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"The Study on Impact of Tourism on Aquatic fauna and Water status of Lidder Streamin Pahalgam"

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ABSTRACT:

The present study is based on the effect of tourism on macro zoobenthos community and water parameters in lidderstream in pahalgam valley. Tourism effects the aquatic fauna of lidder stream badly. Due to tourism, there is increase in organic matter in lidder stream due to various activities like bathing, rafting, sewage disposal in the banks of lidder stream.Due to various pollutants the water status and aquatic fauna is affected drastically. The physical parameters like PH, Temperature, Alkalinity, Electrical conductivity, DO, BOD, Free CO_2, Chlorine, Nitrate Nitrogen, phosphate also gets affected by the pollutants. The water of lidder stream is used for many commercial purposes like irrigation, drinking water, Domestic etc. These commercial purposes have direct impact on water quality of lidder stream. It is evident from the study that tourism effects the water quality badly with which the aquatic fauna and water status is deteriorated.

KEYWORDS: Lidder stream, Aquatic fauna, Diversity, Macrozoobenthos, physio-chemical parameters

INTRODUCTION

Pahalgam is a town and associated area of District Anantnag. It is a popularly known for tourist destination and hill station. Its natural lush green meadows and crystal-clear water attract thousands of tourists from all over the world each year.It is located 45 kilometres (28 miles) from Anantnag on the banks of Lidder River at an altitude of 7,200 feet (2,200 m). Pahalgam is the headquarters of one of the five tehsils of Anantnag district.Pahalgam is located at34.01^{O}N 75.19^{O}E. Pahalgam holds a central position in theLidder Valley, has an average elevation of 2,740 metres (8,990 ft).Famous for scenic beauty, the jewel of the Lidder valley, surrounded by the great Himalayas, it is positioned on the banks of the Lidder River. The alpine weather conditions create pleasant and mild weather conditions in summers from April to June, while winters from November to February are cold and experience heavy snowfall. The rainy seasons of July and August see a huge entourage of pilgrims who come here to visit the holy cave of Amarnath, the abode of Lord Shiva, as Pahalgam is the starting point of the famous Amarnath Yatra.

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

The mention of Pahalgam is found in the regions ruled by the Mughals in the medieval period. Local Hindu kings later ruled over it as a part of the Kingdom of Kashmir until this princely state annexed into India, after independence. The natural beauty of Pahalgam and the luxuriant Lidder valley attracts the tourists. There are number of picnic spots on the shores of River Lidder, flowing near Pahalgam. Pahalgam offers quite a few hiking and trekking trails, which one can explore riding on horseback.

The snow-capped peaks and lush green pine forestsattract the eyes of the travellers. The Lidder River is popular among travellers interested in rafting and trout fishing. Virgin pine forests, clear mountain streams, and meadows of wildflowers mark Pahalgam as part of the paradisiacal beauty of Kashmir.

Macrozoobenthos being diverse in nature, react strongly and often indicate the human influences in aquatic ecosystem. They act as a useful tool for biological monitoring of freshwater ecosystems as they have broad range of sensitivities to change in both water quality and habitats (Hallewell, 1986; Abel, 1989). Macrozoobenthos form the basis of the trophic level and any ill-effect caused by pollution in the community structure can in turn affect trophic relationships. Macrozoobenthic invertebrates convert low quality low energy detritus into high-quality high-energy food for larger consumers in complex food webs (Hynes, 1970; Jimoh et al., 2011). Different species comprises distinct functional groups that provide ecological integrity. In some cases, these functional groups may be represented by only a few species, so that any loss of species diversity could be detrimental to continued ecosystem functioning. Thus, it is increasingly becoming important to protect macrozoobenthic communities owing to their immense importance in their natural habitats. The present study is focussed on lidder stream which is one of the major sources for commercial purposes in surrounding areas, is an attempt to assess the water quality of the stream with special reference to the diversity and community structure of macroinvertebrates.

Pahalgam originally a shepherd village is naturally known for products made of wool, Gabbas and Namdas can be purchased from Local shops (Rabbany et al., 2013; Rashid and Romshoo, 2013). The most important tourism resources are the natural beauty of the place, their distinctive or exotic character, their recreational possibilities and the cultural interest of the people. The hotels, resorts, transportation networks, recreational facilities and other tourism infra-structure can complement but never completely replaced the dependence on environmental resources (Aggarwal and Arora, 2012). The disadvantages of haphazard and

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

unplanned development of tourism are well illustrated by many areas of the world. Similarly, Pahalgam valley in Kashmir is facing environmental problems (Kumari et al., 2013; Rashid and Romshoo, 2013).

MATERIALS AND METHODS

STUDY AREA: Present study was carried out at different sampling sites located nearby Lidder valley, Anantnag (J&K) India in order to record the physicochemical parameters of water quality of Lidder stream. The following sites were selected for the present study: Site I: - Chandanwari Site II: - Inner Pahalgam (main village) Site III: - Yenedpahalgam (Rafting site)

CLIMATIC VARIABLES: The state of Jammu and Kashmir including Ladakh is known for having a varied climate. The variability in climate in these diverse territories of the state is so marked than even for a small area, it is not possible to depend on the averages for purposes of the study of climate conditions. The weather in Pahalgam is alpine. Summers (April-June) are mild while winters (November- February) are cold. The temperature in the summer months reaches as high as 250C and the temperature in winter goes as low as -100C.This is because the valley is located at an altitude of 2130 meters above sea level and is covered by dense forests. More over the Lidder River also influence the climate of Pahalgam and keep it moderate in hot summer. In Pahalgam one needs light woollen clothes even in summer and heavy woollen clothes in winter. Pahalgam receives the large amount of precipitation in the form of snow which is also a mark of attraction for adventurous tourist and those who enjoys the games of skiing and skating. Summer is the best in Pahalgam valley. However, the place can be visited during the annual Amarnath yatra in July-August.

WATER QUALITY ANALYSIS: The impact of tourism on water quality of Lidder stream is assessed mainly through the physic-chemical study of water quality because it is an outstanding indicator of human utilization of the ecosystem. Tourism data were acquired from Jammu and Kashmir Tourism Department to analyse the seasonal variation in tourist flow. Tourism data were correlated with water quality results in order to assess the impact of tourism on water quality. Present study was carried out at different sampling sites located nearby Lidder valley, Anantnag (J&K) India in order to record the physicochemical parameters of water quality of Lidder stream. Three water sampling sites were taken along the length of the river for physio-chemical analysis. The physiochemical characteristics of water have been monitored on monthly basis. The surface water samples were collected 10.00 am to 1.00 pm from each of sampling sites in one litre plastic bottles for the laboratory

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

investigations. The parameters including air temperature (AT), water temperature (WT), pH and electrical conductivity (EC) were analyzed on the spot, while the rest of parameters such as total alkalinity (TA), free carbon dioxide (F.CO2), chloride (Cl-) dissolved oxygen (DO), biological oxygen demand (BOD), Nitrate nitrogen (NO3 -N), ammonical nitrogen (NH4 +N), orthophosphate (OPP) and Total Phosphorus (TP) were determined in the laboratory within 24 hours of sampling. The analysis was done by adopting standard methods of APHA (2012).

MACRO-ZOOBENTHOS SAMPLING: - A D-net (Cuffney et al., 1993) with 0.5 mm mesh is used for sampling macro-zoobenthos. Using a D - frame net (500 micro meter mesh), macro-zoobenthos were collected on monthly basis at productive spots in each station. To dislodge the macro-zoobenthos, 2-feet by 2-feet of sampling area was thoroughly stirred up with feet for 3 minutes. All the dislodged organisms were carried by the water into the net. Then the net was removed from the stream with a forward scooping motion to prevent any of the organisms it contained to wash away; after which the contents of the net were poured into a white basin big tray with water. Any fish, amphibian or reptile caught was immediately returned to the stream. The macro-zoobenthos were picked from white basin tray with the help of forceps and kept in separate sampling bottles.

SORTING OF SAMPLE: Sorting was performed at the site immediately after sampling. Some or the entire sample was emptied into a white tray, which was having about 2 cm of clean water. The sample was allowed to settle and any movement in the water was observed. Any taxa that were seen were carefully collected using a spoon or a plastic pipette. The collected taxa were transferred into a white ice-block tray for a closer observation with a magnifying glass. The ice-block tray also was filled with clean water in the compartments. Similar macroinvertebrates were placed into the same compartments. The sorting process took greater than 20 minutes as some taxa were quite hard to find.

PRESERVATION: The organisms were kept separately in different bottles after fixing them with 90% ethanol. The preservation was done right at the time of collection. If the invertebrates were not treated with chemicals, they were found to undergo excessive and irregular contraction. Macrozoobenthic classes/orders/taxa were then identified and counted.

IDENTIFICATION OF MACROINVERTEBRATES: Identification of the organisms was done with the help of standard works of Edmondson (1959) and Adoni (1985) and protocols adopted from the USEPA (1997).

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

RESULTS

Physio-chemical Parameters: Of all the abiotic parameters affecting the water quality, temperature is an important regulatory factor which influences mixing and stratification patterns. During the present study, all the parameters have been found to follow more or less similar trend (Tables 1). The air and water temperature recorded higher values in summer (9^0C for air and 7^0C for water) and lower values in winter (3^0C for air and 2^0C for water). Likewise, pH, total alkalinity, dissolved oxygen, BOD and Total Phosphorus recorded maxima in summer (7.8, 95mg/l, 10.10mg/l, 15.80mg/l, 57μg/l) and minima in winter (7.1, 62mg/l, 9.6mg/l, 10.10mg/l, 38μg/l). But conductivity recorded higher values in spring (146μS/cm) and lower values in winter (90 μS/cm).

Macrozoobenthos: During the present study, a total of 17 taxa of benthic organisms (Table 2) were recorded from all the three sampling sites viz., Arthopoda (Insecta - 15, Crustacea - 1 and unidentified - 1). Thus, benthos comprised of 16 species of insects and 1 Crustacea of phylum Arthropoda. Perusal of table 3 reveals that the species rich class Insecta is in itself an assemblage of different forms belonging to 6 different orders (Ephemeroptera - 4, Diptera - 6, Trichoptera - 2, Plecoptera - 1, Coleoptera - 2 and Malacostraca -1). The five most common species found at all the sites during the period of present study included Chironomous sp., Baetisrhodani, Baetiella sp., Tipula sp., and Diamesinae sp. and the 8 rare ones (Tabanus sp., Simulium sp., Hydropsygche sp., Dytiscus sp., Perlidaesp,.Gamarus sp., Lamprima sp. And unidentified Pupa) found only at one site. Certain forms like Athrix sp., Ecdgnorus sp., Epeorus sp. and Limniphillus sp. were recorded only from two sites. Amongst the 17 taxa, the greatest number was noted for site 1 (12 taxa), followed by site III (9 taxa) and then site II (7 taxa). In general, the highest numbers of taxonomic forms were encountered from sites having relatively higher flow velocity as at site I.

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

The pattern of dominance of various benthic forms in terms of their abundance and density at various sites was as follows:

Distributional pattern of macrozoobenthos at Site 1 (Hirpora): Diamesianae sp. >Athrix sp. >Chironomous sp. >Tipula sp. >Baetis sp. >Baetiella sp. >Limniphilus sp. >Ecdgnorus sp. >Epeorus sp. > Pupa (unidentified) >Lamprima sp. >Tabanus sp. >Simulium sp.

Distributional pattern of macrozoobenthos at Site II (Chowgam): Diamesianae sp. >Limniphilus sp. >Tipula sp. >Baetiella sp. >Baetis sp. >Dytiscus sp. >Chironomous sp.>Hydropsgche sp.

Distributional pattern of Macrozoobenthos at Site- III (Shirmal): Diamesianae sp. >Tipula sp. >Ecdgnous sp. >Epeorus sp. >Baetiella sp. >Baetis sp. > Gammarus sp>Chironomous sp. >Athrix sp. >Perlidae sp.

TABLE 1:MONTHLYVARIATIONOF VARIOUSPHYSIO-CHEMICALPARAMETERS OF STREAM LIDDER AT VARIOUS SITES

Parameters	**Chandanwari**						**Main Pahalgam**						**Yenedpahalgam**					
	Dec.	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**
Air Temperature(°C)	5.0	2.0	6.0	5.0	6.0	8.0	6.0	2.0	5.0	7.0	8.0	9.0	5.0	4.0	7.0	8.0	9.0	9.0
WaterTemperature (°C)	4.0	2.0	5.0	7.0	6.0	7.0	5.0	3.0	5.0	6.0	5.0	9.0	5.0	3.0	5.0	8.0	7.0	9.0
pH	7.1	7.16	7.6	7.35	7.36	7.4	7.2	7.48	7.6	7.5	7.52	7.65	7.5	7.9	7.8	7.7	7.8	7.8
ElectricalConductivity (µS/cm)	80	90	120	130	146	149	120	130	128	112	116	120	90	96	98	116	112	122
TotalAlkalinity (mg/l)	80	88	82	80	92	95	62	62	70	75	87	80	70	75	66	99	78	79
Dissolved oxygen (mg/l)	10.5	10.4	7.8	7.8	6.8	6.5	10.3	10.2	8.2	7.7	7.0	7.4	9.7	9.6	8.6	8.2	9.6	8.0
BOD (mg/l)	11	11	12.6	14.6	15.0	15.0	10.5	11	12	14.0	14.6	14.6	10.1	11	14.0	14.6	14.0	14.2
Chloride(mg/l)	16	18	24	34	25	36	15	20	30	24	24	34	20	22	20	32	37	42
Total phosphorus (µg/l)	35	38	52	54	56	52	40	46	48	50	52	47	40	44	49	52	52	57
Free Co_2(mg/l)	3.0	4.0	6.0	8.0	9.0	9.0	4.0	5.0	5.0	7.0	8.0	10.0	4.0	5.0	6.0	9.0	8.0	9.0

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

TABLE2:DISTRIBUTIONALPATTERNOF BENTHICFAUNAINLIDDERSTREAMATTHREESTUDYSTATIONS

Species/Taxa	Chandanwari						Main Pahalgam						YenedPahalgam					
	Dec.	Jan.	Feb.	Mar.	Apr.	May	Dec.	Jan.	Feb.	Mar.	Apr.	May	Dec.	Jan.	Feb.	Mar.	Apr.	May
Baetiellasp.	3	2	2	0	3	4	2	2	0	4	3	3	0	0	2	3	4	3
Baetissp.	3	3	4	0	3	4	0	2	0	3	3	4	0	0	2	3	3	2
Ecdyourus sp.	1	1	2	2	3	3	0	0	0	0	0	0	1	1	3	3	2	2
Epeorussp.	0	0	2	3	2	4	0	0	0	0	0	0	1	1	2	2	3	3
Tipulasp.	5	6	8	0	0	0	1	2	2	3	6	5	2	2	4	6	5	6
Chironomussp.	0	0	4	3	3	4	0	0	0	3	3	2	0	0	0	0	3	4
Athrixsp.	2	2	3	4	4	5	0	0	0	0	0	0	0	1	0	1	2	1
Diamesinaesp.	3	5	6	4	4	5	6	9	20	30	5	4	4	5	5	9	7	6
Limnephilussp.	0	1	2	4	3	3	3	4	5	3	2	3	0	0	0	0	0	0
Lamprimasp.	0	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche sp.	0	0	0	0	0	0	0	0	1	2	1	1	0	0	0	0	0	0
Dytiscussp.	0	0	0	0	0	0	0	2	0	3	2	1	0	0	0	0	0	0
Perlodidaesp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1
Gammarussp.	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	1	1
Tabanussp.	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0

TABLE3:MACROBENTHICINVERTEBRATEDIVERSITY OFLIDDERSTREAM

Group /Orders	Chandanwari						Main Pahalgam						YenedPahalgam						TOTAL
	Dec	Jan	Feb	Mar	Apr	May	Dec	Jan	Feb	Mar	Apr	May	Dec	Jan	Feb	Mar	Apr	May	
Ephemeroptera	7	6	10	5	11	13	2	4	0	7	6	7	2	2	9	11	12	10	124
Diptera	10	13	21	10	13	16	7	11	22	36	14	11	6	8	9	16	17	17	257
Trichoptera	0	1	2	4	3	3	3	4	6	5	3	4	0	0	0	0	0	0	38
Coleoptera	0	0	2	1	0	1	0	2	0	3	2	0	0	0	0	0	0	0	11
Plecoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1	5
Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	1	1	7
Pupa (Unidentified)	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	7

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

CONCLUSIONS

- In all the three selected sites, water temperature was always found to be lessthan air temperature and followed the trend of air temperature. A positivesignificantcorrelationbetweenairandwatertemperaturewasobserved.
- High values of pH were recorded in all the selected sites throughout the courseof study, which might be related to enhanced photosynthesis carried out byphytoplankton and macrophytes, wherein CO_2 is removed, and hence pH israised.
- High values of dissolved oxygen content in December and January could berelatedtoincreasedoxygenretentioncapacityofwaterandreductioninrespiratory consumption of oxygen due to reduced metabolic rate, while lowervalues during April and May might be due to death and decomposition oforganic matter, increasing water temperature leading to decrease in oxygenretention capacity of water and increase in the respiratory consumption ofoxygenduetoincreasedmetabolicrate.
- High values of hardness recorded throughout the study period in all the threeselected sites might be due anthropogenic activities in and around this waterbodyinadditionofincomingsewage.
- Highvaluesofcalciumrecordedinallthethreeselectedsitescouldbeattributed to heavy input of sewage from surrounding area and weathering ofcalcareous materials.
- Higher values of chloride during may in all selected sites might be due to thehigher rate of evaporation and organic pollution of animal origin, whereaslower values during Feb. and Mar. could be related to reduction in siltation orallochthonousimportofchloridealongwithrainwaterfromcatchmentarea.
- HighervaluesofTSSduringAprilandMayinallselectedsitesmightbeduetoerodedsoilparticles,surfacerunoff,highrateofevaporationandsedimentation.
- BenthicfaunaofthisstreamcomprisedofEphemeroptera,Diptera,Coleoptera,Malacostraca,Trichopteraandunidentifiedgroup.
- Class insect formed the first most abundant group of benthic fauna and wasrepresentedby*Baetiella,Baetisrhodani,Ecdyourus,Epeorus,Tipula,Tabanus,Chironomus,Simulium,Athrix,Diamesinae,LimnephilusandLamprima.*
- Trichopteransshowedlowfrequencyacrossselectedsites.Thisclearlyindicated that they are sensitive to pollution. It can be further concluded thatthese insects can live in polluted water which can be related to the availabilityoffoodandoxygeninthisstreaminadditiontootherfactors.
- Benthic forms are an important component of food chains and energy flowpathways.Benthiccommunityconstitutesanimportantpartofanimalproduction and is tightly integrated into the structure and functioning of thesehabitats (e.g., organic matter processing, nutrient retention, food resources forvertebrates,suchas amphibians,fish).
- Benthic organisms are often good indicators; insects mostly sensitive to waterpollutionaretheEphemeropterans(mayflies),Plecopterans(stonefly)and Trichopterans (caddisfly). The sparse distribution, low numerical abundanceand low species diversity in present study is therefore, indicate that this streamhavebeenseverelydisturbed.

ISSN- 2394-5125 VOL 07, ISSUE 12, 2020

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