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Assessing catchment area and morphometric dynamics and its impact on the water chemistry of Wular Lake, Kashmir

Dar Rafi, R.
Government Degree College, Kulgam, Kashmir
Corresponding Author: rafiramzandar@gmail.com

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ABSTRACT

Wular Lake, the largest fresh water wetland of India, located at about 50 kilometres North-West of Srinagar city at an altitude of 1570 metres, plays a significant role not only in the hydrographic system of Kashmir Valley but also in its biological, social and economic aspects. Because of its immense values and functions, it has been declared as a Ramsar Site in 1990. However, the entire catchment area of this wetland is highly degraded that contributes to heavy load of silt into it leading to its shrinkage and reduction in its water level as well as deteriorating its quality. In this study, the author has tried to assess the nature of catchment area of Wular Lake and its morphometry as well as its cumulative impact on the water chemistry of this wetland. The main causes responsible for the deterioration of this water body have been highlighted. It has been found that besides the highly unconsolidated catchment, this lake is surrounded by the households of poor socio-economic background which leave no stone unturned in adding sewage and other effluents into it. As a result of which a question mark has been laid on the status of its health and survival. The study is based on both primary and secondary sources of data which have been collected from the socio-economic survey of 09 sampled settlements located in its periphery and from Wular and Manasbal Development Authority (WUMDA) respectively. Finally, the study has come up with some substantial suggestions which, if taken into consideration by the concerned agencies and stakeholders, can prove beneficial for the well-being and everlasting sustenance of this wetland.

KEYWORDS

Wetland | Catchment Area | Morphometry | Water Chemistry

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Introduction

The chemistry of lake water is a cumulative reflection of catchment geology, weathering and erosional processes as well as anthropogenic inputs. Since many lakes are sinks of agricultural runoff and municipal and industrial waste water discharges, they become enriched with nutrients, sediments and associated heavy metals (Koussouris and Diapoulis, 1989).

Wular-lake plays an important role in the hydrographic system of Kashmir valley by acting as a huge absorption basin for the annual flood waters of river Jhelum. Besides being a natural habitat for wildlife, it is an important fish resource, accounting to about 60 per cent of the total fish production in the Valley. The lake with its associated wetlands is an important habitat for migratory water birds within the central Asian flyway and supports rich biodiversity.

On the basis of its immense hydrological, biological and socio-economic significance, Wular Lake has been declared as the wetland of national importance under the wetlands program of Ministry of Environment and Forestry, Govt. of India in 1986 and subsequently declared as a Ramsar Site (Site No. 461) on 23th of March, 1990 to give it the status of wetland of International importance.

However, Wular Lake is at the verge of extinction. The lack of understanding of the values and functions of this lake and its associated wetlands led to the conversion of its large area for plantation, agriculture, settlements and other developmental activities (Wetlands International South Asia, 2007) which reduced its area as well as deteriorated its water quality.

Study Area

Wular-lake, situated at about 50 km North West of Srinagar city at an altitude of 1,570 meters above mean sea level, between 34o16'-34o25'N latitude and 74o29'E-74o40'E longitude is the largest fresh water wetland in India (J&K Envis Newsletter, 2014). This balloon shaped lake (Fig. 1) with a maximum length of 16 Kms, maximum width of 7.6 Kms, water temperature of 2o to 29.5oc and average depth of 5.8 meters is calm and placid across most seasons of the year (http://www.discoverindia.com).The origin of Wular Lake may be attributed to a Kashmiri word Wul which refers to a gap or a fissure which could be a pointer to its origin to a fissure or gap created by some natural phenomena. However, Wular for Wul possibly became common around 12th century. Wular Lake is drained by three major rivers of Madhumati, Erin and Jhelum. The river Jhelum enters it at Banyari (40 Kms from Srinagar) and again separates at Ningli. The deepest portion of the lake is called Mota Khon or Gulf of corpses.

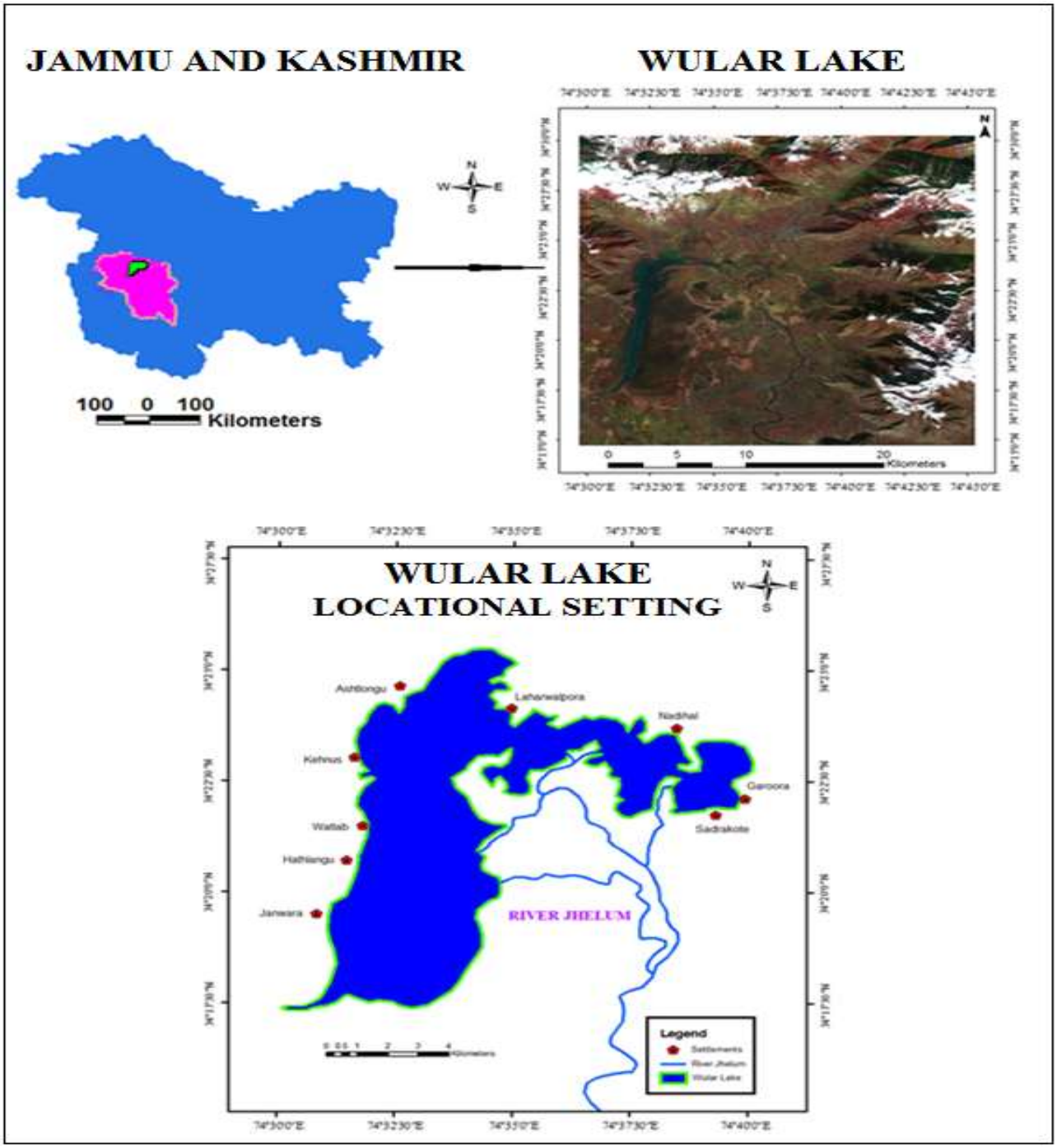
The present study has tried to access the nature of catchment area as well as morphological dynamics of Wular Lake and its impact on the water chemistry of this wetland. On the basis of this assessment, the authors have tried to provide some substantial measures, which if taken into account, can prove beneficial for the sustenance of this water body.

Database and Methodology

The study is based on both primary and secondary sources of data. The Primary data has been collected from the socio-economic survey of 09 sampled villages located around Wular Lake in two districts- Bandipora and Baramulla- of Kashmir Valley. The secondary data regarding catchment area and water quality of Wular Lake has been collected from Wular and Manasbal Development Authority (WUMDA).

The selection of Settlements has been made on the basis of their location and dependency on Wular Lake. Simple percentage methods have been used to derive the respective dependencies of sampled settlements on the lake water and the intensity of pollution caused by them to the health of its water. Thus, logical conclusions have been derived out of that analysis.

Fig. 1: Source: Prepared by the Researcher from Topographic Maps of Kashmir Valley



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Results and Discussion

Nature of Wular Catchment Area

Wular Lake forms a part of river Jhelum basin which is a sub-division of Indus-Basin. The Jhelum basin extends to 12,777 Sq. Kms. of which six watersheds with an area of 1,444 Sq. Kms drain directly into the lake forming its direct catchment (Fig. 2).

Wular lake is surrounded by high mountain ranges on the North- Eastern and North Western sides, which drain their runoff into it through various Nullahs, prominent being Erin and Madhumati. Their watersheds located on the Northern periphery of Wular account for 20 per cent and 32 per cent of its catchment area respectively. Madhumati (Bod Kol) rises from the northern slopes of Harmukh glacier and drains into Wular near Dacchigam passing through Kalusa bridge. Erin catchment is formed from the drainage of Shir-Sar and SukhaSar draining through Chitrar Nullah, Titwan Kain Nulllah, and Kubnai-nar which meet at Isrur tar to from Erin. Wular Lake is surrounded by 31 villages within the districts of Baramulla and Bandipora with a population of 10,964 households (Census of India, 2001). Besides, 26 villages of nomadic origin inhabit the hills around this wetland.

On its eastern and western sides, this wetland is surrounded by the low lying areas of Sonawari which used to get inundated almost every year until numerous criss-crossing embankments were constructed along river Jhelum. The wetland area thus reclaimed has in the recent past been brought under cultivation of paddy and plantations of willow, poplar and fruit trees. On the western side in the Sopore-Watlab section, low lying areas have also been brought under paddy cultivation and on the eastern side of the wetland, there is an island.

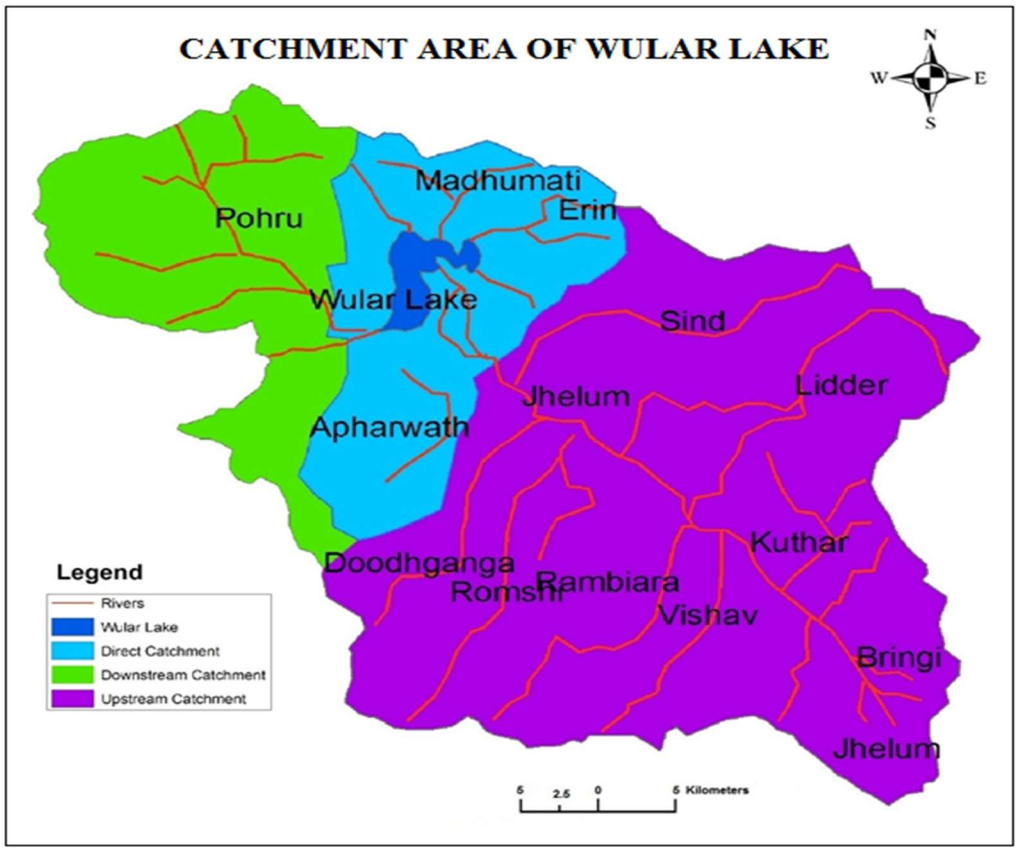

Fig. 2: Source: Comprehensive Management Action Plan for Wular Lake, Kashmir. (2007). Wetlands International, South Asia

which was raised and shaped by a famous ruler of Kashmir, Zainual Abideen (1420 - 1470 A.D). The southern tip of Wular Lake is enclosed by Ningli and Gundar watersheds. Ningli drains highly erodible Karewas whereas Gundar watersheds are influenced by the drainage of Apharwat and Tangmarg, the famous alpine pastures of Kashmir valley.

Above all, Wular Lake is flanked by a series of short and flashy drains on its right and left which form extensive marshes on both sides of river Jhelum and play an important role in governing the hydrological regimes apart from sustaining its rich biodiversity.

The catchment area of this wetland supports coniferous forests, alpine pastures and orchards, adding to the natural grandeur of the wetland. However, the entire Jhelum basin including the direct catchment of Wular Lake is highly degraded that contributes to heavy load of silt into it leading to its shrinkage and reduction in water level.

Morphometry of Wular Lake

Morphmetric analysis of a watershed is an essential first step towards basic understanding of watershed-dynamics. Wular Lake consists of a vast catchment area accounts for 7.6 per cent of the total area of Kashmir Valley (Kanth and Hasan, 2012). Its altitudinal range varies from 1,580 meters near Wular Lake to about 4,500 meters near Hurmukh range. The mophometry of Wular lake can be studied under two parameters: Linear parameters and Shape parameters.

Linear parameters

These include various parameters like stream order, number, drainage, density, stream frequency, bifurcation ration, drainage- texture and length of overland flow etc. These have a direct relationship with erodibility, Higher the value, more is the erodibility.

The first and the foremost important parameter in the drainage basin analysis is ordering, whereby the hierarchical position of the streams is designated. Following Strathler scheme, it has been found that the total number of streams in Wular catchment is 2,708, out of which 2,158 belong to 1st order, 427 are of 2nd order, 94 are of 3rd order, 25 are of 4th order, 3 are of 5th order and 1 is of 6th order, besides Jhelum that too is of 6th order. The drainage network of Wular catchment is characterized by total length of 2317.8 Km. The mean value (2.39) of drainage density indicates that the region is composed of impermeable sub- surface materials, sparse vegetation and high mountainous relief.

The mean value of stream frequency is 2.8. The higher value of stream frequency indicates high relief and low infiltration capacity of the bed-rock. The mean bifurcation ratio of the Wular catchment is 4.93. Low bifurcation ratio means less structural disturbance and high bifurcation ratio means high structural complexity and low permeability of terrain. The drainage texture ranges from very course to course from 1.05-7.85. Similarly, the length of overland flow of Wular catchment is 0.84. It also varies from 0.61- 4.39. Higher value of overland flow represents low relief. Whereas, its lower value is an indicator of high relief.

Shape Parameters

These comprise of parameters like form factor, shape factor, circulatory ratio, elongation ratio and compactness coefficient etc. These have an inverse relationship with erodibility (Nooka Ratnam et al., 2005). Lower the value more is the erodibillity. Wular catchment has a form factor of 0.23. It varies from 0.29-0.40 which indicates the elongated shape and suggesting flatter peak flow for longer duration. Shape factor varies from 2.50-3.45, its mean value is 4.38. Similarly, the elongation ratio varies from 0.61-0.71 and its mean value is 0.45 which is an indicative of high relief and steep ground slope. Morphometric features of Wular Lake are given in Table 1.

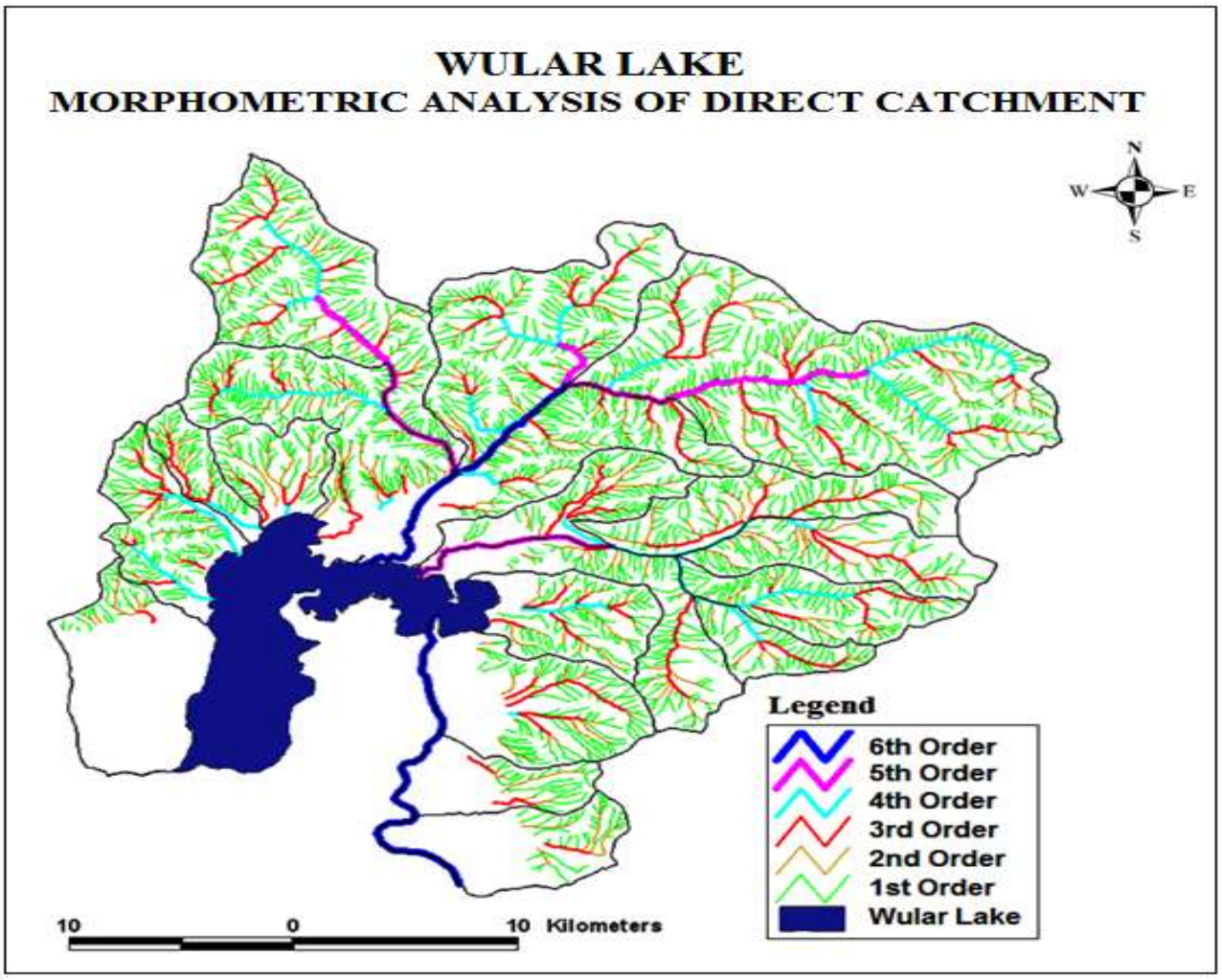

Fig. 3: Source: Adapted from Kanth, T. A., & Hassan, Z. (2012).

S. No.	Parameters	Value
1.	Area (A) Km^2	961.8
2.	Perimeter (P) Km	208
3.	Length of Basin (LB) Km	64.91
4.	Stream frequency (Fs) Km/Km^2	2.82
5.	Drainage density (Dd)	2.39
6.	Form factor (Rf)	0.23
7.	Elongation ratio (Re)	0.54
8.	Mean Bifurcation Ratio (Rb)	4.03
9.	Drainage Texture (T)	13.02
10.	Length of overland flow (Lg)	0.84
11.	Compactness coefficient (Ce)	1.89
12.	Shape factor (Bs)	4.38

Table 1: Morphometric Analysis of Wular Catchment

Impact of Catchment Area and Morphemetric Dynamics on Water Chemistry of Wular Lake

Wular Lake and other wetlands of Kashmir Valley are generally alkaline in nature with relatively higher amounts of magnesium, calcium and other ions and are hence categorized as hard water systems. The valley lakes are essentially shallow basined, profusely covered by aquatic vegetation and most of the lakes are eutrophic in nature with high concentrations of biologically important nutrients. (Wetlands International South Asia, 2007).

Wular Lake being at the terminus of the drainage system acts as a receptacle for pollutants flowing downstream from highly urbanized area of Srinagar. Discharge of solid, liquid and other wastes from human settlements all along Jhelum River are finally deposited in the Wular Lake. Besides, heavy doses of fertilizers and pesticides used in agricultural fields and spraying chemical in orchards for pest control are ultimately washed into Jhelum flowing into Wular Lake. There are no regulations for the disposal of solid wastes including carcasses throughout Jhelum. The sewerage system is generally lacking throughout the Valley except in some parts of Srinagar. All the streams, channels and aquatic bodies directly or indirectly draining into river Jhelum deposit heavy load of pollutants into Wular Lake.

Parameters	Units	1992	2006
Water Temperature	^{o}C	3.1-25	6.3-27.3
Transparency	M	0.1-1.3	0.16-0.73
pH	---	7.1-9.8	7.2-7.7
Conductivity	µs/cm	57.0-350	118-429
Dissolved Oxygen	mg/l	1.3-15.2	4.5-8.0
Chloride	mg/l	11.0-81.0	11.8-28.0
Calcium	mg/l	4.6-73.8	20.5-62.3
Magnesium	mg/l	0.8-35.6	12.2-30.1
Ammonia	µg/l	1.0-205	64.0-101
Nitrate Nitrogen	µg/l	9.0-580	205-419
Ortho Phosphate	µg/l	0.0-31.0	79-131.7
Total Phosphorus	µg/l	0.0-103	180.0-292.5

Table 2: Changes in Water Chemistry of Wular Lake (1992 to 2006)

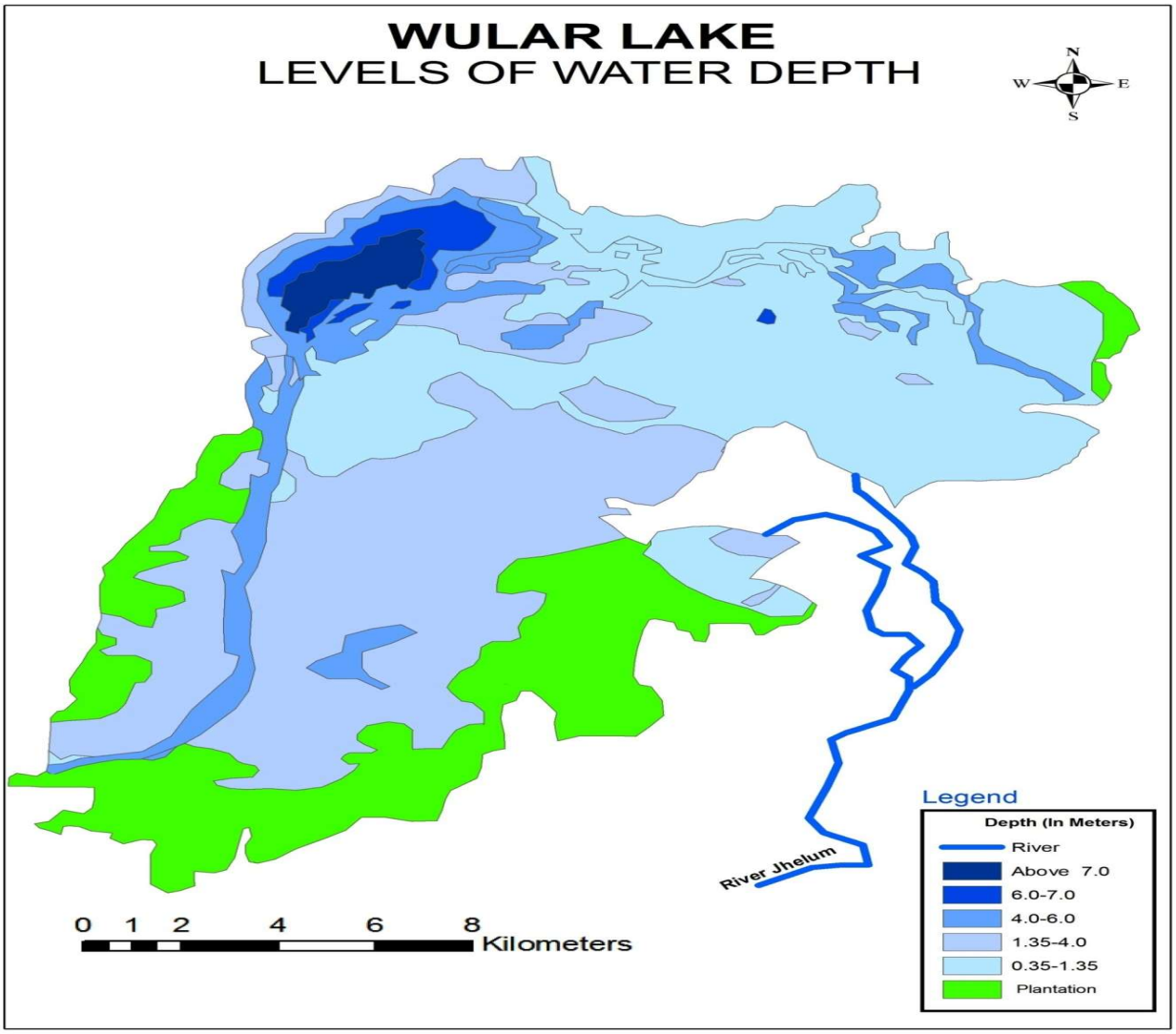

Fig. 4: Source: Adapted from Comprehensive Management Action Plan for Wular Lake, Kashmir. (2007). Final Report prepared for the Department of Wildlife Protection, Govt. of J&K, Wetland International, South Asia. Retrieved from http://www.wetlands.org

The socio economic analysis of sampled population of 3,534 persons from the 09 sampled settlements around Wular Lake has revealed that 1,283 (36.30 per cent) were workers, the average household size was calculated as 7.58, about 38.05 per cent were educated and 61.95 per cent were uneducated. Besides, 34.40 per cent of the sampled households were Kutcha type. Nearly 23.82 per cent of the sampled population is dependent upon lake water for drinking purposes. Moreover, 32.07 per cent of the total sampled population disposes their solid waste directly/indirectly into the lake and 42.45 per cent dispose their toilet waste into Wular Lake.

In addition to it, the highly erosive nature of its catchment area as well as the morphometric parameters have revealed the high degree of erodibility and vulnerability of this lake to the shrinkage, reduction in its water area and degradation of its well-being. As a result of which the quality of water has deteriorated over a period of time and there has been a progressive increase in specific conductivity,

orthophosphates and total phosphates with a decline in transparency and dissolved oxygen as shown in the Table 2. On the basis of the analysis of water quality, Wular Lake falls within C category as per CPCBs (Central Pollution Control Board) designated criteria.

Conclusion

The erosive and unconsolidated nature of Wular Lake Catchment has increased its vulnerability and fragility. The addition of immense sediment load because of its degraded catchment, proven from morphometric analysis of its various parameters, has revealed the extent of its deteriorating water quality. In addition to it, the poor socio economic background of the people residing on its banks has degraded the water chemistry of this lake beyond limits by addition of immense quantities of solid wastes and toilet wastes. Thus, need of the hour is to wake up, come to the front and take necessary steps for the survival and sustenance of this ecosystem before it gets too late.

Suggestions

- Wular catchment area should be afforested by adopting community participation measures to avoid erosion and run-off of loosely bound sediments by rain water or flood water.
- All the inflow channels like Jhelum, Erin and Madhumati etc should be treated properly by Sewage treatment Plants (STP s) before entering into this water body.
- Suitable weirs should be constructed at the mouths of inflow channels inorder to reduce the sediment load into Wular lake.
- Excessive weeds should be removed at periodic intervals from Wular Lake both from its peripheral areas and the center.
- Dredging works should be carried out at the very outset from all its peripheral areas inorder to increase its water depth and improve water quality.
- People living in the catchment area of Wular Lake at Sudrakote, Garoora, Nadihal, Ashtlon- gu, Laharwalpora, Kehnus, Watlab and Janawara etc. should be educated and made aware about the importance and rapidly deteriorating health of this wetland by organizing various environmental Protection Campaigns and programs on regular basis.

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