Jal Vigyan Sameeksha—a publication of
High Level Technical Committee on Hydrology
Vol. III, No. 1, June 1988

Studies on Lake Pollution due to Mass Bathing, Brahma Sarovar of Kurukshetra-A Case Study

K.R. Ranganathan R.C. Trivedi K.C. Rathore
Central Pollution Control Board, Skylark Building, 60 Nehru Place
New Delhi

ABSTRACT : *Due to mass bathing in Sarovar, the quality of water is deteriorating. Studies have been conducted by Central Pollution Control Board to find out the changes in water quality especially in relation to bacterial population during mass bathing. This study were mainly confined to holy places on the bank of rivers such as Hardwar, Allahabad and Ganga Sagar. It was observed that the quality of Brahma Sarovar water was not fit for bathing even before mass bathing started The coliform organisms increased 1000 times due to mass bathing. Vertical stratification was found to be more distinct at the stations where bathing activity was more.*

1.0 Introduction

All major Hindu festivals are associated with mass bathing in ponds, rivers or lakes. Pilgrims assemble in millions, on occasions of fair and on solar Eclipse throughout the country and take holy dip in these ponds and Sarovars. The water not only carries water borne disease but also transmits them and spread skin diseases to the people who take bath in such water. The belief of people is that such bath on the occasion can rid them of all physical and mental abnormalities.

2.0 Sources of pollution

Hundreds and thousands of villagers come to the holy tanks for bath. They bring along with them various types of ceremonial refuse for discharge into ponds causing pollution of these ponds. The refuse left over after Puja is being collected and finally discharged into these ponds which causes pollution of these ponds.

The people gathering at these places bring with them food articles. After consuming food, the left over is either thrown into ponds or comes into it indirectly.

Lot of people perform Puja in the temples around the pond and refuse disposes into the Sarovars causing pollution of the Sarovar.

When hundreds and thousands of people take bath in the Sarovar, they discharge fecal pollution into the Sarovar. Many of them suffering from skin diseases, vineral diseases, T.B. and other communicable diseases. These diseases in turn are transmitted through water to innocent healthy people who carry them for rest of their life.

After the function is over the left over comes to Sarovars indirectly due to washing of utensils etc. During rainy season due to surface runoff also all materials left over on the nearby ground find its way into Sarovar, this leads to continuous pollution of Sarovar

3.0 Objectives of the study

Studies have been conducted by Central Board to find out the changes in water quality, especially in relation to bacterial population during mass bathing. But these were mainly confined to holy places on the bank of rivers, such as Hardwar. Allahabad and Ganga Sagar. This is the first study on a closed aquatic system.

The study was planned to fulfil the following objectives :

a. to assess the existing water quality in the Brahma Sarovar and Sannihit sarovar and its suitablity for bathing.

b. to assess fhe impact of mass bathing on the quality of the Sarovar water, specially in terms of physiochemical and bacteriological parameters and water quality difference between the pre-and post-mass bathing period.

c. to determine the vertical and horizontal stratification in the Sarovars.

d. to determine dispersion rate by comparing the difference between the water quality of intense bathing zone.

e. to estimate the sufficiency of chlorination done by the health authorities.

4.0 Sampling/Methodology

Sampling for dissolved oxygen and bacteriology was done with the help of a sampler. For the stratification experiment, one sample was taken from 0.3 meter depth, second sample was taken from the bottom and third sample was taken from the mid depth at the same point. As it was desirable to know the average water quality and minimum surface and bottom specific affects, all other samples were taken from 1 meter depth. The samples for bacteriological analysis were collected in pre-sterilised bottles and brought to the laboratory in ice-box. Temperature of the water was measured in situ. For dissolved oxygen measurement samples were collected, fixed and analysed immediately. The samples for other parameters were composited by mixing the equal volumes at fixed time intervals and analysed following the standard methods (APHA 1985). All these samples were analysed in Mobile Laboratory immediately.

5.0 Observations

5.1 Water quality of incoming and out going water

Incoming fresh water to the old Brahma Sarovar was analysed for pH, conductivity, dissolved oxygen, BOD, Chloride, alkalinity, total hardness, turbidity, total coliform and fecal coliform. The water going out from the Brahma Sarovar was also analysed for the above parameters. The analysis results are shown in figure 1.

The results of analysis indicate that pond water had undergone substantial change in its physico-chemical properties. Even after mass bathing slight change was observed in the water quality at outlet. Conductivity increased from 166 umhos/cm^2 to 182 umhos/cm^2, turbidity increased from 10 NTU to 40 NTU. The increase in BOD value from 2.0 mg/l to 4.0 mg/l was observed. Slight increase in hardness was also observed. No marked change in percent saturation of dissolved oxygen was observed.

5.2 Vertical stratification studies

To study vertical stratification six sampling points were located. Out of these six points, four points one on each side of old brahma sarovar, one at new brahma sarovar and one at Sannihit Sarovar were selected. Grab sample

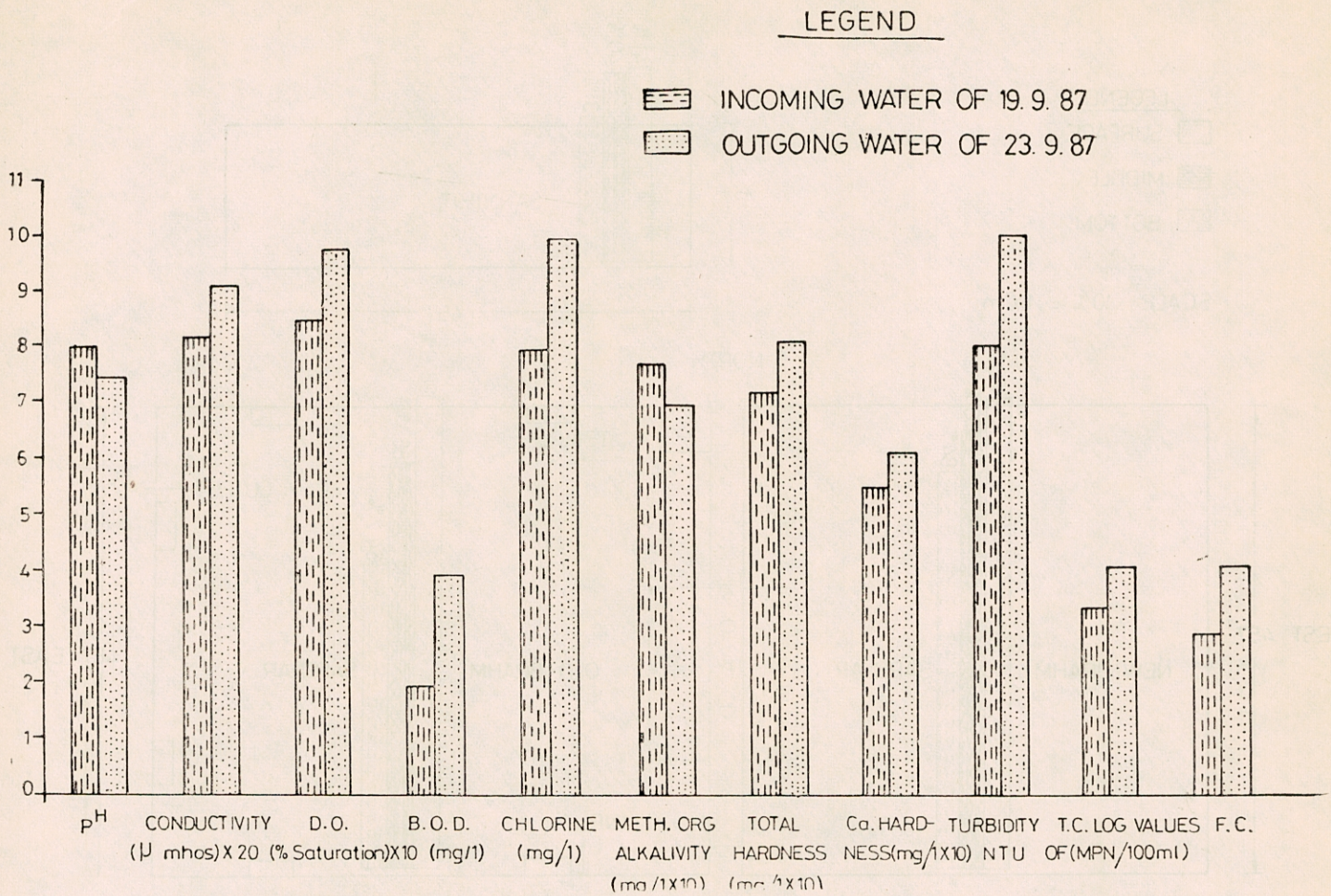

Fig. 1 : Physico-Chemical Quality of Incoming and Outgoing Water of Brahma Sarovar

was analysed for dissolved oxygen and temperature measured. Another sample was taken from about 0.3 meter depth, second from bottom and third from the mid depth. The results are shown in figure 2.

At the Sannihit Sarovar the water samples were collected during peak bathing. These samples did not give considerable variation in temperature and dissolved oxygen.

In new and old Brahma Sarovar the water samples were collected before mass bathing, after mass bathing and another sample after 24 hours of mass bathing. The analysis of water indicate that there was no significant change in water temperature at various depths. It was found that old Brahma Sarovar surface water was .1.0°C hotter than middle layer and 1.6°C, hotter than bottom water. The average temperature variation was found to be 0.7 to 0.8 degree centigrade.

The present saturation of dissolved oxygen was showing marked variations from surface. The surface water of new and old Brahma Sarovar was found to be saturated but the dissolved oxygen dropped down in the middle and bottom from 86 to 64 percent saturation in new brahma sarovar and 93 to 84 per cent in old Brahma Sarovar. The surface water of old Sannihit Sarovar was found to be deficient in dissolved oxygen due to high organic loading. The average dissolved oxygen saturation value was found to be 41 per cent at surface which dropped down to 31 per cent at the bottom.

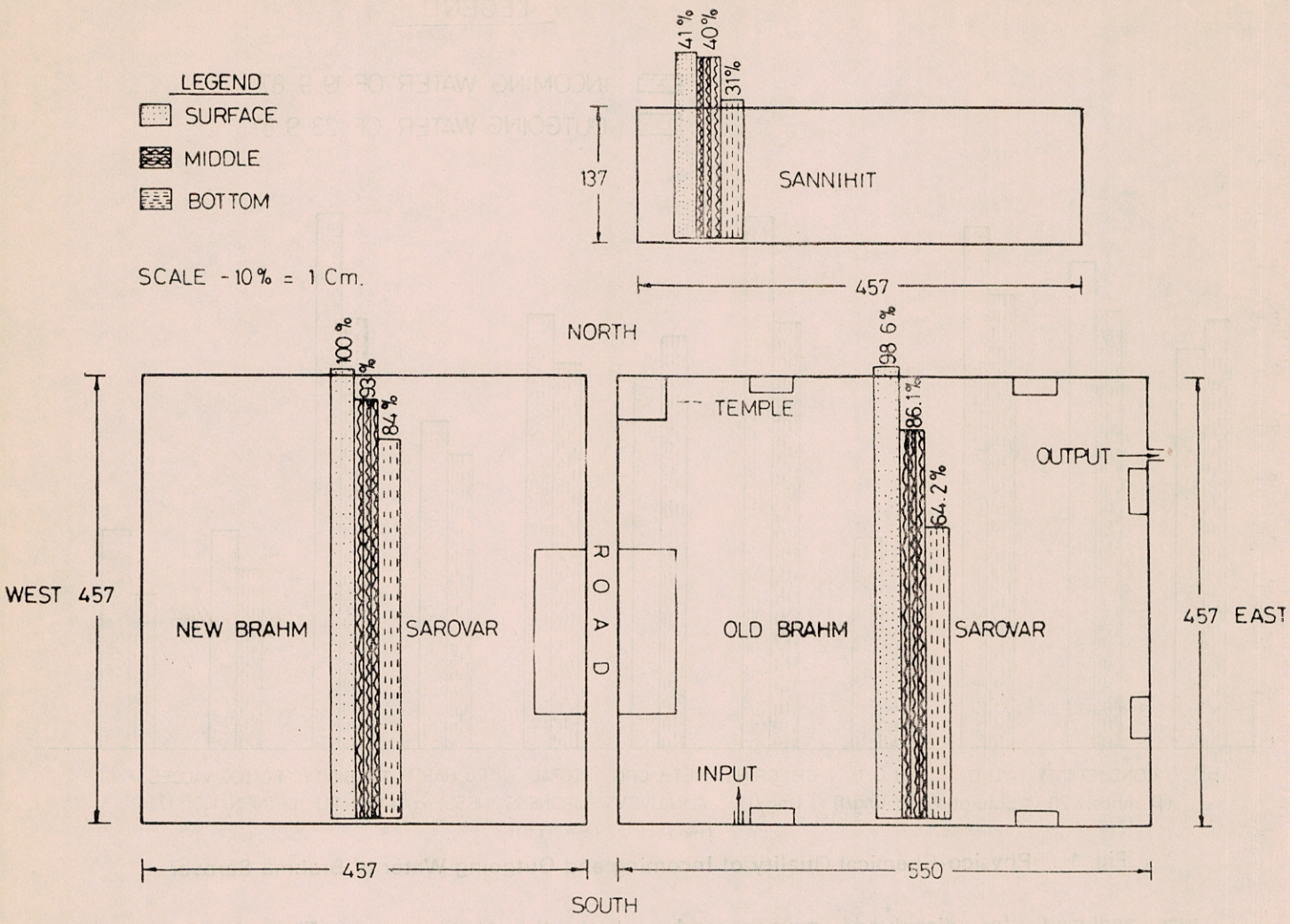

Fig. 2 : Vertical Stratification in Respect of Percent Saturation of Dissolved Oxygen

5.3 Extent of Bacterial pollution during mass bathing and its dispersion.

This study was conducted during peak bathing time. Inside railings on north side, total coliform number was found to be 24 lakhs per 100 ml. while the fecal coliform increased from 11 lakhs to 24 lakhs/100 ml. On north side, outside railing area indicated comparatively less number of total and fecal coliform. However, gradual increase in total and fecal coliform was observed. The study indicated that it takes about an hour for coliform to disperse to 10-25 mtrs.

5.4 Effect of mass bathing on water quality

5.4.1 Physico-chemical observations

The physico-chemical characteristics of water do not show significant change due to mass bathing. The pH value of water at all monitoring stations was found to be in alkaline range. After mass bathing, it was reduced slightly to 7.5. Alkalinity of water was found to reduce from 77 mg/l to 56 mg/l due to mass bathing. The turbidity of water increased from 6 NTU to 40 NTU after mass bathing.

On post bathing day the physico-chemical characteristics of water remained unchanged at all monitoring points in Sarovars. This study has also shown that per person chloride contribution is 4.1 mg/l.

5.4.2 Bacterilogical observations

The coliform density was found to be the single parameter affected due to mass bathing. The average value of total coliform increased from 2150/100 ml to 24,00000 and fecal coliform increased from 560/100 ml to 24,00,000. The coliforms were gradually dispersed inside the sarovars where there density was found increasing gradually. Before mass bathing, it was observed that average total and fecal coliform in the Brahma Sarovar varied from 2467 MPN/100 ml to 1800 MPN/100 ml and 100 MPN/100 ml to 625 MPN/100 ml respectively. The ratio of total to fecal coliform was found to vary between 2.24 to 2.88. This ratio gradually reduced to one indicating presence of fecal coliform only in the water.

On mass bathing day during peak bathing hours, samples were analysed and significant change was observed in BOD, chlorine demand and coliform density. The average BOD of Sarovar water was found to change from 2.0 mg/l to 3.0 mg/l. At same places, the BOD value was found to be as high as 33 mg/l due to concentration of bathers at the point. The chlorine demand was also increased from 2.6 mg/l to 4.3 mg/l.

6. Conclusions

1. It was found that the quality of Brahma Sarovar water was not fit for bathihg even before mass bathing started.
2. The coliform organisms increased 1000 times due to mass bathing.
3. It was found that fecal coliform increased more rapidly than total coliform.
4. Vertical stratification was found to be more distinct at the stations where bathing activity was more.
5. Variation in physico-chemical parameters was found to be insignificant.