

## **Hanjis Activities and Its Impact on *Dal* Lake and Its Environs (A Case Study of Srinagar City, India)**

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**Abstract:** Nature is the necessary condition for the existence and development of society. But increasing interventions by man in recent past have altered the natural environment to 'humanize' it for their benefits. The relationship between man and nature is twofold. On one hand, man's actions and activities are influenced and conditioned by natural environment. On the other hand, mankind continuously conquers nature and reform geographical surrounding in the process of their development. The bridge between these is man's productive activity through which he continuously changes his geographical surroundings. Every natural system has its carrying capacity. Over dependency and over exploitation of this system beyond its capacity leads to destruction and disintegration of living and non-living components of the system. The present study focuses on the interaction between '*hanjis*' and ecologically important *Dal* Lake and its surroundings in Srinagar city (India). The *Dal* is one of the beautiful lakes of the world for which Lawrence has said, "Perhaps in the whole world there is no corner as pleasant as the *Dal* lake". The study finds that the *Hanjis* with increase in their population have inflicted transformations in and around the lake with their activity. These transformations are leading to deterioration of the *Dal* lake and its environs and there is an urgent need for intervention for the welfare of the *Hanjis* and the management of the *Dal* lake.

**Keywords:** *Dal* lake, hanjis, land use, transformation

### **INTRODUCTION**

Man lives in the natural environment, which is complex, dynamic and interconnected system where actions in one part have its bearing on the other components of the system. Despite of all the cultural development, man's activities have dependence on natural environmental setting. It is this natural setting which sets the stage for human development by providing opportunities. This man-nature relationship makes an important area of study which has held the attention of man from the beginning of civilization. However, this relationship has always been ambiguous. The environment in which man exists and to which he adapts himself, includes not only the physical components but also the socio-cultural and biological components. Today, the dependence on natural environment and its sustenance is a crucial issue before the humanity.

Transformation has escalated through time and in some instances the scales of change have shifted from the local and region to the earth as a whole (Turner, *et al.*, 1990). The harmonious relationship between man and nature is increasingly affected by increase in population and over dependence and exploitation of natural resources. Significantly, developing countries like India where growth of population is high the demand and

dependence on natural environment would continue to be high and so is the degradation of natural environment.

In contemporary times the central theme to the sustainable development debate is the issue of land use change brought out by man, which is one of the main driving forces of global environmental change. Land use change involves land cover transformation i.e., the complete replacement of one cover type by another and land cover modification i.e., the changes that affect the character of land cover without changing its overall classification (Turner *et al.*, 1993; Lambin *et al.*, 2000). The factors which instigate the complex process of land transformations are wide variety of social objectives e.g., the need for food, housing, recreation or energy etc. The drivers leading to land transformation are broadly categorized as biophysical, factors, institutional factors, technological factors and economic factors which cannot be understood independently (Turner *et al.*, 1993; Heilig, 1996; Semeels and Lambin, 2001).

Land transformations have brought significant changes in quality of water, soil and air resources, ecosystem itself through greenhouse gas fluxes and surface albedo effects (Turner, 1989). Presently, environmental changes brought down by land transformation have exceeded the natural variability limits (Shaw *et al.*, 2002; Liu *et al.*, 2004). Changing land use

practices have important impacts on both the quality and the cycle of water resources (Huisman *et al.*, 2004; Dawes *et al.*, 2004). Similarly, the agricultural intensification affects the water quality through nitrate concentrations because of heavy concentration of inorganic fertilizers (Clarke *et al.*, 2002; Yan *et al.*, 2003).

Jenkins (2003) F.N Man's greed to maximise production and exploitation of resources beyond the carrying capacity of the natural environment has made the situation worse. The present study is for the state of Jammu and Kashmir which is bestowed with natural beauty and resources such as the coniferous forests, glaciers, springs or the lakes etc. Srinagar city; the capital city of Kashmir valley ever since its creation has grown with time and gained supremacy in terms of functions associated with politics, administration, commerce, economic development, tourism etc. The city accommodated every decision making centre and various other government and private resource centers which sets a chain of interaction and boosts activities of the population of capital city with the people of different areas and urban centers of Kashmir valley.

The study focuses on land use/land cover change and transformation in Dal lake and its environs in Srinagar city during the study period of 1980 to 2010 using remote sensing and GIS techniques. Dal lake which is the important water body of the city not only from ecological view point but it also describes the cultural and economic identity of the city dwellers. This lake was one of the beautiful lakes of the world for which Lawrence has said, "Perhaps in the whole world there is no corner so pleasant as the Dal Lake".

The study further evaluates the important feature of the valley i.e., "Hanji" habitation, the segment of population living in boats of different shapes, sizes and types and earn their livelihoods in and around the different water-bodies especially in Dal Lake. Over the past few decades the environs of the lake has been significantly transformed and encroached, mainly by the Hanji community inflicting degradation to the lake environment. The economic dependence of these people on the lake has triggered the social transformation which in turn led to the interchange of land use classes in and around the lake. However, land transformation associated with them is governed by many factors including social, economic, historic and sometimes even political factors. Role played by the Hanjis in the process of land transformation and their impacts are highlighted.

**The study area:** Dal Lake is located on the eastern part of the Srinagar city in the hill state of Jammu and Kashmir, on the right bank of Jhelum. Dal Lake the main receiving water body of the watershed situated between 74°48' and 75°08' and 34°3' and 34°13' at an altitude of 1583 in the north east of Srinagar city (Fig. 1 and 2). The lake is fed by the "Arrah" river, flows in a northerly extremity through a dark and deep channel called *Tel Bal*.

Dal Lake is the largest water body of Srinagar city and because of the causeways and the marshy land has been divided into two parts

- Lokut-Dal
- Bud-Dal

Presently the lake is spread over 1620 ha, consisting 1305 ha of water body and 315 ha of marshy area.

This Lake is famous not only for its beauty, but also for its vibrancy, because it sustains within its periphery, a life that is unique anywhere in the world. The *Hanjis* have lived for centuries on the Dal and so complete is its infrastructure within the lake that they rarely require to step out on land. Dal Lake occupies an important position because of its location and physical setting. Many spots of tourist attraction have been built along its periphery, like the *Mughal* gardens, *Nishat* gardens, *Shalimar* gardens, *Cheshma Shahi*, *Naseem Bagh*, *Pari Mahal*, Botanical Garden and different religious shrines like *Hazratbal*, *Shankaracharya* temple etc. Unfortunately, this water body has been affected by the changes brought by the *Hanjis*. The degradation of this lake is largely attributed to extensive agricultural reclamation. The present study focuses on to study the general pattern of expansion and land transformation in Dal lake, further it also tries to investigate specific causes and impacts of these land transformations on Dal Lake, which is incidentally the lifeline for the Srinagar city in general and for *Hanjis* in particular.

**Origin of Dal lake:** Dal is a Tibetan word, which means 'still'. It is believed that in ancient times, there was a large meadow known as "*Vitalanimarg*" at this place. Later due to a massive earthquake, water gushed into the meadows and took the shape of a lake. However, the position and the morphology reveals that the Lake has been derived from an enlarged oxbow in flood plain of river *Jhelum* than from progressive shrinkage of a glacial lake (Dianelle, 1922; De and Paterson, 1939). Wadia considered the valley of Kashmir, as flat plain of Pleistocene alluvium of a lake and the lakes of Kashmir are formed from the inundated parts of the river *Jhelum* having alluvial dams and marshy borders (Wadia, 1947).

**Hanjis and their origin:** The boat man of Kashmir is known as *Ha'enz* in local language and *Hanji* as in Hindi script. They are also called as *Kishtiban* (Boatman) or *Jalbashi* (Water-dweller). *Hanjis* are among the aboriginal inhabitants of Kashmir Valley and are prominent tribe of the Valley. They are inhabitant from ancient past and could be traced also from *Pandit Kalhana's 'Rajatarangani'*, of 826 BC which is the first historical record written on Kashmir valley. Going through the history of Kashmir, *Hanjis* are said to be the descendents of 'Nishada' tribe, who were either kinsmen

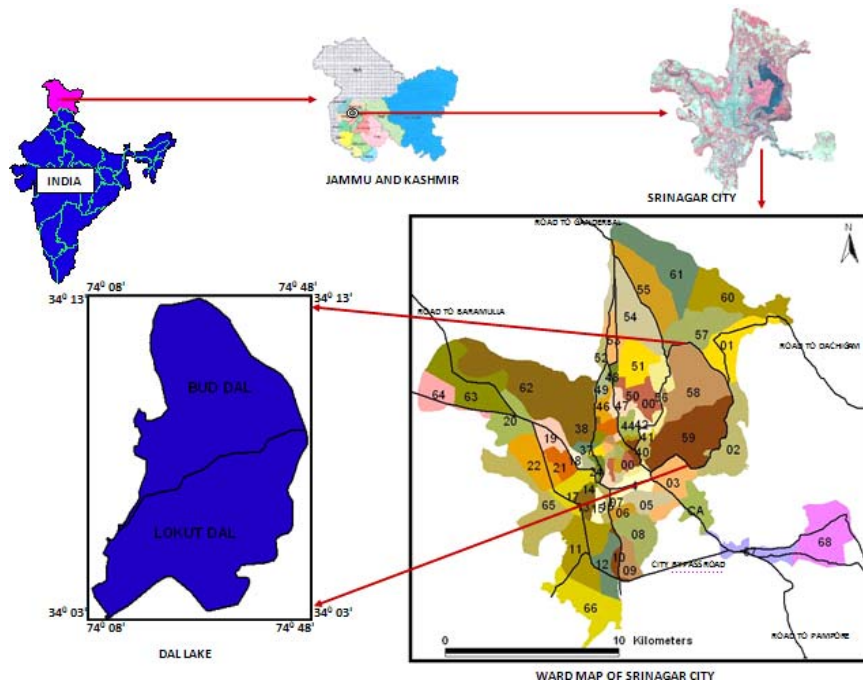


Fig. 1: Location of dal lake

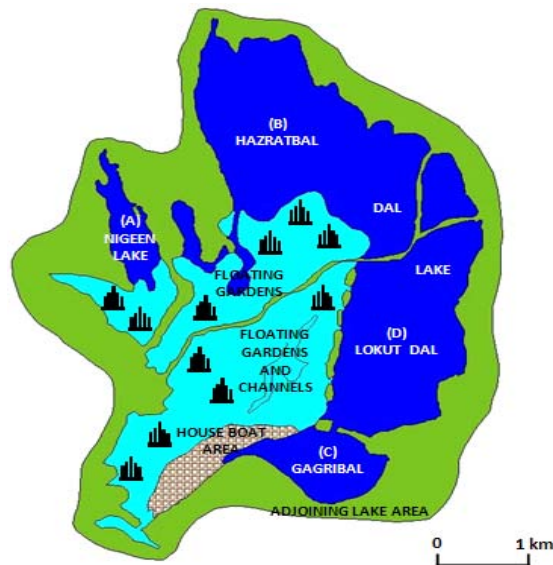


Fig. 2: Sketch map of dal lake and its environs

or contemporaries to 'Naga Race', referred in their account as the premier chieftains of this place. This suggests that these People (*Hanjis*) are among the earliest settlers of the valley. They draw their livelihood from the lake and carrying out activities such as; water transporters, fishermen, vegetable-growers, wood-cutters, grain-carriers, dealers of construction materials, collectors of various lake products, paying guest keepers and tourist

guides etc. The *Hanji's* are considered to be strong and hard working people who have mastery in art of living on water and know the real depths and mysteries of lakes and rivers (Ray, 1970).

**Socio-economic profile of *Hanjis*:** On the basis of different economic activities *Hanjis* can be categorized into eight categories, they are:

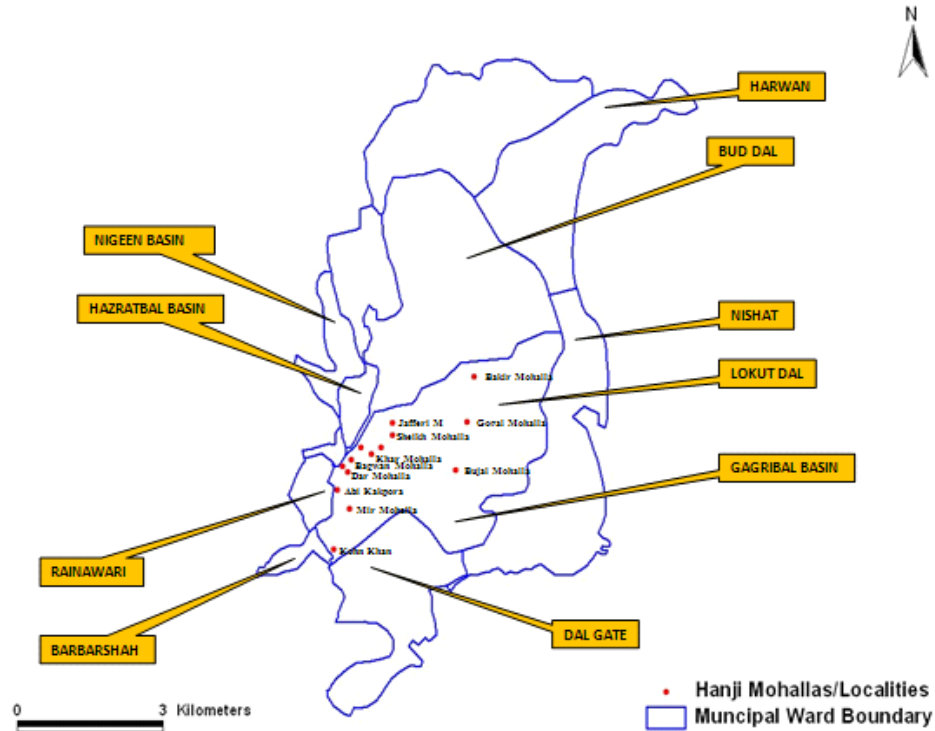


Fig. 3: Location of hanji mohallah as/localities

- Demb Ha'enz (Vegetable growers)
- Gari Ha'enz (Water-nuts gatherers)
- Dunga Ha'enz (Owners of passenger boats, dunga)
- Ma'er Ha'enz (Boat men of Ma'er Nallah)
- Gaad Ha'enz (Fishermen)
- Haka Ha'enz (Collectors of wood from water bodies)
- Shikara Ha'enz (Shikara owners)
- Houseboat Ha'enz. (Houseboat owners)

*Hanjis* have been identified as a separate caste in the state of Jammu and Kashmir. They are a unique homogenous community, pursuing common name, traditions, ceremonies, rituals and perform common traditional occupations. They have several sub-caste based on different occupations, which they have been carrying on traditionally (Sufi, 1949). *Hanjis* are located in pockets, locally known as *mohalla* with in *Bud Dal* and *Lokut Dal* municipal wards of Srinagar city. The important *mohallas* with *Hanjis* concentration are *Kohn Khan*, *Mir Mohalla*, *Abi Kakpora*, *Dar Mohalla*, *Nishat*, *Shalimar*; lying in the periphery of the lake and the localities namely *Bujal Mohalla*, *Gogal Mohalla*, *Bakir Mohalla* are lying further in the interior of the lake (Fig. 3). The form, structure and size of these *Mohallas* vary from one locality to the other. Some localities are big consisting more than hundred of households while some others are as small as five to ten household only. The *Dal Gate* and *Gagribal* area of the lake is having high concentration of *Hanjis*.

As per 2001 census of India, the *Hanji* population living in the lake and its periphery was about 135 thousand (which is currently estimated to be nearly 175 thousand and was only 70 thousand in 1980, showing rapid increase of *Hanji* population). The sex ratio among *Hanjis* was 919 males per thousand females and about 61% of the population is in the productive age group of (15-59 years). The literacy among *Hanjis* of *Dal Lake* is poor, being only about 24%, which is much below the national average. There are an estimated 4210 permanent houses and 3493 temporary (*kutch*a huts) houses and rest of the households live in the lake itself in their house boats with their families. The *Hanji* community depends on *Dal lake* for their sustenance and utilize the lake in different ways. *Hanjis* have limited land holding for their agricultural activities where most of the land is in the form of open water area. A section of *Hanji* community has property rights over 300 ha (6,000 kanals) of agricultural land and 670 ha (13,400 kanals) of water area. There are more than 775 houseboat owners, about 400 Dunga boat owners. In general, the housing condition of the *Hanjis* is reasonably good. The *Hanjis* engaged with tourism industry possess better houses as they live in their luxury houseboats. The *Hanji* localities although disperse in their location within and around *Dal lake* but they connect themselves mainly by the water ways and rarely by the land routes. Infact they are embedded with lake environment so strongly that the traditional *Hanjis* rarely come out of their lake houses. But with increase in

population and increased and contested dependence on *Dal* Lake the lake environment (both physical as well as economic) is under severe stress. The available basic civic amenities and facilities are poor and it is further deteriorated with increase in population and their activities. So despite these *Hanji* localities are with in the urban limits but they are deprived of most of the civic benefits of the city. They still follow the traditional way of life and continue to be one of the backward communities of Kashmir (Rather, 2004).

#### BOX 1: Dal lake products exploited by Hanjis:

**Aquatic foods:** The aquatic foods extracted from the lake area: Lotus roots (Nadru), Duck Potatoes (Kanibabi), Lotus fruit (Pambach), water nuts (Gaer), fishes. Nadru is the root of Lotus. It is cylindrical in shape about 10-20 inches long, one and half inches in diameter. It is used both as vegetables as well as pickles. Pambach is the fruit and Kanibabi is the vegetable. There are number of varieties of fishes like flat white body fish (Kashir gad), Ail gad, Chiriv, Theta Gurun and Parim Gad (Mirror Carp).

**Vegetables grown:** The vegetables grown by the Hanjis on land area and on the floating gardens are; Knol Khol (Hak), Cucumber (Laer), Spinach (Palak), Carrots (Gazir), Tomatoes (Ruwangun), Radish (Mujj), Brinjal (Wangun), Onions (Gandd), Cabbage (Bandgobi), Cauliflower (Phoolgobi), Pumpkin (Al), etc.

**Tree plantation:** The Willow and Poplar tree plantations are used for various purposes especially for the timber and fuel wood.

#### BOX 2: The boats of Hanjis:

**Shikara:** These are the long boats which are used for sightseeing in *Dal* Lake. They are also used as a medium of transport in the lake. There are presently about 2000 *Shikaras* in *Dal* Lake.

**House boat:** House boat is a boat that is designed to be used primarily as a human dwelling as well accommodating tourists. There are presently about 1200 house boats in *Dal* Lake.

#### Shikara rents:

Peak tourist periods: 500-600 rupees per day  
Lean periods: 50-100 rupees per day.

Period	Houseboat rent		
	Deluxe	Semi-deluxe	Economy
Peak tourist periods	4000	3000	1000
Lean periods	1000	600	---

## METHODOLOGY

The present study has been carried out for the *Dal* Lake and its environs located in the fragile hill ecosystem of Kashmir valley. The study period extends from 1980 to 2010 and is mainly based on secondary sources of data, supplemented appropriately by primary information especially for *Hanjis* social and economic characteristics. The primary information were drawn from 58 *Hanji* respondents through stratified random sampling. The data used for the preparation of land use land cover of the study area from town planning map of Srinagar city on 1:15,000 scale for 1980. Similarly, the land use land cover for 2010 was prepared using IRS-1D LISS III + PAN merged satellite imagery. Both the images were first geo-corrected and geo-referenced in Earth Resource Data Analysis System (ERDAS) Imagine 9.0 software, assigning Universal Transverse Mercator with World Geocoded system (UTM WGS 84) projection parameters. Further for assistance in the process of interpretation Survey of India toposheet was also geo-referenced and was given similar projection and datum. The area of interest (*Dal* Lake and its environs) was extracted by sub-setting of the town planning map. Satellite imagery was stacked into different bands to produce a false color composite; the area of interest was extracted by sub-setting of the image. These images were digitized in GIS environment using ArcView 3.2a software in the form of polygons representing different land use land cover categories. The data was classified into 5 land use land cover classes spread over a total area of 2450 ha of the *Dal* Lake (which incidentally are the two municipal ward i.e., ward number 58 and 59 of Srinagar city). The trend and pattern of *Dal* lake transformation was calculated and every polygon representing the particular class was quantified and displayed in respective maps.

## RESULTS AND DISCUSSION

The present study is focused to analyze spatial and temporal land use dynamics in and around the *Dal* lake. Remote sensing, although challenged by the spatial and spectral heterogeneity of urban environments, was used for the study as these sources are found to be an appropriate source of urban data to investigate such studies (Herold *et al.*, 2004; Jensen and Cowen, 1999; LAWDA, 1998, 1999, 2000).

#### BOX 3: Land use classes and their explanation:

**Water body:** In the present study, water body includes the water area of the Lake excluding the marshy area and floating garden. This water area is used for navigation, site seeing, houseboats, fishing etc.

Table 1: Land use land cover of *Dal* Lake and its environs

Land use/land cover of <i>Dal</i> Lake	Area (ha) 1980	Area (ha) 2010	Change (ha)	% age change
Water body	1538	1305	-233	-15
Marshy	862.5	315	-547.5	-63
Agriculture	36	749	713	1980
Plantation/orchard	8	28	20	250
Residential	5.5	53	47.5	863
Total	2450	2450		
Total built-up	5.5	53	47.5	863
Total non-built-up	2444.5	2397	47.5	-1.94

Area in hectares; Based on Town planning map of *Dal* Lake 1980 on 1:15000 scale and IRS-1D LISS; III + PAN 2010 merged satellite imagery of *Dal* Lake

**Marshy area:** Marshy area includes the area which is under the cover of weeds inside the lake where water related activities like the extraction of aquatic foods is carried out. However this area is not used for other water activities like Shikara riding.

**Agriculture:** This includes the area in near Hanji settlements and lake water where agricultural activities are carried out. In the lake area agricultural is carried on the floating gardens where vegetables are grown.

**Plantation:** Plantation includes the area where the trees like willows and poplar have been planted. These trees are used for various economic purposes. Orchards have also been clubbed in this class.

**Residential:** Residential class refers to the dwelling places of Hanjis on land and bank of *Dal* lake. This includes the residential houses and hamlets of Hanjis.

The present study is confined to an area of 2450 ha, which is spread over the municipal ward number 58 and 59 of the Srinagar city. From Table 1 and Fig. 4 and 5, it is evident that *Dal* Lake has witnessed changes in aerial extent and its use. The statistics reveal that the lake area has shrunk to 1305 ha, a decrease of 233 ha during the study period. Whereas other land use classes have also witnessed changes, the marshy area has recorded a decrease of 547 ha, while agricultural land (713 ha), residential (47.5 ha) and orchards and plantation (20 ha) have recorded increases.

The important feature behind the land use change within and around the *Dal* lake is the activities of *Hanjis* which have directly resulted into increase in built-up area and other interchange of land use classes e.g., marshy to agriculture; lake water to agriculture & marshy etc. This land use change and its transformation can be directly attributed to the increase in *Hanji* population. The increase in their population has created demand for more area (both land and lake). Since they are depended on lake for their livelihood, they have gradually encroached upon the lake waters and transformed it for their sustenance.

**Land transformation in *Dal* lake:** Land is in a continuous state of transformation as a result of various

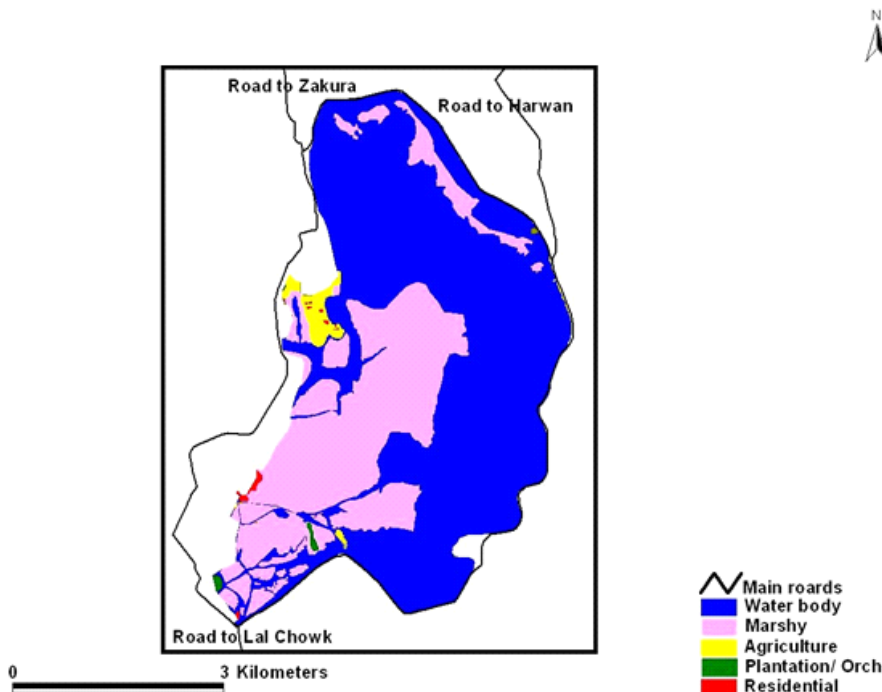


Fig. 4: Land use land cover of dal lake and its environs



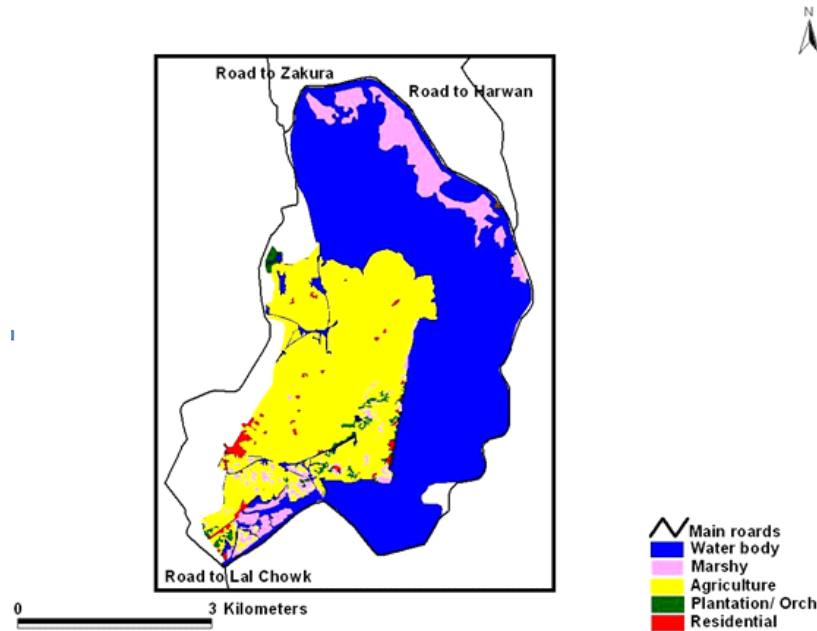


Fig. 5: Land use land cover of dal lake and its environs

Table 2: Land transformation in *Dal* Lake and its environs (1980-2010)

Land use	1 Res	2 Plant	3 Agri	4 Mar	5 Water	Total 2010
Residential	5.5			16	31.5	53
Plantation/ orchard		8	3	13	12	28
Agriculture		8	36	591	122	749
Marshy			5.5	862.5	94.5	315
Water body				27	1538	1305

Area in hectares. Figures in bold (diagonally) are area under that particular land use in 1980, while the figures in the same column represent the conversion in area to other land uses. Similarly, figures in the same row are increases in area, captured from other land uses; Based on IRS-1D LISS III+PAN Satellite imagery (2010) and Town planning map (1980) of *Dal* Lake

natural and man-made processes. Land Transformation is the process where the changes in the land use are observed at different time periods and as the word suggests, it traces the change of form in the land use (Fazal and Amin, 2011).

*Dal* Lake is ecologically, economically and socially an important lake for Srinagar city. The present study focuses on 5 prominent land use/cover classes existing in and around the lake waters. This includes lake area (the water body), marshy area, residential (the settlements), plantation/orchard (Box 3). Among these classes, marshy land and lake area recorded decreases where as area under residential, plantation/orchard and agriculture have increased during the study period. The present study also finds that besides transformation among land use classes there was also substantial interchange of land among different land use classes during the study period.

The land transformation within and around the *Dal* Lake during the study period are represented in the Table

2, 3 and Fig. 6. The growing populations of Hanjis and their increased demand for their economic sustenance and settlement have led to these changes. Moreover the increase in tourist flow to the lake has also resulted in city residents acquiring space to establish and run their business in the form of hotels and restaurants in and around the lake. All these factors have contributed to the land transformations in the environs of *Dal* lake.

The analysis suggests that there were significant land transformation and interchange of land within different land use classes. The marshy areas in and around the lake has been converted to built-up land and floating vegetable gardens/floating gardens (locally known as *Radh*). The area under residential land use has increased, gaining area from Lake area and marshy area. Similarly, plantation/orchards has also recorded increases, gaining land from marshy area, lake area and agricultural land, it also lost area to agriculture (Fig. 6). Land under agriculture has also recorded increases during the study period, gaining land from marshy lands, lake water and plantation/orchard. While marshy area recorded decrease in its area, losing land to agriculture, lake water, residential and plantation/orchard, while it acquired area from lake water. Similarly, area under lake water has decreased during the study period, losing area to agriculture, marshy, residential and plantation/orchard. This clearly shows that there is a pattern of land transformation, where lake water is converted to marshy lands which subsequently converted for agriculture, orchards and residential uses.

Table 3: Transformation of *Dal* Lake and its environs (1980-2010)

Water body	Area in 1980 (ha)	Transformations	Area in 2010 (ha)
<i>Dal</i> Lake	Residential (5.5)	Plantation/orchard to agriculture (8)	Residential (53)
	Plantation/orchard (8)	Marshy to agriculture (591)	Plantation/orchard (28)
	Agriculture (36)	Marshy to water body (27)	Agriculture (749)
	Marshy (862.5)	Marshy to residential (16)	Marshy (315)
	Water body (1538)	Marshy to plantation/orchard (13)	Water body (1305)
		Water body to agriculture (122)	
		Water body to marshy (94.5)	
		Water body to residential (31.5)	
		Water body to plantation/orchard (12)	

Based on IRS-1D LISS III+PAN Satellite imagery (2010) and Town planning map (1980) of *Dal* Lake

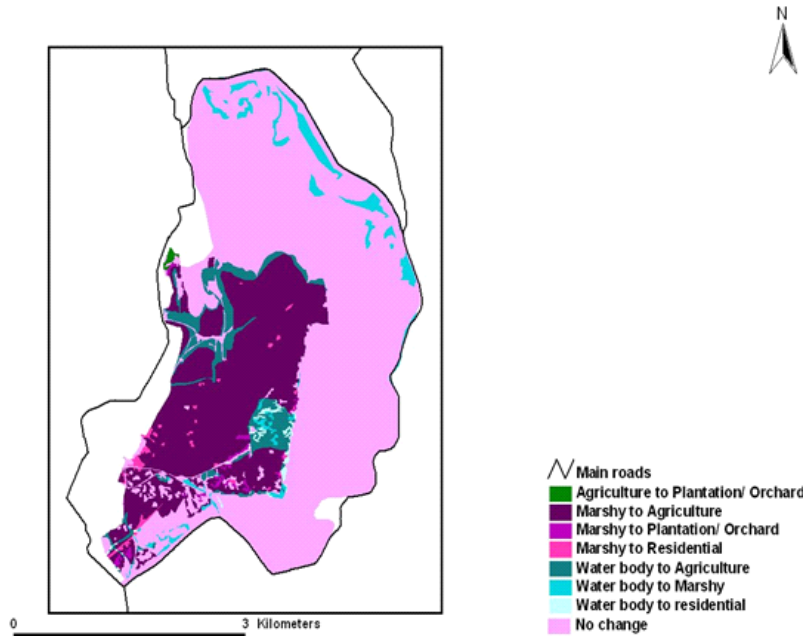


Fig. 6: Land transformation in dal lake and its environs

#### Box 4: Biological features in *Dal* lake:

##### Flora:

- **Emerged macrophytes:** *Typha angustifolia*, *Phragmites australis*.
- **Floating macrophytes:** *Salvinia natans*, *Hydrocharis dubia*, *Nymphoides peltata*, *Nymphaea*, *Nelumbo nucifera*, *Potamogeton natans*.
- **Submerged macrophytes:** *Myriophyllum spicatum*, *Ceratophyllum demersum*, *Potamogeton crispus*, *lucens*.
- **Phytoplankton:** *Navicula radiosa*, *Nitzschia accicularis*, *Fragilaria crotonensis*, *Diatoma elongatum*, *Scenedesmus bijuga*, *Pediastrum duplex*, *Tetraedron minimum*, *Microcystis aeruginosa*, *Merismopedia elegans*.

##### Fauna:

- **Zooplankton:** *Keratella cochlearis*, *K. serrulata*, *Polyarthra vulgaris*, *Brachionus plicatilis*, *Monostyla*

*bullae*, *Alona monocantha*, *Cyclops ladakanus*, *Mesocyclops leukarti*.

- **Benthos:** *Chironomus*, *Tubifex*.
- **Fish:** *Cyprinus carpio specularis*, *carpio communis*, *Schizothorax niger*, *esocinus*, *curviformis*, *Crossocheilus latius*.

**Pattern and direction of land transformation:** Table 4 shows the pattern, causes and consequences of land transformation in Dal lake and its environs. These transformations are discussed below:

**Plantation/orchard to agriculture:** During the study period 8 ha of land under plantation/orchard was transformed to agriculture and this was observed near *Kohn Khan* (5 ha) and on the north of *Nehru park* (3 ha). Here *Hanjis* have removed the tree plantation and converted it into agricultural land.

**Marshy to agriculture:** Large area under marshy class was transformed for agricultural activity in and around the *Dal* Lake. These transformations were observed almost in



Table 4: Causes and consequences of transformation in *Dal* Lake and its environs

Nature and location of transformation	Area transformed (ha) (1980-2010)	Main activities	Impacts
<b>Plantation/orchard to agriculture:</b>			
<ul style="list-style-type: none"> <li>Near Kohn Khan (5 ha)</li> <li>North of Nehru park (3 ha)</li> </ul>	8	Plantation areas are converted into agricultural areas.	Shrinking of the Lake, sedimentation and pollution.
<b>Marshy to agriculture:</b>			
<ul style="list-style-type: none"> <li>North of Nehru Park (45 ha)</li> <li>Western and central parts of Lokut <i>Dal</i> in most of the Hanji localities (310 ha)</li> <li>Mir Mohalla and Kohn Khan in the south of Lokut <i>Dal</i> (15 ha)</li> <li>Western parts of Bud <i>Dal</i> (165 ha)</li> <li>East of Hazratbal Basin of <i>Dal</i> Lake (56 ha)</li> </ul>	591	Marshy lands are filled to convert into floating gardens to produce crops and vegetables.	Shrinking of the Lake, sedimentation and pollution.
<b>Marshy to water body:</b>			
<ul style="list-style-type: none"> <li>West of Bud <i>Dal</i> adjacent to Hazratbal Basin (17 ha)</li> <li>Eastern margin of Bud <i>Dal</i> (10 ha)</li> </ul>	27	Meager initiatives by government to clean the Lake.	Leap frog rehabilitation with no significant results.
<b>Marshy to residential:</b>			
<ul style="list-style-type: none"> <li>Around Chopan, Gaddi, Jafferi and Sheikh Mohalla, Bata pora Khurd, Abi Kak pora in Lokut <i>Dal</i> (8 ha)</li> <li><i>Dal</i> gate basin (5 ha)</li> <li>Around Gogal and Bujal Mohalla in Lokut <i>Dal</i> (3 ha)</li> </ul>	16	Illegal encroachments by Hanjis for residential purposes.	Shrinking of the lake.
<b>Marshy to plantation/orchard:</b>			
<ul style="list-style-type: none"> <li>Middle of Lokut <i>Dal</i> in scattered patches (8 ha)</li> <li><i>Dal</i> gate basin (5 ha)</li> </ul>	13	Willow plantation by Hanjis	Illegal ownership of land
<b>Water body to agriculture:</b>			
<ul style="list-style-type: none"> <li>North of Bujal Mohalla (42 ha)</li> <li>Middle and western parts of Bud <i>Dal</i> (69 ha)</li> <li>Near Abi Kak pora &amp; Kohn Khan (11 ha)</li> </ul>	122	Illegal encroachments of the lake area and practicing of agricultural activities especially, floating gardens producing mainly vegetables.	Shrinking of the Lake, sedimentation and pollution.
<b>Water body to marshy:</b>			
<ul style="list-style-type: none"> <li>Eastern &amp; northern margin of Bud <i>Dal</i> (58 ha)</li> <li>Middle of Lokut <i>Dal</i> and <i>Dal</i> gate basin (36 ha)</li> </ul>	94.5	Effluents from houses, hotels, restaurants and especially the house boats lead to over growth of dense weed.	Conversion of water body to land through gradual systematic encroachments.
<b>Water body to residential:</b>			
<ul style="list-style-type: none"> <li>Middle of Lokut <i>Dal</i>; around Hanji localities (36 ha)</li> </ul>	36	Illegal encroachments by Hanjis for residential purposes.	Shrinking of the lake.
<b>Water body to plantation/orchard:</b>			
<ul style="list-style-type: none"> <li>Western Bud <i>Dal</i> (12 ha)</li> </ul>	12	Willow plantation by Hanjis	Illegal ownership of land

Based on IRS-1D LISS III+PAN Satellite imagery (2010) and Town planning map (1980) of *Dal* Lake

all sides of the lake, prominent transformation took place in the north of *Nehru* park (45 ha), Western and central parts of Lokut *Dal*, where Hanji settlements are concentrated (310 ha), Mir Mohalla and Kohn Khan in the south of Lokut *Dal* (15 ha), Western parts of Bud *Dal* (165 ha). Similarly, marshy area was converted into the Floating/vegetable gardens (*Radh*) by Hanjis in the east of Hazratbal Basin of *Dal* Lake (56 ha).

**Marshy to water body:** Marshy lands lying in the lake margins when remain unused by Hanjis convert backs into lake water and this transformation was prominent in the west of Bud *Dal* adjacent to Hazratbal Basin (17 ha) and eastern margin of Bud *Dal* (10 ha). Time to time government also attempts for dredging and dewatering from the lake which also results into the conversion of marshy area into lake water.

**Marshy to residential:** About 16 ha of marshy area was transformed into residential settlements. This transformation was recorded around Chopan, Gaddi, Jafferi, Sheikh Mohalla, Bata pora Khurd, Abi Kak pora in Lokut *Dal* (8 ha), *Dal* gate basin (5 ha) and around Gogal and Bujal Mohalla in Lokut *Dal* (3 ha). This transformation is because of the growing population of Hanjis, which have expanded their settlements around there existing settlements converting the marshy area.

**Marshy to plantation/orchard:** The study area has also witnessed transformation of marshy area to plantation/orchard. Such transformation was observed in the middle of Lokut *Dal* in scattered patches (8 ha), *Dal* gate basin (5 ha). This is mainly used to produce apples in these areas.

**Water body to agriculture:** During the study period, 122 ha of lake water area was transformed for agricultural activity. The significant transformation of lake water to agriculture was observed in the north of *Bujal Mohalla* (42 ha), Middle and western parts of *Bud Dal* (69 ha) and around *Abi Kak pora* and *Kohn Khan* (11 ha). Here the *Hanjis* have illegally encroached upon the lake area and practice agricultural activity to produce mainly vegetables. This vegetable cultivation caters the city's demand, which is also crucial to the economy of the *Hanjis*.

**Water body to marshy:** Nearly, 94.5 ha of lake water of the *Dal Lake* has been transformed into marshy lands. This transformation was mainly observed in eastern & northern margin of *Bud Dal* (58 ha) and in the middle of *Lokut Dal* and *Dal gate basin* (36 ha). Here rapid undergrowth of weeds, especially the weed *Azolla Pinnata* has converted the lake water into dense marsh. This growth of weeds was mainly because of effluents discharged from houses, hotels, restaurants and the house boats.

**Water body to residential:** *Dal Lake* area has also been transformed into residential land at various locations. This transformation was witnessed in the middle of *Lokut Dal*, around *Hanji* localities (36 ha). *Hanjis* gradually but illegally expanded their settlements encroaching upon the lake waters.

**Water body to plantation/orchard:** About 12 ha of lake water has also been converted into plantation/orchard during the study period. This was found mainly in the western parts of *Bud Dal* (12 ha).

**Impact of land transformation on Dal lake:** *Dal Lake* including the *Hanji* localities are important landscapes of the Srinagar city because it does not only attract the tourist but it is also embedded with city's economic, social and cultural existence. During the peak tourist season business activities thrives heavily in its vicinity. Tourists also prefer to stay in house boats and hotels in and around the lake sides, all this on one hand is a lucrative opportunity to earn livelihood but it also exerts pressure on civic amenities and more significantly to the lake ecology. So on one hand there are efforts to attract more tourists to this politically volatile area as this boost the prosperity of *Kashmiri* people in general and *Hanjis* in particular but at the same time this affair is also adversely affecting the lake. The study finds that the water of *Dal Lake* has suffered deterioration in both its areal extent as well as in the quality of water, which by increased activities in its surrounding found to have greater influx of chemical effluents.

Although, *Hanjis* lived and performed activities in this area for centuries but with increase in their population and continued dependence on *Dal lake* have far exceeded the carrying capacity of the lake. Lack of cultural and social upliftment of *Hanjis*, poverty and illiteracy among these people has indirectly contributed to the degradation of lake. The study finds the following direct impacts in the *Dal lake* environment:

#### **Impact of hanji activities on the Dal lake:**

##### **Dense mushrooming of settlements around the lake:**

*Dal Lake* is experiencing mushrooming of both permanent and mobile settlements. Largely these settlements are occupied by *Hanjis* for residence and over the years with increases in their population, these settlements have expanded as well as become denser. At present *Dal lake* provides shelter to about 50 hamlets with a population of over 50,000 people, who have property rights over 300 ha (6,000 kanals) of agricultural land and 670 ha (13,400 kanals) of lake water area. Besides this, a large number of commercial and residential buildings such as hotels, guest houses and restaurants have sprung up in and around the *Dal Lake*. All this have direct as well as indirect bearing on lake ecology. Directly it inflicts encroachment over lake area and transformations in other land use classes, while indirectly, it exert pressure on civic amenities especially sanitation and garbage dumping. Most of which ultimately drain into the lake. Moreover, this mushrooming of settlements has also blocked smaller channels which were used to connect various water bodies in the watershed, distributing and circulating of water. Most significantly, the *Nallah Mar* canal used to connect *Dal Lake* with the *Aanchar Lake* in the north western part of the Srinagar city, but concentration of *Hanjis* in this area choked the water channels to restrict the circulation of water in the watershed.

**Increase in number of house boats in the lake:** House boats are one of the attractions of Srinagar city, presently there are more than 1200 house boats inside the *Dal Lake*. These numbers have increased by almost 3 times during the study period. Although there have been significant efforts and arrangements to sanitized and treatment of generated wastes before dumping it in to lake (as there is no possibility of collection and dumping any where else). But phenomenal increase in number of houseboats, tourists and extended peak tourist season all contributes to huge amount of waste generation and dumping in the lake. This waste is far beyond the carrying capacity of *Dal Lake* resulting in deterioration in the water quality of lake. The sample survey estimates that the existing 1200 house boats inside the *Dal Lake* generate approximately 9000 metric tons of waste annually which is dumped into *Dal Lake*. This dumping of wastes in lake is aggravating and

Table 5: Chemical effluents in Dal Lake

Parameters	Hazratbal basin		Lokut dal basin		Gagribal basin		Nigeen basin	
	1977	2007	1977	2007	1977	2007	1977	2007
pH	7.7-9.5	6.9-9.5	7.4-9.5	7.9-9.2	7.5-9.5	7.3-9.4	7.7-9.5	7.2-9.0
Total alkalinity (mg l-1)	70-120	44-164	22-210	29-160	70-125	20-126	80-134	22-204
Nitrate-Nitrogen ( $\mu\text{g l}^{-1}$ )	80-650	100-3680	95-691	150-2800	80-603	80-3360	90-632	90-3700
Total phosphorous ( $\mu\text{g l}^{-1}$ )	62-623	76-820	65-620	48-750	70-506	100-840	90-873	96-580

accelerating the sedimentation and weed growth processes.

**Agricultural activity in and around the Dal lake and its implications:** The *Hanjis* mainly draw their livelihood from agricultural activities. With the increase in their population and continued dependence on agricultural activity has resulted into encroachments upon the lake area by filling up the lake and transforming the lake in to floating gardens. These floating gardens are engaged for producing vegetables. The *Demb Hanjis*, who are the agrarian *Hanjis* collectively, produces an estimated Rs 3.5 million worth of vegetables annually. This transformation leads not only to shrinking of lake area but agricultural activity also results in increased sedimentation of soil and leaching of chemicals in to the lake.

**Rise in the influx of nutrients and chemicals:** As described in the above paragraphs the activities of *Hanjis* have also led to the deterioration in the quality of water in the Dal Lake. The Dal Lake is also subject to pollution with the influx of chemicals into it. The study finds that there are 15 major drains charged with an estimated 18.17 tons of phosphorous and 25 tons of inorganic nitrogen nutrients and chemicals discharge into the lake waters annually (Rather *et al.*, 2010). Several studies have also found that over the years the concentration of chemicals in the Dal Lake has increased, it has recorded higher levels of pH value, alkalinity and phosphorous concentration in the waters of the lake (Table 5).

**Growth of weeds in the Dal lake:** The land transformations and activities in and around the Dal Lake and resultant sedimentation and influx of chemicals have also resulted in rapid undergrowth of weeds, especially the recent grown up weed *Azolla Pinnata*. This has converted the lake water into dense marsh. The discharges from houses, hotels, restaurants and the house boats act as nutrients to these weeds. Studies have found that there is an alarming growth of duckweed, water ferns and algae in the water bodies of Srinagar city (Rashid and Naseem, 2007). The efforts for weeding out the lakes are grossly inadequate and slow, resulting in spread of marshy area.

**Shrinking of the lake:** Reduction in the aerial extent of Dal Lake is the most conspicuous outcome of human intervention with in the lake. The present study shows that lake water area has reduced by nearly 233 ha during the

study period. There were widespread conversions and transformations in land use along with sedimentation and weed growth etc., all these have contributed in diminution of lake area.

#### Impact of land transformation on Hanji localities:

**Residential congestion:** There was an obvious natural growth of *Hanjis* population resulting in congestion of the *Hanji* localities of Dal and surrounding areas. Moreover, the governmental efforts to relocate them were not successful for the simple reason that the efforts were focused only for their physical relocation. Since *Hanjis* livelihood and economic activities were linked with Dal Lake, their physical relocation without proper economic relocation was destined to be unsuccessful. But this failure of relocation has resulted in *Hanji* settlements becoming denser and expanded leading to congestion and poor living conditions. The sample survey found that poor and congested living condition was adversely affecting the general health conditions of *Hanjis*.

**Sanitation and drainage problems:** The increase in *Hanjis* population and tourists inflow were also generating increased wastes. With the limited infrastructure, the *Hanjis* locality (around Dal Lake) is also subject to sanitation and drainage problems. The efforts of government and NGO's to maintain clean are grossly inadequate. The sample survey finds that the estimated waste generation in the Lokut and Bud Dal wards is about 97000 Kg/day. The capacity and efforts of Srinagar Municipal Corporation were found to be inadequate resulting in heaps garbage and clogged sewage. This becomes alarming because it ultimately spills in to Dal Lake contaminating the lake water.

**Obstruction and blockade in natural drains:** In addition to the increase in population, tourist inflow, their increased waste generation and inadequate removal, there was also obstruction and blockade of inner water channels. These natural channels networked to circulate and distribute the wastes. The sample survey found that in the absence of it the incidences of diseases and epidemics have increased alarmingly. Especially, during summer months patients with diseases like malaria, dengue as well as water borne diseases like cholera were common.

**Local climatic change:** There are also evidences of rise in the mean maximum temperatures of Srinagar city. The main reason attributed to this local microclimatic variation

is again large scale land transformation and shrinking water bodies in the city. Studies suggest that mean maximum temperatures during summers shows a rising trend (Singh, *et al.*, 2000). The average temperature data in the month of July during the study period have increased by almost 4 degree celsius.

**Occurrence of floods and water logging:** The shrinking and the squeezing of water bodies and marshy area in *Dal* Lake of Srinagar city has also resulted in higher and increased incidence of floods and water logging especially in and after rainy season. The main reason is again the land transformation, since, these marshy areas and water bodies used to act as the sponge and take in water, preventing it to spill in low-lying areas of the city. Now with lesser area under water bodies and marsh as well as sedimentation in the lake, the flood hazard is a regular feature.

## CONCLUSION

The present study was done for aboriginal community of Kashmir (India), the *Hanjis* and their dependence on *Dal* Lake for livelihood. The study finds that with the increase in their population and increased resource exploitation, the environs of *Dal* Lake is severely affected. There are clear indications of decay in lake environment, the lake area is shrinking, the quality of water is deteriorating and the exploitation of resources is increasing. The unfortunate part of this process is that the transformations are done by *Hanjis* and they are the main sufferers too because any harm to lake environment directly inflicts harm to *Hanjis* livelihood and their wellbeing. The economic exploitation by *Hanjis* of *Dal* appears to be beyond the lake's carrying capacity. This needs to be understood by both *Hanjis* and the government which needs to take a more proactive action approach.

The government needs to intervene and act as it is necessary for both the endurance of *Dal* Lake as well as the well being of *Hanjis*. According to constitution of India, water resource is a state subject and the state government need to plan for development, conservation, utilization and management of *Dal* Lake adopting sustainable approach based on principles of equity. The national water policy (2002) also stressed on maintaining of ecological balance while pursuing all kind of developments. It also accepts the role of local people in maintaining and utilizing it for their cultural and economic benefits. But participatory development efforts are absent in planning, it is either strict enforcement and restrictions by governmental agencies or a completely ignorant attitude. In the present case the *Hanjis* are alienated from development plans for *Dal* Lake. This has in some way made them "greedy" as they have exploited

the *Dal* Lake as never before. The sense of attachment and reliance seems to have disappeared.

The above analysis clearly points towards the fact that changes in land use and transformations have swallowed a significant proportion of the *Dal* Lake of Srinagar city during the study period and the process is still continuing. There is an urgent need to protect and preserve, once the "Paradise on Earth" for future generations. These water bodies are precious because they are not only tourist attractions but they also act as lifeline to the city as it provides livelihood to a large population, directly or indirectly.

The study suggests following important measures for the sustainable management of *Dal* Lake of Srinagar city:

- The foremost remedy lies in restricting any increase in the settlements in and around these water bodies and marshy lands. In this perspective, the governments' proactive approach is essential because state high court in 2003 has already banned all kinds of constructional activities in the periphery of *Dal* Lake.
- The state government needs to implement strictly the Jammu and Kashmir High Court orders which have passed order prohibiting to litter in and around *Dal* Lake and restriction on the constructional activities affecting the water bodies. The order also banned any constructional activity within 200 m from the center of the foreshore road (newly constructed road on the eastern margin of *Dal* Lake). Further it also directed that no further change will be made in even the existing buildings.
- The already settled population in and around the lake area should be relocated and rehabilitated outside the *Dal* Lake periphery. In this context some efforts have already been made by some agencies (Jammu and Kashmir lakes and Water Ways Authority), where some 1221 families living in 441 houses have been resettled but the process remained incomplete. The successful and complete rehabilitation would be possible only when relocation is done with provisions of suitable livelihood options. There is an urgent need to resume the relocation process which should include provisions of reasonable and suitable alternate livelihood opportunities. The relocation should be with the consent of *Hanjis* with formal land transfer rights and adequate compensations.
- Another important task for preserving the water bodies is to get rid from duckweed, water ferns and algae. There must be sincere efforts to perform deweeding and dredging activities on periodic basis in the affected water bodies to maintain water clean. But while deweeding and dredging, some basic precautions are required as mechanical deweeding,

instead of uprooting the macrophytes results in their trimming, which promotes their quick and luxuriant growth. Same is the case of *Azolla pinnata*, where skimming results in its fragmentation, promoting its profuse growth. Similarly, the removal of willow plantation was also found to be leading to profuse growth and expansion of *Azolla pinnata*. There should also be efforts to use weed as raw material to produce organic manure as this will serve dual purpose of cleaning of water as well as utilizing the waste.

- There is need to restrict the formation of marshy area in the lake. There must be sincere effort to restrict the effluents drained in to the lake waters from the cultivation of vegetables by the *Hanjis* and the direct discharge of sewerage into the lake. Srinagar city requires operational sewage treatment plants so that no untreated sewage is disposed off in any of the water bodies.
- Another important reason of the creation of marshy area is the deforestation in the river catchment area which results in the flow of silt into the lake from the *Hazratbal* basin from *Tailbal Nallah* which feeds the Lake, this also need to be checked.

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