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ASSESSMENT OF BIODIVERSITY CONSERVATION & RESTORATION OF KHAJJIAR WETLAND, CHAMBA (H.P)

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Abstract:-

The present study was undertaken from 2009 to 2011 in order to understand the current status of wetlands in district Chamba. The study was conducted in Khajjiar wetland and its catchments area for biodiversity. Repeated visits were made to the field to record the flora and vegetation of the area. In India, majority of the wetlands are badly affected and some of them are even highly threatened or on the verge of extinction mainly due to anthropogenic interventions. The remaining wetlands also threatened by air and water pollutants, and hydrologic alterations. Natural wetlands in India consist of high altitude Himalayan lakes. According to International importance, there are 25 Ramsar sites in India out of them 3 wetlands in the State of Himachal Pradesh have been declared as wetlands of international importance. The Khajjiar wetland is one of important lake although it is not an international importance. It is important because of socio-cultural and ecological values and services it provides. Presently lake is under threat due to anthropogenic pressures. The problem is further accentuated because of loss of water quality data, ecological services, information etc. Thus it is necessary to reclaim and develop the wetlands for its optimum potential use, for this a reliable and accurate data base is required. Therefore, present study endeavour aimed to generate data base in terms of socio-cultural and ecological aspects i.e. physical aspects / land use, extent of water spread and its water quality, vegetation status of catchments area and surrounding of lake and to determine the importance of these wetlands for the local people and to give an indication of the distribution of the benefits among various stakeholders.

Keywords: - *Khajjiar Wetland, Chamba, Biodiversity, Himachal*

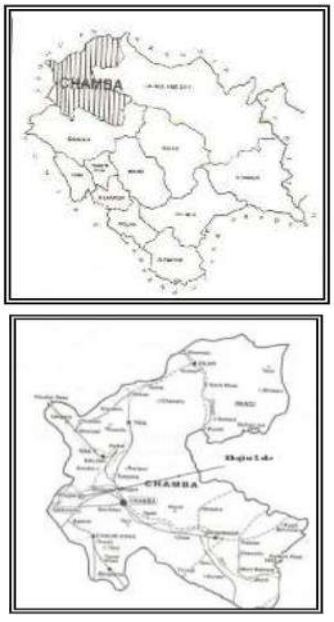
INTRODUCTION

Wetland constitutes a resource of great economic, cultural, scientific and recreational value to human life and is an essential habitat for numerous threatened and endangered species of flora and fauna. Wetlands are areas covered by water some or all the time. Wetlands may not always be flooded but are covered by water at least for a few days during different seasons. Water usually moves very slowly through wetlands, which is an important factor to consider as it affects their functions. The chemistry and hydrology of the water are the most important factors that determine the nature of wetland soil development and which kinds of plants and animals live in the area. . A wetland is an area of land whose soil is saturated with moisture either permanently of seasonally. Such areas may also be covered partially or completely by shallow pools of water. Under the Ramsar convention wetlands are defined as "*areas of marsh , fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing , fresh, brackish or salty including areas of marine water the depth of which at low tide does not exceed six meters*". Globally, a majority of the wetlands are badly affected and some of them are even highly threatened or on the verge of extinction mainly due to anthropogenic interventions. The remaining wetlands are also threatened by air and water pollutants, and hydrologic alterations. In India, approximately one third of Wullar lake of Kashmir is degraded due to siltation and encroachment, which have also affected may other lakes in India especially Chilka lake in Orissa, Kolleru Lake (Andhra) and Suklana lake , a man made wetland in Chandigarh. Most of these lakes lost their water-holding capacity in just two decades. Eutrophication and weed infestation also threaten many wetlands in India.

Himachal Pradesh is a captivating region of the Indian Himalayas. It has dozens of large and small lakes spread over the state. The state has a one percent area cover by lakes (HPSCST&E,2000). Wetlands occupy approximately 1.77% of the total area of Himachal Pradesh. There is limited information on the wetlands of H.P. in terms of their status, water supply and management conservation plans. No systematic work has been carried out in the state. Some of these wetlands are extensively explored but most of them still unknown. With increasing human pressure and prevalent underlying causes, these wetlands are under increasing pressure. Therefore, integrated studies of Individual wetlands are necessary to know their status for their monitoring and conservation. Wetlands management therefore requires planning, system standardization, implementation, impact assessment and monitoring. The wetland ecosystems did not receive deserved attention from the planners, although such systems have potential for high biological activity until the Ramsar Convection of IUCN held in 1971. In the recent years anthropogenic pressure has created an ecological imbalance to a great extent. It is therefore necessary to reclaim and develop this lake for their optimum potential use, but at present a reliable and accurate wetland data is not available. This study has been base line information is generated about spatial distribution of vegetation in and surrounding of lakes by using field survey, GPS for physical verification and water analysis for quality of lake water.

Description of Study area

At an altitude of 1983 metres with Latitude & Longitude: N 32° 32′ 50° 00″ and E 76° 03′ 34° 00″, and Circumference/Area, 605.4 m / 30592 m^2 in district Chamba 16 k.m. from Dalhousue and 25 k.m. from Chamba. Khajjiar has thick forest of the Kalatope sanctuary surrounding its soft green grass. In the centre of a grassy meadow, it is 1.5 km long and 1 km wide, and surrounded by cedar forest, a small lake, called the Kund, that forms the centre piece of Khajjiar. Khajjiar is known as *'Mini Switzerland'.* The average depth of the lake is sitated to be thirteen feet as per District Gazetteer.



Map of Study Area

Methodology
The present study was undertaken from 2009 to 2011 in order to understand the current status of wetlands in district Chamba. The study was conducted in Khajjiar Lakes. Repeated visits were made to the field to record the flora and vegetation of the area. Suitable ecological methods following various authors were used to study the flora of the area. Based on field survey of lake and its surrounding area for its vegetation, physical parameters were studied by use of GPS and water quality of lake was also studied. Secondary data was also used for analysis.

Results & Discussion Physical features:
Fed by tiny streams, this small lake lies at in the centre of large Khajjiar glade. The glade and the lake are held sacred to Khajjinag- after whom the place is named. Dense conifer and broad leaved forests cover the steep mountain slopes around this lake. This lake remains full of water in all seasons. It requires no rain water for survival. For a close view, it has been made accessible with the help of a wooden bridge. A tiny island covered with reeds, keep floating to divine reasons. The climate is tempreate with well-defined seasons. However, there may be variations because of micro-climatic systems depending upon altitude and mountain aspect. The winters last from December to February. March and April generally remain cool and dry but snowfall does occur at higher elevations during these months. The temperature begins to rise rapidly from the middle of April till last week of June or first week of July when monsoon breaks-in. Monsoon continues till the end of August or mid-September. During the monsoon, the weather remains misty, humid and cloudy. October and November are comparatively dry but cold.

Historical and Cultural Background:
This is the magical paradise called *'Khajjiar Lake'.* A temple dedicated to *'Khajjiar Nag'* is also located there. It lies in a depression formed by ancient glaciations. It was christened mini Switzerland by Swiss Envoy Willy P. Blazer on 7th July 1992, and was put on world map. In the presence of Indian officials P. Blazer put up a yellow Swiss hiking footpath sign toward which formally and officially declared Khajjiar as 'mini Switzerland'. The sign board also indicates the actual distance from the Swiss capital Berne upto Khajjiar as 6194. Blazer as per tradition of his country had taken a stone from Khajjiar which was made a part of stone sculpture installed opposite the Parliament mansion in Berne. Places allover the world similar to Switzerland in respect of geographical and topographical traits and scenic elegance are named after it. Hence Khajjiar became the 160th tourist spot in the world to christened mini Switzerland.
The Architecture of the original wooden temple of Khaji Naag dated of back to the period earlier to 12th Century A.D. in thw 16th Century A.D. Raja bal Balbhasra Barman elected wooden Panowas ststurs. This temple is renovated by batlu the religious nurse of Raja Prithvi Singh in 17th century A.D. In the mandapa of the temple one can see the images of the Pandavas and the defeated Kaurvas hanging from the roof of the circumambulatory path. For the local people this lake holds sacredness and they believe that it is unfathomable. The lake takes its name from Khajji Nag, the deity in the temple nearby.

Local Human Population:
Large number of peoples residing in the vicinity of Lake. Literacy rate is poor, they mainly involved in vegetable farming and rearing sheep goats. Males are involved in horse rearing for providing horse riding around the lake to the visitor.

Visitor and Visitor Facilities:
Thousands of tourists visit this place every year. To make it a major tourist attraction, state government has started its beautification plan. Khajjiar is often referred to as "Gulmarg of Himachal Pradesh". There is a small lake in the center of the saucer shaped meadow which has in it a floating island. Much of the lake has degenerated into slush because of heavy silting during rains. Still the landscape of Khajjiar is picturesque and a photographer's delight.

Physical Characteristics of water: The average **pH** observed during the study period for different sites was 7.35. Hydrogen ion concentration below 4.5 and above 9 is particularly injuries and unproductive. Besides being toxic to the aquatic life they react with the natural alkalinity of the water there by increasing the carbonate hardness and thus rendering it unfit for further use. **Electrical conductivity (EC) 75.0** is dependent on temperature of the water and it increases with increase in temperature. EC is a direct indicator of total dissolved Table:1**. Water quality of lake:** ions in water. **Total suspended solid (TSS) is 0.1,** with the increase in turbidity total suspended solids in the lake water increases. **Alkalinity** is **50,** a measure of bicarbonates, carbonates and hydrates. Fluctuation in Alkalinity damages the aquatic environment. This also alters the pH of the water, which leads to the death of aquatic biota. **Dissolve oxygen** was observed above **4 mg/L** in all the study sites. The level of dissolve oxygen ranged between 8.9 to 10.5 mg/L. The concentration of dissolves oxygen decreases with increase in temperature Matcaff and Eddy, 1979, also made same observations. Low concentration of DO indicates the presence of organic matter in water. With high organic load, dissolve oxygen is consumed rapidly during the putrifaction of organic substances contained in the lakebed. If vertical mixing of water is insufficient due to stratification, oxygen dissolves on the surface of water from the atmospheric air can't reach the bottom. In addition poor clarity of water, weakens sufficient penetration of the sun bim and significantly photosynthetic reaction in the bottom water layer. Under these conditions the DO in the bottom water will decrease ultimately leading 0oxygen state. As a result aquatic fauna in that area is seriously affected. **Biological Oxygen Demand (BOD) is 0.7,** demand of water has been a quantity related to the amount of water present in water sample, BOD indicates the amount of dissolve

Sr. No.	Parameters	Values
1.	pH	7.45
2.	Electrical Conductivity µmhocm^{-1}	---
3.	Total suspended solids, mg/l	----
4.	Total alkalinity mg/l	150
5.	Dissolve oxygen (DO) mg/l	3.6
6.	BOD, mg/l	1.9
7.	COD, mg/l	4.75
8.	Turbidity NTU	153.9
9.	NH_3-M	0.051
10.	Silicates	93.3

Oxygen used up during the oxidation of oxygen demanding waste. It could be found out incubating a sample of water for 5 days at 20^{0}C. Increase in BOD indicates higher organic matter contents in the lake water sample. **Chemical Oxygen Demand (COD) is 1.75** the minimum of COD loading is insignification to cause any adverse impacts on water quality. COD values were found to be very low indicating absence of organic pollution load. **Turbidity is zero** Clear ponds with less than 25 ppm turbidity have 12-8 times more plankton and 5.5 times more fish production than ponds with a turbidity exceeding 100 ppm (Prabbakar, 2000). The increased silt in the lake increased turbidity and reduces the oxygen intake in the water leading to impact on all life in the lake.

Water temperature in lake varied from 4.0 to 10.0^{o}C. During the summer, and a decline in water temperature was recorded in the winter season. Increase in temperature accelerates the biodegradation of the organic matter, both in bottom deposits and over lying water. This enhances the BOD level. Some aquatic fauna remain active in near 0^{0}C temperature which is present in streams of the lesser and greater Himalayas during Dec and Jan. Water temperature also regulates species composition, metabolism and reproduction of essentially pikilothermic aquatic life. It influences water quality. At higher temperature oxygen becomes less soluble and in order to cope with biodegradation, results in oxygen depletion. Dissolve oxygen has been a fundamental requirement of life for the plant and animal population. Their survival is dependent upon the availability of water to maintain certain minimal consideration. The disappearance of plant and animal life is an obvious result of the oxygen depletion.

Floral Diversity

The floristic composition of this area varies from chil pine(*Pinus roxburghii*) with a mixture of ban oak in the lower zone to pure deodar in the middle reaches with culminates in to mixed crop of deodar(*Cedrus deodara*) , fir (*Abies pindrow*), and spruce (*Picea smithiana*) species with some alpine pasture towards Dainkund area. Undergrowth in the forest is well developed, dense in places with a good cover of grass. With its alluring charm, soothing quietness and abundant natural beauty, Khajjiar can be made more attractive. Pastures land for grazing, number of wild and medicinal plants are found to be here (Table:2).

Table: 2. Floral Diversity around Wetland & its catchment's area

S. No.	Scientific name	Family
1.	*Achyranthes aspera,*	Amaranthaceae
2.	*Acorus calamus,*	Acoraceae
3.	*Anaphalis*	Asteraceae
	triplinervis,	
4.	*Arisaema intermedium*	Araceae
5.	*Arisaema jacquemontii*	Araceae
6.	*Begonia picta*	Begoniaceae
7.	*Berberis aristata*	Berberidaceae
8.	*Bergenia ciliata*	Saxifragaceae

9.	*Cedrus deodara*	Coniferae
10.	*Cotoneaster microphyllus*	Rosaceae
11.	*Dioscorea bulbifera*	Dioscoreaceae
12.	*Erigeron bellidioides*	Asteraceae
13.	*Fragaria indica*	Rosaceae
14.	*Gerardiana diversifolia*	Urticaceae
15.	*Hedychium spicatum,*	*Hedychium spicatum*
16.	*Indigofera heterantha*	Leguminosae
17.	*Malaxis muscifera*	Orchidaceae
18.	*Myrsine Africana,*	Myrsinaceae
19.	*Nasturtium officinale*	Brassicaceae
20.	*Persea duthiei*	Lauraceae
21.	*Persicaria capitata*	Polygonaceae
22.	*Picea smithiana,*	Pinaceae
23.	*Pilea scripta*	Urticaceae
24.	*Pinus roxburghii,*	Pinaceae
25.	*Podophyllum hexandrum,*	Berberidaceae
26.	*Prinsepia utilis*	Rosaceae
27.	*Pteracanthus urticifolius*	Acanthaceae
28.	*Quercus incana*	Cupuliferae
29.	*Quercus leucotrichophora*	Fagaceae
30.	*Rhododendron arboreum*	Ericaceae
31.	*Rosa moschata*	Rosaceae
32.	*Rubia cordifolia,*	Rubiaceae
33.	*Rubus ellipticus*	Rosaceae
34.	*Rubus niveus*	Rosaceae
35.	*Rumex napalensis*	Polygonaceae
36.	*Sarcococca saligna*	Buxaceae
37.	*Solanum nigrum,*	Solanaceae
38.	*Solanum xanthocarpum,*	Solanaceae
39.	*Sorbaria tomentosa*	Rosaceae
40.	*Taraxacum officinale,*	Asteraceae
41.	*Thymus linearis,*	Lamiaceae
42.	*Trifolium repens*	Leguminosae
43.	*Urtica parviflora*	Urticaceae
44.	*Urtica dioica*	Urticaceae
45.	*Valeriana jatamansi*	Valerianaceae
46.	*Verbascum thapsus,*	Scrophulariaceae
47.	*Viburnum erubescens*	Caprifoliaceae
48.	*Viola canescens,*	Violaceae
49.	*Zanthoxyllum armatum,*	Rutaceae

Faunal Diversity around Wetland & its catchment's area: Leopard, Himalayan Fox, Black bear, Goral, Hanuman Langur , Rhesus monkey, Himalayan Weasel, Serow. Birds: Black Eagle, Himalayan Monal, Kalij Pheasant, Koklass Pheasant, wedge –tailed Green Pigeon, Asian Barred Owlet, Grey Headed Woodpacker, etc. Butterflies: Papilio protenor protenor, Papilio polyctor polyctor, Parnassius hardwickei hardwickei, Pieris canidia indica, Gonepteryx rhamni nepalenasis etc.(Source: Kalatop - Khajjiar Wildlife Sanctuary –Animal life at a glance, ZSI, Solan) (Table :3)

Conservation value:

Lake and its surrounding land are constantly under threat from weeds. Increasing Pressure of solid waste residues left out by visitors. Large number tourists

come from Punjab every weekend to this site. They left out solid waste materials and also cause sound and vehicular pollution all over the area. Water quality of lake is also detourious due to eutrification. Large numbers of animal herds are grazing over the year in this ground which causes water pollution. Horse riding over a year is around also another reason for water pollution.

Conservation Management:

The Khajjiar Eco-tourism Society with the Conservator of Forests (Wildlife), North Zone, Dharamsala, as its Chairman was established in 2002 but no pragmatic solution to resolve the problem has so far been found. The lake, the centre of attraction, has to be cleared of weeds and silt. Wet dredging is the answer, say experts. A horse-riding circular road needs a drain to take the rain water out of the "bowl". The gullies need to be filled. The grazing rights of the local people have to be curtailed. For this, they will have to be adequately compensated and given alternative pastures. According to official sources, to curb unwarranted and unruly activities in the ambient of Khajjiar lake, this beauty spot has been designated as *"a special development area"* under the Town and Country Planning Act and to look after the cleanliness and development of Khajjiar, a body called, *"the Khajjiar Development Board"* has been constituted of members of various departments under the chairmanship of the Deputy Commissioner of Chamba.No management plan is prepared or approved by Government. In December 1984. Protection of this lake presents little difficulty given the high altitude, provided that adequate manpower is made available. Despite various studies and solutions worked out by experts in the past two decades, little has been done for the upkeep and beautification of the famous Khajjiar lake here. An effort was made in the early '80s to desilt the lake after pumping out its water. The project registered only a moderate success since organic matter kept choking the pumping equipment. Only some silt from the periphery could be removed. In view of the conjectures that water stagnation in the lake is due to the impermeability developed by the filling up of joints and cracks in igneous rocks of this area, they suggested that upper-forested slopes be channelised, the northern slopes be terraced and protected by a retaining wall and the hydrophytes in the lake be manually removed. Mechanical cutting of weeds below surface and removal, draining out of dirty water, construction of a pucca drainage channel around the outer periphery of the lake and a small stonewall to avoid the entry of material and a physiographic map of the lake by the Geological Survey of India were among the suggestions made. Chemical control of weeds by standardisation of dose etc was also suggested. A proposal for relocation and extinguishing of the grazing rights of people was prepared in 1993. Two courses of action were suggested — to close the area to graziers for 30 years provided that an alternative grazing site is earmarked and, secondly, to acquire rights of the people while providing an alternative common pasture. The closest, viable alternative grazing site was found in the Jhurdu forests 6 km away. It was proposed to divert the main water stream, desilt the lake and provide drainage on the main road, formation of a small earthen bund around the periphery to diver the water from nullah and meadow catchment. For the overall development of this area, it is envisaged to de-weed the lake, divert the water of small nullahs feeding the lake, control silt and develop the meadows from the tourists point of view. It is proposed to fence the lake so that soil disturbance in its immediate periphery is halted. Manual removal of floating islets of vegetation in the lake is also mooted.

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S .No.	Scientific Name	Common name	Family
Mammal			
1.	*Semnopithecus entellus*	Hanuman Langur	Cercopithecidae
2.	*Macaca mulatta*	Rhesus Macaque	Cercopithecidae
3.	*Cervus unicolor*	Barking deer	Cervidae
4.	*Naemorhedus sumatraensis*	Mainland Serrow	Bovidae
5.	*Mustela sibrica*	Himalayan Weasel	Mustelidae
6.	*Martes flavigula*	Yellow throated marten	Mustelidae
7.	*Nemarhedus goral*	Goral	Bovidae
8.	*Ursus thibetanus*	Asiatic Black Bear	Ursidae
9.	*Panthera pardus*	Common Leopard	Felidae
10	*Pataurista* sp	Flying Squirrel	Sciuridae
11	*Hystrix indica*	Porcupine	Hystricidae
12	*Vuples vulpes*	Himalayan Fox	Canidae
13	*Myotis sp*	Bat	Hystricidae
14	*Suncus murinus*	House Shrew	Soricidae

Reptiles			
1.	*Laudakia tuberculata*	……	Agamidae
2.	*Oriotaris major*	……	Agamidae
3.	*Asymblepharus himlalanus*	……	Scincidae
4.	*Amphiesma platyceps*	……	Colubridae
5.	*Ptyas mucosa*	……	Colubridae
Amphibian			
1.	*Rana liebigii*	……	Ranidae
Pisces			
2.	*Cyprinus carpio communis* Linnaeus	Common carp	Cyprinidae
3.	*Cyprinus carpio specularis* Lacepeds	Minor carp	Cyprinidae
Insects			
1.	*Acrida exalta*	……	Acrididae
2.	*Oxya fuscovittata*	……	Acrididae
3.	*Oedaleus abruptus* (Thunberg)	……	Acrididae
4.	*Eyprepocnemis alacris alacris* (Serville)	……	Acrididae
5.	*Oxya hyla hyla* Serville	……	Acrididae
6.	*Xenocatanthops humilis humilis* (Serville)	……	Acrididae
7.	*Patanga succincta* (Johansson)	……	Acrididae
8.	*Loxoblemmus*	……	Gryllidae

Table: 3 Faunal Diversity around

53	*Garrulus glandarius*	Eurasian Jay	Corvidae
54	*Garrulus lanceolatus*	Black-headed Jay	Corvidae
55	*Urocissa flavirostris*	Yellow-billed Blue Magpie	Corvidae
56	*Urocissa erythrorhyncha*	Red-billed Blue Magpie	Corvidae
57	*Dendrocitta formosae*	Grey Treepie	Corvidae
58	*Corvus macrorhynchos*	Jungle Crow	Corvidae