

The Importance of Sustainable Wetland Management

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Abstract:- Wetlands have faced a global reduction from 64% to 71% during the 20th century, and it is estimated that habitat loss could lead to the extinction of around 1,700 vertebrate species by 2070. This study analyzed data from SCI, Scopus, Web of Science, Google Scholar, and a range of theses to explore sustainable wetland management. While previous research focused on the consequences of wetland degradation, this study highlights the critical need for sustainable management. Wetlands are biodiversity hotspots, home to numerous endemic and endangered species, making their conservation vital for protecting global biodiversity. Wetlands also contribute significantly to climate change mitigation by sequestering carbon, regulating water flow, and reducing catastrophe risk. Sustainable wetland management is essential to harness these benefits, particularly in light of growing environmental challenges. Wetlands also provide crucial ecosystem services, such as water purification, flood control, and recreational opportunities, emphasizing their socio-economic importance.

Despite these benefits, wetlands face ongoing threats from habitat destruction, pollution, and unsustainable use. Effective management requires a comprehensive approach, incorporating conservation, community engagement, policy development, and scientific research. Embracing sustainable practices is essential to preserve wetlands for future generations, reaffirming their role as critical ecosystems that support life and resilience. This abstract calls for global action to prioritize sustainable wetland management as a key aspect of environmental protection and sustainable development.

Keywords:- Wetland, Sustainable Development, Ecosystem, Wetland Management.

I. GENERAL INTRODUCTION

Wetlands, which cover around 5-8% of the Earth's native area, include marshes, swamps, bogs, and other landscapes characterized by waterlogged soils, either continuously or periodically. These ecosystems are crucial for supporting biodiversity, purifying water, mitigating floods, and storing carbon. Despite their importance, wetlands are under threat from human activities such as drainage, agriculture, and urban expansion. Protecting and restoring wetlands is essential for

maintaining ecosystem health and resilience (Salimi et al., 2021a).

Wetlands offers a variety of benefits to both humans and the environment. These include tangible resources such as food and water, as well as intangible ecological services critical for sustainable development. These services encompass waste degradation, carbon storage, air purification, climate regulation, soil fertility maintenance, fuel sources, medicinal resources, educational and research opportunities, ecological balance, nutrient cycling, support for diverse crops, industrial materials, cultural significance, erosion control, and soil detoxification.

Global wetland areas have declined significantly, with an estimated loss of 64% to 71% during the 20th century (Ramsar, 2013). Inland wetlands have been particularly impacted, experiencing an average loss of 61%, compared to a 46% loss for coastal wetlands. Wetlands have diminished across all regions, with Oceania seeing a 12% reduction and Latin America experiencing a 59% decrease. Between 1970 and 2015, more than 35% of upland and coastal wetlands were lost (Fennessy & Lei, 2018). The rate of decline has accelerated, with losses in the past century occurring 3.7 times faster than in previous centuries (Davidson, 2014). The accelerated degradation of wetlands has led to a decline in essential ecosystem services, including reduced carbon sequestration, weakened coastal protection, increased flooding, fluctuations in water availability, and the loss of vital habitats for fisheries (Moomaw et al., 2018; Barbier et al., 2011).

The Ramsar Convention divides wetlands into three types: marine and coastal wetlands, interior wetlands, and man-made wetlands. However, wetlands are progressively degraded as a result of crucial global challenges like climate change and the ongoing ecological catastrophe, including catastrophic biodiversity loss (Matthews 1993).

Previous research has primarily focused on the impacts, causes, and consequences of wetland degradation. The goal of this study is to investigate the relationship between sustainable wetland management and the Sustainable Development Goals (SDGs) in order to promote environmentally friendly practices (Kundu, Kundu et al. 2024). Sustainable wetland management is in line with numerous SDGs, notably SDG 6 (Clean Water and Sanitation) and SDG 15 (Life on Land), which highlight

the protection and maintenance of global wetlands. SDG 15 intends to safeguard, restore, and encourage the sustainable use of terrestrial ecosystems, manage forests sustainably, combat desertification, halt land degradation, and prevent biodiversity loss. SDG 6 is specifically focused on guaranteeing the availability and sustainable management of water and sanitation.

This research will highlight the importance of wetland management through various Ramsar Convention guidelines, including conserving and wisely using all wetlands, designating and protecting Wetlands of Universal Importance (Ramsar Sites), and fostering international cooperation on transboundary wetlands and shared species. The paper will also address policies, strategies, and discussions on sustainable global wetland management with input from national, non-governmental, and local stakeholders.

II. METHODOLOGY

A desk review methodology is essentially a structured approach to gathering, synthesizing, and analyzing existing literature and documents related to a specific topic without conducting primary research. Here's a suggested methodology for conducting a desk review on "The Importance of Sustainable Wetland Management":

Clearly outline the objectives of the desk review and define the scope of the study. For instance, specify whether the focus will be on a particular geographic region, wetland type, or aspect of wetland management (e.g., ecological, economic, social). Develop a systematic search strategy to identify relevant literature and documents. Utilize academic databases (e.g., PubMed, Web of Science, Scopus), government websites, institutional repositories, and grey literature sources. Use appropriate keywords such as "wetland management," "sustainability," "ecosystem services," and "conservation."

Establish criteria for selecting literature and documents to ensure relevance and reliability. Consider factors such as publication date, language, geographic focus, and study design. Exclude sources that are outdated, not peer-reviewed, or not directly related to sustainable wetland management. Develop a data extraction form to systematically record relevant information from selected sources. Extract data on key themes, findings, methodologies, and conclusions. Organize extracted data in a structured manner to facilitate synthesis and analysis.

Analyze the extracted data to identify common themes, trends, and patterns related to the importance of sustainable wetland management. Synthesize findings from different sources to develop a comprehensive understanding of the topic. Highlight key insights, challenges, and gaps in the literature. Critically evaluate the strengths and limitations of the literature reviewed. Assess the quality of evidence,

methodologies used, and validity of conclusions. Identify areas of consensus and disagreement among authors. Consider using conceptual frameworks or models to organize and structure the review findings. Frameworks like the Millennium Ecosystem Assessment and the DPSIR (Driving Forces-Pressures-State-Impacts-Responses) model are valuable tools for examining the intricate relationships between human activities and wetland ecosystems. Discuss the implications of the review findings for policy, practice, and future research. Identify recommendations for improving wetland management policies and practices to enhance sustainability and conservation outcomes. Prepare a well-structured report summarizing the desk review methodology, findings, analysis, and conclusions. Clearly communicate the importance of sustainable wetland management based on the synthesized evidence.

III. RESULTS

A. Impacts of Wetland Degradation

Wetlands are vanishing three times more quickly than forests, according to UN Climate Change Report. Threats to wetlands are becoming more frequent, endangering their health. Land drainage, pollution, urbanization, and climate change are putting these priceless ecosystems, which are vital flood buffers and animal havens, under jeopardy (Ramsar, 2018b).

➤ Habitat Loss

Worldwide, ongoing habitat loss is expected to lead to the extinction of roughly 1,700 vertebrate species by 2070 (Hurlbert & Jetz, 2007). Because of drainage, urbanization, sea level rise, erosion, and subsidence, coastal wetlands are particularly vulnerable to this danger (Ramsar, 2008). Typical direct effects of habitat loss in wetlands include vegetation removal, water level fluctuations, and construction activities. The decline of wetland habitats has significant economic and societal consequences. The degradation of these ecosystems has caused a reduction in both the size and diversity of fish populations, resulting in fewer opportunities for commercial and recreational fishing. This has negatively impacted the livelihoods and recreational activities of numerous individuals and communities (Pinto et al., 2023). The loss of wetland habitats not only impacts fish populations and the recreational activities associated with them but also disrupts the fragile balance of the ecosystem. Since fish are essential to the food chain, their decline can alter the abundance and behavior of other species, affecting the overall health and stability of the wetland ecosystem (Hammer, 2020).

➤ Pollution (Plastic Waste in Wetland Areas)

Pollution may negatively impact wetlands, compromising their ecological integrity and reducing their ability to perform essential activities. The delicate balance of wetland ecosystems is seriously threatened by pollution from a variety of sources, including as industrial discharges, urban

toxins, and agricultural runoff. This threatens not only the plant and animal inhabitants of these ecosystems but also the vital functions they provide (Alikhani et al., 2021). According to a NOAA Fisheries article, high pollution levels can overwhelm a wetland's filtration system's capacity, allowing excess nutrients and toxic chemicals to concentrate in waterways and creating dead zones that make it impossible for aquatic organisms to survive (US EPA, 2022). Wetlands not only allow plastic garbage to flow through them, but they also operate as places where material gathers over time, creating ongoing problems (Salimi et al., 2021b). Road development and resource exploitation are two examples of how human activity has severely disrupted marsh ecosystems. Due to this, wetlands that had previously been drained are now more vulnerable to wildfires, which raises the possibility of air pollution from the poisonous metals that wetlands have absorbed and retained while they rest in peat, which can endanger human and environmental health. Peatland fires are challenging to suppress once they start because they can smolder for weeks, months, or even years in a drained marsh. They emit a great deal of ash and smoke, which covers the air with tiny particles (Xu et al., 2019).

➤ *Invasive Species: Nutria (*Myocastor coypus*)*

Invasive species are inflicting significant damage to wetlands by outcompeting native plants and animals, upsetting the delicate balance of these ecosystems. These intruders frequently grow more aggressively and can alter the structure and function of the wetland, diminishing its ability to manage flooding and purify water. Furthermore, invasive species can reduce the availability of suitable habitats for native species and contribute to the overall decline of wetland health (Havel et al., 2015). The Nutria is one of several creatures that constitute an invasive species hazard to wetlands. The Nutria is a semi-aquatic mouse that originated in South America but was introduced to the United States in 1889 owing to the attractiveness of its fur. Over time, it has taken over wetlands after being released or escape ranches. Because of their rapid reproduction rate and lack of adequate population management, these rodents have caused agricultural damage, a decline in native vegetation owing to eating, and an increase in flood damage due to their poorly constructed burrows (Ramsar, 2008).

➤ *Climate Change*

Climate change has a considerable influence on wetlands, mostly due to rising temperatures and shifting precipitation patterns. These alterations can cause adjustments in wetland habitats, influencing the distribution of plant and animal species (Salimi et al., 2021a). Furthermore, rising temperatures can lead to the loss of wetland habitat and contribute to sea-level rise, which can jeopardize the stability and function of coastal wetlands. They can also cause altered precipitation patterns and prolonged droughts, resulting in lower water levels and drying of wetlands. As temperatures rise, wetlands become increasingly vulnerable to frequent and

devastating wildfires. Increased fire danger can destroy wetland vegetation, further reducing their potential to support species and maintain ecological services (Ramsar, 2018a).

B. Importance of Ecosystem services provided by the wetlands

Table 1 shows that wetlands are diverse ecosystems with a wide range of critical activities that benefit both the environment and human cultures

➤ *Floodwater storage and filtering*

Wetlands can help lessen the effects of floods in places by storing floodwater. According to the Vermont Department of Environmental Conservation, many wetlands, particularly those located in floodplains, have the capacity to temporarily store extra floods under high runoff conditions. While wetlands have been compared to natural sponges in the past, their function is superior to that of natural reservoirs. They store floods that overflow riverbanks or collect in low-lying regions. As floodwaters recede, these wetlands gradually release stored water from their soils. This feature, which retains certain floods and regulates the rate at which water re-enters the stream, can successfully reduce the intensity of downstream flooding and erosion (Climate Central, 2022). Wetlands also help with water filtering by eliminating surplus nutrients, slowing the flow, and enabling particles to settle out of the water, which may then be absorbed by plant roots. Their plants and soil trap sediments and pollutants, while the wetland's helpful bacteria degrade hazardous compounds. In this way, these crustaceans may remove up to 90% of the germs from the water (US EPA, 2003).

➤ *Ecosystem*

Beavers are one of many creatures that use wetlands as a habitat. Beavers build dams as homes for their kids, which serve as a safe refuge from predators and climatic conditions.

Wetlands are crucial habitats for a vast range of plant and animal species, and they serve as a foundation for ecological variety. Wetlands are used by a variety of fish and animal species. Some species rely on wetlands as their primary habitat, while others utilize them periodically for food and refuge. Wetlands are critical for the survival of many species, and they provide as key seasonal homes for others (Hernández-Blanco, 2023). The combination of shallow waters, ample nutrients, and high primary production produces a great habitat for the growth of creatures that form the basis of the food chain, giving nutrition for diverse fish, amphibians, shellfish, and insects (Ansari et al., 2023). Wetlands have also been a popular area for scientists to help in the development and discovery of medicines. An estimated 70-80% of people worldwide rely on herbal medicine and earn money from the collection and trading of plants for therapeutic purposes. Although there is no global inventory of wetland medicinal plants, the white willow is one example. This riverine plant is utilized in skin care products and is also the

source of salicylic acid (Yi et al., 2024). Furthermore, various species of birds and mammals rely on wetlands to obtain their food, drink water, and have a safe place to rest, especially during lengthy treks or while they're delivering young (Ramsar, 2006).

➤ *Mitigation of Climate Change*

Wetlands have an important and complex role in mitigating climate change through their natural processes and activities (Metcalf, Nagabhatla et al. 2018). They absorb carbon from the air as plants develop and trap silt in water. Carbon may be stored in plants, leaves, soil, and mud for thousands of years (Brown 2024). According to a paper published by A.M. Nahlik and M.S. Fennessy, wetlands globally absorb around 700 billion tons of carbon, primarily in peat soils, with an annual sequestration rate of 96 million tons. Wetlands in the United States are estimated to hold 11.52 billion tons of carbon, which is comparable to about 1% of the worldwide soil carbon reservoir. This shows the carbon storage capability of wetlands on a global scale (Nahlik and Fennessy 2016).

➤ *Biological productivity*

Wetlands represent just around 5% of the land surface in the Conterminous United States, yet they sustain 31% of all plant species. Because of their propensity to absorb nutrients, wetlands may be extremely biologically productive (producing biomass fast). In terms of plant production, freshwater wetlands rival tropical rainforests. Their capacity to effectively produce biomass may be essential in the development of alternate energy sources (Nahlik & Fennessy, 2016).

➤ *Research, Education and Recreation*

Aside from their biological value, wetlands provide numerous recreational activities, are excellent educational resources, and serve as living laboratories for critical research. These distinct ecosystems attract outdoor enthusiasts by giving opportunities for activities like as birding, hiking, and photography, as well as educational platforms where people may learn about nature and environmental protection. Furthermore, wetlands give researchers with dynamic habitats to study numerous ecological processes and species, adding to our understanding of the natural world. ("Valuing Wetlands," 2021).

Table 1: Importance of Ecosystem Services

Services	Comments and Examples
Provisioning	
Food	Production of fish, wild game, fruits, and grains
Fresh	water Storage and retention of water for domestic, industrial, and agricultural use
Fiber and fuel	Production of logs, fuel wood, peat, fodder
Biochemical	Extraction of medicines and other materials from biota
Genetic materials	Genes for resistance to plant pathogens, ornamental species, and so on
Regulation	
Climate regulation	Source of and sink for greenhouse gases; influence local and regional temperature, Precipitation, and other climatic processes
Water regulation (hydrological flows)	Groundwater recharge/discharge
Water purification and waste treatment	Retention, recovery, and removal of excess nutrients and other pollutants
Erosion regulation	Retention of soils and sediments
Natural hazard regulation	Flood control, storm protection
Pollination	Habitat for pollinators
Cultural	
Spiritual and inspirational	Source of inspiration; many religions attach spiritual and religious values to aspects of wetland ecosystems
Recreational	Opportunities for recreational activities
Aesthetic	Many people find beauty or aesthetic value in aspects of wetland ecosystems
Educational	Opportunities for formal and informal education and training
Supporting	
Soil formation	Sediment retention and accumulation of organic matter
Nutrient cycling	Storage, recycling, processing, and acquisition of nutrients

Source (Chuma et al., 2012)

C. Linkage between Policy Frameworks, Sustainable Development Goals (SDGs) and Sustainable Wetland Management (SWM)

The Sustainable Development Goals (SDGs) and sustainable wetland management (SWM) are interdependent, with the objectives of sustainable development serving as concrete measures for preserving wetlands and the global environment. Figure 1 demonstrates the essential role wetlands play in supporting sustainable development. Wetlands are critical for human well-being, economic progress, and climate adaptation and mitigation efforts. They supply drinking and irrigation water, safeguard coastlines, enhance urban resilience, and function as significant natural carbon sinks. Additionally, wetlands promote biodiversity, contribute to climate action, and support livelihoods, making them indispensable for human health and welfare. These ecosystems provide various services, including water purification, flood regulation, and biodiversity preservation.

Wetlands are characterized by areas that are either permanently or seasonally saturated with water, forming distinct ecosystems. These include inland wetlands such as lakes, rivers, and swamps, as well as coastal wetlands like estuaries, mangroves, and coral reefs. Even artificial wetlands, such as rice paddies, play a significant role in ecosystem services.

Wetlands play a crucial role in fulfilling the Sustainable Development Goals (SDGs), which seek to eliminate poverty and advance sustainable development by 2030. The Ramsar Convention on Wetlands highlights the importance of the sustainable use and preservation of wetlands to assist nations in reaching SDG objectives. The convention's Strategic Plan is closely aligned with both the SDGs and the Aichi Targets set by the Convention on Biological Diversity, advocating for enhanced collaboration among global environmental initiatives.



Fig 1; Linkage of Wetland and Sustainable Development
Source: (Wetlands, 2018)

➤ *Ramsar Convention on Wetlands*

The Ramsar Convention, founded in 1971, is an international agreement dedicated to the preservation and sustainable management of wetlands. It advocates for the designation of Wetlands of International Importance, known as Ramsar Sites, and urges nations to formulate national policies for wetland protection. The convention places particular emphasis on the sustainable use of wetlands, the conservation of Ramsar Sites, and fostering international collaboration on wetlands that cross national borders. Additionally, it promotes initiatives to restore degraded wetlands and encourages the integration of wetlands into national and local development strategies (Gell, Finlayson et al. 2023).

The goal of the Ramsar Convention on Wetlands (1971) is to promote the conservation and sustainable management of wetlands through local, national, and international efforts, contributing to global sustainable development. By 2018, the convention had expanded to 170 Contracting Parties, with 2,308 designated Wetlands of International Importance, known as Ramsar Sites, covering a total area of 228,930,640 hectares. Countries that join the convention must designate at least one site of international significance, based on nine criteria, and commit to its protection. Furthermore, Contracting Parties agree to ensure the sustainable use, or "wise use," of all wetlands within their territories, incorporating wetland conservation into national planning. The concept of "wise use" refers to utilizing wetlands in a way that preserves their ecological integrity for future generations. The convention also emphasizes international collaboration, especially concerning transboundary wetlands and migratory species. Given the rapid degradation of wetlands, restoration has become a central focus of the convention's activities.

➤ *Sustainable Development Goals (SDGs)*

SDG 6 (Clean Water and Sanitation) aims to ensure the availability and sustainable management of water and sanitation for all. Wetlands serve an important function in purifying and sustaining water quality. Despite this, SDG 14 (Life Below Water) aims to protect and sustainably use the oceans, seas, and marine resources. Healthy wetlands prevent coastal eutrophication and sustain marine biodiversity (Baskaran 2022). Furthermore, SDG 15 (Life on Land) focuses on protecting, restoring, and promoting the sustainable use of terrestrial ecosystems, including wetlands. This target intends to prevent desertification, halt and reverse land degradation, and stop biodiversity loss, with a particular emphasis on wetlands.

➤ *Convention on Biological Diversity (CBD)*

The CBD, founded in 1992, seeks to conserve biodiversity, encourage sustainable use of its components, and ensure a fair and equitable distribution of benefits. Wetlands are crucial to these aims because they are rich in biodiversity and provide ecological services (McGraw 2017). In January

1996, the Secretariats of the Ramsar Convention and the CBD signed their first Memorandum of Cooperation. In November of that year, the CBD's COP3 urged Ramsar "to cooperate as a lead partner" in conducting CBD wetlands operations, and shortly after, an innovative Joint Work Plan for 1998-1999 was established. These groundbreaking connections have been extensively replicated by other international organizations, and the two conventions continue to collaborate closely, now under a 5th Joint Work Plan.

➤ *UN Framework Convention on Climate Change (UNFCCC)*

The United Nations Framework Convention on Climate Change (UNFCCC), created in 1992, focuses on climate change and its effects. Wetlands contribute significantly to climate control by sequestering carbon and mitigating the consequences of climate change (Bodansky 1993).

➤ *Global Environmental Facility (GEF)*

The GEF sponsors programs that address global environmental challenges, such as wetlands. It funds the protection and sustainable management of wetlands and associated ecological services (Sjöberg 2017).

➤ *International Union for Conservation of Nature (IUCN)*

The International Union for Conservation of Nature seeks to influence, promote, and support societies across the world in conserving nature's integrity and diversity. Wetlands are an important emphasis because of their biodiversity and ecological significance (Regan, Colyvan et al. 2000).

➤ *Convention to Combat Desertification (UNCCD)*

The United Nations Convention on Climate Change focuses on preventing desertification, land degradation, and drought. Wetlands help to restore land and keep soil fertile (Vlek, Khamzina et al. 2017).

IV. DISCUSSION

Sustainable wetland management is vital for maintaining the ecological, economic, and social advantages that wetlands bring. These ecosystems, which include swamps, marshes, bogs, and floodplains, support biodiversity, water purification, climate regulation, and flood control. The connection between wetlands and sustainable development is evident in various ways, with wetland management contributing to many Sustainable Development Goals (SDGs) beyond just SDG 6 on clean water (Seifollahi-Aghmiuni, Nockrach et al. 2019). For example, maintaining healthy inland wetlands helps prevent coastal eutrophication, supporting SDG 14 (Life Below Water), and sustains fisheries, aiding in SDG 2 (Zero Hunger). In 2017, fish made up 17% of the global population's animal protein intake, with two-thirds of these fish relying on coastal wetlands (Jaramillo, Desormeaux et al. 2019).

Access to healthy wetlands can also improve human well-being, as spending time in natural environments, such as wetlands, is linked to better mental health (SDG 3, Good Health and Well-being). Wetlands and water serve as "climate connectors," playing a crucial role in efforts to combat climate change, manage disaster risk, and promote sustainable development. Wetlands are also significant carbon sinks, supporting SDG 13 (Climate Action), and can contribute to peace and justice (SDG 16, Peace, Justice, and Strong Institutions) by promoting equitable sharing of resources, although wetland conservation is not often a focus in peace-building efforts.

Nature-based solutions that leverage the benefits of healthy wetlands in managing water risks are key to moving beyond reliance on human-made infrastructure, especially in coastal areas where population density, economic activity, and environmental challenges are highest. However, despite progress, there are still challenges in scaling up investment and knowledge in these solutions. While efforts to designate protected areas on land and sea are increasing, more work is needed to ensure these areas safeguard critical biodiversity and are effectively managed and connected to larger ecosystems.

Wetlands also hold deep spiritual, aesthetic, and cultural significance. They offer more than just material benefits; for example, thousands of pilgrims visit the Himalayan wetland Mansarovar annually for spiritual purposes. Recognizing the "rights of nature," including wetlands, in legal frameworks reflects a more ethical and sustainable relationship between humans and the environment. To achieve sustainable development, we must go beyond conventional conservation efforts, as current strategies are not enough to safeguard nature and meet the SDGs.

Wetlands play a crucial role in achieving key leverage points for sustainability, such as reducing consumption and waste, promoting justice and inclusion, and enhancing education and knowledge sharing. The Convention on Wetlands must be better implemented, with stronger collaboration among multilateral environmental agreements and institutions. Wetlands of International Importance can serve as models for sustainable management, and building capacity among Contracting Parties is critical for national success.

V. CONCLUSION

In conclusion, the significance of sustainable wetland management cannot be overstated. Wetlands are invaluable ecosystems that provide a multitude of ecological, social, and economic benefits. Through biodiversity conservation, climate regulation, and provision of ecosystem services, wetlands play an essential role in conserving global environmental health and human well-being. However, these vital ecosystems are

under increasing threat from human activities and environmental degradation.

Sustainable wetland management is essential to ensure the continued provision of these benefits. It requires a holistic approach that balances conservation goals with the needs of local communities and economic development. Effective management strategies must incorporate scientific research, community engagement, and robust policy frameworks to address the complex challenges facing wetlands.

By embracing sustainability principles and prioritizing the preservation and restoration of wetland ecosystems, we can safeguard their invaluable contributions to biodiversity, climate resilience, and social welfare. Sustainable wetland management is not only a moral imperative but also a practical necessity for building a more resilient and sustainable future for both people and the planet.

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