS, remote sensing, and field assessments helps track changes in wetland area, water quality, and biodiversity. Early detection of degradation allows timely management interventions.

### Awareness and Education

Public awareness programs, school education, and stakeholder training increase understanding of wetland values. Informed communities are more likely to support conservation initiatives and adopt environmentally responsible practices.

## VIII. GOVERNMENT INITIATIVES AND POLICIES

Wetlands are critical ecosystems, and their conservation requires strong legal, institutional, and policy support. Governments at national and international levels have developed initiatives to protect wetlands from degradation and promote sustainable use.

### 1. National Wetland Conservation Programme (NWCP), India

Launched in 1985, this program focuses on conservation, management, and restoration of wetlands.

Provides financial and technical support to states for wetland protection, pollution control, and habitat restoration. Example: Restoration of Chilika Lake in Odisha, which improved fish productivity and biodiversity.

### 2. Wetlands (Conservation and Management) Rules, 2017

Provides a legal framework for identification, regulation, and management of wetlands in India. Regulates activities such as encroachment, waste disposal, and land conversion.

Mandates states to notify wetlands of ecological and economic importance.

### 3. Ramsar Convention (International Initiative)

India is a signatory to this international treaty on wetlands, committed to the “wise use” of wetlands. Recognizes Ramsar sites, providing global attention, technical support, and conservation funding.

Example: Sundarbans (West Bengal) and Keoladeo National Park (Rajasthan) are Ramsar-listed wetlands.

#### 4. State-Level Initiatives

Several states have their own wetland conservation policies.

Example: Maharashtra’s “Wetland Conservation and Management Policy” aims to restore urban lakes and prevent encroachment.

States also conduct community awareness campaigns and involve local bodies in wetland management.

#### 5. Monitoring and Scientific Support

Government programs use GIS, remote sensing, and field surveys for mapping and monitoring wetland health. Helps identify degraded areas, monitor pollution, and plan restoration projects effectively.

#### 6. Community Participation and Awareness

Policies encourage active participation of local communities, NGOs, and educational institutions. Programs focus on promoting eco-tourism, sustainable fishing, and wetland-based livelihoods while conserving biodiversity.

#### 7. Integration with Sustainable Development Goals (SDGs)

Government initiatives align with global SDGs, such as clean water (SDG 6), climate action (SDG 13), and life below water (SDG 14).

Ensures that wetland conservation contributes to both ecological and socio-economic sustainability.

### IX. FUTURE CHALLENGES IN WETLAND CONSERVATION

Wetlands are under increasing pressure from human activities and environmental changes. Despite government initiatives and conservation efforts, several challenges hinder effective wetland protection and sustainable management. These challenges are interconnected and require integrated solutions.

#### 1. Rapid Urbanization and Land Conversion

Expanding cities and infrastructure development are major threats to wetlands.

Wetlands are often drained, filled, or encroached upon for housing, roads, and industries.

Loss of wetland area reduces biodiversity, water storage capacity, and natural flood protection.

#### 2. Pollution and Waste Management Issues

Increasing industrialization, agricultural runoff, and domestic sewage continue to degrade wetlands. Many wetlands are located near urban centers, receiving untreated waste.

Future challenge: Implementing effective pollution control and wastewater treatment remains difficult, especially in developing regions.

#### 3. Climate Change Impacts

Rising temperatures, erratic rainfall, and extreme weather events affect wetland hydrology.

Freshwater wetlands may dry up during droughts, while coastal wetlands face sea-level rise and saltwater intrusion.

Climate change also increases the frequency of floods and storms, further stressing wetland ecosystems.

#### 4. Invasive Species and Biodiversity Loss

Non-native plants (e.g., water hyacinth) and animals can dominate wetlands, outcompeting native species.

Future challenge: Controlling invasive species and protecting native biodiversity while maintaining wetland functions.

#### 5. Over-Exploitation of Resources

Wetlands are heavily used for fishing, agriculture, sand mining, and timber collection. Unsustainable use reduces productivity and ecological integrity.

Future challenge: Promoting sustainable livelihoods without compromising wetland health.

#### 6. Lack of Public Awareness and Community Participation

Many local communities and urban residents are unaware of wetland importance.

Future conservation depends on active participation, education, and behavior change, which remain limited.

#### 7. Policy Implementation and Enforcement Gaps

Existing laws and regulations are often poorly enforced due to lack of monitoring, coordination, or funding. Wetlands continue to be encroached upon or

degraded despite legal protection.

Future challenge: Strengthening governance, ensuring compliance, and integrating policies across sectors.

#### 8. Balancing Development and Conservation

Development pressures (urban growth, industrial projects, agriculture expansion) conflict with wetland conservation.

Future challenge: Achieving sustainable development, where economic growth does not compromise wetland ecosystems.

#### 9. Data Gaps and Scientific Challenges

In many regions, information on wetland extent, biodiversity, and hydrology is incomplete. Lack of scientific data hampers restoration, monitoring, and planning efforts.

Future challenge: Expanding research, mapping, and monitoring programs using modern tools like GIS and remote sensing.

### X. CONCLUSION

Wetlands are vital ecosystems that provide essential environmental, social, and economic services. Their degradation due to urbanization, pollution, agricultural runoff, climate change, and unsustainable resource use has led to severe consequences, including loss of biodiversity, declining water quality, increased flooding, and reduced livelihoods. Wetlands also play a key role in sustainable development, climate regulation, and disaster risk reduction.

Conservation and management require scientific restoration, strict policy enforcement, community participation, and modern monitoring tools. Government initiatives, such as the National Wetland Conservation Programme and international frameworks like the Ramsar Convention, provide a foundation for protection, but future challenges remain. Integrated efforts are urgently needed to safeguard wetlands, ensuring ecological balance, water security, and sustainable livelihoods for future generations.

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