

ASSESSMENT OF CURRENT STATUS AND THREATS TO IMPORTANT WETLANDS IN KASHMIR VALLEY

Ishfaq Hussain Malik

Assistant Professor, Department of Geography, S P College Srinagar, Cluster University
Srinagar, Email: mulikishfaq@gmail.com

Abstract

Wetlands are the most diverse, dynamic, productive, and ecologically sensitive ecosystems on the planet. The Kashmir Himalayas are endowed with a plethora of beautiful wetlands. These wetlands play an important role in regulating ecosystem services such as fresh water supplies, food products, fisheries, water purification, harbour biodiversity, and regional climate regulation. These are also important as socioeconomic support systems for people and as habitats for migratory birds that visit Kashmir valley from all over the world. These wetlands are degrading at an alarming rate as a result of increased anthropogenic activities and anthropogenically driven changes in natural processes, threatening their health and water quality. Pollution, changes in land use and land cover, urbanisation and encroachment, and climate change are the major threats to wetlands. Over the last few decades, intensive agricultural practises, the introduction of exotic species, and changes in hydrological flows have resulted in the degradation of wetlands throughout this region. Wetland management is critical because these ecosystems provide a variety of ecological functions that support livelihoods all over the world. The current study examines the status of important wetlands in Kashmir and the threats they face.

Key words: Wetlands, Kashmir Valley, threats, urbanisation, encroachment

Introduction

Lakes are sensitive ecosystems that contribute to regional hydrology (Kebede et al., 2006; Thiery et al., 2015) and pristine biodiversity (Jeppesen et al., 2000; Zutshi and Gopal, 2000) and play an important role in sustaining the socio-economy of the dependent populations (Carpenter and Cottingham, 1997; Eshenroder, 1987). Past 50 years of limnological research reveals that the anthropogenic activities, within the lakes and their catchments, are deteriorating the health of these pristine ecosystems at an alarming pace by altering the bio-physical setup (Du et al., 2011; Jones and Orr, 1994; León-Muñoz et al., 2013; Samecka-Cymerman and Kempers, 2001) and lake biogeochemistry (Kundangar and Abubakr, 2004; Kiage et al., 2007; Søndergaard and Jeppesen, 2007). The land system changes impair the water quality, degrade biodiversity and irreversibly alter biogeochemical cycles of a lake ecosystem (Carpenter et al., 1999; Gao et al., 2015; Huang et al., 2014; Romshoo, 2003; Scavia et al., 2014; Schindler, 2006; Smith et al., 1999; Vadeboncoeur et al., 2003). Most of the lakes in Kashmir Himalaya, India have been subjected to anthropogenic pressures which include unplanned urbanization and deforestation of

catchments, extensive use of fertilizers and pesticides for agriculture and horticulture respectively and tourism infrastructure development (Hassan et al., 2015; Masoodi et al., 2013; Pandit, 1988; Rashid et al. 2013a; Romshoo and Muslim, 2011; Zutshi et al., 1980). Although eutrophication in Kashmir lakes is a recent phenomenon (Khan and Ansari, 2005; Vass, 1980; Zargar et al., 2012a), yet in the short span of time, it has adversely impacted the functionality of lake ecosystems in the region. Additionally, the depleting cryosphere in the Kashmir Himalayan region, under the changing climate, has significantly reduced the stream flows that sufficiently contribute to the lake inflows in the Kashmir valley (Romshoo et al., 2015; Rashid, 2017).

Wetlands are ecosystems intermediate between aquatic and terrestrial systems, which are permanently or seasonally covered with shallow water (Mitsch and Gosselink, 1986). They occupy ~6% of earth's land surface (Maltby, 1988). Wetlands are productive (Ghermandi et al., 2008) and biologically diverse ecosystems (Keddy et al., 2009). They provide numerous socio-economic and ecosystem services (Prasad et al., 2002; Ramsar Convention Bureau., 2002) including wildlife habitat, maintenance and conservation of biodiversity (Mitsch and Gosselink, 2007; Whitehouse et al., 2008), water purification (Brown et al., 2000), fisheries and recreation (Keddy, 2010; Junk et al., 2013), flood control (Penatti et al., 2015), water supply (Lemly, 1994), nutrient removal (Raich and Schlesinger, 1992), carbon sequestration (Turner et al., 2000), and environmental restoration (Fink and Mitsch, 2007; Moreno et al., 2007). Wetlands serve as a means of livelihood for rural times. They are a great source of natural products like fish, fodder, vegetables, tourism, and a variety of economically important aquatic plants (Pandit and Qadri, 1990; Bano et al., 2018). However, over the last few decades, the deteriorating water quality (Verma et al., 2001; Rashid et al., 2017a) and land system changes (Romshoo and Rashid, 2014; Rashid and Aneaus, 2019) including encroachment of otherwise notified wetland areas and depleting stream flows (Mitsch and Gosselink, 2000; Showqi et al., 2014; Romshoo et al., 2015) have impacted their health (Iwanoff, 1998; Chauhan, 2010; Naja et al., 2010; Reza and Singh, 2010).

Nowadays, wetlands are being recognized as “wastelands” serving as grounds for a variety of waste materials (Khan et al., 2004; Bano et al., 2018). The increasing trend of conversion of agricultural lands into urban areas is currently one of the dominant patterns of land use change in the valley of Kashmir (Rashid and Romshoo, 2013; Rashid et al., 2017b). This pattern of land use change has the potential to alter the composition and functional processes of wetlands by changing the hydrological regimes and sedimentation processes besides the flux of nutrient materials. The ecological consequences of agricultural runoff and municipal wastewater discharges have resulted into widespread eutrophication (Khan and Ansar, 2005; Badar et al., 2013a). The conversion of forested and agricultural areas into built up areas has impaired the water quality (Rather et al., 2016) that has led to the extirpation of local populations of aquatic species. As a result, many freshwater wetlands have altogether vanished or are facing severe anthropogenic pressures. The harmful social, financial, and ecological impacts of declining biodiversity and degrading water quality are a matter of concern (Verma et al., 2001; Bassi et al., 2014). Most of these wetlands used to act as buffers soaking flood waters but the encroachment

and infrastructure development within these wetlands has reduced their water holding capacity, increasing the vulnerability of people toward flooding (Romshoo et al., 2017). The central business hub of Srinagar, the capital city, is often affected during a normal precipitation event as the drainage channels that used to drain out storm water runoff have mostly been taken over by concrete surfaces (Rashid and Naseem, 2008). The changes in the spatial extent of lakes and wetlands in Srinagar are presented in Table 1. As a result of unplanned urbanization, encroachments, and population pressures, nearly 91.2 km² of wetland area has been lost between 1911 and 2004 (Rashid and Naseem, 2008; Dar et al., 2020).

Science helps to relate the observed patterns of parameters and phenomena in nature to the underlying processes. According to Levin (1992), these patterns are an indication of the natural spatiotemporal heterogeneity which is characteristic of all ecosystems including lakes. Understanding the lake processes and functions to deduce its ecological significance is dependent on our ability to measure and monitor patterns of variation in physical, chemical and biological characteristics of these ecosystems at relevant ecological and spatiotemporal scales (Underwood et al. 2000; Turner et al. 2003). Lakes and wetlands besides being the world's major fresh water resources are also recognized as important ecological and socio-economic valued ecosystems (Dudgeon et al. 2006; Nelson et al. 2015; Walsh and Milon 2016). However, it is ironic, that despite this recognition, most of the lakes and wetlands, indeed, other freshwater ecosystems, are exposed to unparalleled anthropogenic pressures. Across all landscapes, the ecological health of many important lakes of the world such as Lake Baikal in Russia, Great Lakes of America, Lake Tanganyika in Africa, Urmia lake in Iran, Taihu lake in China, Chilka lake in India, Wullar and Dal lakes in Kashmir Himalaya etc. are adversely affected by various factors like acidification, climate change, population pressure, eutrophication, hydrological alteration and in some cases, even by the invasion of alien species (Scheffer 1998; Vorosmarty et al. 2000; O'Reilly et al. 2003; Smith 2003; Badar et al. 2013a; Rashid et al. 2017). While there is a range of factors vexing the important lakes of the world, the main cause of their deterioration is the increasing influx of untreated nutrients under the burgeoning economies and demographics (Khanday et al., 2018).

Human influences (over-exploitation of waters, unplanned urbanization, catchment deforestation, ingress of untreated sewage, agricultural and industrial wastes) and natural causes (weathering of crustal ingredients, erosion, precipitation changes and depleting water resources) contribute towards the deterioration of surface water quality (WQ) of lakes and seriously impair their use for drinking, recreation, aquatic life, agricultural and industrial purposes (Carpenter et al. 1998; Jarvie et al. 1998; Zhang et al. 2007; Romshoo and Muslim 2011; Varol et al. 2012; Badar et al. 2013b; Rashid et al. 2013). Because of the intricacies of a lake ecosystem, lake managers are significantly challenged in their efforts to manage quality of lake waters for multiple uses (Elhatip et al. 2007).

Spatiotemporal characterization of lake WQ can, therefore, provide valuable knowledge about lake health and influencing factors, thus assisting lake managers in developing

strategies for sustainable lake ecosystem management (Kolovos et al. 2002; Wang 2002; Chang 2005, Rashid et al. 2017).

Many lake studies have focused on assessing the state of health of Kashmir lakes, yet the knowledge about the factors responsible for their deterioration remains inadequate. Studies conducted so far are unifocal taking into consideration just a single aspect such as water quality assessment (Bhat et al., 2013; Khan, 2010; Sarwar, 1999; Wani et al., 1996), and aquatic vegetation (Shah et al., 2014; Zargar et al., 2012b). A few studies, based on the use of remotely sensed data, have determined the spatio-temporal changes of a single or a couple of factors within the lakes and their catchments in the Indian Himalaya and linked it to the lake ecosystems (Chopra et al., 2001; Mushtaq and Pandey, 2014; Romshoo et al., 2011; Sharma et al., 2015).

In order to holistically comprehend and quantify the influence of causal factors on lake degradation, it is important to integrate all the available data from archives, remotely sensed platforms, in-situ measurements and field surveys in a geospatial modelling environment (Hereher, 2015; Liu et al., 2007; Nielsen et al., 2012; Wasige et al., 2013; Yan et al., 2015). The important wetlands in Kashmir are discussed below;

1. Anchar Lake:

Anchar is a semiurban, single basin lake situated between 34° 07' - 34° 10' N latitudes and 74° 46' -74° 48' E longitudes at an altitude of 1,583 m above mean sea level (a.m.s.l.). The lake is situated about 14 km from Srinagar city on the northwestern part. The lake covered an area of 19.54 km² during 1893–1894 (Lawrence, 1895). Since then, the area of the lake declined substantially to 6.5 km² (Jeelani and Kaur, 2012). The current area of the lake is 4.26 km² (Sushil et al., 2014; Fazili et al., 2017). The water supply of Anchar Lake is maintained by Sindh, a tributary stream of Jhelum and Achan Nallah in addition to springs along the vicinity of lake. The lake has a vast catchment area that comprised a mixture of residential, forest, agricultural, and horticultural land (Jeelani and Kaur, 2012; Bhat et al., 2013). The last few decades have resulted in the decline of the water quality of the lake (Farooq et al., 2018; Dar et al., 2020). The main causes of degradation of Anchar Lake are anthropogenic activities, encroachments, sewage, and dumping of domestic wastes including polythene, clothes, plastic bottles, and effluents from hospitals and wastewater treatment plants (Najar and Khan, 2012; Bhat et al., 2013; Fazili et al., 2017).

2. Dal Lake:

The Dal is an open drainage and urban valley lake in the north east of Srinagar city in Kashmir Himalaya. The lake is located between 34° 50' –34° 90' N and 74° 49' –74° 53' E at a mean altitude of 1584 m asl. It is the second largest fresh water body in the Kashmir valley and is spread over an area of about 24 km², (Rashid et al. 2017), with an average water depth of 2.32 m (Javaid and Ahmad 2015) and its watershed area is approximately 337 km² (Badar et al. 2013b). The Dal lake with its uniqueness of staying in Houseboats, the Shikara rides and floating gardens, is an internationally recognized picturesque tourist attraction and recreation center. Large quantity

of Nadru (Lotus stem), and other vegetables are cultivated within the lake waters, on land masses and floating gardens in addition to fish production for human use in Srinagar city. Water Lily in the lake provides a marvelous sight when in bloom, and its petioles and leaves are used as fodder for the cattle. Importantly, the waters of the Dal are used for drinking purposes and is being lifted from the lake at Nishat and Nigeensource points. On an average about 45 million gallons per day (MGD) water are used from the Lake for human consumption (Kawoosa 2017; Malik and Hashmi, 2020). However, till date there has been no study about the economic valuation of the services and products provided by the Dal Lake ecosystem. The catchment area is mostly mountainous towards the north, south and east, while the area towards west is a flat land having urban settlements on it. The surface runoff predominantly originates from the hilly areas of the catchment geologically comprising of Panjal traps, Agglomerate slates and Karewa deposits (Varadan 1977; Datta 1983; (Malik and Hashmi, 2021). The settlement areas in the periphery of the lake particularly towards the east and west, discharge huge volume of both treated and untreated sewage into the lake. The catchment areas in the north and east also discharge significant volume of sediments and other nutrients into the lake due to the agriculture, horticulture and other anthropogenic activities in the catchment (Khanday et al., 2018). Overall, the lake waters are enriched by 12.30 9 106 m³ of liquid waste containing 18.17 t of phosphorus and 25 t of inorganic nitrogen (Masoodi 2017). The Dal lake is fed by a perennial, alpine-origin Dachigam creek from north, which in its lower reaches splits into four smaller creeks viz., Telbal, Boutkol, Pishpaw and Meerakshah (Badar et al. 2013b; Solim and Wanganeo 2008). The water flows out of the lake from two outlets namely, Dalgate and Ameer Khan channel in south and west directions respectively (Khanday et al. 2016). The climate of the area is sub-Mediterranean with four seasons based on the variation of mean temperature and precipitation (Bagnolus and Meher-Homji 1959).

3. Wular Lake:

Wular Lake is a freshwater lake located in Bandipora district of North Kashmir Valley at an estimated distance of 54 km northwest of capital city Srinagar of J&K with a mean elevation of 1580 m (AMSL). Its shape is elliptical which stretches over a length of about 16 km and a breadth of 7.6 km. Greater Himalayas encircle this freshwater Lake on its north, north-eastern and north-western sides, which form a more substantial part of its catchment area. These high altitude mountains drain their runoff directly into the Wular Lake through various streams like Erin, Madhumati, Dudganga, Sukhnag, Kausar Nag and Jhelum River. Among these streams Jhelum river is the main feeding river bringing all the waste and silt from the Jhelum basin including the materials from Srinagar city which is being dumped onto the Wular floor Wular Lake is among the low depth lakes with a maximum depth of about 5.8 m (Ganaie et al. 2020). The total area covered by Wular lake was 5870 ha according to the Survey of India (SOI) map of 1962 records but due to variation in amount of water in the lake every year, the limits increase and decrease. According to CMAP (2007), the estimated area of the Lake is 18,900 ha. However, revenue records reveal the lake area to be about 13,000 ha. Considering the highest flood level,

the immediate area of the Lake has been estimated to be around 17,300 ha. The judicious conservation of Wular Lake is a significant challenge in wake of socioeconomic dependence on the lake ecosystem (Badar et al. 2013; Malik, 2021).

4. Hokersar Wetland:

Hokersar is the queen of the wetlands of Kashmir valley situated between 34° 06' N latitude and 74° 05' E longitude having an altitude of 1,580 m a.m.s.l. in the northern part of Doodhganga catchment, 10 km west of Srinagar city. The water supply of Hokersar wetland is maintained by the Doodhganga stream on the eastern side and by the Sukhnag stream on the western side. The depth of the wetland varies from a maximum of 2.5 m to a minimum of 0.7 m during spring and autumn, respectively. Hokersar is a game reserve and habitat for about 2 million species of migratory birds of Europe, Siberia, and Central Asia. The marshland supports various ecological and economic services, which include fisheries, food products, freshwater, and purification of water, and regulates global climate (Davis, 1993; Romshoo and Rashid, 2014). The wetland supports a broad range of hydrological functions, for example, regulation of floods, recharge of groundwater, control stream flow (Joshi et al., 2002), and carbon sequestration (Romshoo and Rashid, 2014). In this context, the wetland was designated as a Ramsar site in November 2005. Due to increased human intervention and changing natural processes (Joshi et al., 2002), the area of the wetland has declined from 18.75 km² in 1969 to 13.00 km² in 2008 (Romshoo and Rashid, 2014). This wetland has lost 5.75 km² of area during the last four decades (Romshoo and Rashid, 2014). During the last two to three decades, macrophytic species like *Acorus calamus*, *Euryale ferox*, and *Nelumbo nucifera* within the wetland had disappeared (Khan et al., 2004). The wetland is now choked by invasive species like *Azolla* spp., *Salvinia natans*, and *Menyanthes* spp. (Khan et al., 2004; Bano et al., 2018). The increased silt load from the catchment area due to deforestation of higher reaches is the possible cause for the disappearance of the species and depletion of water depth, which has been reported to have reduced from 1.12 m (Pandit, 1980) to 0.63 m (Rather and Pandit, 2002). It is also pertinent to mention that during the last few decades, the water quality of the wetland has deteriorated (Shah et al., 2019) severely (Dar et al., 2020).

Threats to Wetlands in Kashmir:

Among the freshwater ecosystems, wetlands are the most widely used and are heavily exploited for sustainability and livelihood (Molur et al., 2011). The main threats to wetlands in Srinagar city are attributed to anthropogenic pressures that include urbanization (Farooq and Muslim, 2014), land use changes (Fazal and Amin, 2011), and large-scale encroachments (Wani and Khairkar, 2011; Kuchay and Bhat, 2014) in the catchment as well as in the wetlands itself (Rather et al., 2016). Besides, natural siltation associated with the anthropogenic siltation brought about by deforestation in the catchment areas has also been an important factor resulting in the loss of wetlands (Pandit and Qadri, 1990; Pandit, 1991; Shah et al., 2017; Amin and

Romshoo, 2019). Another important driver of the loss of wetlands comes in the form of problems relating to drainage (Romshoo et al., 2017; Alam et al., 2018). The huge inflow of sewage from the catchment areas into the water bodies has resulted in excessive macrophytic growth (Dar et al., 2014). Wetlands are biologically most diverse and economically valuable ecosystems all over the world. They cover about 6% of the surface of the earth and provide important ecological and economic services. Srinagar city in the valley of Kashmir has several lakes and wetlands. These are important as socio-economic assets and function as absorption basins for flood waters. They help in the maintenance of biodiversity, purification, and recharge of groundwater (Dar et al., 2020). The wetlands in Kashmir are in dire need of conservation to main the ecological balance of Kashmir.

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