

Ecological Significance and Conservation Issues of Internationally Important Wetlands of Nepal: A Review

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ABSTRACT

Wetlands, once considered unproductive land, are now recognized as highly productive ecosystems with significant biodiversity. Nepal has 10 wetlands listed on the Ramsar Sites but their degradation is becoming a growing concern. Therefore, this review paper investigates the ecological significance and conservation issues of internationally important wetlands in Nepal using an analytical framework called DPSIR (Driving force-Pressure-State-Impact-Response). The study discovered that wetlands offer various advantages, encompassing ecological, economic, aesthetic, religious, and socio-cultural benefits. Nevertheless, they face obstacles such as encroachment, pollution, sedimentation, the invasion of non-native species, and the decline of biodiversity, which endanger their ecological attributes. Despite having a National wetland policy and strategic plan, their implementation is insufficient. The current status of wetlands in Nepal is declining, indicating the urgent need for a review and strong implementation of existing policies, programs, and institutional arrangements.

Keywords: Ramsar sites, framework Analysis, Conservation issues, Management response

INTRODUCTION

Nepal is home to numerous wetlands that are important both nationally and internationally due to their ecological, economic, and socio-cultural significance. The wetlands are spread across various regions of Nepal, from the Terai region in the south to the Himalayan region in the north. These wetlands include lakes, ponds, rivers, marshes, and floodplains, and they provide a range of ecosystem services such as water regulation, nutrient cycling, habitat for biodiversity, and recreational opportunities.

Internationally, wetlands are defined as all areas that are permanently or intermittently inundated to a depth of water of maximum six meters (RCS, 2019). They are some of the most productive ecosystems globally (Thompson & Hollis, 1995), and therefore tagged as the “biological supermarkets” (Bhandari *et al.*, 2003). They play a crucial role in maintaining the water and nutrient cycles while also regulating the balance of the ecosystem. (Holland *et al.*, 1991; Lie and Cameron, 2001).



According to Turner, 1991, wetlands constitute 6% of the world's total land area. In Nepal, wetlands occupy approximately 5.5% of the country's land area. Nepal became a signatory to the Ramsar Convention in 1988 and has registered ten wetlands of international importance as Ramsar sites (Table 1).

Internationally important wetlands are significant ecological resources due to their high productivity and biodiversity. They help regulate the water cycle, storing water during periods of excess and releasing it during times of drought. Wetlands are also responsible for nutrient cycling and water purification, which helps to maintain water quality in surrounding ecosystems. These habitats serve as breeding and nesting grounds for a diverse array of plant and animal species, including migratory birds, amphibians, fish, and invertebrates.

These wetlands represent different geographical locations varying from low land of Terai to the high Himalayas. They possess a distinct combination of habitats that harbor an exceptionally diverse range of flora and fauna, which hold significant ecological value. However, a considerable portion of this biodiversity remains unexplored from a biological standpoint. (CSUWN, 2000). However, these wetlands are vulnerable and are subjected to over exploitation (Bhattarai, 2015).

Despite having a National Wetland

Policy and strategic plan, their implementation is insufficient. The current status of wetlands in Nepal is declining, indicating a need for urgent review and strong implementation of existing policies, programs, and institutional arrangements. Thus, this paper aimed to review the ecological significance and conservation issues of the Ramsar Sites in Nepal.

MATERIALS AND METHODS

This study provides a comprehensive review of the ecological importance of Nepal's internationally significant wetlands and the challenges they face in terms of conservation. The research analyzed 56 articles published between 1970 and 2021 on wetlands in Nepal, using keywords such as "wetland," "Nepal," "conservation issues," "ecosystem services," and "ecological value." Articles were selected for a systematic analysis, which was used to develop a logical discussion and draw conclusions about the ecological significance and conservation issues related to Nepal's wetlands.

In a study, Saadati *et al.* (2013) utilized the DPSIR (Drivers, Pressures, State, Impacts, and Responses) approach to investigate the status and conservation issues of wetlands. We used the same DPSIR analytical method which is a modified version of the widely used Pressure-State-Response (PSR) framework. The approach consists of five interconnected components.



"Drivers" are the forces including hydrologic and socioeconomic factors that cause environmental problems, such as encroachment and climatic conditions. "Pressures" are the human activities that directly cause environmental degradation, such as pollution and land use change. "State" refers to the existing environmental conditions influenced by driving forces and pressures. "Impacts" include the socioeconomic effects of environmental degradation, such as biodiversity loss and economic damage. "Responses" are actions taken by society to alleviate

environmental pressures and enhance environmental quality. Responses are best applied to driving forces to alleviate pressures and dependent system effects, but it can also be applied directly to each of driving force, pressure, state or impacts. By collecting data and information on each of the elements in the DPSIR chain, the possible connections between these different aspects were postulated, and the effectiveness of the responses put in place could be evaluated. (Fig.1) illustrates the schematic representation of the DPSIR model for this study.

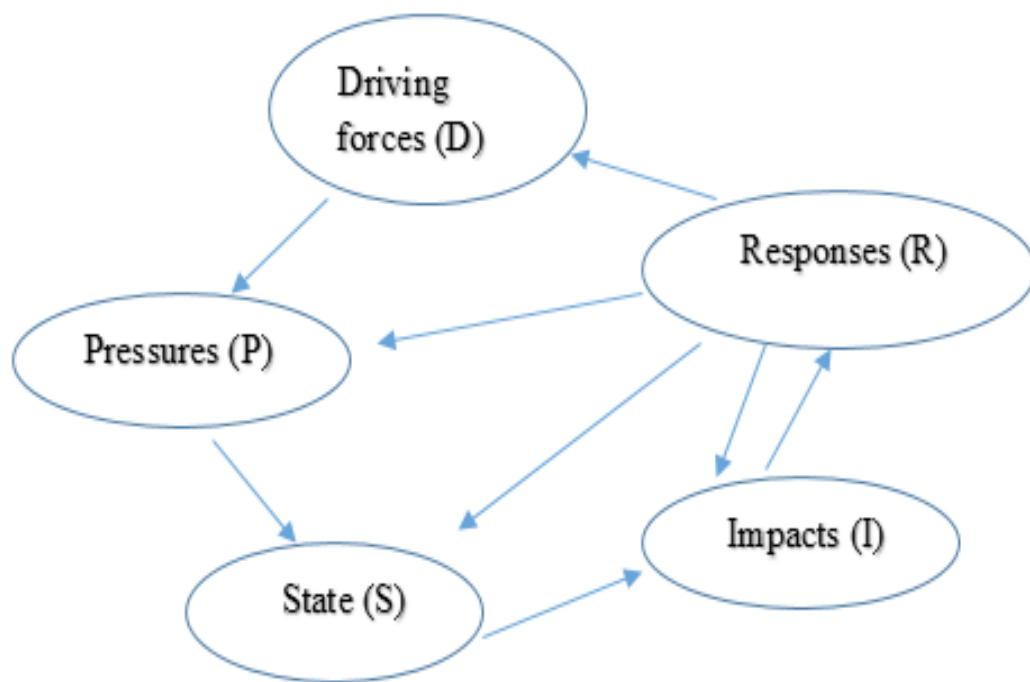


Figure 1: The systematic representation of DPSIR (adopted from Eurostat, 1997)

Information obtained through relevant journal available in Google scholar, policy and plan documents and article and report produced from

different institutions were thoroughly reviewed to derive the expected information.

RESULTS

The study investigates the overall status and conservation issues of ten internationally important wetlands that are registered as Ramsar sites in Nepal (Table 1) which are distributed

across different ecological regions of the country (Fig.2) To achieve this, we specifically focused on the ecosystem, ecosystem services, and their utilization practices, problems, and management responses of these wetlands.

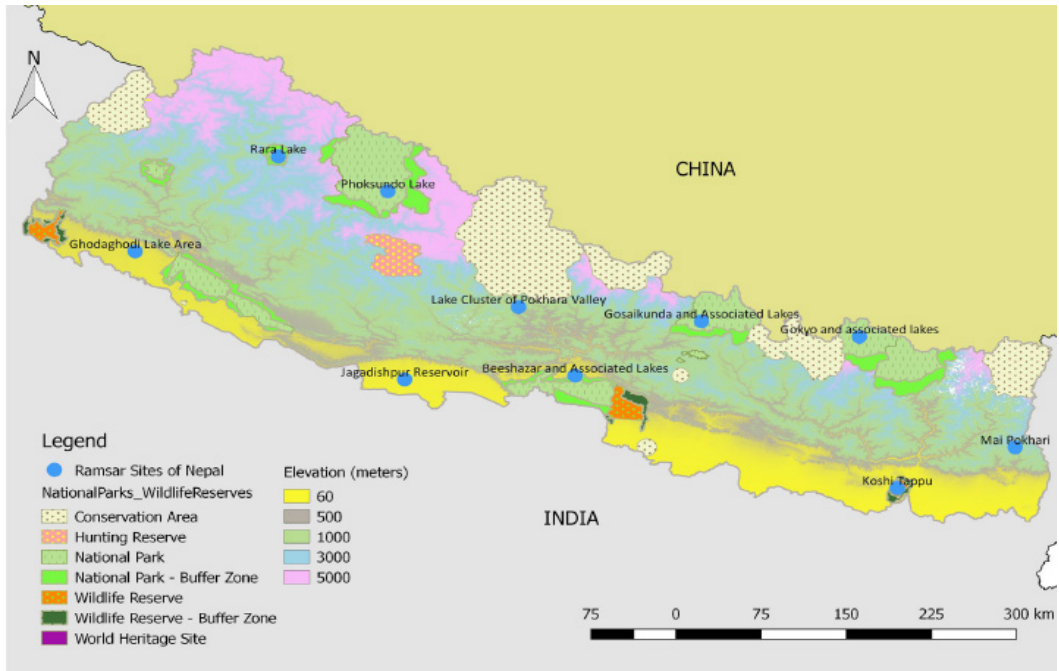


Figure 2: Spatial Distribution of Ramsar Sites in Nepal (NRSAP, 2018-2024)

Table 1: Wetlands of International Importance in Nepal

S. N.	Ramsar Site No.	Name	Location (District)	Designation Date (A.D.)	Area (ha)	Zone	Elevat (msl)
1	380	Koshi Tappu	Sunsari	17.12.1987	17,500	Terai	75-81
2	1313	Beeshazar and Associated Lakes	Chitwan	13.08.2003	3,200	Terai	286
3	1314	Ghodaghodi Lake Area	Kailali	13.08.2003	2,563	Terai	205
4	1315	Jagadishpur Reservoir	Kapilvastu	13.08.2003	225	Terai	197
5	1692	Gokyo and Associated Lakes	Solukhumbu	23.09.2007	7,770	Himal	4,700-5,000
6	1693	Gosaikunda and Associated Lakes	Rasuwa	23.09.2007	1,030	Himal	4,000-4,700
7	1694	Phoksundo Lake	Dolpa	23.09.2007	494	Himal	3,612
8	1695	Rara Lake	Mugu	23.09.2007	1,583	Himal	2,990
9	1850	Mai Pokhari	Ilam	28.10.2008	90	Midhills	2,100
10	2257	Lake Cluster of Pokhara Valley	Kaski	02.02.2016	26,106	Midhills	827
	Total				60,561		

Source: (DNPWC, 2016)



Ecological significance and use practices

Ecological significance of ten Ramsar sites of Nepal was explained in terms of wetland resources basically ecosystem, ecosystem services and

use practices. Some unique ecological importance (Ramsar Convention on Wetlands, 2019; DNPWC, 2019) which are presented in the Table 2 below. Table 2: Different ecological significance of internationally importance wetlands

SN	Name	Ecological values	Current use practices
1	Koshi Tappu	<ul style="list-style-type: none"> ✓ Biodiversity hotspot area with 514 plant species, 485 bird species, 200 species of fish, 31 species of mammals and 26 % of Nepal's herpetofauna (Chhetri <i>et al.</i>, 2013). ✓ Home to endangered species like <i>Python molurus</i>, <i>Bubalus bubalis</i>, <i>Platanista gangetica</i>, <i>Boselaphustragocamelus</i>, <i>Francolinusgularis</i> and <i>Hu-baropsis bengalensis</i> (Lam, 2004). 	<ul style="list-style-type: none"> ✓ Indigenous ethnic communities heavily depend on various primary resources, including fish, cattail (<i>Typha latifolia</i>) used for mat weaving, water for agricultural irrigation, medicinal plants, fodder for domestic animals, and firewood. These products serve as the main sources of sustenance for these communities.(BCN, 2008, Bhattarai, 2015).
2	Beeshazar and Associated Lakes	<ul style="list-style-type: none"> ✓ Biodiversity richness with 21 mammal species, 13 reptile species, 17 species of fishes, 37 species of aquatic insects, 273 bird species and 131 plant species (Bhandari 1998a). ✓ Excellent habitat as a water hole and corridor for <i>Gyps bengalensis</i>, <i>Panthera tigris</i>, <i>Rhinoceros unicornis</i>, <i>Gavialis gangeticus</i>, <i>Lutra perphisillata</i>, <i>Leptotilos javanicus</i>, <i>Aythya nyroca</i> and <i>Haileetus leucoryphus</i> (Thapa, 2010). 	<ul style="list-style-type: none"> ✓ The local population currently uses the wetlands for fishing, fodder and fuelwood collection, domestic use and supply of water for irrigation, regulating flow in the Khageri river for flood control (Lamichhane, 2016).



3	Ghodaghodi Lake Area	<ul style="list-style-type: none"> ✓ Wildlife corridor between the lowland and the Siwalik with 473 species of plants, about 16% avifauna (140 spp.) of the country along with 29 fish species (Jha, 2008). ✓ Support endangered species like <i>Kachugakachuga</i>, <i>Panthera tigris</i>, <i>Lutraperpiscillata</i>, <i>Cervus duvaucelli</i>, <i>Leptotilosjavanicus</i> and <i>Crocodylus palustris</i>, religiously important and threatened Lotus (<i>Nelumbo nucifera</i>), and rare wild rice (<i>Hygrohizaaristata</i>) (Lamsal et al., 2014). 	<ul style="list-style-type: none"> ✓ Lamsal et al. (2015) showed that the wetland has special religious importance for indigenous Tharu along with this local people extract fuelwood, fish, fodder, trapa (<i>Trapa natans</i>, <i>T. bicornis</i>) and sal (<i>Shorearoubusta</i>) leaf for their livelihood.
4	Jagadishpur Reservoir	<ul style="list-style-type: none"> ✓ Shelter for plants such as endangered <i>Rauvolfia serpentine</i>, rare <i>Potamogetonlucens</i>, threatened <i>Nelumbo nucifera</i>, along with endangered and the tallest flying bird species <i>Grus antigone</i> (IUCN, 2015). 	<ul style="list-style-type: none"> ✓ Fish farming, grazing, fuel wood and fodder collection, other forms of recreation like picnics, swimming, boating, bathing, etc and also providing an irrigation service to large command area measuring 6070 ha (Baral et al., 2016).
5	Gokyo and Associated Lakes	<ul style="list-style-type: none"> ✓ Support a number of IUCN redlisted rare and vulnerable species, such as <i>Picrorhizakurroo</i> plant, <i>Hemitragusjemplahicus</i>, <i>Uncia uncia</i>, <i>Gallinagonemorica</i>, endemic species like the flowering plant <i>Kobresiafissiglumis</i>, and many important birds like <i>Aythya nyroca</i> and <i>Grus vigor</i> (Karki et al., 2007). ✓ One of the most popular tourist destinations leading towards the Sagarmatha base camp and other peaks (Bhujju et al., 2007). 	<ul style="list-style-type: none"> ✓ World's highest freshwater lake system comprising six main lakes, and providing the vital source of water for downstream communities (Sharma et al., 2012).



6	Gosaikunda and Associated Lakes	<ul style="list-style-type: none"> ✓ Harbors plant species like <i>Meconopsisdhovjii</i>, <i>Primula aureata</i>, <i>Heraceleumlalii</i>, <i>Cremanthodiumnepalense</i> and animal species like <i>Muschuschrysogaster</i> and <i>Ailurus fulgens</i> (Shrestha & Joshi, 1996). ✓ Religious associations for Hindus and Buddhists and is the locus of the important Ganga-dashahara and Janaipurnima festivals (GoN, 2016). 	<ul style="list-style-type: none"> ✓ Tourism is the major source of income and this wetland acts as the important source of water for the famous Trishuli tributary of the Narayani River system of Nepal (Karki, 2007).
7	Phoksundo Lake	<ul style="list-style-type: none"> ✓ Habitat for a number of rare and vulnerable plants and animals, including <i>Uncia uncia</i>, <i>Moschus chrysogaster</i> and <i>Canis lupus</i> (Karki et al., 2007). 	<ul style="list-style-type: none"> ✓ Deepest fresh water lake (145m) and the important source of water for Thuli Bheri river of Nepal (DHM, 2019). ✓ Great cultural, religious and tourism importance has supported the people's livelihood (Bhujju et al., 2007).
8	Rara Lake	<ul style="list-style-type: none"> ✓ Unique floras and faunas which include 16 endemic flora, 51 species of mammals and 214 species of birds (Bhandari, 2009). ✓ The endemic frog <i>Paararica</i> along with three endemic species of snow trout, <i>Schizothorax macrophthalmus</i>, <i>S. nepalensis</i>, and <i>S. raraensis</i>, are found only here (Kafle et al., 2008). 	<ul style="list-style-type: none"> ✓ The Largest lake of Nepal, provides water to the important Karnali River, aesthetic beauty, local people earn through tourism and selling of medicinal plants (Basnet, 2010).
9	Mai Pokhari	<ul style="list-style-type: none"> ✓ The wetlands harbors around 300 species of birds and is the habitat for significant epiphytic orchids as well as for protecting species such as <i>Gyps bengalensis</i>, <i>Prionailurus bengalensis</i> and <i>Lutra Lutra</i> and endemic species like <i>Japalura variegata</i> (Kafle & Savillo, 2009). 	<ul style="list-style-type: none"> ✓ Wetland provides Significant religious-cultural value, ground water recharge, food, fresh water supply, recreation and aesthetic beauty (Rai, 2011).



10	Lake Cluster of Pokhara valley	<ul style="list-style-type: none"> ✓ The Site hosts a wide variety of globally threatened migratory birds such as the critically endangered <i>Aythya baeri</i> and <i>Gyps indicus</i>, and mammals such as the vulnerable <i>Neofelisnebulosa</i> and the endangered <i>Manis crassicaudata</i> (Ramsar convention, 2019). ✓ The lake holds 28 fish species, 11 amphibian species, 28 reptile species and 32 mammal species (DNPWC, 2016). 	<ul style="list-style-type: none"> ✓ Hydrological functions like recharging groundwater, controlling floods and trapping sediment, income from tourism, fishing, irrigation, electricity generation and water supply (Tamrakar, 2008).
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Common problems on wetland resources

Despite the numerous advantages provided by wetlands, such as ecological, economic, aesthetic, religious, and socio-cultural benefits, these ecosystems face several challenges that endanger their ecological integrity and disrupt their functions (Kafle *et al.*, 2008). The most common problems around all ten wetlands listed by (Ramsar Convention on Wetlands, 2019; NRSAP, 2018-2024) are:

- Loss/degradation of wetlands (sedimentation, overgrazing, over fishing, fish and bird poisoning, deforestation, habitat loss, poaching, encroachments

and park-people conflicts).

- Invasive Alien Species, eutrophication, Climate Change effects.
- Pollution due to infrastructure development and tourism.
- Depletion of species abundance and diversity, Loss of ecosystem integrity
- Inadequate Knowledge and Science-based Information

To obtain a brief overview of the conservation status of each wetland, we compiled a list of significant issues affecting these ecosystems based on various literature sources. The summarized findings are presented in Table 3:



Table 3: Major problems observed in Ramsar sites

Wetlands	Major problems				
	Encroachment	Pollution	Sedimentation	Invasive Species	Biodiversity Loss
Koshi Tappu					
Beeshazar					
Ghodaghodi					
Jagadishpur					
Gokyo					
Gosaikunda					
Phoksundo					
Rara					
Mai Pokhari					
Lake Cluster of Pokhara valley					



Problematic,



Less problematic

Legend colours represent;

Source: (NRSAP, 2018-2024; Karki et al., 2007; K.C. et al., 2012)

The identified major problems, such as pollution, sedimentation, encroachment, invasion of alien species, and biodiversity loss, pose significant threats to these Ramsar sites (Kafle and Savillo, 2009, Siwakoti & Karki, 2010) Pollution, including both point and non-point sources, is causing harmful impacts on wetland ecosystems by altering water quality and contaminating the soil, leading

to reduced biodiversity and degraded habitats. Sedimentation is also a significant issue that is affecting these wetlands, as it can reduce water quality, limit light penetration, and impact aquatic vegetation growth. Encroachment is another significant issue seen, that can affect Ramsar sites, particularly in areas where wetlands are located close to urban centers. This is leading to land-



use conflicts, where wetlands are converted for development or other human activities. Invasion of alien species is also a serious concern, as these species can outcompete native species, alter ecosystem functions, and impact overall ecosystem health. Similarly, biodiversity loss is a significant problem that affects many wetlands worldwide. The loss of biodiversity can have negative impacts on ecosystem functions, such as nutrient cycling, and can limit the benefits that wetlands provide to humans and other species. Furthermore, we utilized the DPSIR framework to gain a better understanding of the conservation status of Ramsar sites and identify gaps in conservation efforts.

DPSIR Framework analysis

The DPSIR framework, as illustrated in Figure 1, is a causal chain consisting of five elements. These have been described in depth throughout pertinent literature. The driving forces consist of any natural (biophysical) or human-induced (socio-economic) factors that can lead to environmental pressures. The expansion of croplands, invasion of alien species and climate change effects can serve as examples of driving forces in these Ramsar listed wetlands (Burlakoti & Karmacharya, 2004; Lamsal *et al.*, 2014). Pressures consist of the

driving forces consequences on the environment such as the pollution and the production of waste or noise and land use changes due to overexploitation in these wetlands (Siwakoti and Karki, 2009). As a result of pressures, the 'state' of the environment is affected; that is, the quality of the various natural resources (air, water, soil, etc.) in relation to the functions that these resources fulfill. The 'state of the environment' is thus the combination of the physical, chemical and biological conditions. The change in soil salinity, air and water quality along with the extinction of bird and fish can serve as pertinent examples in wetlands (Singh, 2001). Changes in the state may have an impact on human health, ecosystems, biodiversity, amenity value, financial value, etc. (Kafle, 2008). Impacts may be expressed in terms of the level of environmental harm occurring in the wetlands and finally, the responses demonstrate the social efforts to solve the problems identified by the assessed impacts, e.g. policy measures and planning actions, international cooperation and financing, awareness and wise use of the wetlands (NRSAP, 2018-2024; Kafle, 2008; Poudel, 2009). Furthermore, the linkage between different components of the wetlands interpreted through the DPSIR framework as shown in Figure 3.



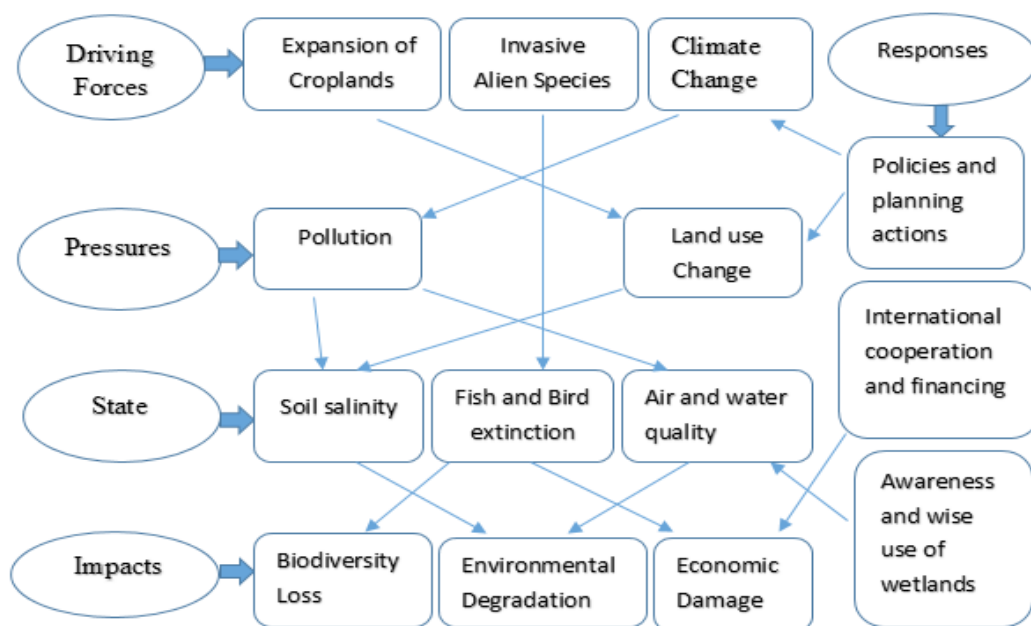


Figure 3: The DPSIR conceptual framework

Based on the findings from relevant literature and the application of the DPSIR framework, we have summarized the conservation status of internationally significant wetlands in Table 4. This table outlines the key driving forces, pressures, impacts, and responses associated with wetland conservation, highlighting the current

conservation status of each wetland. By identifying the gaps and challenges associated with wetland conservation, this table provides a comprehensive overview of the current state of these ecosystems and the need for increased conservation efforts to ensure their long-term sustainability.

Table 4: Conservation status of the Ramsar sitelisted wetlands of Nepal (NRSAP, 2018-2024; Karki et al., 2007; K.C. et al., 2012)

Drivers	Pressure	State	Impacts	Response
Expansion of crop land and chemical fertilizers use, Urbanization/ infrastructure development, Climate change, Invasion of alien species	Pollution (air, water, noise etc.), Land use change, Erosion and sedimentation, Prolonged drought period	Decline in soil and water quality, Loss of bird species, Loss of aquatic species, Decline in productivity	Loss of ecological values and functioning, Decline in ecosystem services, Vulnerability of associated community, Loss of recreational and use values	Ramsar Declaration, National wetland policy, Long-term strategy, Management plan

Conservation Issues

Wetland conservation is a growing concern in Nepal due to its impact on biodiversity and environmental services, such as freshwater for drinking and irrigation, aquatic plants, and organisms. Anthropogenic activities, such as encroachment, pollution, unsustainable harvesting, and haphazard construction along wetland areas, pose a significant threat to Nepal's wetlands (Siwakoti & Karki, 2010). According to the reviewed papers, the demographic and socio-economic conditions around wetlands are continually changing, with agriculture being the main source of income in the country. However, various businesses such as grocery shops, tailoring, fishing, tourism, handicrafts, teashops, and firewood collection also exist. The inhabitants residing in the vicinity of wetlands rely significantly on the resources provided by these wetland ecosystems (Bhattarai, 2015), both directly and indirectly, to meet their basic needs. Additionally, due to the lack of alternative energy sources, people living around wetlands are highly dependent on firewood for cooking. The overuse of wetland resources, as well as the degradation and loss of wetland habitats, threaten the biodiversity of Nepal's wetlands. Therefore, effective conservation strategies are necessary to protect these valuable ecosystems and the services they provide. Despite above mentioned various socio-

economic related conservation issues, a well-defined mechanism that can be effective in wetland management has not still been specified in wetland policy. Recently, (NRSAP, 2018-2024) discussed about sustainable financing as a growing issue and hence there is a need for innovative and sustainable financing mechanism to promote wetland conservation and local livelihoods. Programs through REDD++, World Bank, Asian Development Bank, Global Environmental Facility, Social obligation fund of enterprises, NGO, Inter-governmental organizations, and Government have been funding wetland conservation activities. So, institutional development and capacity building with multi stakeholders is another important conservation issue of the present time. The upstream activities directly or indirectly disturb the downstream environment (Singh, 2010). Hence, strengthening the upstream and downstream linkages is always a major conservation issues in wetlands. In addition, the lack of effective and implementation-oriented policy, plan, program and commitments with unclarity in the roles and responsibilities at all three tiers of government is another important conservation issues.

DISCUSSION

The Ramsar wetlands in Nepal are ecologically significant due to their capacity to support diverse plant



and animal species, many of which are at risk of disappearing which is also noted by (Singh, 2001). These wetlands play a crucial role in maintaining biodiversity in the region by providing habitats for these species. Furthermore, these wetlands provide a range of ecological advantages such as water purification, flood control, and carbon sequestration and also offer livelihood opportunities for local communities through activities such as fishing, agriculture, and tourism.

Although the Ramsar sites in Nepal are ecologically valuable, they are under threat from various factors such as degradation and loss of their habitats, overfishing, and pollution. To tackle these challenges, the Nepalese government has taken measures to manage and conserve these critical ecosystems (Ramsar Convention on Wetlands, 2019; DNPWC, 2019). These measures involve creating protected areas, community-led conservation initiatives, and imposing rules on fishing and other extractive activities. To address these challenges, as noted by (DNPWC, 2019) the government of Nepal has implemented a range of management practices aimed at protecting and conserving these vital ecosystems which is in fact the need of a time.

Wetlands are highly beneficial ecosystems that provide numerous advantages, such as ecological, economic, aesthetic, religious, and socio-cultural benefits. However,

these ecosystems face several challenges that threaten their ecological integrity and disrupt their functions, as pointed out by (Kafle et al., 2008). The challenges that are common to all ten wetlands listed by Ramsar Convention on Wetlands (2019) and NRSAP (2018-2024) include wetland loss or degradation due to factors such as sedimentation, overgrazing, overfishing, poisoning of fish and birds, deforestation, habitat loss, poaching, encroachment, and conflicts between the park and people. Other challenges include the presence of invasive alien species, eutrophication, and effects of climate change. Wetlands are also subject to pollution due to infrastructure development and tourism, leading to depletion of species abundance and diversity, and loss of ecosystem integrity. Furthermore, there is inadequate knowledge and science-based information regarding wetlands management and conservation.

The DPSIR framework is a useful tool for understanding the causal chain of environmental issues in Ramsar wetlands. The framework consists of five elements, each of which has been thoroughly described in various literature sources. (Lamsal et al., 2014) noted the first element, driving forces, refers to natural or human-induced factors that lead to environmental pressures such as land use changes, the spread of invasive species, and the impacts of climate change on these wetlands. The second element,



pressures, are the consequences of driving forces on the environment, including pollution, waste production, noise, and land use changes (Lamsal *et al.*, 2015). The third element, the state of the environment, is affected by pressures and refers to the quality of natural resources such as air, water, soil, and biodiversity (Siwakoti and Karki, 2009). Changes in the state of the environment can be measured by changes in soil salinity, water and air quality, and loss of bird and fish species. The fourth element, impacts, refers to the effects of environmental changes on human health, ecosystems, biodiversity, financial value, and other factors (Kafle, 2008). Impacts can be quantified in terms of the level of environmental harm occurring in the wetlands. The fifth and final element, responses, involves social efforts to address the problems identified by the assessed impacts, such as policy measures, planning actions, international cooperation and financing, and awareness and wise use of the wetlands (Poudel, 2009). Overall, the DPSIR framework provides a comprehensive and structured approach to understanding the complex and interrelated factors that contribute to environmental issues in Ramsar wetlands based on NRSAP (2018-2024).

(Thapa and Dahal, 2009) noted that conservation of wetlands is becoming increasingly important in Nepal, as it impacts biodiversity and environmental services such

as freshwater for drinking and irrigation, aquatic organisms, and plants. Human activities such as pollution, encroachment, haphazard construction, and unsustainable harvesting pose a significant threat to Nepal's wetlands (Siwakoti & Karki, 2010). The socio-economic activities around wetlands are continually evolving, with agriculture being the primary source of income in the country. However, there are various other businesses such as fishing, tourism, handicrafts, teashops, firewood collection, and grocery shops. People living in and around wetlands depend heavily on these resources, both directly and indirectly, to fulfill their basic needs. Furthermore, due to the lack of alternative energy sources, people living around wetlands rely heavily on firewood for cooking. The excessive use of wetland resources, as well as the degradation and loss of wetland habitats, pose a threat to the biodiversity of Nepal's wetlands which is also noted by (Burlakoti & Karmacharya, 2004) in their study. Therefore, effective conservation strategies are critical to safeguard these valuable ecosystems and the services they provide.

A clear and effective mechanism for wetland management has not yet been established in wetland policy, despite the various socio-economic issues mentioned earlier. Sustainable financing has become a growing concern for wetland



conservation, and innovative and sustainable financing mechanisms are needed to promote wetland conservation and support local livelihoods, as discussed by (NRSAP, 2018-2024). Wetland conservation activities are being funded by various programs and organizations such as REDD++, the World Bank, the Asian Development Bank, the Global Environmental Facility, social obligation funds of enterprises, NGOs, inter-governmental organizations, and governments. Institutional development and capacity building involving multiple stakeholders is also a crucial conservation issue at present. Activities in the upstream areas can indirectly or directly impact the downstream environment, so strengthening the linkages between upstream and downstream areas is another major conservation issue in wetlands, as noted by (Singh, 2010). Furthermore, the lack of clear and effective policies, plans, programs, and commitments with undefined roles and responsibilities at all levels of government is another important conservation issue that needs to be addressed promptly, according to (Poudel, 2009) and which is the fact.

CONCLUSION AND RECOMMENDATION

Based on the review of scholarly works on wetlands using the DPSIR approach, it has been concluded that Nepal is making satisfactory progress in demonstrating its commitment

to wetland conservation, and it has designated 10 wetlands as Ramsar sites. These sites have significant ecological value, as they maintain threatened flora and fauna species and hold religious and tourism importance. However, the livelihood dependency of impoverished communities on wetlands poses a challenge to conservation efforts, with various stakeholders at the community level having diverse interests. Despite the recognition of their importance, these wetlands are under pressure from anthropogenic and natural factors. Issues such as legal and policy matters, documentation of indigenous knowledge systems, coordination among public and private institutions, valuation, benefit sharing, and financial resource mobilization in wetland management, and building an understanding of ecological functioning and principles in decision-making processes are major challenges to wetland conservation. Therefore, individuals from various backgrounds must work together at local, national, and international levels to adopt a strategic approach to wetland management through community participation, monitor ecological changes, disseminate information, and design appropriate restoration plans. More research is necessary in this field, and there is a growing need for all three tiers of government to promote wetland conservation and reduce their degradation.



REFERENCES

- Baral, S., Basnyat, B., Khanal, R., & Gauli, K. (2016). *A total economic valuation of wetland ecosystem services: An evidence from Jagadishpur Ramsar site, Nepal*. The Scientific World Journal, 2016.
- Basnet, B. K. (2011). *Documentation of flora of Rara lake and adjoining areas in mid-western region of Nepal*. Banko Janakari, 21(1), 41–47.
- BCN. (2008). *General Overview of Koshi Tappu wildlife Reserve*. Bird Conservation Nepal.
- Bhandari, B. (1998a). *A study on conservation of Beesh Hazar Tal*. Kathmandu: IUCN Nepal. 42 p.
- Bhandari, B.B. (2009). *Wise Use of Wetlands in Nepal*. Banko Janakari, pp. 10-17..
- Bhandari, B. (1970). *Wise use of Wetlands in Nepal*. Banko Janakari, December, 10–17. <https://doi.org/10.3126/banko.v19i3.2206>.
- Bhandari, B.B., Osamu, A., Masahiro, T. & Akihiro, N. (2003). *Doing Education at Wetland Sites: Examples and Modalities from Asia, Japan*: International Institute for Global Environmental Strategies (IGES), Ramsar Center Japan and Mahidol University.
- Bhattarai, M. (2015). *Conservation issues and utilization of wetlands in Nepal: a case study from Koshi Tappu Wildlife Reserve*. M.sc. thesis, NTNU.
- Bhujui, U. R., Shakyaa, P. R., Basnet, T. B., & Shrestha, S. (2007). *Nepal biodiversity resource book: protected areas, Ramsar sites, and World Heritage sites*. International Centre for Integrated Mountain Development (ICIMOD).
- Burlakoti, C., & Karmacharya, S. B. (2004). *Quantitative analysis of macrophytes of Beeshazar Tal, Chitwan, Nepal*. Himalayan Journal of Sciences, 2(3), 37–41.
- Chettri, N., Uddin, K., Chaudhary, S., & Sharma, E. (2013). *Linking Spatio-temporal land cover change to biodiversity conservation in the koshi tappu wildlife reserve, Nepal*. Diversity, 5(2), 335–351. <https://doi.org/10.3390/d5020335>.
- CSUWN. (2000). *Nepal Wetlands*. In: Ministry of Forest and Soil Conservation..
- DHM. (2019). *Preparation of Bathymetric Map of Phoksundo Lake of Dolpa to Update its Inventory*. Kathmandu: Department of Hydrology and Meteorology.
- DNPWC. (2016). *Protected Areas of Nepal*. Department of National Parks and Wildlife Conservation, Babar Mahal, Kathmandu.
- DNPWC. (2019). *Protected Areas of Nepal*. Department of National Parks and Wildlife Conservation, Babar Mahal, Kathmandu.
- Eurostat. (1997). *Indicators of Sustainable Development: a Pilot Study Following the Methodology of the United Nations Commission on Sustainable Development*. Office for Official Publications of the European Communities.
- Finlayson 1, C. M., Davidson 2, N., Pritchard 3, D., Milton 4, G. R., & MacKay 5, H. (2011). *The Ramsar Convention and ecosystem-based approaches to the wise use and sustainable development of wetlands*. Journal of International Wildlife Law & Policy, 14(3-4), 176-198.
- Gereta, E. J. (2010). *The role of biodiversity conservation in the development of the tourism industry in Tanzania. Conservation of Natural Resources: Some Africans and Asian Examples*. Tapir Academic Press, Trondheim, Norway.
- GoN. (2013). *Good Practices and Lesson Learned from the Conservation and Sustainable Use of Wetlands in Nepal Project*. Kathmandu, Nepal.
- GoN. (2016). *Ministry of Culture, Tourism and Civil Aviation*. www.tourism.gov.np.
- Holland, M. M., & Risser, P. G. (1991). *The role of landscape boundaries in the management and restoration of changing environments: introduction*. In Ecotones (pp. 1-7). Springer, Boston, MA.
- IUCN. (2015). *Biodiversity and Livelihoods Assessment in Jagadishpur Reservoir Ramsar Site*, International Union for Conservation of Nature, Kathmandu, Nepal.



- Jha, S. (2008). *Status and Conservation of Lowland Terai Wetlands in Nepal*. *Our Nature* 6: 67-77.
- Kafle, G., Balla, M.K. & Paudyal, B.K. (2008). *A Review of Threats to Ramsar Sites and Associated Biodiversity of Nepal*, FAO. Tiger Paper. 35(1).
- Kafle, G and Savillo, IT, (2009). *Present status of Ramsar sites in Nepal*. *International Journal of Biodiversity and Conservation* Vol. 1(5) pp. 146-150 September, 2009, <https://doi.org/10.5897/IJBC.9000114>
- Karki, J.B. (2007). *Some wetlands of high himal and middle mountain region of Nepal (in Nepali: Nepal ka Uccha Himali ra Madhya Pahadi Chhetra Ka Kehi Simsarharu*. *Paryabaran Monthly*, vol 14, no-9.
- Karki, J. B., Siwakoti, M., & Pradhan, N. S. (2007). *High Altitude Ramsar Sites of Nepal: Criteria and Future Ahead*. *The Initiation*, 1, 9-15.
- KC, J. K., Gurung, K. D., & Shrestha, P. D. (2013). *Lowland Wetlands in Nepal*. *The Initiation*, 5, 182-193.
- Lam, L. M. (2004). *A study of stated attitudes and behaviour of local people toward conservation in Koshi Tappu Wildlife Reserve, Nepal*. A Paper Presented at the 15th Biennial Conference of the Asian Studies Association of Australia in Canberra 29th June-July.
- Lamichhane, S., Kandel, R. C., Pokheral, C. P., Dahal, T. P., & Bhattarai, S. (2016). *Biodiversity profile of Beeshazar and associated lakes, Chitwan*. DNPWC, CNP, NTNC, Norad, Ramsar Site International.
- Lamsal, P, Pant, K. P., Kumar, L., & Atreya, K. (2014). *Diversity, uses, and threats in the Ghodaghodi Lake complex, a Ramsar site in western lowland Nepal*. *International Scholarly Research Notices*, 2014.
- Lamsal, P, Pant, K. P., Kumar, L., & Atreya, K. (2015). *Sustainable livelihoods through conservation of wetland resources: a case of economic benefits from Ghodaghodi Lake, western Nepal*. *Ecology and Society*, 20(1).
- Liu, A. J., & Cameron, G. N. (2001). *Analysis of landscape patterns in coastal wetlands of Galveston Bay, Texas (USA)*. *Landscape Ecology*, 16(7), 581-595.
- NRSAP. (2018-2024). *Ministry of Forests and Environment*, Singha Durbar, Kathmandu, Nepal.
- Poudel, B.S. (2009). *Wetland Conservation in Nepal: Policies, Practices, Problems and Possibilities*. Banko Janakari, pp: 3-9.
- Rai, K.R.K. (2011). *Comparative studies on lentic environment of Mai Pokhari, Ilam and Kechana jheel wetland ecosystems, Jhapa, Nepal (With reference to bottom dwelling fauna)*. *Nepalese Journal of Biosciences*, 1: 32-36.
- Roy, M. B., Roy, P. K., Samal, N. R., & Mazumdar, A. (2012). *Socio-economic valuations of wetland based occupations of lower gangetic basin through participatory approach*. *Environment and Natural Resources Research*, 2(4), 30.
- Saadati, S., Motevallian, S. S., Rheinheimer, D. E., & Najafi, H. (2013). *Indicators for sustainable management of wetland ecosystems using a DPSIR approach: A case study in Iran*. *Proceeding of: 6th International Perspective on Water Resources & the Environment Conference (IPWE 2013)*, At Izmir, Turkey.
- Sharma, B., Rasul, G., & Chettri, N. (2015). *The economic value of wetland ecosystem services: Evidence from the Koshi Tappu Wildlife Reserve, Nepal*. *Ecosystem Services*, 12, 84-93. <https://doi.org/10.1016/j.ecoser.2015.02.007>.
- Sharma, C. M., Sharma, S., Bajracharya, R. M., Gurung, S., Jüttner, I., Kang, S., Zhang, Q., & Li, Q. (2012). *First results on bathymetry and limnology of high-altitude lakes in the Gokyo Valley, Sagarmatha (Everest) National Park, Nepal*. *Limnology*, 13(1), 181-192.
- Shrestha, B., Shrestha, S., Shrestha, A., & Khadka, U. R. (2020). *Ramsar sites in Nepal: Conservation, present scenario, biodiversity value and threats*. *Journal of Wetlands Ecology*, 2020(September), 0-15. <https://doi.org/10.3126/jowe.v2020i0.24782>.



- Shrestha, R. K., & Alavalapati, J. R. R. (2006). *Linking conservation and development: An analysis of local people's attitude towards Koshi Tappu Wildlife Reserve, Nepal*. Environment, Development and Sustainability, 8(1), 69–84.
- Shrestha, T.B. & Joshi, R.M. (1996). *Rare, endemic and endangered plants of Nepal*. WWF Nepal Program, Kathmandu, Nepal. 244p.
- Shrestha, U. (2013). *Community Participation In Wetland Conservation In Nepal*. Journal of Agriculture and Environment, 12, 140–147. <https://doi.org/10.3126/aej.v12i0.7574>.
- Singh, B.K. (2010). *Assessment of the Upstream Chure Hills and Downstream Tarai Plains Linkage: An Environmental Services Perspective*. Banko Janakari, 20 (1), 17-23.
- Singh, B.P. (2001). *The Eastern Himalaya: Wetlands, Forests and Beliefs*. Economic and Political Weekly, 2968-2975.
- Siwakoti, M., & Karki, J. B. (2010). *Conservation status of Ramsar sites of Nepal Tarai: an overview*. Botanica Orientalis: Journal of Plant Science, 6, 76–84. <https://doi.org/10.3126/botor.v6i0.2914>.
- Tamrakar, R. (2008). *Status and Biodiversity of Lakes and Ponds of Lekhnath Municipality*. Thesis for the partial fulfillment of Bachelors Degree, Institute of Forestry. Pokhara, Nepal.
- Thapa, D. (2010). *Bio-Diversity Conservation in Nepal*. Bibechana, 6, 31-36.
- Thapa, I. & Dahal, B. (2009). *Sustainable wetland management for wildlife and people at Koshi Tappu Wildlife Reserve*. BankoJanakari, 19, 36-39.
- Thapa, S., Wang, L., Koirala, A., Shrestha, S., Bhattarai, S., & Aye, W. N. (2020). *Valuation of Ecosystem Services from an Important Wetland of Nepal: A Study from Begnas Watershed System*. Wetlands, 40(5), 1071–1083. <https://doi.org/10.1007/s13157-020-01303-7>.
- The Ramsar Convention on Wetlands. (2019). www.ramsar.org. Ramsar Convention Secretariat, Gland, Switzerland.
- Thompson, J.R. & Hollis, G.E. (1995). *Hydrological modelling and the sustainable development of the Hadejia-Nguru wetlands, Nigeria*. Hydrological Sciences Journal, 40, 97-116.
- Turner, K. (1991). *Economics and Wetland Management*. Ambio, 20, 59-63.
- Upadhaya, S., Chalise, L., & Paudel, R. P. (2009). *High altitude ramsar sites of Nepal*. The Initiation, 3, 135-148.
- Wetlands International/Ramsar (2019). www.wetlands.org. Ramsar Sites Information Service, Wetlands International and Ramsar Convention Secretariat.
- Wilcox, A.D. (2008). *Education and Training of Future Wetland Scientists and Managers*. Wetlands. 28: 578- 584.

