

## IMPACT OF HOUSEBOAT SANITATION ON ECOLOGY AND HEALTH OF DAL LAKE KASHMIR

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**Abstract:** Presence of Houseboats in Dal lake Kashmir is one of the unique features of this world famous tourist destination and to stay in houseboats has remained a craze with incoming tourists in general and for foreigners in particular. Due to the poor sanitary conditions of these houseboats and their continuous discharge of the effluents into the lake has posed many serious ecological problems both for the lake and the visiting tourists. However the present studies reveal that the threat of houseboat sanitation is not so scary than the malfunctioning of the STPs installed on the periphery of Dal and Nigeen Lake which carry more loads of hazardous nutrients into the lake than the house boats. The present studies regarding the houseboat areas reveal in terms of biological assessments and prevailing physico-chemical features of the lake water in houseboat areas coupled with sanitary conditions of the houseboats are very poor.

**Key Words:** (Lake Ecology , Dal Lake, Nigeen Lake, Kashmir).

### I. INTRODUCTION

Dal lake Kashmir has been the tourist destination for centuries as the summers of Kashmir are sunny, but cooler than the oppressive heat of the Indian plains. In the winter there is snow which gives enough opportunity for extensive sports. The mountains and the valleys give Kashmir a great scenic beauty, with pines, willow and mountain side. Thousands of tourists from all over India and abroad throng the valley in general and to the Dal Lake in particular. The foreign tourists comprise up to 10% while the 90% comprise of south east Asian countries. The Houseboats in Dal Lake are the main attraction for the tourists in general as they are the luxury mobile hotels on the serene waters which provide a solace for every tourist. These Houseboats have usually full occupancy during the peak tourist season both in Dal lake and Nigeen basin of the lake. The continued discharge of liquid and solid waste directly into the lake body has posed a serious threat to the health and ecology of the lake which has resulted in drastic changes in physico-chemical and biological characteristics of this freshwater lake and thus turned it into an eutrophic water body. In the present paper an attempt has been made to study the current status of the water quality of the Houseboat areas and that of the outfall sites where the "treated effluents" from the immediate catchments of the lake are being pumped into the lake as to assess the

impacts on the ecology and health of the lake ecosystem.



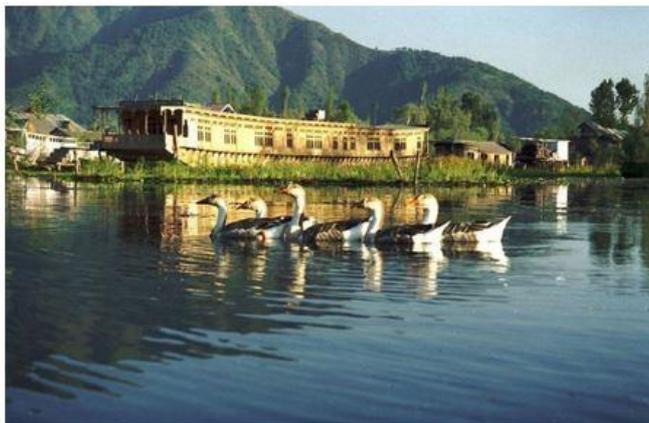
Outfall STP Habak



Outfall STP Habak



Outfall STP Hazratbal



Houseboat in Dal Lake

## II. LITERATURE REVIEW

Adnan and Kundangar (2005) while studying the Bacterial Dynamics of Dal Lake correlating the Bacterial population density with physico-chemical parameters recorded high population density of Faecal coliforms and Total Coliforms around Houseboat areas of both Dal Lake and Nigeen Lake.

Adnan and Kundangar (2009) in a research paper entitled, "Three Decades of Dal Lake Pollution-restoration" recorded the changes in hydro-chemistry and biodiversity of Dal Lake during the last three decades besides giving the current ecological status of the Lake. The authors revealed that FAB based Sewage Treatment for effluents entering the lake at Hazratbal, Habak are a total failure particularly during winter months.

J& K State Pollution Board (PCB)(2009) in a status report on Dal Lake described the ecological situation of Dal and Nigeen visibly bad with intense overgrowth of weeds and algal patches. The water quality at many places was recorded septic in nature with high content of P, N and suggested tertiary treatment measures.

Murtaza, (2010) while studying the impact of pollutants on Physico-chemical parameters of the Dal Lake reported increase in Specific Conductivity, total alkalinity and Nitrate-nitrogen besides decrease in dissolved oxygen, silicates and Phosphorous.

Shariqa (2011) while studying the water quality changes in Nigeen basin of Dal Lake reported marked changes in morphometry of the lake basin besides chemical enrichment over a period of time.

Shabina Masoodi et al. (2014) While assessing the causes of pollution of Dal lake and remedial measures reported the House boat areas in the lake are the most polluted ones and there is a high risk of infection especially for foreign tourists. The effect on the Tourism would be catastrophic if the Houseboat pollution is not addressed at priority.

## III. METHODOLOGY

The water quality of the houseboats areas and that of the outfall sites( STPs) were analyzed by APHA(1997) methods where as solid waste generation was assessed through daily field studies.

## IV. RESULTS AND DISCUSSION

The average Physico-chemical parameters in and around Houseboat areas in Dal and Nigeen are set in table (1).

Table 1: Average Physico-Chemical Parameters In And Around Houseboat Sites Of Dal Lake Kashmir

| Parameters         | Unit    | Dal | Nigeen |
|--------------------|---------|-----|--------|
| pH                 |         | 7.8 | 7.8    |
| Conductivity       | µS@25°C | 301 | 333    |
| Oxygen             | mg/l    | 5.9 | 5.6    |
| Total Alkalinity   | mg/l    | 224 | 240    |
| NO <sub>3</sub> -N | µg/l    | 424 | 426    |
| NH <sub>4</sub> -N | µg/l    | 523 | 416    |
| PO <sub>4</sub> -P | µg/l    | 185 | 184    |
| Total Phosphorous  | µg/l    | 668 | 667    |

The water Quality of the studied areas reveal that the specific conductivity, Nitrate-nitrogen, Ammonical-nitrogen and total Phosphorous are depicting higher values which are detrimental for the lake Ecosystem. The results are in conformity with the findings of J& K Pollution Control Board (PCB, 2009) , Murtaza (2010), Shariqa (2011) and that of Shabina Masoodi et. al. (2014) who reported the houseboat areas in the Dal lake, the polluted ones with high risk of infection. The bacterial population (table 2) also reveals that there is progressive increase in fecal coliforms and Total coliforms in and around Houseboat areas which is in conformity with the findings of Adnan and Kundangar (2005).

Table 2: Average Bacterial Population in Houseboat Areas of Dal And Nigeen Lake

| Bacterial Population | Units      | Dal Lake | Nigeen Lake |
|----------------------|------------|----------|-------------|
| Total Coliforms      | CFU/100 ml | 1850     | 480         |
| Faecal Coliforms     | CFU/100 ml | 180      | 230         |

The solid waste generation during the study period ( table3 & 4) reveals that in Dal lake it ranged between 33.6 tons to 62 tons with an average of 48.3 tons while in Nigeen lake the estimated load of solid wastes ranged between8.4 tons to 15.5 tons.

Table 3: Monthly Solid Waste Generation (Tonnes) In Dal Lake

| Months   | Solid Waste Generation |
|----------|------------------------|
| January  | 37.2                   |
| February | 33.6                   |

|       |       |
|-------|-------|
| March | 37.2  |
| April | 60    |
| May   | 62    |
| June  | 60    |
|       | 48.33 |

Table 4: Monthly Solid Waste Generation (Tonnes) In Nigeen Lake

| Months   | Solid Waste Generation |
|----------|------------------------|
| January  | 9.3                    |
| February | 8.4                    |
| March    | 9.3                    |
| April    | 15                     |
| May      | 15.5                   |
| June     | 15                     |
| X        | 12.08                  |

Since the occupancy of the houseboats during the study period was very low the same would have been much higher if there would have been full occupancy. Despite the fact that the solid wastes are managed on door to door basis yet all the solid wastes are not being managed in a systematic manner as most of the open water areas and estuaries could be seen full of plastic bags, tin cans and plastic bottles floating on the surface of water. Interestingly when the water quality parameters of the houseboat area are compared with those of treated effluents at the outfall sites, it is vividly revealed that the outfall sites are more polluted than houseboat areas (table 5).

Table 5: Comparison Of Water Quality At Houseboat Sites (a) and Treated Effluent Outfall Sites (b) of Dal and Nigeen Lakes

| Parameters         | Unit                   | Dal Lake(a) | Dal Lake(b) | Nigeen Lake(a) | Nigeen Lake(b) |
|--------------------|------------------------|-------------|-------------|----------------|----------------|
| pH                 |                        | 7.8         | 7.7         | 7.8            | 7.8            |
| Conductivity       | $\mu S @ 25^{\circ} C$ | 301         | 383         | 333            | 276            |
| Dissolved Oxygen   | mg/l                   | 5.9         | 5.1         | 5.6            | 4.5            |
| Total Alkalinity   | mg/l                   | 224         | 316         | 240            | 244            |
| NO <sup>3</sup> -N | $\mu g/l$              | 424         | 489         | 426            | 476            |
| NH <sup>4</sup> -N | $\mu g/l$              | 523         | 564         | 416            | 392            |
| PO <sup>4</sup> -P | $\mu g/l$              | 185         | 434         | 184            | 412            |
| Total Phosphorous  | $\mu g/l$              | 668         | 1210        | 667            | 1061           |

It affirms that the STPs installed on the periphery of Dal and Nigeen lake are malfunctioning and have become the point source pollution sites for the entire Dal lake. The present study authenticates the findings of Adnan and Kundangar (2009) where under the authors recorded the changes in the hydrochemistry and biodiversity of Dal lake during the last three decades besides giving the current ecological status of Dal lake. The authors revealed that the FAB based Sewerage Treatment Plants installed on the lake banks are failure particularly in winter months. The continued ingress of the effluent discharge from the houseboats including the grey waters from the toilets not only are the contributory factors of the lake pollution but enhance the eutrophic aquatic weeds in and around Houseboat areas which include *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Azolla* sp., *Salvinianatans*, *Phragmites* sp., *Typha angustata* etc. However these aquatic weeds lock up the nutrients in their roots and rhizomes but enrich the lake substratum on their death and decay during the winter months. The present studies regarding the houseboat areas reveal in terms of biological assessments and prevailing physico-chemical features of the lake water in houseboat areas coupled with sanitary conditions of the houseboats are very poor. The risk of infections is very high especially for foreign visitors. There is no protection against the spread of Cholera, Typhoid, Hepatitis which are water borne diseases. There is some risk that gives an appropriate set of climatic and lake conditions an explosion of aquatic water ferns (*Azolla* and *Salvinia*). These floating aquatic weeds have formed dense mats all around Houseboat sites and STP fall outs which could prevent day light reaching the weed growing on the lake floor. The weeds die and decompose causing de oxygenation of the lake water with subsequent release of nutrients from the lake bed resulting in triggering of frequent Algal blooms. The present studies reveal that the so called Sewage Treatment Plants are potential source of Pollution than those of Houseboats as they are discharging loads of hazardous nutrients like Nitrates n Phosphates round the clock into the lake body hence warrant immediate solution including those of Houseboat as well.

#### V. CONCLUSION

- The water Quality of the studied areas in and around Houseboat areas including those of outfall sites of STPs reveal that the specific conductivity, Nitrate-nitrogen, Ammonical-nitrogen and total Phosphorous are depicting higher values which are detrimental for the lake Ecosystem.
- Despite the fact that the solid wastes are managed on door to door basis yet all the solid wastes are not being managed in a systematic manner.
- The continued ingress of the effluent discharge from the houseboats including the grey waters from the toilets not only are the contributory factors of the lake pollution but enhance the eutrophic aquatic weeds in and around Houseboat areas .
- There is some risk that gives an appropriate set of climatic and lake conditions an explosion of aquatic water ferns (*Azolla* and *Salvinia*). These floating

aquatic weeds have formed dense mats all around Houseboat sites.

- The present studies reveal that the so called Sewage Treatment Plants are potential source of Pollution than those of Houseboats as they are discharging loads of hazardous nutrients like Nitrates and Phosphates round the clock into the lake body hence warrant immediate solution including those of Houseboat as well.

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