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Restoration and Conservation of Urban Lakes

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Abstract

In the light of shortage of water in several parts of the world, especially in the developing country like India, there is an eminent need for devising newer approaches of water management. Urban lakes form vital ecosystems supporting livelihood with social, economic and aesthetic benefits that are essential for quality life. Lakes, ponds, tanks which are built to hold water must be protected. These water bodies not only provide drinking water, support livelihoods and biodiversity but also control the rate of runoff and subsequently control the runoff. Despite knowing their environmental, social and economic significance, these water bodies are being continuously ignored. Because of unplanned urbanization, much of the landscape around the lakes has been covered by impervious surfaces. As a result, instead of rainwater, it is the sewage and effluents that are filling up urban water bodies.Considering this alarming situation of negligence urban water bodies, this paper intends to step ahead to the conservation of one such urban water bodies. A layout plan for a lake is designed for both recreational activities and maintains ecological integrity for long term restoration and sustainability. The paper will also explore the technical tools for the management of water bodies.

Keywords: Lakes, Wetlands, Eutrophication, Flooding, Conservation, Silting.

Introduction

The landscape of India is dotted with large number of lakes, reservoir and wetlands. Among these surface resources, reservoirs are numerically most abundant and represent traditional wisdom of people inhabiting this region for centuries. Water bodies in the form of lakes, ponds, johars, baolies, tanks and wetlands are an integral part of the hydrological cycle. These have traditionally served the function of meeting water requirements of the populace for drinking, household uses like washing, for agriculture, fishing and also for religious and cultural purposes. Uses of the lake /pond have been disturbed due to deterioration of lake water. Today they are subjected to a great amount of ecological stress and strain in terms of pollution and ecocrisis. The rural lakes serve various purposes like biodiversity habitat, livelihood source (agriculture, fishing, and aquatic products.). As lakes transform from rural to peri-urban or urban areas, its environment, function, stakes, and all associated characteristics undergo a change. The catchment gets transformed from agriculture/grassland to settlements with increased popullated area.

Rapid urbanization around many lakes, together with degradation of their catchments due to various anthropogenic pressures, has resulted in their gradual deterioration. Over last five decades, more than 50% of such urban lakes in India have been filled up due to unmanaged sewerage, storm water drainage or disposal solid waste. The lake ends up becoming dumping yard of solid waste due to which the ground water recharge reduces. This further result in foul smell, mosquito breeding as well as, degrading water quality, and encroachment takes place resulting low death of the lake. Such loss of lakes in urban areas results in reduced ground water recharge, more frequent floods, water logging, etc, creating hazards.

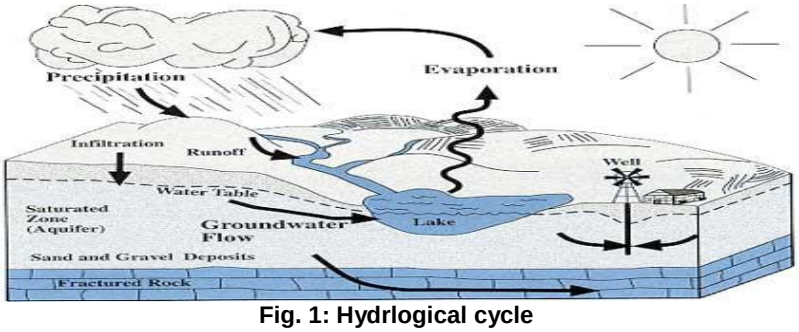

Fig. 1: Hydrlogical cycle

The nexus between residents, real estate, and the municipal bodies results in the destruction of these valuable public and recreational spaces. On the other hand, healthy urban lakes helps in maintaining the micro climate, buffer the floods, provide valuable open spaces and also serve as emergency water sources, in case of failure of water grid systems.

Lake conservation requires management of catchment as well as actual lake water. At catchment levels, prevention of pollution of storm water drainage as well sewerage is necessary. Chhattisgarh is the land of ponds and lakes. Durg is a city located in Chhattisgarh state, Central India. It is located just east of the Seonath River (Shivnath River) and is part of the Durg-Bhilai urban fascicle. The city is an agricultural market and is heavily engaged in milling rice and pigeon peas. Durg gained importance as an industrial centre after the establishment of a large steel plant at Bhilai. Industries include brass working and bell-metal working, oil pressing, mining, and weaving. It is the headquarters of Durg District, the third largest district of Chattisgarh.

Nature is very kind to Chhattisgarh in terms of rainfall as compared to several other states of the Union. Average rainfall in the state is around 1400 mm. and about 90% of the total rainfall is confined in the Monsoon season i.e. 15th June to September. Mahanadi, Sheonath, Indravati, Arpa, Hasdeo, Kelo, Son, Rehar, and Kanhar are some of the main rivers in Chhattisgarh.

The lake is in Durg, Chhattisgarh called as “DAU KA TALAB” (21°10'59"N) by the local pond, are part of the watershed area. Durg area is located in Mahanadi basin which has 75858 sq- Km geographical area (56.2%).

Increased anthropogenic activities in and around the water bodies damage the aquatic systems and ultimately the physicochemical properties of water. The effort to conserve these resources is present need as the crises of water will becommon at all class of community in coming years. So this is our moral responsibility to step ahead and start preventing the natural resources. A report has been prepared with a view to restore Dau Ka Talab, with a proposal of beautification of this pond in durg district, Chhattisgarh. The objective of this paper is to restore and improve the water quality of existing lake for the municipal purposes by local communities, especially poor and Lake Catchment treatment. This is an attempt to create a balance between Social and ecological systems.

Guidelines of NLCP & ACTS [4], [18]

Defining Lakes

In India, National Lake Conservation Programme under the Ministry of Environment and forests (MoEF) defines lakes as “standing waterbodies which have a minimum water depth of 3m, generally cover a water spread of more than ten hectares and have no or very little aquatic vegetation (Ministry of Environment and Forests, 2010)”. The purpose of any definition is to provide an entity an identity which plays an important part in its survival. However, unfortunately, it is this very definition of lakes that pave ways for their exploitation. This is because as due to various environmental and climatic conditions often there are fluctuations in the given three parameters of a lake used in MoEF definition to define a lake. This is the loophole that is often used to exploit these waterbodies to be used for other purposes.

Table 1: Designated Best Use Criteria for Surface Waters (Source: CPCB)

Designated Best Use	Class of Criteria	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms OrganismMPN/ 100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20^{o}C 2mg/l or less
Outdoor bathing (Organized)	B	1. Fecal Coliforms Organism MPN/ 100ml shall be 2500 (Imax permissible), or 1000 (desirable) 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20^{o}C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/ 100ml shall be 5000 or less 2. pH between 6 to 9 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20^{o}C 3mg/l or less
Propagation of Wild life and Fisheries	D	1. pH between 6.5 to 8.5 Fisheries 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 to 8.5 Controlled Waste disposal 2. Electrical Conductivity at 25o C micro mhos/cm Max.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l

Problem Identification

The anthropogenic pressures in the catchment itself has resulted in degradation of the catchment area due to deforestation, extensive agricultural use and consequent erosion and increased silt flows, which have vitiated the quality of water stored in the lakes. Infrastructure development, housing pressure and encroachments have resulted in converting all urban lakes into hyper eutrophic state. Most urban lakes and rural lakes have vanished under this pressure. In the lakes, which have survived, the drinking water supply has been substantially reduced or become totally non potable, flood absorption capacity mpaired, bio-diversity

threatened, and livelihood of fisher folks affected.

About three-fourth of earth's surface is covered by oceans.according to the UN estimate the total amount of water on earth is about 1385.5 Mm3. 97.3% of total water available on earth is salt water, only about 2.7% is fresh water and about 75.2% of which is ice in polar regions and another 22.6% is ground water. The rest about 2.2% of the fresh water is available in rivers, lakes moisture, soil and vegitation.What is effectively available for comsuption and other uses is a small prportion of the quantity available in the rivers, lakes and ground water.

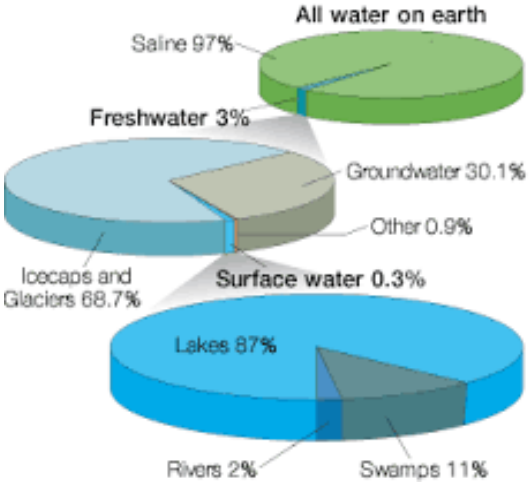

Fig. 2: Water Distribution on Earth

For the last decade urban waterbodies have been a victim to unplanned urbanization in India. The water quality of urban lakes has deteriorated so much as to cause serious disturbance to the bio-diversity of the lake environment.

Problem Faced by Most of the Urban Lakes

1. Urbanization / industrialization
2. Change of land use
3. Tampering inflow and outflow channel
4. Cattle washing
5. Dumping of debris and garbage
6. Industrial effluents
7. Continuous flow of untreated waste water
8. Eutrophication
9. Pollution due to idol immersion
10. Encroachments

Fig. 3: Polluted lake sites

3.2 Pollution in take- Waste water

Table 2: Sources of pollution in lakes

Source	Type of problem
Point Sources	
Power plants	Combustion of fossil fuels emit nitrogen products into the atmosphere, which are carried down by rainfall and other processes, causing eutrophication in water bodies
Sewage Treatment Plants	Treatment process releases oxides of nitrogen and phosphorous in effluents, which drain into water bodies
Industrial Plants	Industrial processes release nitrogen and phosphorous products in effluents, which drain into water bodies
Non-Point Sources	
Agriculture	Farming practices, including use of fertilizers rich in nitrogen and phosphorous, deposit increased amounts of these nutrients in the soil. Run-off from these farms cause eutrophication in water bodies
Sewage	Direct discharge of sewage from domestic sources, not connected to treatment plants, will eventually make its way into water bodies

3.3 Key issues causing degradation of lakes

3.3.1 Pollution

Fig. 4: Pollution

For the last two decades, there has been an explosive increase in the urban population without corresponding expansion of civic facilities such as adequate infrastructure for the disposal of waste. Hence, as more and more people are migrating to cities the urban civic services are becoming less adequate. As a result, almost all urban water bodies in India are suffering because of pollution and are used for disposing untreated local sewage and solid waste, and in many cases the water bodies have been ultimately turned into landfills.

3.3.2 Encroachment

Fig. 5: Encrochment

Encroachment is another major threat to waterbodies particularly in urban areas. As more people are migrating to cities the availability of land is getting scarce. Hence, these urban water bodies are no more acknowledged for their ecosystem services but as real estate. The dumping of solid waste, sewage discharge, and construction of new buildings such as a railway stations and a new road have shrunk this wetland to a great extend.

3.3.3 Eutrofication

Fig. 6: Eutrophication

Primarily being lentic water systems, lakes are almost closed ecosystems. Hence, a large part of the substances that enter in the lakes become a permanent part of the system as only a part of that can be removed depending on the water exchange system. As a result, the entry of nutrients through raw sewage become the part of lake system and cause various destructive changes in the waterbody such as prolific growth of aquatic weeds in lakes and ponds that ultimately disturb and kill the ecology of the waterbody. Bheels of Assam is a well known example of high growth of hyacinth due to pollution.

3.3.4 Siltation

Fig. 7: Siltation

Water flowing into a lake brings silt. Increased deforestation loosens the top soil, which finds its way into lakes. Some of the silt is washed out when the lake overflows. However, the outflow of silt does not always match the inflow and silt settles at the bottom of the lake.

3.3.5 Flooding

Traditionally tanks were created as a chain of water bodies to have a cascading system so that the inter-connectivity would retain flowing water, maintain it round the year, leaving little room for water to be wasted. Such a system is impacted for past some decades.

3.5.1 Pollutants Entering from Fixed Point Sources

1. Nutrients from wastewater from municipal and domestic effluents
2. Organic, inorganic and toxic pollution from industrial effluents
3. Storm water runoff.

3.5.2 Pollutants Entering from Non- Point Sources

1. Nutrients through fertilizers, toxic pesticides and other chemicals, mainly from agriculture runoff.
2. Organic pollution from human settlements spread over areas along the periphery of the lakes and reservoirs.
3. Competition for using lake water such as for drinking, irrigation, hydropower etc.
4. Untreated or inadequately treated domestic and industrial effluents from point sources located all over the basin.

Present Scenario: “Dau ka talab” Durg

A layout plan for “Dau ka talab” is designed for both recreational activities and maintains ecological integrity for long term restoration and sustainability. It is shallow enough to support rooted plants. Many times plants grow all the way across a shallow pond. This pond is surrounded by all four sides, out of two is the road connecting the city and other two side by slums who are dependent on this pond for there daily activity. Eutrophication is there at the edges and the bed level has gone up by few feets due to which, the water enters the nearby houses at the sloping side in rainy seasons. Foul smell due to the pollution of sewage entering in are the cause of concern.

Fig. 8: State Chhattisgarh-City Durg

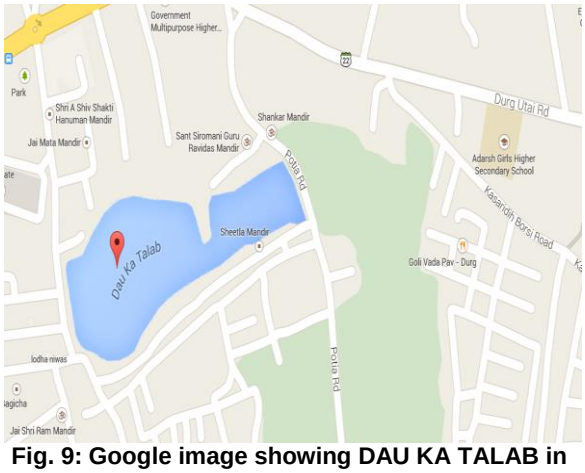

Fig. 9: Google image showing DAU KA TALAB in Durg City

Material & Methodology

The goals for conservation of pond have to be tailored to individual regions, specific to the problems of degradation and based on the level of dependence. This requires reconstruction of the physical conditions; chemical adjustment of both the soil and water; biological manipulation, reintroduction of native flora and fauna, etc. The study is based on market information, whether from public and private sources, and it has been ensured to the best of its ability, the correctness and the validity of the same, by cross checking from various sources. Socio economic study of the lake surroundings for identification of direct and indirect dependents within the vicinity of the lakes.

Fig. 10: Cattle washing

Fig. 11: Sewage inflow

Table 3: Test result of the water sample of "Dau ka Talab"conducted in laboratory.

S. No.	Name of Experiments	Values (Sept)	Range (May)
	Temp.	26^{o}C	38^{0}C
1	pH Value	8.4	8.7
2.	Turbity	6.8NTU	6.2
3.	DO	6.9Mg/l	7.5Mg/l
3.	BOD 5 Days	9.5Mg/l	9.4Mg/l
4.	COD	19.7Mg/l	20.8Mg/l
5.	Hardness ($CaCO_3$)	188Mg/l	190.0Mg/l
6	Chloride	300.0Mg/l	303.0 Mg/l
7	Floride	0.5Mg/l	0.5 Mg/l
8.	Total Nitrogen	6.86Mg/l	6.44Mg/l
9	Phosphors	0.4 Mg/l	0.50Mg/l

Following element has been planned keeping in view of the present status for the effective restoration of the pond which is explained as below.

Theme of Proposed Concept Plan of conservation: Area: Dau ka talab 309996.45 Sq m^2

1. The Vista connecting the island to the main fountain near public entrance area. Thus enhancing the asthetics as well as attracting the local eco – tourism activities.
2. **Landscape Garden:** The land scape garden on the main entrance, to lure the public thus bringing in the campus and educating them to restore the precious watre bodies left. Also the landscappe offers an invitation to the public. (By area: 2551.80 m2).
3. **Ecological Balance:** waste water to be treated by treatement plant installation and the treated water can recycle back thus maintain the pond water balance.
4. **Artificial Islands:** islands enhancing the biodiversity as the birds get attracted and come to take rest on such islands.
5. **Water Fountains:** Water needs to be aerated contantly naturally or artificially to maintain the DO level.
6. Facilities like jogging track around the periphery, landscape gardens, boat rides, benches, ghats in all sides; fountains etc increases the revival of lake and thus increase the nearby land value.

In order to implement and achieve above criteria proper plaaning should be done in terms of the measures listed below for the restoration of the Dau ka talab and nearby area from further getting it degrade and lost.

Suggestion and Discussion

Measures suggested for the resoration of Lake Front other than its beautification part:

1. Construction of RCC storm water inlets.
2. Landscaping and development of parks and play area and introducing fountains to Control of organic load. Aeration of the water column with the help of a variety of aerators and diffusers using small amounts of oxygen as well, are generally used to reduce the organic content of the water column.
3. Nutrients enter the lakes from point sources with the discharge of the sewage or storm water

chains. Nutrients inputs from nonpoint sources can be reduced by, deweeding.

4. Afforestation or development of suitable plant covers in the catchments especially those prone to erosion. Making separate drains to collect storm water a s well as to by pass the sewage coming from near by area.
5. Formation of peripherial bunds all along the lake.
6. Construction of Screen barriers to check the entry of floating objects.
7. Lighting all around the periphery of the lake.
8. Construction of localized treatment plant where ever necessary to maintain the lake water.

This paper not only included cleaning and beautifying of the lake but also took steps for creating lake as the hub of economic activity, thereby providing an indirect source of live hood for many people and a recreational place. Preparation of biodiversity plans for the city should integrate Lake Ecosystem. At the end it is more important to safeguard the lake ecosystem which will help in holding rain water, recharge ground water, treating the wastewater, and maintain local healthy micro-climate instead of converting into commercial and recreational activities.

Discussion

The fundamental problem of the lake restoration is an economic mismatch: those who cause the problem do not benefit sufficiently from the remediation. On the other hand, the beneficiaries of the lake restoration are not those who caused the degradation.

Lake Conservation and management should support ecology, socio-cultural activities and users who have the dependency on the lake. Lakes should not be handed over to the private companies since, lakes are the public spaces, and thus the strategies should not consider the uses and users of the lake along with the active participation of the community, NGOs, and different institutions. Lake Development should be done considering the lake catchment, community and the use of the lake for all class of the community.

Conclusion and Future Scope

Environmental & Social Impact of Lake Restoration

Each lake is unique, and each management process is as complex as the concerns it addresses. But the ecological, social, and economic benefits of a well-managed lake can span generations. Effective, long-term lake conservation plan is a complex undertaking that must deal with sociology as well as biology. The decision to restore or protect a particular lake has to be based on a thorough study of the lake, its watershed, and the commitment of time and money necessary for long-term management.

The study recommends that all lakes be assessed for their chemical and physical properties.

Future Scope

In the study, there are various parameters, subjects, issues which are interconnected and need to be studied and designed individually for any suistanabile development. It include design of eco zone, green belt, water treatement plant based on the density and volume of the water, a proper solid waste collection and treatement system, rehabilitation of the socity dwelling near by.

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