

## A Stewardship Of Ramgarh Lake In Gorakhpur District: Uses, Problems And Management

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### Abstract

*Water is essential for sustaining life and at the same time, it is an important component for almost all developmental plans, however, Growing population, urbanization and industrialization has led to considerable increase in demand of water for various purposes. The present work is focused on uses, deteriorating factors and suggestion for restoration of Ramgarh Lake. Ramgarh Lake (26°42'30"N - 26°45'N & 83°24'20"E- 83°25'20"), covering an area of 576 hectare which is situated in the center of Gorakhpur district and this district exist in the north-eastern part of Uttar Pradesh. Large populations depend on this water body for fish, vegetable, water, irrigation, waste disposal site, washing site and recreational activity. Dumping of solid as well as liquid wastes has resulted in the uncontrolled growth of aquatic weeds, eutrophication and sedimentation, which have altered lake's morphology, volume, depth and quality of water. Importance of lakes understood by the people and therefore serious measures are being taken towards the stewardships of water bodies. Ramgarh lake also being neglected in past, but now, this conservation of lake is estimated to ensure the better future of Gorakhpur city.*

**Keywords:** *Algal Bloom, eutrophication, sedimentation, sewage disposal.*

### Introduction

A lake is an area of variable size filled with water, localized in a basin that is surrounded by land, apart from any river or other outlet that serves to feed or drain the lake. Lakes contain 90 percent of the freshwater on the earth's surface which is critical element of the water cycle that sustain aquatic biodiversity and provide livelihood social, economic and aesthetic benefits that are essential for the quality of life of the people in Lake Basin. Lakes constitute vital components of the regional hydrological cycle. They are highly productive, support large biological diversity, and provide a

wide range of ecosystem services such as food, fiber, waste assimilation, water purification, flood mitigation, erosion control, groundwater recharge, microclimate regulation, enhance mount of aesthetics of the landscape and support many significant recreational, social and cultural activities, aside from being a part of our cultural heritage. In India, there are enormous number of natural and manmade water bodies used for various purposes, mainly for drinking and agriculture. However, in recent years, due to rapid urbanization and modern agricultural activities, the quality of water bodies is deteriorating causing

environmental hazards. Due to direct or indirect interferences of man, water bodies have been contaminated with variety of hazardous chemical pollutants causing an adverse impact on human health and aquatic life as well (Telliard and Rubin, 1987).

It was acknowledged that most urban water-bodies are seriously threatened by conversion to non water bodies or concretization of surface, encroachment through land filling, discharge of domestic and hospitals wastes, disposal of solid wastes and overexploitation of water resource. This results in loss of biodiversity and disruption in goods and services provided by lakes and ponds (Ramachandra, 2009 a, b, c; Ramachandra et al., 2012). Considering the current trends of deterioration of lakes, it is urgently needed in aquatic ecosystem conservation, restoration and management including the hydrological and the biophysical aspects through people's participation and involved of governmental, educational institution emphasizing restoration, conservation, and management of lakes in future research. Gorakhpur district is situated in the north east Tarai region of Uttar Pradesh (India). The remarkable characteristic of the Gorakhpur District is the presence of numerous annual and perennial ponds and lakes of varying dimensions. The Ramgarh Lake, selected for the present investigation, is the biggest lake of the area that is formed by the abandoned channel of Rapti river, which have been blocked by the accumulation of silt. Ramgarh Lake has immense ecological and economic value, but encroachment, eutrophication and sedimentation in the lake resulted in reduction in area, depth and volume of water. Urgent measures are required to explore

the pollution loading of the lake, existing position of deterioration and to understand the response of the lake to pollution loading. Deterioration can be checked by placing sewage treatment plants, proper disposal of wastes, management of inflow-outflow of water, removing sediments and checking encroachments in the lake. Ramgarh Lake is the biggest lake of the area facing the multi-dimensional problems due to urban dwellers. This paper analyzed the utilization pattern of the lake, deteriorating factors and strategic to restore the lake.

### **Literature Review**

Pant, M.C., Sharma, P.C., Sharma, A.P. and Gupta, P.K., (1985) examined certain microbiological, biological, and chemical aspect of pollution in Lake Naini and also found the unabated activities of humans that virtually converted it into a dangerously polluted cistern. Sharma, V.N., (2001) focused on a geographical survey of morphology, economic use and deteriorative factors of Ramgarh Lake, a highly affected water body due to urbanization of adjoining areas of Gorakhpur town. He added that dumping of wastes into the lake had resulted in the menacing growth of aquatic weeds, serve eutrophication and sedimentation that altered the lake morphology and the volume, depth and quality of lacustrine water. Vyas, A., Mishra, D.D., Bajapai, A., Dixit, S., Verma, N., (2006) examined the environmental impact of idol immersion activity in lakes of Bhopal. The immersion of idol of Lord Ganesh and Durga during Ganesh Ustav and Navratris festival was a major source of contamination and sedimentation to the lake water. Ramchandra, T.V., (2008) focused on spatial analysis and

characterization of lentic ecosystem of Varthur Lake, Bangalore. Mahapatra, D.G., Chankya, H.N. and Ramchandra, T.V., (2011) discussed the Macrophytes that play a major role in maintaining the nutrient levels due to prolific growth of invasive species such as hyacinth (*Eichhornia crassipes*) in urban aquatic systems. This condition provided hinders aerobic functioning of the lake by restricting sunlight penetration and affecting algal photosynthesis which necessitates the regular removal of macrophytes from the lake. Yadav, P., Yadav, V.K., Yadav, A.K. and Khare, P.K., (2013) examined present physico-chemical characteristics of Mahil pond, located in Orai in Jalaun district of Uttar Pradesh. The study was carried out for a period of one year in which different parameters were taken and the result of the present study indicated that the water of the pond was just below the level of eutrophication. Tiwari, F., (2013) revealed an aspect of physico-chemical factors and zooplankton of Ramgarh Lake. He focused that all the physicochemical parameters exhibited highly significant spatial variations ( $p < 0.001$ ). The lake is gradually tending towards eutrophication. Bharati, A.K., Pandey, G., (2015), focused on proper conservation and management of a lake. Water quality monitoring and analysis of the Ramgarh Tal was carried out for various physico-chemical, and bacteriological parameters i.e. pH, total dissolved solids, turbidity, acidity, alkalinity, total hardness, chloride, DO, BOD, COD,

fecal coliform, during January-2015 to June-2015. Pandey, A.K., Prakash, C., (2016) analyzed of monthly variation in physico-chemical parameters of water of Ramgarh lake, Gorakhpur. Kumari, M., Singh, A., (2017) examined about the hematological and biochemical changes induced by water pollutants in fishes collected from Ramgarh lake of Gorakhpur.

### **The Study Area**

Ramgarh Lake, an ox-bow lake, formed by the river Rapti (Singh, 1977), is situated at the eastern end of Gorakhpur city in Uttar Pradesh (Fig.1). It is about 5 kilometers long and 3 kilometers wide having shallow flat basin with marginal slope. Two connecting stream namely Gurdhuia (10km) feed water to the lake from the north while one outlet named the Gurrah (14km) drains the lake-water in rainy season. The present work is focused on economic use, deteriorating factors and remedial measures of Ramgarh Lake ( $26^{\circ}42'30''N - 26^{\circ}45'N$  &  $83^{\circ}24'20''E - 83^{\circ}25'20''$  covering an area of 576 hectare). Its western side bordered with embankment and Sewage Treatment Plant ( Padleyganj), Buddha Vihar, Tourist Residential House, Government Circuit House, Tara Mondal, Nauka Vihar etc. whereas in the eastern side a Sewage Treatment Plant ( Jharkhandi) is existed. Ramgarh Lake is a big size perennial and eutrophic lake. It receives the drainage of the city from north west and east sides which are the major source of organic pollution.

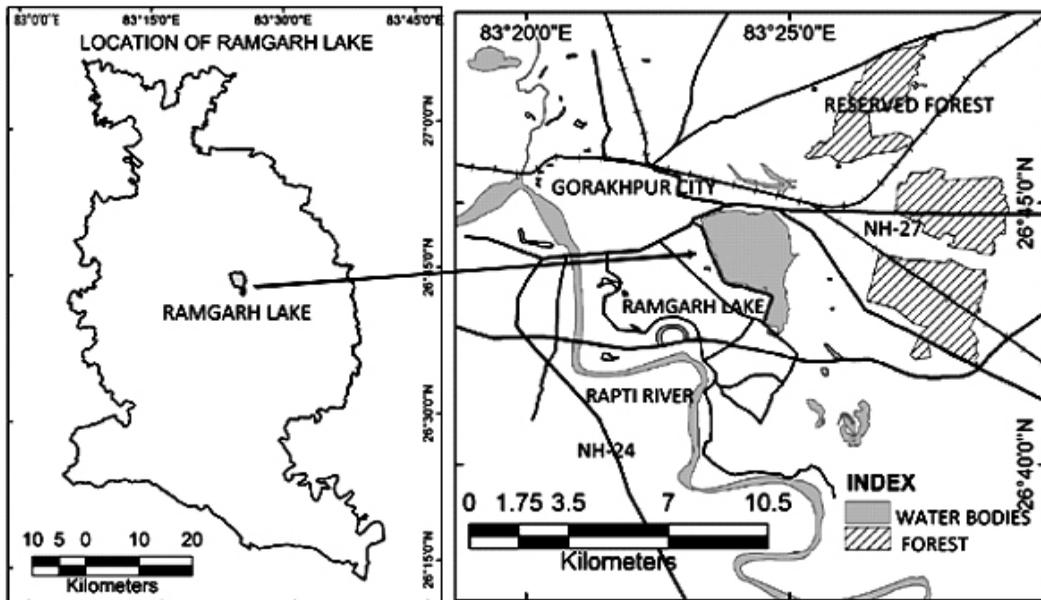


Fig.1, LOCATION OF RAMGARH LAKE

## Objective

Present study focuses on spatio-temporal patterns of Ramgarh lake of Gorakhpur district along with a case study of utilization and degradation.

## Material and method

The study based on the secondary data obtained from different sources. Toposheets are collected from the Survey of India, Lucknow (U.P.) on the scale of 1:50000 in the year of 2010-2011. Satellite imageries are taken from USGS site, in which the time series remote sensing data acquired from Landsat Series Multispectral sensor and 28.5m resolution of the sensors for the period 1992, 2004, 2014 and were downloaded from public domain (<http://glof.umiacs.umd.edu/data>). Google Earth data (<http://earth.google.com>) used for classification process and validation of the results. The

remote sensing data were geo-referenced, rectified, projected and cropped pertaining to the study area. Geo-registration of remote sensing data (Landsat data) was done using ground control points collected from geo-referenced topographic maps published by the Survey of India. After that different layers are digitized and classified as many shape files with the name of river, large lake, nalas. And also with the help of Satellite Imageries and toposheets the encroachment of lake areas by anthropogenic activities from 1990s to 2014 near Ramgarh Lake are derived. For above all purpose computer software like, Arc-GIS, ERDAS and MS Excel are used for data calculation as well as mapping. Moreover the status of activities in Ramgarh Lake is also focused through the help of personal survey. For the primary survey an area of influence surrounding the Ramgarh Lake covering about 200 meters around the lake is taken only. Primary

information collected from 60 household from Padleyganj, Circuit house, kundaghat, jharkhandi and Maharbaki Bari (fishermen's village) by an interview schedule.

### Observation

#### Utilization pattern of Ramgarh Lake

The economic value of lake includes both direct and indirect. Direct use involves

human interaction with the resource. It may be derived from outputs that can be consumed, such as, water supply for irrigation and drinking purposes, recreation, food (fish), fodder, etc; and the indirect use arise from the function occurring within the ecosystem, such as, water quality, flood control, temperature moderation of the surrounding city, biodiversity maintenance and habitats for many aquatic organism.

Table -1 : Utilization Status of Ramgarh Lake

Activities	Current Status	Response of Respondents	In Percent
Fishing	Continue	60	100
Irrigation	Continue	48	80
Vegetable Cropping	2005	52	86.6
Washing	1998	47	78.3
Recreational Activities	Continue	60	100
Religious Activities	Continue	56	93.3
Dumping Sites	Continue	60	100
Cattle Bathing	2011	53	88.3
Drinking Purpose	1980	46	76.7
Boating	2004	48	80

Source: Field Survey (February 2017)

Moreover, some specific human activities are happened, in which few activities are still continued and many are banned by government. Due to reckless dumping of sewage water in Ramgarh lake, livelihood of very large number people's (washer men, fishermen, farmers etc) are badly influenced. Fishing activity is continued with 100 kilogram in one day during fishing season, irrigation facility provided by the east part of the lake at a little scale because the lake water is very toxic

and polluted that is not suitable for natural flora, whereas vegetable crop production was banned through the government in the year of 2011 in the lake when a embankment was built up surrounding the lake for purpose of conservation and management. Washing activity was also banned after by government for prevention of lake water quality from the washing detergent which was used in washing the clothes by washer-man. The recreational and religious activities are continued but their rate is

decreased from the past due to deterioration in natural health of the lake. Lake water is not hygienic due to dumping of plastic packets, bottles, rappers near and in lake. One very destroying use of the Ramgarh Lake at present is dumping site for sewage water. The very recent scene was in February 2017 that Padleyganj, Mohaddipur and Kundaghat the drain water direct entered into lake without any treatment in west north and north-east side of lake near. Now, the

cattle's bathing is also moderate but very nil because after construction of embankment in 2011 interrupts the animals to enter in lake. Up to 1980, Ramgarh Lake's water was so pure that it was used for drinking, cooking, etc. but in recent time scenario is different; the water of lake is not suitable even for fish, other animals and thus human is very far from the use of this water. The boating activity in lake is continued but only for fishing and caring of lake.

Table - 2 : Status of Activities

Type of Activities	Status of Use in 2005	Response of Respondents in (%)	Status of Use in 2011	Response of Respondents in (%)	Status of Use in 2017	Response of Respondents in (%)
Fishing	More	83.3	Moderate	95	More	100
Irrigation	More	83.3	Moderate	88.3	Nil	96.7
Recreational Activities	More	81.7	Moderate	93.3	Moderate	100
Religious Activities	More	78.3	Moderate	88.3	Nil	93.3
Dumping Sites	Nil	80	Moderate	93.3	More	100
Cattle Bathing	More	83.3	Moderate	95	Nil	100
Boating	Moderate	83.3	Nil	93.3	Nil	100
Cropping	More	81.7	Nil	95	Nil	100

Source: Field Survey (February 2017)

Fishing activity was less in year of 2005 while in 2011, recorded moderate and 2017 more production was recorded because demand of fishes increases due to increase in population and also the Government gave to private agency for caring the lake and the irrigation activities was more in 2005 than that of 2017 because during past time water quality was better and used for crop cultivation but at present very poor quality of water is not suitable for crop production. Gorakhpur development authority took

some steps to control the recreational activities after 2005 and so at present is recorded less due conservation of lake area from non- renewable materials (plastics bottles, packets etc.). Idol immersion type of religious activities in lake's water is controlled in recent years than the past year of 2005. Use of Ramgarh lake as dumping site for sewage is increased at present due to increasing the population and mushrooming of residential colonies in comparison to 2005. Cattle bathing activity was more in

2005 but it is less in 2011 and 2017 due to embankment surrounding the lake. In 2005, boating activity in Ramgarh lake for tourism purpose was start but due to addition of pollutants through tourism this activity was controlled and this time boating is being done for fishing and caring of lake. Thus, we can see the livelihood of fishermen, washerman, and farmers are influenced due to set up of new residential colonies and encroach into the lake areas.

### Problems in Ramgarh Lake

Various anthropogenic activities have altered the physical, chemical and also biological processes within aquatic ecosystem of Ramgarh lake. Accumulation of silt and pollutants due to recreational activities and residential sites near the lake are important reasons for the degradation of lake. The lake receives waste water through several drains such as the Kunda Ghat Nala, Mohaddipur power house Nala, waste water of hospital in Padley Ganj, residential house in Jharkhandi Maharwa ki Bari village and colonies of Ramgarh lake project etc. The municipal solid wastes largely degrading the quality of lake water. Liquid wastes from the entire N.E. Railway establishments like, loco shed, loco workshop, railway hospital and a large number of residential quarters are drained into Gurdhuia nala and finally flows into the lake. Enhancement in nutrients and algal growth in lakes due to household wastes and also growth in exotic flora are major problems for lakes. The most severe problem is the disposal of non-decomposable material because it can never participate in the recycling process.

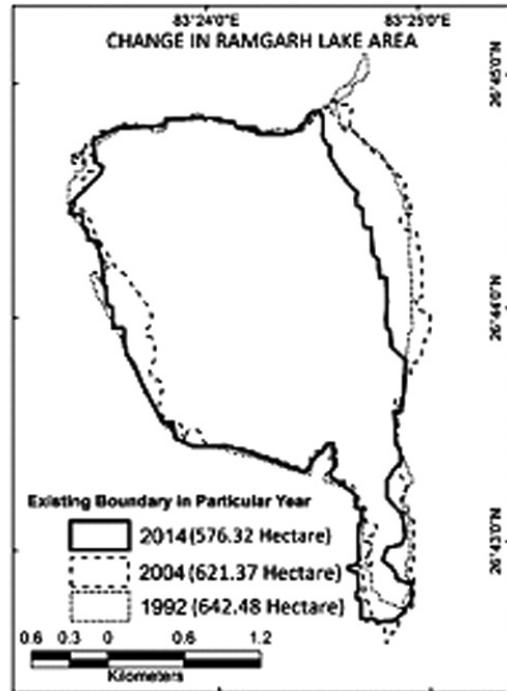


Fig.2

Ramgarh Lake occupies an area of about 723 hectare in 1970s, but now it has shrunk to 576 hectare only (fig.2). While the maximum depth decreased from 4.5meter in (1990) to less than 2 to 3 meter at present. According to satellite imageries of 1992 the area of Ramgarh Lake was 642 hectare, in 2004 it was 621 hectare and in the year of 2014 the lake area has shrunk about 21% from 1970 and remained 576 hectare only due to increasing anthropogenic activities (agriculture, urban settlements) that increased amount of sediments, nutrients and toxic substances through runoff. And thus, Increase the pollution and habitat loss. The reduction in area and depth by siltation and encroachment has affected the economic value of the lake and indirectly affected the ecological value. Moreover at present Ramgarh Lake is used for dumping

site of waste materials (domestics, hospitals, hotels, shops, etc.) All sewage lines of Gorakhpur city entered into the Ramgarh lake from east, north and west sides of the

lake. Gorakhpur Development authority is setting up a STP (sewage treatment plant) near Padleyganj that is not sufficient.

### Physio-chemical Properties of Ramgarh Lake

Table - 3 : Physio-chemical Properties of Ramgarh Lake

Parameter	Measurement		
	2013	2015	General Standard For India Of Inland Surface Water (Central Pollution Control Board)
Temperature	19.36°C	26.2°C	Shall not exceed 5°C above the receiving water
pH	8.33	8.6	5.5 - 8.5
DO	6.74 mg/L	10.3 mg/L	4 mg/L
BOD	4.63 mg/L	77.5 mg/L	30 mg/L
COD	9.32 mg/L	94.02 mg/L	250 mg/L

Source: Tiwari, F., 2013, Pandey, A. K., and Prakash, C., (2016), Kumari, M., Singh, A., (2017).

The result of physio-chemical properties of Ramgarh Lake's water is presented with a sample of 2013 and 2015. The table reveals that quality of lake's water is continuously decreasing. The average temperature was 19.36 degree Celsius in 2012 whereas in 2015 it was 23.2 degree Celsius. The intensity of acidity and alkalinity of water is measured in terms of pH. The presence of carbonate and bicarbonate ions and chemical buffering in water may be responsible for the alkaline state of pH. The pH value was 8.33 of Ramgarh lake in 2012 and that was recorded as 8.49 in 2015. The pH value more than 8 in natural water is produced by photosynthetic rate that demand more CO<sub>2</sub> than quantities furnished by respiration and decomposition. The total dissolved solid in natural water is result of presence of carbonates, bicarbonates, chloride, sulphate, nitrate, calcium, magnesium, potassium

and manganese. The value of TDS depends upon the addition of waste water to the water body in which organic material is released into the water body which causes the high concentration of TDS. The amount of TDS was 83.09 mg/L in 2012 whereas in 2015 it was reached up to 219.4 mg/L due to large addition of sewage water drained by the densed residential colonies. The measurement of BOD of water gives an idea about the biodegradability of the organic waste present in the water. The pollution strength in water body for which the main pollution sources are the municipal and domestic wastewater, is measured by the determination of biochemical oxygen demand in the water body. That mean BOD reflects the needs of oxygen by living organism for their survival in particular water-bodies. In Ramgarh lake the amount of biological oxygen demand was 4.63mg/L

in 2012 whereas in 2015 it was 24.5 mg/L. Thus the condition shows huge requirement of oxygen through microbes to decomposing the pollutants in lake's water because pollutants are being added day by day in lake's water. One of the most important water quality parameter is dissolved oxygen. The concentration of dissolved oxygen affects the biological and physical process occurring in water body. Its presence is important for the aquatic life for their survival. The value of Dissolved oxygen in lake water was 6.74mg/L in 2012 that decreased in 2015 and that was recorded as 5.05 mg/L, that means that oxygen level is decreasing day to day and the living organisms are facing much problems to sustain their life. COD measurement is the determination of oxygen required for the oxidation of all the substances (biodegradable and non-biodegradable). COD of water is directly proportional to the concentration of organic materials present in water. The COD of the lake water was 9.32mg/L in 2012 whereas in 2015 it was largely increased and recorded as 94.02 mg/L that show very high concentration of organic material in lake's water that depicts huge amount of sewage drained in the lake by newly growing residential colonies. Therefore, the status of lake water quality is found to be polluted in terms of pH, and Organic material. The lake water is found turbid and alkaline in nature. BOD and COD of the lake water show high level of organic pollution. The remediation methods for Lake should focus other reduction of the level of organic matter in the lake water.

## **Result and Discussion**

The utilization pattern of Ramgarh lake has been changed with increasing population pressure, infrastructure development and awareness in people for lake conservation. As a result, some specific activities (fishing, waste disposal site, recreational activities, etc) are going on and some activities (washing site, drinking water purpose, vegetable cropping, etc) are gone out in present time. Increasing population caused reckless dumping of sewage water in Ramgarh Lake and as a result a very large number of people's livelihood (washer men, fishermen, farmers etc) are badly influenced. At present lake water looks like a green soup due to five to six point sources of sewage carrying with absence of treatment plant. Water quality (physical, chemical) of the Ramgarh Lake is deteriorating day by day due to increasing algal bloom and eutrophication problem. In Ramgarh lake, BOD, TSS, TDS, Turbidity, phosphate, chloride and nitrate etc are increased whereas DO, transparency, depth etc are decreased due to algal bloom (Table No. 3) Therefore, as a result algal growth has also made the water toxic and declined the dissolved oxygen concentration in water which caused decrease in the species composition, growth reduction and even death of flora and fauna. With the passing of time loss in area of the lake has been very common feature due to recreational activities, new residential sites near the lake and accumulation of silt and pollutants in the lake. Therefore, the depending people are detached from the lake for livelihood and flora and fauna are facing problem for life and space.

## Conclusion

Lakes have their own ecosystem and nearby inhabitants are closely related with it. The people have been using the lakes as a source for food, recreation, industrial and irrigation water and for waste disposal. Lakes also present special pollution problems and act as sinks for pollutants, Ramgarh Lake is a boon for Gorakhpur city because it provides many direct and indirect economic, recreational and ecological benefits but now the lake is facing so many limnogeographical problems. Controlling of eutrophication, minimization of nutrient inflows and treating of sewage water before entering the water body are urgently needed to save the living organism and water quality of the lake. Mechanical removal of sediments, fencing the bank of the lake, tree plantation and protection from the grazing are also needed to save the lake. Community participation and public awareness programs for lake conservation, monitoring of water quality and lake ecology, focus on beautification of lake like gardening, plantation of trees, development of parks, water parks, jogging path etc. using modern techniques and information system like GIS may be strong strategy and tools for further protection and management of the lake. A forestation programme will be fruitful near the lake side for preservation of lake Environment and ecology through development of Ayurveda Park for medicine purpose will be set up. Ramgarh Lake is the very important source of water near the city which supports well environment and recreational platforms. A joint effort including the participation of government agencies, non-government organizations and the public is needed to overcome the lake degradation problems.

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