TN-106

HYDROLOGIC STUDIES FOR IMPROVEMENT OF KHAJJIAR LAKE (H.P.)

NATIONAL INSTITUTE OF HYDROLOGY
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PREFACE

Lakes are natural reservoirs in which water is temporarily stored during its passage to the sea. It is proposed to undertake hydrologic and ecosystem studies on a short time basis of 3 to 5 years by instrumenting the selected lake Khajjiar and collecting the data for the analysis. Long term studies would also be examined . The studies would go a long way in understanding the ecosystem of Khajjiar for efficient utilisation of water resources of the lake. The study is also expected to cover other objectives of supporting agencies for research and development.

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ABSTRACT

The report examines the proposed hydrologic and ecosystem studies at the Khajjiar lake in Himachal Pradesh. Since the lake plays a significant role in the ecology of the watershed all aspects concerning water in the form of input and output needs to be studied.

The state agencies are mostly concerned with the beautification of the lake and its surroundings, particularly from tourist point of view. However the problem needs to be examined in its overall perspective by studying the forest, stream and lake ecosystems.

1.0 INTRODUCTION:

The hydrology of lake is a subject that had not attracted the attention of Indian hydrologists even upto 1980's. Lakes in general represent additional storage capacity of hydrologic systems. Natural or artificial changes in storage either in quality or quantity of water alter not only the streamflow regime but also the water balance in the region. Alteration of flow regime and quality of lake water, a common problem faced everywhere, arising from increase in demand and several developmental activities, result in the hampering of activities supported by lake. There are also side effects of ecological imbalances in the region.

There are several natural lakes in the high altitude regions of the Himalayas. Due to neglect and accumulation of silt, debris and dead organic matter the water quality of lake is adversely affected. Water also flows away haphazardly creating rills and erosion problems. It is therefore, essential to study the water balance of the lakes and monitor the variations of such parameters as would affect the water availability and water quality of the lake while preserving a healthy ecosystem.

The Khajjiar watershed is a saucer shaped plateau 1.5 km long and 1 km wide. It is surrounded by a dense forest of gigantic Deodars which form part of the catchment of the Khajjiar watershed. The watershed is located at a height of 1940 m in the valley between Dhauladhar and the Pir Panjal ranges in Chamba

district of Himachal pradesh. Several agencies of the State Govt and department of Environment are considering proposals for improvement and beautification of the lake. The khajjiar forest has been declared as a national sanctuary to protect wild life.

In the present report some of the hydrologic and ecological aspects are proposed to be studied by instrumenting the watershed and collecting data for analysis. The study should be useful for better management of water in the lake and in general improvement of the ecosystem.

2.0 SCOPE AND OBJECTIVES OF STUDY:

The Regional Centre, NIH, Jammu now proposes to instrument the watershed and collect hydrologic and climatic data with the help of State administration, Forest, Irrigation and Public health departments of Himachal pradesh. Broadly the study is intended to cover the ecosystem of the Khajjiar watershed with special emphasis on the quality and quantity of water in the lake. Some of the aspects such as forest influences on water yield, nutrients escaping with water, impact of grazing, silting of lake or in general the ecology of the watershed and surrounding region need to be examined. Specific studies/ activities proposed to be undertaken include:

1. Installation of raingauges, snowgauges and evaporimeters in the forest around the lake and carry out observations for three to five years.
2. Installation of gauges for measurement of flows through various streams into the lake and estimate sediment yield.
3. Carrying out piezometric studies to study the recharging of lake from other sources during non rainy periods.
4. Finding out ways for deweeding (physically or chemically) from the lake.
5. Studying the water quality of the lake waters and evolve measures to improve the quality of lake water.
6. Exploration of ways for developing alternate pasture lands to divert the grazing animals.
7. Studying means of increasing water yield in the lake to

increase the quantity of water and also the area of the lake.

8. Developing a model using the data collected from the watershed typical of forested catchments in the region.

3.0 REVIEW :

3.1 General:

Lakes and swamps are transitory features of the earths surface, and each has a birth, life and death, related to certain geologic and biologic processes. The lakes of the world are basically a natural resource available for use by man. Throughout the history of civilization lakes have supplied such basic needs as food, primary water supply, and transportation routes. More recently, in addition to the above, lakes have provided energy to drive water propelled turbines and have made possible recreational activities of great variety. Lake definition and classification are briefly discussed below.

3.1.1 Definition:

From Geologic point of view, a lake consists of two distinct parts, the basin and the water body. Zumberge (1952), defined lake as an inland basin filled with water. A further restriction of size seems necessary, as pointed out by Welch (1952), who made a distinction between lake and pond.

3.1.2 Classification:

The following classification (Chow, 1964) is based on origin of lakes:

- Tectonic lake basins
- Lake basins produced by volcanic activity
- Lake basins produced by landsliding
- Lake basins produced by action of glaciers
- Lake basins produced by fluvatile action

- Lake basins produced by wind action
- Lake basins produced by shoreline process
- Lake basins formed by meteorites etc.

3.2 Lake Morphometry and Morphology:

The three dimensional form of a lake basin and several aspects of the nature of the lake within it depend in part upon the kind of topography in which the lake was formed, in part upon the physical means by which the lake was brought into being and in part upon conditions and events in the lake and in the drainage basin since the lake was formed. Lakes formed in mountainous terrain have different form characteristics from those of lakes in lowlands. Lakes after being formed, are subject to filling in at different rates and with different materials, depending upon the tributary gradients, rock types, erosive agents, biological activity, and land use practices occurring in their drainage basins.

The measurement of form characteristics of lakes and lake basins is termed as morphometry. The determination and use of standard morphometric parameters have advantages in enabling the quantitative expression of aspects of lake form and the meaningful comparison of one lake with another (Welch, 1948),(Hutchinson, 1957). The basic device in morphometry however are hydrographic and bathymetric charts. The bathymetric mapping was first applied in India by Mukherjee in 1932 for survey of Dal lake in Kashmir. This technique was later applied to by Khanka (1983) to analyse the morphometric characteristics of Kumaun lakes of the

Himalayan region (UP). Some of the lake morphometric parameters include: Max length, max effective length, Max width, direction of major axis, mean width, max depth, volume, mean depth, development of volume, shoreline, development of shoreline, hypsographic curves, slope of basin etc.

Morphology is determined initially and primarily by the terrain in which lakes are formed and by the mode of their formation. These forms determine the initial forms of the submerged basin and of the shoreline. After the lake has formed, it undergoes a characteristic series of events, which are visibly expressed in varying degrees, depending upon the nature of the basin materials.

3.3 Lakes in the hydrologic cycle:

The hydrologic cycle is driven by solar energy and gravity. Most of the precipitation which falls on the land surface is derived from oceanic evaporation. Water falling on land is eventually returned to the sea, though some of it reaches the oceanic reservoir by complex and devious routes. Lakes are natural reservoirs in which water is temporarily stored during its passage to the sea.

Lakes and swamps are supplied by meteoric water and are sensitive to variations in the net rate of supply. This sensitivity is registered in rise or fall in lake level, reflecting volumetric water changes in the lake basins. Lake-level fluctuations not only record changes in water gain, but also changes in water losses, both of which are a function of climatological

variations with time. The water level of a lake is a function of the volume contained in the lake basin. The rate of change of water volume is controlled by the rate at which water enters the basin from all sources minus the rate at which water is lost by evaporation from its surface and discharged by surface and sub-surface effluents.

3.4 Lake water balance:

Water balance relationships form the basis for rational deterministic hydrological forecasting models. The study of water balance of lakes is necessary in order to estimate quantitatively the water resources potential available for practical use. The water balance equation for lakes for any time interval is a continuity equation. According to law of conservation of matter, there is equilibrium between inflow components, outflow components and change of water volume for each interval of time. This equilibrium is described by water balance equation.

$$I_{Si} + I_{Gi} + P - E - I_o - I_{GO} - S = 0$$

Where, I_{Si} = Surface inflow into the lake

I_{Gi} = Ground water inflow

P = Precipitation on the surface of the lake

E = Evaporation from the lake

I_o = Surface outflow from the lake

I_{GO} = Underground outflow

S = Change in the water storage in the lake

The relative magnitudes of water balance components vary from place to place and season to season. Morphological, geological, and climatological factors which are the main components to

influence the magnitude of the terms in the water balance equation.

Various methods are available to predict the components of water balance equation. For example, surface inflow into the lake is dependent upon the morphological, geological and climatological factors of the lake basin. Lake inflow is mainly related to amount of precipitation and stream flow and ground water seepage in the lake basin. Statistical, stochastic and real time analysis are generally applied to determine the quantity of inflow into the lake.

As such studies concerned with lake (natural) water balance specifically with reference to Indian lakes had not been reported anywhere. Number of studies had however been carried out on reservoirs to mention a few ones, Rao K L and Palta B R (1973) Bhakra lake and Kumaraswamy P (1973) on Budery tank in Tamil nadu state.

3.5 Sedimentation of lakes:

Sediment is carried into a lake by streams and rivers and also by overland flow entering into the lake. Sediment entering a lake may consist of a wide range of sizes, from gravel or boulder to silt are clay particle. Because of the low current velocities available to transport the sediment through a lake, the coarser particles and quickly deposited and form deltas. Seldom will any sediment larger than silt size be discharged from a lake. The appropriate way of obtaining an accurate determination of the amount of sediment being carried to a lake by streams or by

overland flow is to measure the flow rate and sediment concentration of the inflowing water just upstream of the lake. For purposes of measurement, the sediment carried by stream is usually subdivided into two parts.

a) Fine, with particle diameters less than 0.062 mm and

b) Coarse with particle diameters greater than 0.062 mm. that can further be divided into suspended load and bed load.

Following methods (Ghosh, 1992) are commonly used to estimate the rate of accumulation of sediment in a lake.

i) Surveying methods.

ii) Dating of sediment

iii) Remote sensing

iv) Sediment Density

v) Particle size

vi) Water currents

vii) Residence time in reservoirs or lakes.

3.6 Biological Processes of Lakes:

Lakes are considered to undergo a process of aging, which has been characterized by three qualitatively defined conditions. The initial condition of a lake is termed 'oligotrophic' and is normally associated with deep lakes, where waters at the bottom of the lake are cold and relatively contain high level of dissolved oxygen throughout the year. Oligotrophic lakes are poorly fed; have a low concentration of nutrient elements such as nitrogen, and phosphorus productivity in terms of population levels of

phytoplankton, rooted aquatic plants, and zooplankton. On the other hand, eutrophic or 'well fed' lakes have high concentration of plant nutrients and large concentrations of phosphorus plankton due to high organic productivity. Eutrophic lakes may be either shallow or deep. These are characterized by high concentrations of suspended organic matter in the water column and by relatively large sediment depths with high organic contents particularly in the upper layers of sediment. Biological productivity is high and the diversity of biological population may be some what limited.

A third lake condition is mesotrophic which is an intermediate state between oligotrophic and eutrophic. Mesotrophic lakes have intermediate level of biological productivity and can have some reductions in bottom dissolved oxygen levels. Two nutrients, nitrogen and phosphorus are of greatest concern in the growth of biological organic matters in the lake. In addition to these nutrients, phyto plankton requires carbon dioxide and a host of minor elements (potassium, sodium) and trace elements (iron, cobalt, manganese, copper, zinc, boron etc).

Of the nutrient elements needed for photosynthesis, hydrogen and oxygen are readily available and also carbon is generally available from atmospheric carbon dioxide. The major elements that are not always available are nitrogen and phosphorus. Since phosphorus does occur as a gas in atmosphere, a lake has no way of compensating for phosphorus deficiencies, and thus becomes the limiting nutrient. Phosphorus input can increase during cultural eutrophication of lakes. The primary source of phosphorus and

nitrogen in lakes are direct rainfall and snowfall on the lake and runoff from the surrounding drainage area. In oligotrophic lakes most phosphorus in runoff comes from rock weathering and soil transport. However, in areas influenced by human there are additional sources of phosphorus, including agricultural runoff and sewage, which are discharged directly into the lake or its inlet tributaries. Atmospheric precipitation may be a very important source of phosphorus for oligotrophic, particularly those in areas of granitic terrain with low contributions of nutrients from weathering and those lakes whose area is large compared to the drainage area.

3.7 Indian Scenario of lake study:

Study carried out so far in India before and after Independence mainly concerned with the ecological, environmental, socio-economic and limnological aspects of lakes located in various corners of the country. Many Governmental and semi governmental, voluntary organisations, Universities and Institutions are engaged for extending study of India's Lakes. Due to topographic, hydrologic and geological variations, there are a number of lakes of different sizes located in various regions of the country. The exact statistics of number of lakes have not yet been assessed. A national inventory of wetlands, entitled "The all India Wetland Survey", established by the Govt of India, initiated a study as in the late 1960's and could only give a broad assessment of wetland areas in the country in 1984. Studies undertaken on different lakes of the country and nature of study conducted are

presented in Table 1.

Some of the Governmental and nongovernmental organisations undertaking studies covering ecological and limnological aspects of lake are as under;

Governmental Organisations

i) Ministry of Environment and Forests, New Delhi
ii) Planning Commission, New Delhi
iii) Ministry of Water Resources, New Delhi
iv) Ministry of Agriculture, New Delhi
v) Indian Board for Wild Life
vi) Forest Research Institute, Dehradun
vii) Ganga Water Authority
viii) Institute of Wet Land Management and Ecological Design
ix) Environmental Monitoring Organisations
x) National Ecodevelopmental Board

Nongovernmental organisations.

i) Bombay Natural History Society
ii) UNDP/ UNESCO
iii) Ecological Society, Pune.
iv) Indian Society of Naturalist (Baroda)
v) Wildlife Preservation Society of India (Dehradun)
vi) Tourism and Wildlife Society of India (Jaipur)
vii) Assam Valley Wildlife Society.

TABLE 1.

Studies undertook on different lakes of the country and nature of study conducted are summerized below (Ghosh, 1992)

	Name of Lake and Location	Area/ Altitude	Nature of Study conducted	Researcher/ References
	1	2	3	4
1.	Pangong Tso, Jammu & Kashmir	65000 ha 4218 m	Breeding ecology of Grusnigricollis	Khacher (1982)
2.	Chushul Marshes, Jammu & Kashmir	11000 ha 4385 m	Ecology of Grus nigricollis	Ali (1979) Gole (1981) Hussain(1987), Khacher(1982) Narayan(1987) Nurbu (1987)
3.	Hanle River Marshes, Jammu & Kashmir	7500 ha +500 m widestrip 4250-4350 m	Marsh Flora & the bredding black-necked Cranes	Gole (1981 & 1987), Khacher(1982) Nurbu (1987)
4.	Tso Morari, Jammu & Kashmir	12000 ha 4511 m	On breeding birds	Gole (1981 & 1982), Hussain (1987), Khacher (1982), Narayan (1987), Nurbu(1987)
5.	Tso Kar Basin, Jammu & Kashmir	20000 ha 4530 m	On breeding birds particularly Anser indicus and Grus-Nigricollis	Gole(1987), Hussain (1987), Khacher (1982) & Nurbu (1987)
6.	Dal Lake, Jammu & Kashmir	1670 ha 1587 m	Considerable study had been carried out on the limnological,ecological, environmental, eutrophication and siltation problems of the lake. Bathymetric survey was first introduced in the lake study for Dal Lake.	Mukherjee(1921, 1925,1931,1935) Zuthi & Vass (1979,1984,1971, 1973,1978,1988), Zuthi (1968,1975), Kant & Kachroo (1971,1977).
7.	Shallabugh Lake, Jammu & Kashmir	750 ha 1580 m	On hydrology of lake and some waterfowl censuses.	
8.	Wuler Lake, Jammu & Kashmir	20000 ha 1580 m	On limnological aspects of lake	Abdulali & Savage (1970), Luther & Rzoska (1971)

9.	Haigam Rakh, Jammu & Kashmir	1400 ha 1580,m	Department of Botany of Kashmir University conducted some study on limnological and ecological aspect of the lake. Areas covered in the research were: study of mineral composition biogeochemical cycling,plankton populations,biomass productivity, trophic structure and plant community architectures. The Bombay Natural History Society had worked on avifauna of the lake. The Department of Wildlife Protection had conducted some waterfowl census and two oxford University Expeditions had studied the breeding birds & passage migrants.	Abdulali & Savage (1970); Deneil (1985);Fernandes (1987).Kaul (1979, 1982,&1984, Kaul et.al(1982),Kaul, v (1970 & 1977), Kaul,v.et.al (1978), Kaul, Pandit et.al. (1980), Kaul,Trisal et.al(1980), Pandit (1982),Pandit & Kaul (1982).
10	Mirgund Lake, Jammu & Kashmir	300 ha 1580 m	Scientists from the Department of Botany at the University of Kashmir had conducted considerable amount of limnological and ecological study	Kaul,S (1979) & (1982), Kaul,S. et.al (1982), Kaul,V.(1970 & 1977), Kaul, V et.al.(1978), Pandit & Kaul, (1982).
11.	Hokarsar, Jammu & Kashmir	1300 ha 1580 m	Limnological and ecological study had been carried out by the Biologists from Department of Botany at the University of Kashmir.	Abdulali & Savage (1970); Daniel (1985). Fernandes(1987); Kaul,S.(1979 & 1982; Kaul,S.et.al. (1982); Kaul V. (1970 & 1977) Kaul,V.et.al.(1978) Pandit (1982); Pandit & Kaul (1982).
12.	Renuka Lake, Himachal Pradesh	17.70 Ha 645 m.	Department of Biosciences, Himachal Pradesh University had conducted study on limnological & ecological aspects of the lake with special reference to its Flora & Fauna.	Singh,B.& Mishra S.M.et al(1987).

13.	Khurpatal, Uttar Pradesh	10 ha 1620 m	Considerable studies had been carried out on the limnological and ecological aspects of lakes of Kumaun Himalaya. Limnological study was conducted through bathymetric map.	Das,S.M.(1980);-Hukku,B.M.,et.al.(1984); Joshi S.C.,et al(1983) Khanka, L.S.(1983) Kharkwal, S.C. (1971), Mathu,S.M. (1955), Pande,I.C. (1974),Rawat,J.S. (1987), Thomas, A. (1952).
14	Naina Lake, Uttar Pradesh	45.07 ha. 1937 m	- do -	- do -
15.	Bhimatal Lake,	46.26 ha 1345 m	- do -	- do -
16	Naukuchiyatal Lake, Uttar Pradesh	37.53 ha 1320 m	- do -	- do -
17.	Punatal Lake, Uttar Pradesh	14.85 ha 1360 m	- do -	- do -
18.	Sattal Lake, Uttar Pradesh	34.02 ha 1300 m	- do -	- do -
19.	Pyagpur and Sitadwar Jheels, Uttar Pradesh	2800 ha (Pyagpur) 150 m (Sitadwar) 125 m	The Bombay Natural History Society had conduc' preliminary survey and waterfowl censuses.	
20.	Chandpata Lake, Madhya Pradesh	200-300 ha 450 m	Studies had been carried out on flora & fauna.	Karpowicz (1985)
21.	Chhata Lakes, Uttar Pradesh-Rajasthan Boarder	3000 ha 190 m	Preliminary survey work had been conducted.	
22.	Sultanpur Jheels, Haryana State	13,727 ha 220-230 m	Some waterfowl censues had been carried out and avifuana had been well documented.	Fernandes (1987), Gole (1982), Haryana Government (1956).
23.	Sambhar,Phulera and Didwana Salt Lakes, Rajasthan.	Sambhar 23,300 ha Phulera	Several waterfowl surveys had been conducted at the	Abdulali & Savage (1970), Alam (1982),

		200 ha Didwana 200 ha	lakes and also archaeological, palaeobotanical and palaeontological research had been carried out in the surrounding areas	Ali & Ripley (1968),De Block (1981), Fernandes (1987).
24.	Khijadia Lake, Gujarat	1000 ha. 0 - 2 m.	Some ecological studies had been carried out mainly with reference to waterfowl censuses	Gole (1984), Karpowicz (1985)
25.	Nalsarovar Lake, Gujarat	11500 ha. 11.5 m.	Ecological studies were conducted specially with reference to flora and fauna.	Fernandes (1987) Gole [1984 (a)&(b)].
26.	Ajwa, Vadhwana and Pavagadh Lakes, Gujarat	Ajwa 200-300 ha Vadhwana 400 ha Pavagadh 100 ha 50-60 m.	Waterfowl Survey had only been conducted	
27	Khabartal, Bihar	7400 ha 45 m	The state forest department had conducted a preliminary study of the lake ecosystem.	Mishra & Negi (1985)
28	Logtak Lake, Manipur	26000 ha 770 m.	Studies carried out on ecological and socio-economic importance of Logtak Lake.	Yadav and Varshney (1982)
29	Salt Lakes Swamp West Bengal	12000 ha 5 m	The West Bengal Department of Fisheries had conducted some research on sewage purification and fish production in the swamp. The Institute of Wetland Management and Ecological Design had conducted some studies on public health issues and ecological aspects of lakes.	Fernandes(1987) Ghosh (1983), Maltby (1986)
30	Chilka Lake, Orissa	116500 ha 0 - 2 m.	The Bombay Natural Society had conducted some studies on bird ringing programmes	Abdulali & Savage (1970), Ahmed (1987), Anon (1984), Asthana (1979),

				Banerjee & Roy-Choudhery (1971).
31.	Kollem Lake, Andhra Pradesh	90000 ha 0 - 5 m	Study had been carried out on aquatic biota of the lake and on the ecology of the lake.	
32.	Pulicat Lake, Andhra Pradesh	72000 ha 0 - 10 m	The Bombay Natural History Society carried out an ornithological survey and the zoological survey of India had complied species lists for many groups of flora and fauna.	Abdulali & Savage (1970), Fernandes (1987), Hussain (1987), Krishnan (1984), Neelakantan (1980).
33.	Lake Mir Alam, Andhra Pradesh	16900 ha 540 m.	Some limnological & ecological studies had been carried out by different scientists	Reddy (1984), Mohan (1985, 1986, 1987). Mohan and Reddy (1986, 1987 and 1989)
34.	Lake Periyar, Kerala	2500 ha 1000 m	The State Forest Department and the Kerala Forest Research Institute had conducted some studies on ecological aspects of the lake	M. Krishnan
35.	Mayem Lake, Goa.		Studies had been carried out on limnological aspects.	Desai (1991)

4.0 STUDY AREA :

4.1 General

It is proposed to undertake hydrologic and ecosystem studies on a short term basis of 3 to 5 years by instrumenting the watershed and collecting the data for analysis. Long term studies would also be examined. The studies would go a long way in understanding the ecosystem of khajjiar for efficient utilisation of water resources of Khajjiar lake. The study is also expected to cover other objectives of supporting agencies for research and development.

4.2 Description of study area:

Khajjiar lake and its surroundings are one of the most picturesque saucer shaped plateaus and a tourist attraction spot. The green pastures surrounding the lake are approximately 1.5 km long and 1 km wide. The watershed is located at a height of 1940 m in a valley between Dhauladhar and Pir panjal ranges of the Himalayas. The watershed lies at latitude of 32.5 degrees and a longitude of 76.1 degrees. The study area is described below.

4.2.1 The lake

The Khajjiar lake and the meadow are surrounded by a thick forest of Deodar and Spruce Fir. The lake has a small floating island in the centre. The size of the lake is not large and is more or less like a pond of about 60 to 80 m radius.

Currently the lake is in a state of neglect with grass and weeds all over (see fig.1). The waste from grazing animals (numbering 250) including horses (for tourist recreation) have added

to the deterioration of lake. The lake as such has plenty of slush, weeds and decaying organic matter, resulting in the lake becoming more or less like a swamp. However, the state administration and various departments (PWD, Tourism and Forest) are planning to clear the lake of weeds, divert water coming from rivulets feeding the lake, control the silt and develop greener pastures around the lake.

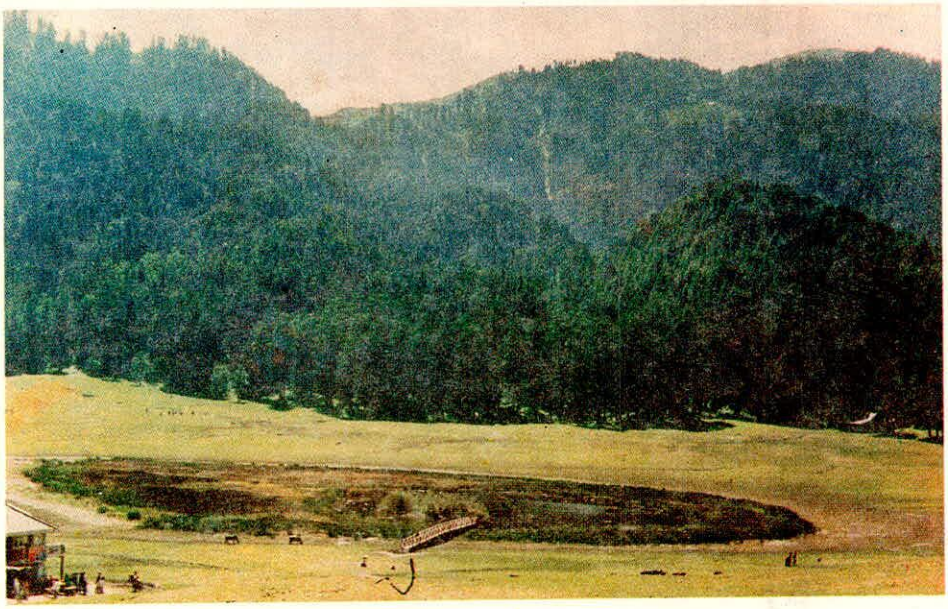

Fig 1. Khajjiar lake (HP)

4.2.2 Forest and Meadow:

The naturally occurring meadow surrounds the lake which in turn is surrounded by a thick forest. This is an interesting and characteristic feature of Khajjiar watershed. The meadow is roughly 1 x 1.5 km in area. The total watershed area including lake, meadow and the forest is about 2.7 sq kms.

The forest species include the conifers, predominantly Deodar with some other types of Spruce and Fir. Most trees are mature and are more than 200 years old. The forest cover is quite thick with cover density greater than 0.8

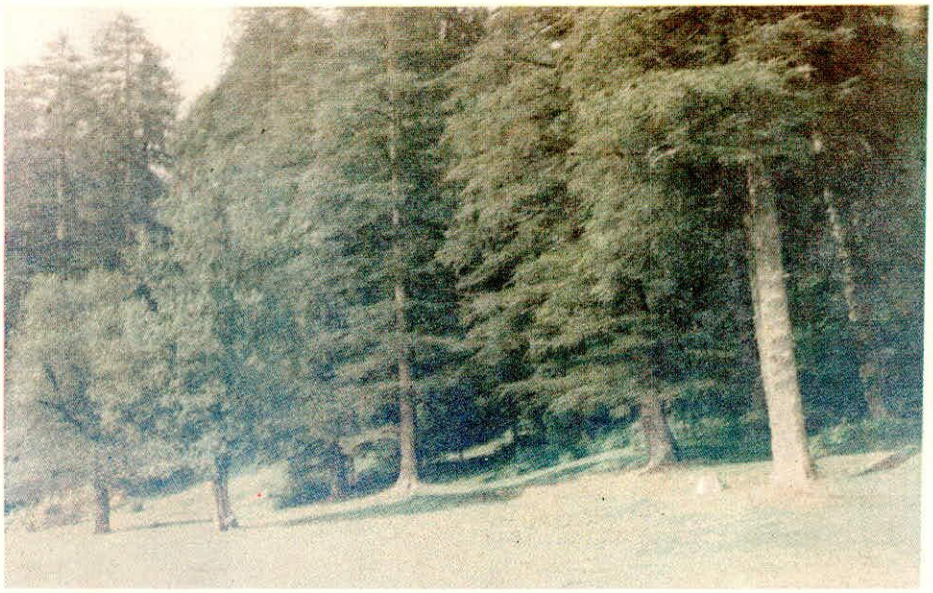

Fig 2. Khajjiar Forest

4.2.3 Climate:

The watershed experiences a moist temperate climate. The precipitation is in the form of snow during January to March and rain during the south west monsoon. The annual average precipitation is 1.2 m.

4.2.4 Soils:

The soils are sandy loam in the meadow part, while under the forest they are highly organic with humus and litter. The soil thicknesses vary from 30 to 40 Cms.

4.2.5 Streams and rivulets:

Due to a mountainous terrain several streams and rivulets are seen feeding the lake from all directions. These streams flow mostly during the monsoon period or during the melting of snow in the spring season. The lake water spread area is not large (ap-

proximately 60 - 80 m diameter) as also its capacity. The lake water level does not increase much from its existing level since a concrete pipe (1 m diameter) laid by the state PWD drains out the water to a point of watershed outlet.

Fig 3. Rivulets feeding the lake.

Since a map of desired scale (like 1:25000) was not available a sketch map of the watershed is shown in fig 4. This map was drawn after a reconnaissance survey.

4.2.6 Check dams and Silt control:

The forest deptt (wild life), Chamba (HP) have constructed check dams at a number of places in the gullies of rivulets to control silt entering the lake. However not much silt has been observed.

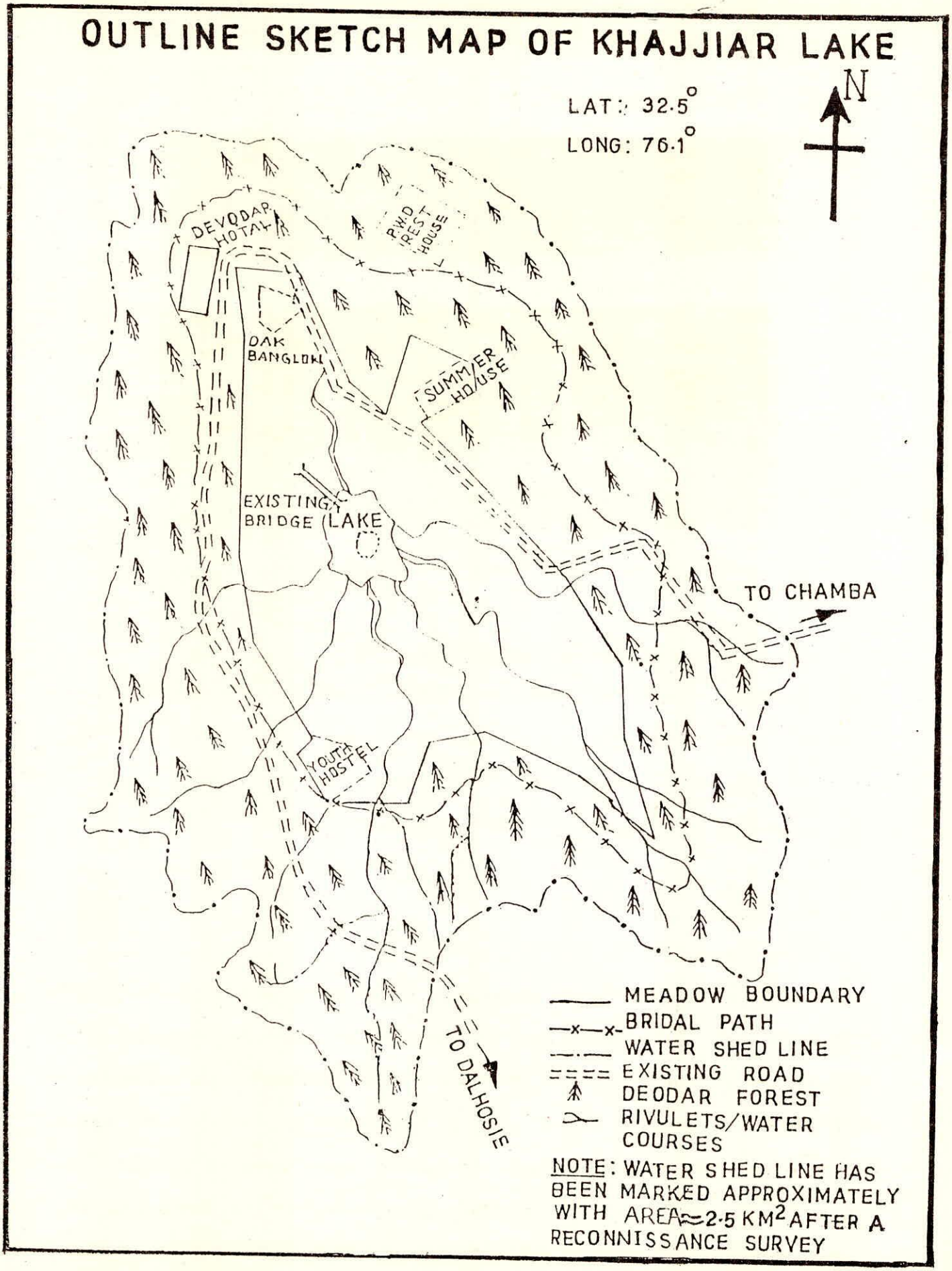
OUTLINE SKETCH MAP OF KHAJJIAR LAKE
LAT: 32·5°
LONG: 76·1°
N
DEVDAR HOTAL
P.W.D REST HOUSE
OAK BANGLOW
SUMMER HOUSE
EXISTING BRIDGE
LAKE
TO CHAMBA
YOUTH HOSTEL
TO DALHOSIE
MEADOW BOUNDARY
BRIDAL PATH
WATER SHED LINE
EXISTING ROAD
DEODAR FOREST
RIVULETS/WATER COURSES
NOTE: WATER SHED LINE HAS BEEN MARKED APPROXIMATELY WITH AREA ≃ 2·5 KM² AFTER A RECONNISSANCE SURVEY

Figure-4

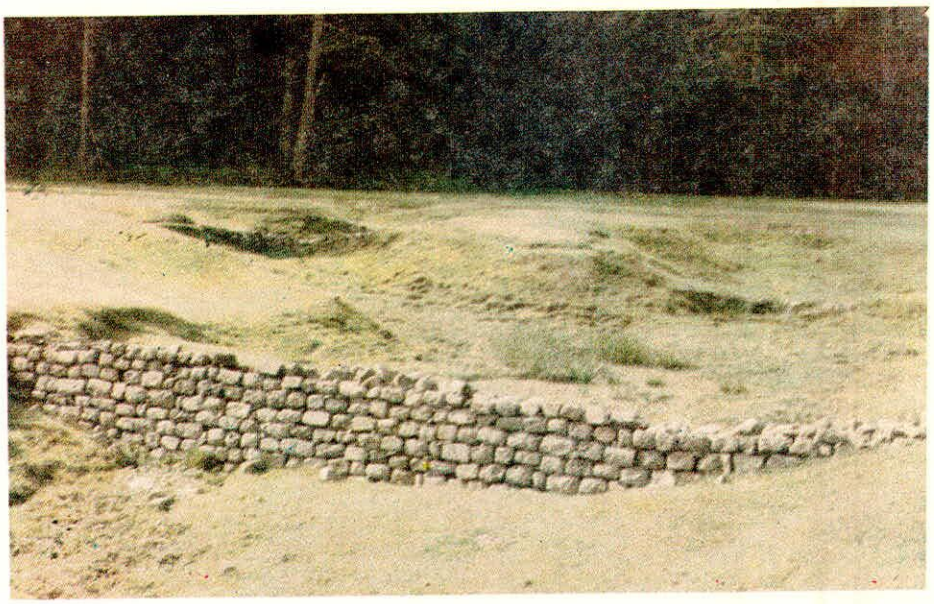

Fig5. Check dams to control silt.

4.2.7 Ground water exploitation:

Despite a sparse population as observed in most hilly places, water shortages have been reported in the Khajjiar regions for drinking water and other purposes. Hence drilling rigs for exploitation of ground water was seen.

4.3 Study Plan

4.3.1 General:

Broadly the Khajjiar watershed studies would include areas of forest and lake hydrology in particular and the ecosystem of the region in general. The studies are proposed to be undertaken on a short term (3 - 5 yrs) and a long term (10 - 15 yrs) basis as an experimental watershed. Since no hydrometeorological or hydrological data exists in the watershed, it is proposed to

instrument the watershed and collect data. Intensive/ extensive investigations of soil and biological parameters is also proposed. The instrumentation consistent with study objectives, methods of data collection and staffing is proposed to start during 1993 - 94. Collaborative studies with other departments including Forest, PWD and academic organisations such as Universities would also be examined.

A detailed topographic and soil survey are proposed before the commencement of study programme.

4.3.2 Studies:

The study programme is intended to cover areas of surrounding forest and lake. The short term studies involving measurement of hydromet and hydrological parameters such as precipitation, discharge, interception, throughfall, infiltration, silt, soil moisture, water quality etc would initially be carried out. Subsequently water balance and water quality studies are proposed to be undertaken. However long term studies involving entire forest and lake eco-systems would be considered later. Some of these would include impact of cultural and silvicultural changes on hydrology and climate. Impact of grazing, loss of nutrients would be other studies. The large amount of data so collected during the study would also be used in the development of a forest hydrologic model.

4.3.3 Instrumentation:

The instrumentation of the watershed is proposed in a phased manner in 3 or 4 subbasins of Khajjiar watershed. Initially simple instruments such as precipitation rainguages (suitable

network of recording and nonrecording gauges), discharge devices (weirs and V-notches), silt and discharge gauge posts, thermometers, piezometers, evaporimeters, anemometers etc would be installed. For experimental investigations such as infiltration, interception, soil moisture, water quality etc, prefabricated or laboratory procured equipment would be used. All equipments would however confirm to specifications of standard equipments.

It is also proposed to procure more sophisticated equipment through UNDP, such as automatic weather stations, stage recorders, lysimeters etc.

4.3.4 Method of Observations:

Except streamflow which is an integrated observation for an entire basin, hydrological observations are mostly point samples. Since observations at point as well as averages for a basin are often required, it is scientifically and economically desirable to establish within the watershed a number of so called 'master sites' where point observations are made for a number of hydrological characteristics (such as precipitation, infiltration, soil moisture, etc). While standard methods of installation (of equipment) and observation would be followed, it will be also examined where ever required, the biasness in data being collected.

4.3.5 Maintenance of Equipments and Staffing:

While trained manpower are required for observation, data collection, data processing and maintenance of equipments, it is proposed to take the manpower from forest department (wild life),

Chamba, during the initial period of 1 or 2 years. Basic training for data collection and maintenance of equipment to forest staff (such as Forest Guards, Rangers etc) would be imparted by the research staff of the NIH regional Centre at Jammu. The research staff of the NIH would be posted subsequently for this purpose.

5.0 CONCLUSIONS

Lake plays a significant role in shaping the hydrology, ecology, environmental and socio-economic structure. Degradation of lake water and its development programme not only adversely affect the local environment but also have bearings on socio-economic and socio-cultural structure of the region. This preliminary report brings about instrumention program and undertaking forest and lake hydrologic studies at Khajjiar (HP).

The lakes study as discussed requires field infrastructures such as trained manpower, equipments for long term monitoring and many other resources. For the purpose, it is required to create a separate study group and a separate field unit which calls for providing additional supports to the regional centre.

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REFERENCES

Abdulali, H & Savage, C D W (1970), Status of the Main wildfowl Reports in India. In: Isakov, Y A (ed), Proc. International Regional Meeting on Conservation of Wildfowl Resources, Leuingard, USSR, 25-30 Sept. 1968, pp.335-337, Moscow.

Alam, M (1982), The Flamingos of Sambhar Lake, J. Bombay Natural History Society, 79.

Asthana, V (1979), Limnological Studies of Lake Chilka, Orissa, Technical Report of MAB Project, Department of Science & Technology, New Delhi.

Banerjee, A C & Raychoudhery, N C (1971), Observation on some physio-chemical features of Chilka Lake, India. J Fisheries 13(2).

Chow, Ven tee (1964) - Hydrology of lakes and Swamps. Applied hydrology.

Fernandes, J (ed), (1987), Wetlands- status and Management in India: An Overview, New Delhi: Environmental Services Group, World Wildlife Fund - India.

Gole, P (1984a), Birds of Saurashtra. Hornbill April-June, 1984

Gole, P (1984b), Some Wetlands of Ornithological Importance in Western India. Unpublished report submitted to the XXXth Annual Meeting of the International Waterfowl Research Bureau, Groningen, Netherlands, May,1984

Gole, P (1987), Some Management considerations for Birds Sancturies. Paper Presented at the Conference on Wetlands and Waterfowl Conservations in Asia, Malacca, Malysia, 23-28 Feb.1987

Ghosh, N C (1992), 'Lake Hydrology' - Hydrological developments in India. A contribution to hydrological sciences.

Hussain, S A (1987), Wetlands of India : An Overview, Paper Presented at the Conference on Wetland and Waterfowl Conservation in Asia, Malacca, Malaysia, 23-28 Feb.1987

Kaul, S (1982), Community Architecture Biomass and Production in some typical wetlands of Kashmir, India. Indian Journal of Ecology 9: pp 320-329.

Kaul, S (1984), Biomass and mineral composition of aquatic macrophytes in Hygam Wetland, kashmir. Acta Hydrochim Hydrobiology 12, pp 81-91.

Kaul V (1977), Limnological Survey of Kashmir Lakes with reference to Trophic status and Conservations. Int J Ecology and Environment sciences 3: pp 29-49

Mukherjee, S K (1934), The Charophytes of the Dal, Kashmir Proc. 21st Indian Science Congress.

Narayan, G (1987), Black necked Crane Survey Report. Bombay Natural History Society, Bombay, Unpublished Report.

Singh, R & Mishra, S M et al (1987), Morphometry and catchment study of Renuka Lake, HP, India, With a note on its Flora & Fauna. Western Himalaya, Vol II Ed by Y P Pangley and S C Joshi.

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