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People's perception of the impacts of drivers of degradation on Hokersar Wetland in Kashmir Himalaya

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Abstract

Hokersar wetland is endowed with diverse flora and fauna, which deliver vast socio-economic and environmental values. However, this wetland is exposed to severe degradation due to various anthropogenic factors, which impose major constraints on conservation planning. The study was carried out to assess the impacts of anthropogenic drivers of degradation on Hokersar wetland in the Kashmir Himalaya and suggest conservation strategies. Multi-stage random sampling was the procedure employed to select the villages (10) and the households (195). Structured interviews, focus group discussions, and non-participant observations were used to gather data. The findings indicated that the most effective driver of wetland degradation is pollution inputs (fertilizer, sediment, human sewage, pesticides, animal waste, etc.) (WMS, 2.89) which was followed by expansion for agriculture (WMS, 2.08), population growth/encroachment (WMS, 1.93), ambiguous property rights (WMS, 1.87), poverty/subsistence/unemployment (WMS, 1.76), livestock grazing/fodder extraction (WMS, 1.71), governmental apathy (WMS, 1.64), lack of awareness about the importance of wetlands (WMS, 1.53), fuel wood/pole collection (WMS, 1.2), and disturbance by tourism (WMS, 1.1). The percentage contribution of drivers to wetland degradation varied from 6.24% to 16.32%, with the maximum being pollution inputs (fertilizer, sediment, human sewage, pesticides, animal waste, etc.) and the lowest being disturbance by tourism. The influences of anthropogenic activities on wetland degradation assessed in this research will be the basis for future planning and establishing wetland-friendly environment with a view to reduce negative impacts of the drivers of degradation on Hokersar wetland.

Keywords: People's perception, drivers of degradation, Hokersar wetland, Kashmir Himalaya

Introduction

Wetlands are significant components of the terrestrial landscape, having valuable biological productivity, vast resource potential, and innumerable environmental functions (Ganaie *et al.*, 2020) [4]. They play a crucial role in a variety of processes, including flood management, aquifer replenishment, natural sewage treatment, residential use, habitat preservation, irrigation, energy production, and more (Song *et al.*, 2014) [27]. Hokersar wetland (34°06' N latitude, 74°05' E longitude), a Ramsar site and a protected wildlife reserve is located in the northwest Himalayan biogeographic province of Kashmir, back of the snow-draped Pir Panchal. Approximately two million migratory water fowl from Siberia and Central Asia migrate and spend the winters in the wetland. Two inlet streams, Sukhnag Nalla (from the west) and Doodhganga (from the east), feed the wetland. The wetland in the Doodhganga catchment reaches a maximum depth of 2.5 metres in the spring due to an increase in discharge from snowmelt water in the upper parts. In the autumn, the depth of water is at its lowest. The wetland area decreased from 18.75 km² in 1969 to 13.00 km² in 2008 due to human intervention and natural changes (Joshi *et al.*, 2002 [10]; Romshoo and Rashid, 2014) [21]. In the last forty years, this wetland has lost 5.75 km² (Romshoo and Rashid, 2014) [21]. Macrophytic species such as *Acorus calamus*, *Euryale ferox*, and *Nelumbo nucifera* have disappeared from the wetland over the last two to three decades (Khan *et al.*, 2004) [11]. The wetland is now choked by invasive species like *Azolla* spp., *Salvinia natans, and Menynanthese* spp. (Khan *et al.*, 2004) [11]. The Hokersar Wetland is the largest bird reserve in Kashmir Valley (Rather and Pandit, 2002) [19] and a Ramsar site known for large gatherings of various species of birds, particularly in the winter. The wetland provides shelter and plants of the wetland act as food for thousands of winter migratory birds. These plants have a high nutritional content, which attracts a

huge number of birds (Gibbs, 1993; Paracuellos, 2006) [5], [16]. It's also important to note that, in recent decades, the wetland's water quality has substantially declined (Shah *et al.*, 2019) [23], owing primarily to urbanization in the area (Romshoo *et al.*, 2011) [22]. The symptoms of wetland degradation are also attributed to the catchment's uncontrolled use of fertilizers and pesticides for agriculture and horticulture, which ultimately find their way into the wetland via the Doodhganga River. This fact is corroborated by the physicochemical characteristics of the wetland, as reported by Pandit and Kumar (2006) [14].

The wetlands have been overexploited and destroyed unabatedly by the rapidly increasing human population. The anthropogenic pressure poses a serious threat to the wetland ecosystem and the numerous benefits it supports. As a result, some major anthropogenic factors, have affected the structure of the wetlands and delivered ecosystem disservices to human wellbeing (Smalling *et al.*, 2015) [24]. The Hokersar wetland of Kashmir is not an exception to this, which is exposed to several anthropogenic factors causing degradation at different levels. Along the Srinagar-Baramulla highway, the wetland's northern edge is bounded by populated areas. The area is densely populated, and eutrophication and poaching are important concerns (Habib, 2014) [6]. The rapid increase in population in recent years has resulted in the establishment of new human settlements in the lake's catchment area. Also, extensive areas of forest were converted to cultivation and farms, resulting in the terrestrial ecosystem being opened up, with heavy loads of nutrients seeping into the lake from the fertile top soil of the catchment area (Bano *et al.*, 2018) [1]. To maintain the ecosystem services of the wetland, the identification of anthropogenic factors and their effectiveness need to be assessed. And accordingly, appropriate policies on conservation and management, rules, and regulations need to be established, and action should be taken to sustain the potential and life span of Hokersar wetland. The investigation's objectives were 1) to identify the main anthropogenic factors causing the degradation of wetland and 2) to assess the impacts of anthropogenic factors on wetland degradation in the Hokersar wetland of Kashmir.

Materials and Methods

Study area description

The study was conducted in the fringe villages of Hokersar wetland, situated at latitude 34º0' to 34º10' N, longitude 74º40' to 74º45' E, and altitude 1,584 m amsl the Kashmir Himalaya (Fig. 1). The wetland, located about 10 kilometers west of Srinagar, used extend over an area of 13.26 sq km but has since shrunk to 5.6 sq km (Yousuf and Shah, 2000) [28]. The area has a sub-mediterranean climate, experiencing 7.5 °C winter temperatures and 19.8°C summer temperatures, with an average rainfall of 6150 mm (Pandit and Qadri, 1990) [15]. The wetland is surrounded by a population of 72,000 people, residing in twelve villages (Census of India, 2011) [2].

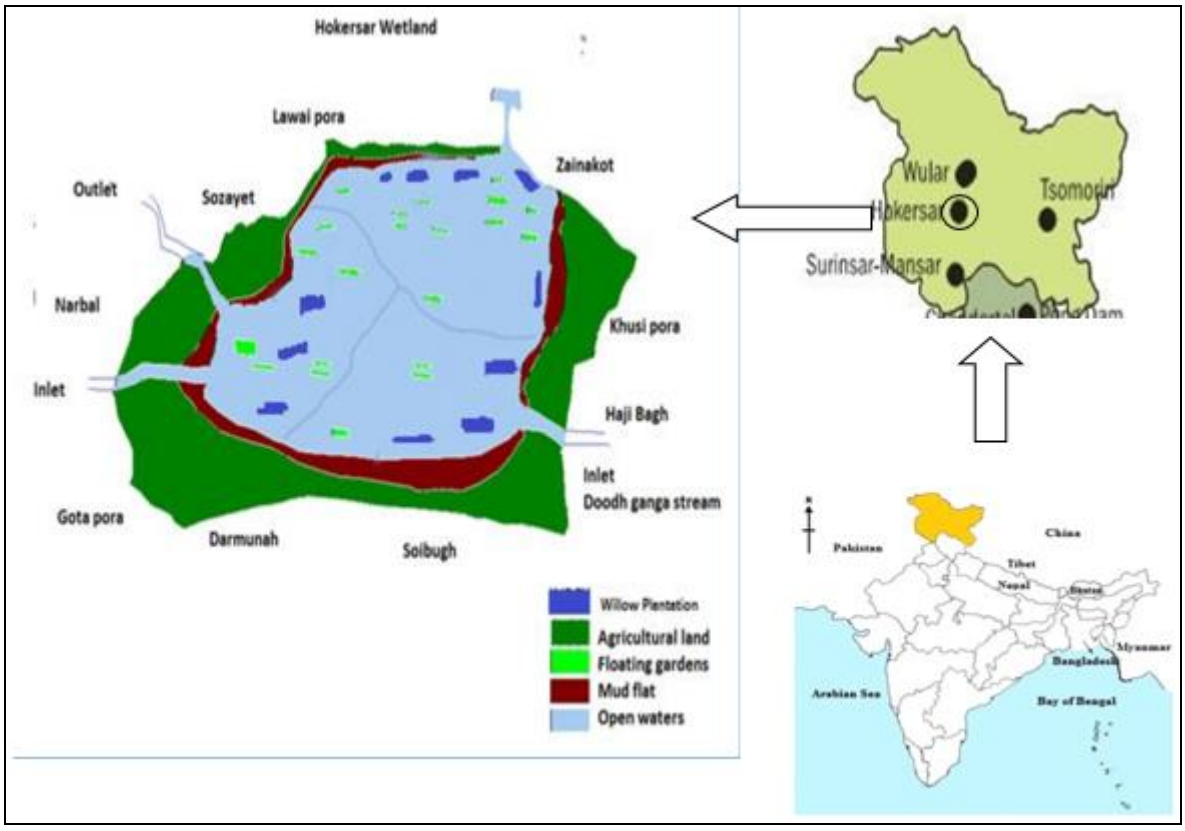

Fig 1: Map locating the study area

Sampling procedure

Multi-stage random sampling was the method (Ray and Mondol, 2004) [20] administered to select the villages and the households. In the first stage, ten villages including Sozeith, Gund Hasibat, Khushipora, Zainakote, Shariafabad and Lawaypora from Srinagar district and Gotapora, Dahar munnah, Soibugh and Hajibagh from Budgam district were selected. In the second stage, a total of 195 households were

selected from the sample villages having 5% sampling intensity by simple proportionate random sampling technique.

Data collection

Data were gathered using a well-structured pre-tested interview schedule, non-participant observations and focus group discussions (FGDs) (Kumar, 2012) [12]. The interviews were conducted at the respondent's residence and the answers were recorded in the schedule. Utmost care was taken to make the respondents to understand about the purposes of the study and clarified their doubts in the interview schedule. In light of the study's objectives, an interview schedule was designed to collect data from respondents. Under non-participant observation the data were recorded by watching and noting the phenomena. FGDs were conducted, involving 8 to 12 experienced and knowledgeable people. To get the people's perception towards the Hokersar wetland degradation, ten broad classes of drivers were incorporated in the schedule and their degree of effectiveness were measured by a 3-point continuum scale, namely, highly important (HI), moderately important (MI) and least important (LI) with their respective scores 3, 2 and 1 (Islam *et al.*, 2015) [8]. The ranking of drivers was done from 1 to 10 based on the mean score to determine their relative importance.

Analytical procedure

To accomplish the objectives and to get meaningful results the data were analyzed by the descriptive statistics *viz*., frequency, percentage, average and rank order (Snedecor and Cochran 1967) [25] after coding with numerals using scoring techniques (Islam *et al.*, 2022) [7]. The findings were calculated as weighted mean score (WMS) for each of the fringe villages using simple ranking technique. The weighted mean score (WMS) for each driver was calculated by multiplying the frequencies with their respective scores, adding them up and dividing by the total number of people as follows:

$$\text{Weighted mean score (WMS)} = \frac{(\text{No. of HI}\times 3) + (\text{No. of MI}\times 2) + (\text{No. of LI}\times 1)}{\text{Total no. of HI + MI + LI}}$$

Where,
HI = Highly important,
MI = Moderately important
LI = Least Important

Data were processed and analyzed with MS Excel and SPSS software and displayed through table and graph.

Results

Perceptions regarding drivers of wetland degradation

In the study, we delve into the intricate web of drivers contributing to Hokersar wetland degradation. The local people's perceptions (Fig. 2) indicated that out of the 10 key drivers identified, pollution inputs (fertilizer, sediment, human sewage, pesticides, animal waste, etc.) (WMS, 2.89) was considered the most effective driver of wetland degradation and assigned the 1st rank. It was followed by expansion for agriculture (WMS, 2.08; rank 2nd), population growth/encroachment (WMS,1.93; rank 3rd), ambiguous property rights (WMS,1.87; rank 4th), poverty/ subsistence/ unemployment (WMS, 1.76; rank 5th), livestock grazing/fodder extraction (WMS,1.71; rank 6th), governmental apathy (WMS,1.64; rank 7th), lack of awareness about importance of wetlands (WMS,1.53; rank 8th), fuel wood/ pole collection (WMS,1.20; rank 9th) and disturbance by tourism (WMS,1.10; rank 10th) (Table 1).

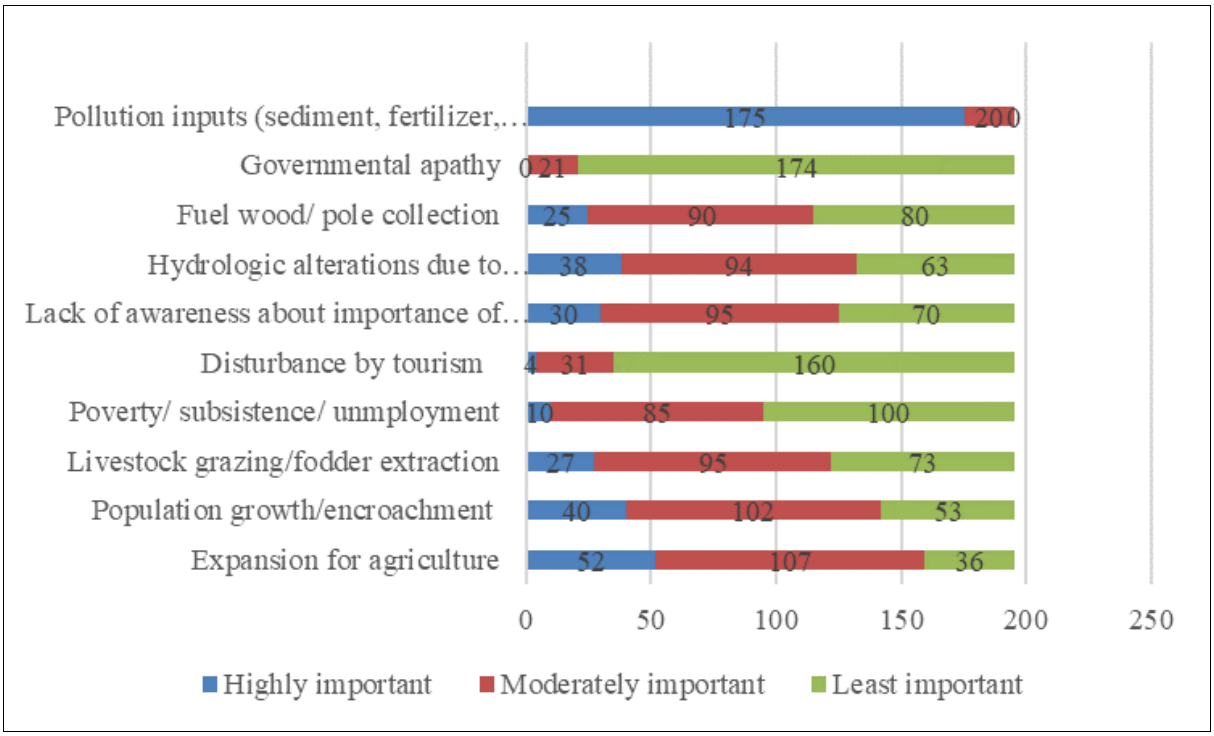

Fig 2: Respondents' distribution to the realization of drivers of wetland degradation

Table 1: The respondent's perception on the drivers of wetland degradation (N=195)

Drivers of wetland degradation	Perception			TWS	WMS	Mean rank
	HI	MI	LI			
Expansion for agriculture	52 (26.66)*	107 (54.87)	36 (18.46)	406	2.08	2nd
Population growth/encroachment	40 (20.51)	102 (52.30)	53 (27.17)	377	1.93	3rd
Poverty/ subsistence/ unemployment	27 (13.85)	95 (48.72)	73 (37.43)	344	1.76	5th
Lack of awareness about importance of wetlands	10 (5.12)	85 (43.59)	100 (51.28)	300	1.53	8th
Fuel wood/ pole collection	4 (2.05)	31 (15.90)	160 (82.05)	234	1.20	9th
Governmental apathy	30 (15.38)	95 (48.71)	70 (35.89)	320	1.64	7th
Ambiguous property rights	38 (19.48)	94 (48.21)	63 (32.30)	365	1.87	4th
Livestock grazing/fodder extraction	25 (12.82)	90 (46.16)	80 (41.02)	335	1.71	6th
Disturbance by tourism	0 (0.00)	21 (10.78)	174 (89.22)	216	1.10	10th
Pollution inputs (fertilizer, sediment, human sewage, pesticides, animal waste, etc.)	175 (89.74)	20 (10.25)	00 (00.00)	565	2.89	1st

Note: HI= Highly important; MI= Moderately important; LI= Least important; TWS= Total weighted score; WMS= Weighted mean score; *= Figures in the parentheses shows percentage

Impacts of anthropogenic drivers on wetland degradation

Figure 3 illustrates the percentage contribution of drivers to wetland degradation. It shows the driver which contributes maximum (16.32%) to wetland degradation was pollution inputs (fertilizer, sediment, human sewage, pesticides, animal waste, etc.), which was followed by expansion for agriculture (11.73%), population growth/encroachment (10.89%), ambiguous property rights (10.54%), poverty/ subsistence/ unemployment (9.94%), livestock grazing/fodder extraction (9.68%), governmental apathy (9.24%), lack of awareness about importance of wetlands (8.67%), fuel wood/ pole collection (6.76%) and disturbance by tourism (6.24%).

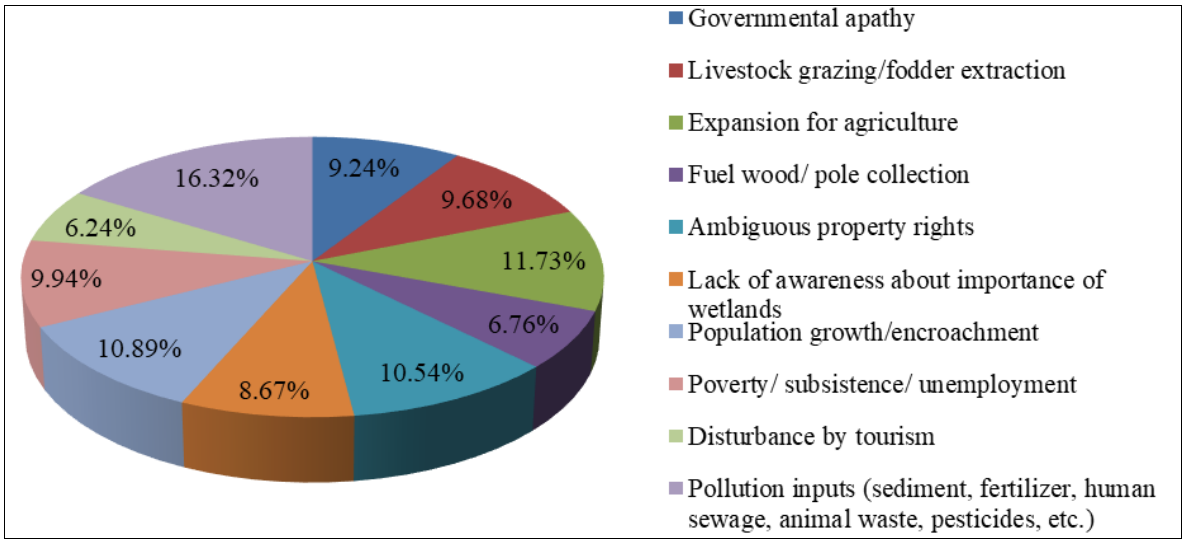

Fig 3: Contribution of anthropogenic drivers on wetland degradation (N=195)

Discussion

People' perceptions of impacts of drivers of wetland degradation were prioritized using a grading system. All the identified drivers, as stated above, had considerably decreased both the quantity and quality of Hokersar wetland, resulting in a negative impact on the ecosystem services (Fig. 4) and livelihoods of the people. Wetlands play an important role in supporting livelihoods and alleviating poverty in fringe communities. Several wetland resources are used by these communities for financial gain, nutrition, healthcare, and other basic needs. Several studies (Chen *et al.*, 2015; Zou *et al.*, 2017) [3, 29] across the world have emphasized the importance of wetlands in safeguarding local livelihoods and conserving regional biodiversity. The awareness of protection and efficient management of wetland resources has been demonstrated by the local people. The approach undertaken to explore and document the impacts of anthropogenic drivers of degradation on Hokerser wetland will provide a basis and lessons for its conservation for upcoming generations and will assist in human well-being. Pal and Talukdar (2018) [13] observed similar findings, wherein flow modification triggered by the Komardanga dam has emerged as a major reason behind the loss of wetlands in the Punarbhaba River Basin of India-Bangladesh, followed by the transformation of wetlands to agriculture extension. Wular Lake's water quality has declined as a result of unplanned settlement growth, unscientific agricultural and horticultural practices, and a lack of sewage treatment systems in the area (Jamal *et al.*, 2022) [9]. Rashid *et al.* (2017) [18], in a study, stated that anthropogenic actions such as urbanization, agricultural-intensive practices both within and outside of the lake, and untreated sewage from the catchment all have a negative impact on Dal's water quality. Although the lake has four sewage treatment plants (STP), none of them are located in the lake's south-eastern portion, where the waters are

heavily polluted. The study (Rashid *et al.*, 2013) [17] informed that Manasbal Lake is deteriorating because of increased nutrient and silt loads from stone quarrying and unplanned urbanization near the wetland. The wetland's water quality is deteriorating, and variations in flora and fauna distribution have significantly impacted the lake's trophic status. The lake's degradation threatens the livelihoods of those who rely on it for goods and services. Anthropogenic actions in the Manasbal catchment have significant ecological and socioeconomic impacts. Ethiopian wetlands face numerous threats, including drainage for agriculture, overgrazing, invasion of alien species, degradation of catchment lands, overharvesting of resources, urbanization, population growth, water diversion, destructive tree plantation, and pollution (Soboka and Gemechu, 2021) [26].

(a) Waste dumped near Hokersar wetland (b) Agriculture expansion

(c) Excessive grazing (d) Reckless growth of Azolla in the wetland

Fig 4: Anthropogenic drivers of degradation on Hokersar wetland

Conclusion

The study offers insightful details regarding the drivers of Hokersar wetland degradation, emphasizing the intricate interactions between human activity and natural ecosystems. The identified drivers of degradation act synergistically to exacerbate the loss and degradation of wetlands worldwide, threatening the invaluable services they provide to both humans and biodiversity. Addressing Hokersar wetland degradation requires a multifaceted approach that integrates policy interventions, scientific research and innovative management strategies. Moreover, technical and financial support is to be extended to the local communities under different government schemes for better biodiversity conservation, ecosystem services, and human well-being. Awareness programmes and capacity building should be conducted for the fringe communities. By implementing these conservation strategies in a coordinated and collaborative manner, it is likely to mitigate the degradation of Hokersar wetland and promote its long-term ecological sustainability.

Conflict of Interest Statement

The authors declare that they have no potential conflicts of interest, whether financial or non-financial.

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