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RESEARCH ARTICLE

REVIVAL AND REJUVENATION STRATEGY OF WATER BODIES IN A METROPOLITAN CITY: A CASE STUDY OF NAJAFGARH LAKE, DELHI, INDIA.

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Abstract

Urban Indian cities are facing a water crisis due to loss of watershed, increasing pollution levels, deteriorating water balance, encroachment, illegal constructions and a dire lack of groundwater recharge. Although there are sufficient polices and acts for protection and restoration of water bodies they remain insufficient and ineffective in the face of such complexities. To meet the rising demand for water augmenting and improving the health of water bodies is of utmost importance. Revival and rejuvenation of water bodies in cities is especially important from a public health perspective as they provide various ecosystem services that are required to manage microclimate, biodiversity and nutrient cycling. This paper looks at Najafgarh Lake, in South-West Delhi that occupied more than 300 km² in the 1960s and was a biodiversity hotspot. Currently it stands as a topographical depression brimming with overgrown grass and garbage. The lake's disappearance has stolen a chunk of Delhi's culture and its use as a dumping ground has raised health concerns for the local population. This can be countered by rejuvenating the Najafgarh Lake through rainwater harvesting and bio-intensive farming. Most of Delhi's precipitation falls during the monsoon in July and August and can be harvested using simple, locally adoptable and eco-friendly low-cost technologies such as creation of ponds. Implementation of community water management schemes with maximum people's participation is crucial to mitigate the ill effects of drought and urbanisation. Similar studies across India and the world lay precedent for such practices and can ameliorate the water shortages faced at a micro level.

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Introduction:-

Urban Indian cities are facing a water crisis due to loss of watershed, increasing levels of pollution, deteriorating water balance, lowering of water table and a dire lack of groundwater recharge(Singh, 2012). Such issues have become a great concern in the Indian context which motivated the Indian Government's Twelfth Five Year Plan to launch a completely revamped programme on Repair, Renovation and Restoration (RRR) of water bodies(Shah, 2013).

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Water determines the full potential of any country (Samuel & Mathew, 1997). Optimum development and efficient utilization of water resources becomes paramount in a country like India which has an ever-rising populace and a seemingly insatiable water demand. The biodiversity of lake and pond ecosystems is increasingly threatened by anthropogenic activities – may it be due to industrialization by-products, pollution or urbanization (Christer & Hansson, 2002); which poses the question can development and sustainability coexist?

In 2001, the Honourable Court ordered a field survey to be conducted by INTACH in association with the several government agencies enjoying jurisdiction over the various water bodies of Delhi. The survey established that there were 508 water bodies in Delhi. Other surveys carried out by Government of National Capital Territory of Delhi (GNCTD) placed the number of water bodies at 629 and by Tapas along with Court Commissioner at over 900 (Govt. of NCT of Delhi, 2013).

The major issues faced by water bodies in the National Capital Territory (NCT) of Delhi are lack of action plans, encroachments and violations of laws, solid waste deposit and polluted water (Govt. of NCT of Delhi, 2013). Through an intensive revival strategy, these water bodies can be brought back to health. Further, through improvement of water quality and groundwater recharge using rainwater harvesting the native ecosystems of the area can be reestablished over time which is crucial for provision of ecosystem services and for the biodiversity of the area (Singh, 2012).

Literature Review:-

Delhi has several surviving ancient structures like baolis (stepwells), small check dams and tanks that display the traditional wisdom of storing water where it falls. These days households are supplied water through technological networks leading to the decline of the old water storage structures (Roy, 2016). These facts when viewed along with a decrease in availability of water resources point to a systemic flaw that can be tackled in a manner of ways.

To ensure sufficient water its uses like municipal, industrial, and agricultural must be integrated into the overall water management of any region. Sustainability, public health, environmental protection, and economics are key factors of consideration. Further, increased storage of water in aquifers via artificial recharge is necessary to save water in times of water surplus for use in times of water shortage (Bouwer, 2002). The above information helps formulate an appropriate solution for Delhi's current scenario – by integrating traditional knowledge into the overall water management of the city.

Rainwater Harvesting:-

Rainwater harvesting essentially means harvesting and storing water in days of abundance for use in lean days. Storing of rainwater can be done in two ways; (i) storing in an artificial storage and (ii) in the soil media as groundwater (Samuel & Mathew, 1997). Rainwater harvesting can be implemented as a viable alternative to conventional water supply or on-farm irrigation projects since any land anywhere can be used to harvest rainwater.

Water demand has increased tremendously globally and water bodies like ponds and lakes are reliable and economical solutions to provide water and provide ecosystem services - benefits people obtain from ecosystems like access to food and water; flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling, that maintain living conditions on Earth (Alcamo & Bennett, 2003).

Further, ponds are reliable mechanisms to store water underground via artificial recharge of groundwater (Bouwer, 2002). Rainwater harvesting besides helping to meet the increasing demand for water, helps to reduce surface runoff, avoid flooding of roads, reduces groundwater pollution, improves quality of groundwater and reduces soil erosion (Ngaachan, 2005).

Rainwater Harvesting in India:-

The practice of rainwater harvesting and reusing the stored water for domestic purpose has been prevalent in India since ancient times (Ministry of Water Resources, 2013; Samuel & Mathew, 1997). Historically in India, settlements grew around temples, and over time temples and tanks became nearly inseparable. Evidence of tank irrigation in Tamil Nadu dates back to the Sangam period of 150 BC to 200 AD, and by the early medieval period (750–1300), tank irrigation was thriving throughout the region (Van Meter, Basu, Tate, & Wyckoff, 2014).

Efficient management of water in traditional farming systems like Kattas and Surangams in North Kerala and Karnataka, Zabo system of Nagaland and Bamboo drip irrigation of Meghalaya and Apatani valley in Arunachal Pradesh can be found all through India (Narain & Agarwal, 1997), where rainwater harvesting and water resource management has been an integral part of communities since centuries.

Usage of rainwater harvesting in recent times in areas like North East India (Ngaachan, 2005) and Kerala (Samuel & Mathew, 1997) have shown immense potential for its applications in other parts of the country and proven its importance in ecosystem revival (Armar-Klemesu, 2000). In fact, rainwater harvesting in South Asia differs from the rest of the world as it has a history of continuous practice for at least the last 8000 years (Pandey, Gupta, & Anderson, 2003). Further an integrated perspective of traditional knowledge on adaptation strategies, such as the rainwater harvesting system is particularly useful to comprehend vulnerability and adaptation to environmental stresses at the local scale, which makes it appropriate for wide application in NCT of Delhi, which is an ecologically sensitive area.

Further, rainwater harvesting and storage are important mechanisms for adapting to climate change and are in use in parts of Africa that are currently experiencing high variability of rainfall (Boelee et al., 2013). Climate change stands to affect India adversely in the coming years due to our sizable population and rising demand for resources and hence revival and rejuvenation of water bodies in Indian cities is crucial.

Rainwater Harvesting Potential of Delhi:-

Delhi's groundwater occurs in confined and semi-confined conditions, with depths varying from 1 - 10 m below ground level (Jain, 2009). The average annual rainfall is approximately 714 mm (Kumar et al., 2015). However, recharge of ground water is limited due to decreased availability of permeable surfaces owing to urbanization and runoff diversion. As of 2011, the annual rainwater harvesting potential has been assessed at 900 billion liters per day (Jain, 2009).

The water consumption in Delhi has been rising over the past few years (Planning Department at Government of NCT of Delhi, 2011) and this can be associated with a rise in the population of the area. Of the 47.0% growth in population in Delhi between 1991-2001 migration constituted 18.7% (Census of India 2001, 2001) and this trend has been noted to continue as Delhi's population has been rising since. Increase in population places pressure on Delhi's natural resources and necessitates a strategy to provide more water storage.

Table 1:- Water Supply of NCT of Delhi (Source: Planning Department at Government of NCT of Delhi, 2012)

S. No.	Water Supply	2008 - 09	2009 - 10	2010 - 11	2011 - 12
1	Water Consumption (lakh K L)	13257	13671	15012	17220
1. a)	Domestic	11997	12413	13754	16242
1. b)	Commercial/Industrial	1260	1258	1258	978
2	Per capita consumption of water (L/day)	189	189	189	193

Water Bodies of NCT of Delhi:-

A large number of the traditional water bodies in the form of ponds, lakes, etc. have been encroached or have otherwise become defunct in the national capital (Jain, 2009). Between 1998 and 2009, 22.26 km² of Delhi's wetlands were lost (Singh, 2012), which intimately support the survival of water bodies. As of 2013, of the 1011 known water bodies across 10 districts, only 971 could be traced. 40 have been lost. South West Delhi, the area where Najafgarh lake used to be was found to have majority of the water bodies that could be traced – 264 in all. 35.8% water bodies were found to be dry, while 17.8% were found to be encroached, of which 58.3% were fully encroached. 12.4% were built upon, where one-third were illegal built upon (Govt. of NCT of Delhi, 2013).

Pilot projects in the region to revive water bodies have been tested, such as DDA-INTACH Project which was started in 2003 where New Delhi based non-governmental organization (NGO) Indian National Trust for Art & Cultural Heritage (INTACH), along with the Delhi Development Authority (DDA), which controls most of urban governance in the city, came up with a plan to revive HauzKhas Lake with treated sewage water. Treated water was taken from a nearby Sewage Treatment Plant (STP), cleaned further through biological processes, and was transported to the dry lake (Roy, 2016).

Field visits yielded the following observations: the project scored well on all three fronts viz. economic, environmental and social but there was scope for improvement particularly on the social front for which it was recommended that there should be better publicity of the environmental benefits of the project and enhancing environmental awareness, especially among the local community.

Table 2:- Distribution of the water bodies of NCT of Delhi (Source: Delhi Parks & Gardens Society, Department of Environment, Govt. of NCT of Delhi, 2013)

S.No.	District	Traceable	%	Non-Traceable	Total	%
1	East	50	5.15	3	53	5.24
2	North East	47	4.84	2	49	4.85
3	North	151	15.55	5	156	15.43
4	North West	165	16.99	1	166	16.42
5	South	115	11.84	5	120	11.87
6	South East	30	3.09	9	39	3.86
7	South West	264	27.19	6	270	26.71
8	West	71	7.31	4	75	7.42
9	New Delhi	55	5.66	3	58	5.74
10	Central	23	2.37	2	25	2.47
11	Total	971	100.00	40	1011	100.00

Najafgarh Lake:-

Despite a mention in the Delhi Gazetteer of 1883 and the Survey of India Map of 1911, currently the Delhi Government says that the Najafgarh Lake (Lat. 28°36'38.67"N, Long. 76°59'12.18"E, Alt. 216 m) no longer exists in Delhi. Prior to its draining post 1960s, Najafgarh Lake in South-West Delhi occupied more than 300 km² and was a biodiversity hotspot, home to various water birds and local wildlife. The fact that a vast lake ever existed here in the region came as a surprise to most residents of the area and the need for resurrecting it is not a popular topic of discussion.

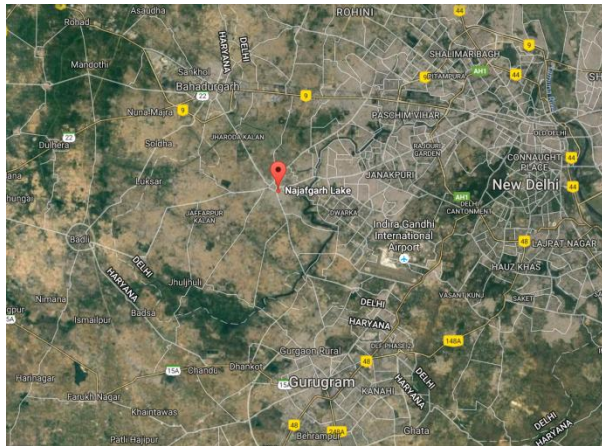


Fig. 1:- Najafgarh Lake in Delhi (Map)



Fig. 2:- Status of Najafgarh Lake, as of 2016

Status of Najafgarh Lake:-

Currently the lake stands as a topographical depression brimming with overgrown grass and garbage. As of 2015, the erstwhile lake like many other traditional water bodies has been removed off Delhi's map instead of reviving them (Jain, 2009). The lake's disappearance has stolen a chunk of Delhi's culture and its use as a dumping ground has raised health concerns for the local population who are migrants from neighbouring states of Delhi.

The land owned by Delhi Development Authority (DDA) has been loaned to the Government Girls Senior Secondary School (II) in Dharampura with intentions to convert it into a park. Despite erection of benches and swings and placement of a fence around the area the land suffers from poor maintenance. Pollution is rampant in the area and Najafgarh drain previously known as Sahibi River with its origination near Najafgarh lake is now one of the most polluting sources contributing the death of river Yamuna (Ratnani, Gurjar, Suruchi, & Manish, 2015).

Before introduction of the sewerage system, the lake used to be the outlet for the local communities' sewage. After the nearby area became connected to the sewerage system, the lake fell into disuse. Lowering of ground water table, encroachment and concrete constructions have led to the lake drying up due to absence of proper water resource planning and scientific management by involved authorities. Residents reported presence of fish up to 10 years back and placed the drying of the lake 5 years hence.

Strategy for Rejuvenation of Najafgarh Lake:-

Rejuvenation of Najafgarh Lake will help accomplish the following objectives:

1. Environmental Education and Awareness: This effective management method is increasingly popular in conserving pond environments in urban areas (Christer & Hansson, 2002) and is essential to keep the lake protected after the revival and rejuvenation processes get completed. The project will help educate the local populace of the need to conserve existing water bodies.
2. Creation of a pond through rainwater harvesting (Ngaachan, 2005): Ponds can be created in a cost-effective manner and don't require a sizable initial investment. They play an important role in providing ecosystem services and help improve the life quality of residents around them.
3. Revival of the area's original wetland ecosystem through set-up of bio-intensive beds to help the growth of indigenous plants and trees: Local plants take easily to an area and do not require a lot of maintenance which makes them ideal for cultivation. They also help in improving the water and air quality of the area where they are planted (Gottschall, Boutin, Crolla, Kinsley, & Champagne, 2007).

The protection of the area can be accomplished by creating a water council. People's participation which focuses on the revival of traditional drainage systems, banning of construction activity and prevention of wastes entering the compound will help ensure the area remains protected (Griffin, 1999). Clear definition of the roles and responsibilities of the people in-charge and the maximization of people participation has been identified as one of the solutions to tackle institutional impediments to effective basin governance management with context to the Tonle Sap Lake in Cambodia and can also be implemented in this region (Sokhem & Sunada, 2006).

Strategy and its Amenability to the area:-

Rainwater harvesting is considered an ideal solution to tackle water problems where there is inadequate groundwater supply or where surface resources are not sufficient as in the case of NCT of Delhi (Samuel & Mathew, 1997). The rainwater collected from the site was found to be bacteriologically pure and free from organic matter, as per the Drinking Water Standards followed in India (Bureau of Indian Standards, 2012).

Analysis of the water sample collected from site showed that it was nearly neutral and had TDS slightly above the permissible drinking quality limit of 500 mg/l. Other water parameters showed that the rainwater was amenable for harvesting and can be used for revival and rejuvenation of the lake without a lot of treatment.

Table 3:- Water Quality Parameters for Water Sample

S. No.	Water Quality Parameters	Trial 1	Trial 2	Trial 3	Mean	Standard
1	Electrical Conductivity (μ S)	828	823	795	815.33	-
2	pH	7.31	7.33	7.33	7.32	6.5 – 8.5
4	Total Dissolved Solids (mg/l)	520	536	536	530.67	500
5	Dissolved Oxygen (ppm)	0	0	0	0	-

Date of Sampling: 20.05.2016

Methodology:-

The amount of runoff that can be expected annually from a given watershed depends on many interrelated factors such as relief, soil infiltration, plant cover, and surface storage which can be identified after further research into the characteristics of the area. Site selection is a pre-requisite for creating a pond and the preexisting depression will be ideal for pond creation as maximum storage volume can be obtained with least amount of earth fill (United States Department of Agriculture, 1997). This also ensures maximum economy.

The methodology to prepare the area consists of three stages. The first stage focuses on preparing the site for the creation of the pond and the wetland development around the area. To do so the area needs to be cleared of the

garbage, the grasses need to be removed and the depression needs to be dug out in a uniform manner. Channels for the drainage system need to be set in the area after which the pond can be created.

The second stage focuses on the creation of the pond, for which the pond's boundary needs to be clearly demarcated and liners need to be laid on the bottom surface to limit the percolation losses. Connections between households around the area and the inlet of the pond need to be constructed. Further, recharge trenches around the pond need to be set up to recharge the ground water level of the area. The final stage will be the development of the wetland area around the pond for which bio-intensive beds can be used. Carefully selected native trees and plants can be planted, as they will help revive the area's biodiversity.

Budget Plan:-

The running, operation and maintenance costs of such a project are minimal. Once the initial construction is carried out, the pond ecosystem sustains itself through natural nutrient and water cycling (Gottschall et al., 2007). The costs associated with various rejuvenation components like digging and clearing the area, the pond construction, set up of the bio-intensive farm, awareness and education tools and the creation of the drainage system along with the rooftop piping are not cost-intensive as established through market analysis. The ecosystem services that this project will provide for the given area include cultural, recreational and environmental benefits such as water regulation, improvement in the water quality, etc. Further, such a project includes intangible benefits, which cannot only be viewed only from a monetary perspective. Therefore, the benefits of this project would far exceed the cost when viewed holistically.

Table 4:-Ecosystem Services Valuation (Source: The Value of the World's Ecosystem Services and Natural Capital, R.Constanza, 1997)

Cost (INR) by Market Analysis		Benefit (INR)	
Digging and Clearing Area	85,500	Ecological Services provided each year -Cultural -Recreation -Habitat -Water Supply -Water Regulation, etc.	9,38,159.26
Construction of Pond	60,000		
Bio-intensive Farm	10,000		
Awareness and Education Tools	15,000		
Drainage System + Rooftop Piping	1,50,000		
Total Costs	(-)3,20,500		(+)9,38,159.26

Conclusion:-

As new environmental threats are predicted to become threats to all freshwater systems, it is necessary to augment the water quantity available in urban cities through natural methods like rainwater harvesting. For a model like this to work, it is crucial for local people to collaborate with other stakeholders to successfully utilise resources and ensure the protection and conservation of green and blue spaces in cities. Further, implementation of integrated water resource management strategies are essential to maintain, augment and manage India's water resources. Reviving the Najafgarh Lake and rejuvenating it will help shape the future of the NCT of Delhi. Usage of rainwater harvesting to rejuvenate erstwhile waterbodies is unique as it not only recharges groundwater but also aids in enhancing the habitat and ecosystem of the area. Water bodies sustain all kinds of life forms and a project like this can be a medium through which the general populace can be educated about the need to revive water bodies. Such initiatives are easy to plan and implement and can spark an environmental revolution in urban cities which is the need of the hour.

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