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A Himalayan Case Study on High Altitude Sacred Lake Parvati Sarovar: Mythological Beliefs, Floral Diversity and Water Quality Analysis.

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Abstract: High Altitude Lakes (HALs), situated above 3000 meters, are prominent features of the Himalayan landscape. Uttarakhand, a Himalayan state in India, is home to numerous such glacial lakes, many of which remain scientifically unexplored. These freshwater bodies are vital for maintaining ecological balance and supporting the local socio-economic fabric. However, HALs are increasingly threatened by anthropogenic pressures, climate change, and natural processes. Parvati Sarovar, located at an elevation of 4290 meters near the base of Adi Kailash in Pithoragarh district, is one such sacred yet understudied lake. This study presents the first scientific assessment of Parvati Sarovar, focusing on its floral diversity and water quality. Field surveys and interactions with local residents revealed deep-rooted mythological beliefs associated with the lake and surrounding areas. A preliminary inventory of the floral species was prepared. Water quality analysis, conducted using standard protocols, indicated that although most physicochemical parameters align with drinking water standards, the presence of coliform bacteria renders the water unsafe for consumption. Additionally, minor littering and plastic waste were observed, raising concerns about environmental degradation. This pioneering study contributes valuable baseline data on Parvati Sarovar and underscores the need for conservation efforts in these fragile high-altitude ecosystems.

Keywords: Parvati Sarovar • Himalaya • High altitude • Lake • Sacred • Water quality • Floral diversity.

Introduction

High-altitude lakes are a type of “high-altitude wetland” (HAW), generally defined as "areas of swamp, marsh, meadow, fen, peatland, or water bodies located above 3,000 meters above mean sea level (amsl), whether natural or artificial, permanent or temporary, with water that may be still or flowing, fresh, brackish, or saline" (Panigrahy et al 2012). High altitude lakes (HALs) represent extreme ecosystems, marked by challenging climates and a layer of seasonal or diurnal permafrost. Unlike lower-altitude lakes, which primarily receive water from local rains, streams, and runoff, high-altitude lakes (HALs) rely on snowmelt, precipitation, and springs. HALs are crucial natural resources that support life in these regions (Walsh & Milon 2016). The Himalayan lakes hold religious, cultural, socio-economic, biodiversity and ecological importance supporting the nature, wildlife, and human population in the surroundings (Shah et al. 2024; Chatterjee et al. 2010). Many of these lakes serve as habitats for rare and endemic species of birds, medicinal plants and mammals. These lakes are distinguished by their unique water sources, habitats, species, and communities and hold cultural and spiritual significance (Gurung et al 2018). Although they appear pristine, high-altitude lakes are at risk from climate change (Pastorino & Prearo 2020), long-range transport of atmospheric pollutants (Schindler & Smol 2006), overgrazing and tourism (Rupakheti et al. 2017), introduction of alien species (Pastorino et al., 2020a; 2020b), and

mountain farming (Tiberti et al. 2014). Remote HALs are particularly vulnerable to pollution, exacerbated by high ultraviolet radiation and the cold distillery phenomenon (Elser et al. 2020; Dar et al. 2021). The HALs acts as natural storehouse for ecological evidence that is associated with the changing climate and other parameters (Kaphle et al.2021)

The Himalayas are the highest, largest and most popular mountain system on earth. It covers 3% of world's land area and 18% of world's mountain area. Outside the poles, Himalaya is known to be the largest source of permanent snow cover (Suresh et al.2022). The Himalayas has been divided into three main regions: the Western Himalayan region, Central Himalayan region and Eastern Himalayan region. The Western Himalayan region comprises majority of Indian Himalayas and includes the states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand (Das et al 2019) The Himalayan region features hundreds of high-altitude lakes with diverse chemistry, reflected in their solute content, biogeochemistry, and eco-hydrology (Panigrahy et al. 2011).

Uttarakhand, known as 'Devbhoomi,' became the 27th state of India and covers an area of 53,483 square kilometers, located between latitudes 28°43' and 31°28' N and longitudes 77°34' and 81°03' E (Singh et al. 2016). It has an elevation ranging from 169 mt to 7795 mt above sea level (Chauhan et al. 2024). This mountainous state, set along the slopes of the Himalayas, is blessed with towering peaks, beautiful valleys, remarkable landscapes, and pristine high-altitude Himalayan lakes.

The Wadia Institute of Himalayan Geology (WIHG) and the International centre for Integrated Mountain Development (ICIMOD) identified 127 glacial lakes in Uttarakhand in 2004-2005 (Campbell 2005). It is very likely that only relatively large or important glacial lakes has been taken into account, because the high glaciars are actually dotted by countless small supra glacial lakes (Manjrekar & Singh 2012).

Parvati Sarovar or Parvati Kund is one such sacred high altitude Himalayan lake, situated at the base of Adi Kailash mountain in the Pithoragarh District of Uttarakhand, India. The lake holds great religious significance in the Hindu mythology. However, there is no published scientific data on this lake. According to a recent study, no scientific research has been undertaken in this lake and has been mentioned as a data deficient lake (Kumari et al. 2023). The present work is aimed to gather information related to high altitude Himalayan holy lake Parvati Sarovar with special reference to some aspects of its limnology. Here we studied the water quality parameters of Parvati sarovar along with the floral diversity in the area. This study also intends to document the mythological stories associated with this area.

Material and Methods

Study site Location: The primary study site was Parvati Sarovar (also known as Parvati Kund) and its surrounding areas. Parvati Sarovar is a picturesque lake situated at the base of the Adi Kailash mountain in the Pithoragarh district of Uttarakhand, India. It is located in the eastern part of the Kumaon region in the kuti-Yangti sub watershed basin. This high-altitude lake is positioned at an elevation of 4,290 meters (14,786 feet) above sea level (Manjrekar & Sing 2012). Its coordinates are 30°21'11.628"N, 80°39'23.22"E. The study was conducted in the month of September 2023.

Water Sample collection: Water samples were collected from 3 different sites of Parvati Sarovar in polyethylene bottles with suitable precautionary measures to prevent any type of gaseous exchange and biological reactions. All the samples were collected at a depth of 0.5 to 1 m from the surface of the water body.

Water sample analysis: A total of 14 physicochemical parameters along with

microbiological analysis of the water were performed. Surface water temperature and pH of the water was measured onsite using digital thermometer and digital pH meter in all the sites. The colour and odour of the samples were tested onsite as well as in Laboratory. The other physiochemical parameters i.e turbidity, dissolved solid, hardness , alkalinity, Calcium, Chloride, Iron, Magnesium, Nitrate, Sulphate and the Microbiological analysis were done in the Laboratory. Each sample was analyzed in triplicate and the data was represented as mean of all the three sites. The test method used for water analysis is listed below (Table. 1)

Table:1: List of test method used to analyze water samples

Parameters	Test method used
Colour	ISO 3025 (Part 4):1983 (RA 2021)
Odour	ISO 3025 (Part 5): 2018
Turbidity	ISO 3025 (Part 10): 1984 (RA: 2017)
Total dissolved solid	ISO 3025 (Part 16): 1984 (RA: 2017)
Hardness	ISO 3025 (Part 21): 2009 (RA: 2019)
Alkalinity	ISO 3025 (Part 23): 1986 (RA: 2019)
Calcium	ISO 3025 (Part 40): 1991 (RA: 2019)
Chloride	ISO 3025 (Part 32): 1988 (RA: 2019)
Iron	ISO 3025 (Part 53): 1988 (RA: 2019)
Nitrate	ISO 3025 (Part 34): 1988 (RA: 2019)
Sulphate	ISO 3025 (Part 24): 1986 (RA: 2019)
Magnesium	APHA 24th Edition -2023, 3500 Mg
Faecal coliform bacteria	APHA 24th Edition -2023, 9222E
Total coliform bacteria	APHA 24th Edition -2023, 9222B

Survey: Survey was conducted among local people and the shepherds using open ended questions regarding the history/ mythology associated with the area.

Floral Diversity: Floral diversity reported in this study was from the plants observed during survey around the Parvati Sarovar and also the information available from the previous report by Gopal R. (Gopal 2018)

Results and Discussions

Description and accessibility of Parvati Sarovar

Parvati Sarovar is a tarn, that is mountain lakes, caused by glacial activity (Fig.1). It is large in size and is more than 300 mt. long. The sarovar/ Kund is shallow in depth. The water is clear and appears turquoise in colour. There is a small temple dedicated to Lord Siva on the bank of Parvati kund. During our survey the banks of the lake appeared clean in most of the places. Only very little amount of litters of plastics and old cloths were observed on the bank of lake adjacent to the temple.

Fig.:1: Parvati Kund or Parvati Sarovar.

Parvati Sarovar has a very limited accessibility and can be visited during a brief period of the year. To reach Parvati Sarovar, the nearest town is Dharchula (at 3000 ft) in Pithoragarh district of Uttarakhand. A drive of 7-8 hours over a distance of 170 km brings to Gunji village located at 10500 ft and a distance of 20-25 Km from Parvati Sarovar. Though few accommodation options are available, Gunji serves as resting place at night for most of visitors travelling to Parvati Kund and Adi Kailash. The distance of Gunji to Jolinkong via Kuti village is 20-25 km and takes 2 hour to drive (Fig.2A). Road conditions are not very good in this stretch. Jholinkong is the last motorable point in this area for the civilians. Parvati Sarovar is a 500 mt. uphill trek from Jholinkong (Fig. 2 C)

The entire area is under the control of Indian Army as it is very near to Indo-Tibet boarder. Government permit is necessary for visiting Adi Kailash and Parvati Kund. Without permit visitors are not allowed beyond kuti village. Adi Kailash and Parvati Sarovar is only accessible in Summer months from April to June and Autumn months i.e September and October. Though roads are open during monsoon i.e July and August, visit during this time is not encouraged. During rest of the year, the area is not accessible due to heavy snow.

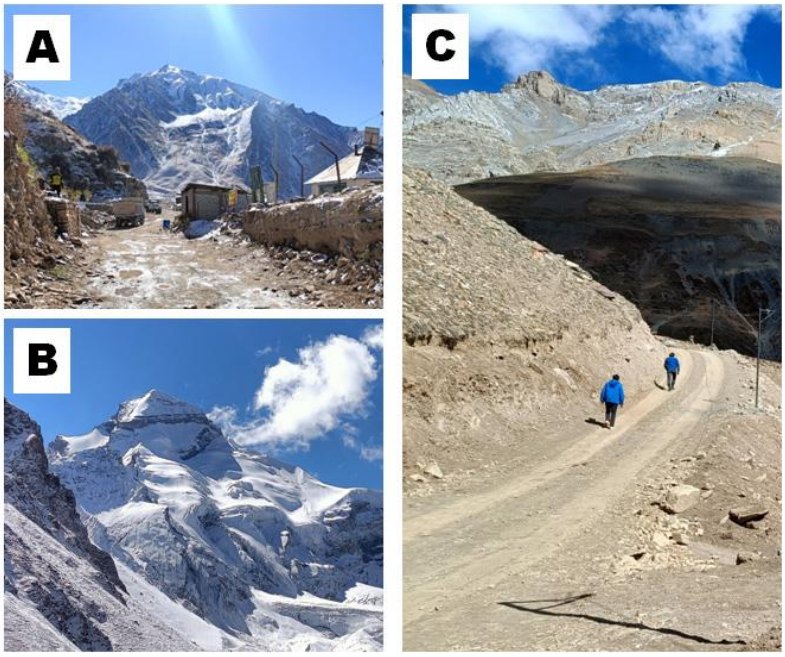

Fig.: 2: A:Way to Parvati Sarovar through Kuti village, B:Adi Kailash peak as viewed from Jolinkong, C: Trek route from Jolinkong to Parvati Sarovar

Mythology associated with Parvati Sarovar, Adi Kailash and adjacent areas

The Kuti Village on the way to Parvati sarovar, has historical and mythological connection. The village is believed to be Kunti's Village, as it is named after Kunti, the mother of Pandavas from the legends of Mahabharata. Just in front on the Kuti village, one can see a ruined fort on the mountain. The locals believe that the pandavas stayed in the fort for some time with their mother Kunti. Thus the fort is called as Pandava's fort or Pandava's killa.

The Adi kailash is a very sacred peak to the Hindus. It is the second among the Panch Kailash, which is believed to be the earthly home of Lord Shiva. The three lines featured on the Adi kailash mountain is believed by the locals to resemble the tilak of Lord Shiva. (Fig. 2 B) According to the locals, a number of mythological stories are associated with this

place. According to some, Lord Shiva performed his cosmic dance, the tandava in his place and revealed his divine form to the sage Ashtavakra. According to locals as well as Puranas, Adi kailash was the first stop of Lord Shiva's marriage procession from Kailash to Triyuginarayan. It is also believed by the locals that Ravana, the demon king from Ramayana, performed penance at Adi Kailash for quest of his power.

Parvati Sarovar is located at the base of Adi Kailash mountain. The locals compare it with the Manasarovar lake of Kailash in Tibet. According to the Hindu mythology and also the local peoples, it is believed that Parvati, the wife of Lord Siva used to bath in this lake and thus it was named Parvati Kund or Parvati sarovar. Local belief is that, the water possesses divine healing properties and can cleanse the mind, body and soul.

Floral Diversity

Large trees were not observed around the lake as well as in the entire area. Signs of presence of grass, herbs or small shrubs were evident. During the survey not much distinguishable vegetation could be observed due to overgrazing in areas around Parvati kund. Only some sedges and lichens (Fig.3C) could be identified. However, we could find a single document mentioning about the flora in this area. The list of flora around Parvati kund as observed in this study and reported by Gopal R. (Gopal 2018) is been listed below in Table 2.

Table:2: List of Plants and Lichens around Parvati Sarovar

Category	Family	Scientific Name	Remarks
Sedges & Larger plants	Cyperaceae	*Blysmus compressus*	Observed during survey in present study and also reported earlier (Gopal 2018)
	Cyperaceae	*Carex sp.*	Observed during survey in present study and also reported earlier (Gopal 2018)
	Potamogetonaceae	*Potamogeton natans*	Reported earlier (Gopal 2018)
	Plantaginaceas	*Hippuris vulgaris.*	Observed during survey in present study and also reported earlier (Gopal 2018)
	Polygonaceae	*Rheum moorcroftianum*	Reported earlier (Gopal 2018)
	Poaceae	*Hierochloa laxa*	Reported earlier (Gopal 2018)
	Salicaceae	*Salix calyculata*	Reported earlier (Gopal 2018)
	Orobanchaceae	*Pedicularis oederi*	Reported earlier (Gopal 2018)
	Primulaceae	*Primula denticulate*	Reported earlier (Gopal 2018)
	Ranunculaceae	*Trollius acaulis*	Reported earlier (Gopal 2018)
Lichens	Rhizocarpaceae	*Rhizocarpon*	Observed during survey in present study and also reported earlier (Gopal 2018)
	Teloschistaceae	*Xanthoria*	Reported earlier (Gopal 2018)
	Acarosporaceae.	*Acarospora*	Observed during survey in present study and also reported earlier (Gopal 2018)
	Teloschistaceae	*Caloplaca*	Reported earlier (Gopal 2018)
	Lecideaceae	*Lecidea*	Observed during survey in present study and also reported earlier (Gopal R. 2018)
	Lecideaceae	*Lecanora*	Reported earlier (Gopal 2018)
	Icmadophilaceae	*Thamnolia vermicularis*	Observed during survey in present study and also reported earlier (Gopal 2018)

Interestingly, a belief prevail among the local people in the area, that *Carex orbicularis* found near the parvati Sarovar is sown by the local deities and is a divine rice.

Water Quality analysis of Parvati Saovar

Water was analyzed from different sites of Parvati Sarovar (Fig. 3A, 3B) as described in materials and method section. The physical qualities of lake water refer to the observable and measurable physical characteristics of water which may affect the health of the lake ecosystem. Some of such physical qualities of water of Parvai kund were analyzed and the result has been given in Table 3. The water was clear, odorless and turquoise blue in colour when observed in the natural condition in the Lake. Laboratory analysis revealed the colour was less than 5 Hazel units and the turbidity was below 1 NTU (Nephelometric Turbidity Unit), both of which are indication of clear water of the lake. Such water indicates higher light penetration. The temperature influences the metabolic rate of aquatic organism and also the oxygen level. The surface water temperature of the studied lake was found to be 5.56° C. The hardness of water is a measure of the dissolved minerals in the water such as magnesium and calcium. The mean hardness of tested water was found to be 148 mg/l indicating that the lake has hard water. However, the water was within the permissible limit of hardness in drinking water. (According to IS10500-2012, permissible limit for total hardness in drinking water in India is within 200 mg/lt)

The total dissolved solid (TDS) was also tested and found to be 175 mg/lt. The TDS was also within the permissible limit for TDS in drinking water. (According to Bureau of Indian standards and World health organization (WHO), permissible limit for total hardness in drinking water should be within 500 mg/lt and 300 mg/lt respectively)

Table:3: Physical qualities of analyzed water samples from Parvati sarovar

Parameters	Results (mean±SEM)
Colour in Hazen Unit	<5
Odour	Agreeable
Turbidity (in NTU)	<1
Surface water temperature (in ° C)	5.56±0.1
Total dissolved solid (in mg/lt)	175±6.55
Hardness (as $CaCO_3$) in mg/l	148±5.56

The pH of the water was found to be 6.4 (Table 4) indicating that the water is slightly acidic in nature. This is within the permissible range of that of the drinking water. The alkalinity of water refers to the ability of water to neutralize acid and bases. Alkalinity of the tested sample was found to be moderate with a value of 90.2 mg/lt (Table 4). The tested sample contained different chemical ions. The amount of calcium, chloride, Iron, Magnesium, Nitrate and sulphate were tested. Results revealed presence of calcium, chloride, Iron, Magnesium, Nitrate and sulphate in the concentration mentioned in Table 4.

Table:4: pH and the amount of chemicals present in the analyzed water samples from Parvati sarovar

Parameters	Results (mean±SEM)
pH	6.4±0.15
Alkalinity (as $CaCO_3$) in mg/lt	90.2± 2.3
Calcium (as Ca) in mg/lt	32 ± 2
Chloride (as Cl) in mg/lt	13.7 ± 1.5
Iron (as Fe) in mg/lt	0.18 ± .015
Magnesium (as Mg) in mg/lt	16.3 ± 1.15
Nitrate (as NO_3) in mg/lt	0.64 ± 0.05
Sulphate (as SO_4) in mg/lt	21.6 ± 1.2

The microbiological analysis was performed to study the presence of any coliform bacteria in the water of Parvati Sarovar. Our result revealed the presence of coliform bacteria in the sampled water. Out of these coliform bacteria, some were from the fecal origin. The

number of the bacteria found in the sampled water is given below (Table. 5). Presence of coliform bacteria makes the water unsuitable for drinking.

Table:5: Microbial analysis of the analyzed water samples from Parvati sarovar

Parameters	Results (mean±SEM)
Fecal Coliform bacteria /100ml	9 ± 0.57
Total Coliform bacteria /100ml	62 ± 1.47

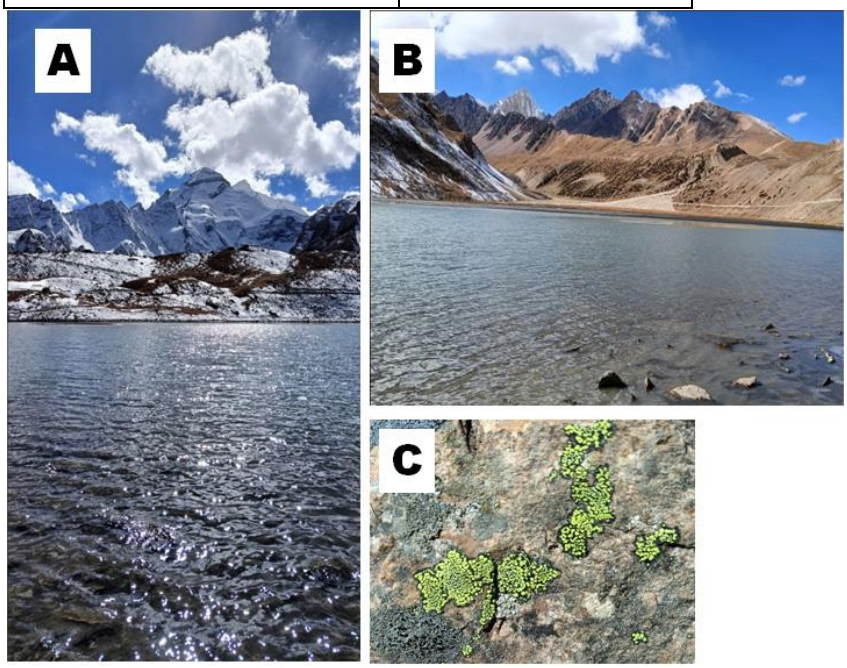

Fig.:3: A: Parvati Sarovar at the base of Mount Adi kailash. Image taken from water collection site 1, B: Parvati Sarovar and the surrounding mountain range. Image taken from water collection site 2, C: Lichens near the bank of Parvati Sarovar

Major Concerns

The area near the lake is an extremely overgrazed site. A large number of animals were seen grazing near the lake. These animals while grazing, excretes in the area near the lake and this fecal materials gets washed away by the rain water or snow melt water, which drains in the kund. Probably this is the source of the fecal coliform bacteria found in the water. Parvati Kund is a holy lake and is visited by pilgrims. Though the number of the pilgrims are not very high due limited accessibility to this area, however, Puja saamagri (items used during worship), plastics and discarded garments were found littered at various places around the lake.

Conclusion

Detailed information about high-altitude Himalayan lakes is essential for assessing the status of these unique wetlands. Given the limited water sources in mountainous regions, these lakes are of critical importance. This study provides a brief overview of Parvati Sarovar (or Parvati Kund), a sacred high-altitude lake in the Himalayas, along with its surrounding areas. Water quality testing conducted during the autumn season reveals that the lake's physicochemical properties indicate clean water suitable for drinking. However, the presence of coliform bacteria makes it unsuitable for consumption. Although the lake currently appears to be in good condition, the growing number of tourists visiting the Adi Kailash region, along with observed litter and plastic waste, raises concerns. Protective measures are urgently needed to preserve the lake's condition, especially considering its religious significance. Conservation of these high-

altitude lakes are vital to ensure a reliable water supply for the region and to protect the communities and biodiversity that rely on these freshwater resources. Fortunately Parvati kund is one of the sites that have been prioritized for conservation by the Government of Uttarakhand (Manjrekar & Singh 2012). More detailed scientific research on this lake would be helpful. Detailed investigation regarding the diversity of phytoplanktons and zooplanktons could be very interesting given the extreme weather condition of the lake. Nevertheless, our work provides the first preliminary data on this lake which may serve as an informative document to the future researchers.

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