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Original Article

Rejuvenation of Guru ka Taal, Agra: Issues, Challenges and Strategy

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Abstract *- Agra is a prime tourism center in Uttar Pradesh state because of the Taj Mahal, one of the world's seven wonders, and other numerous monuments built in the Mughal era. One of those monuments is Guru ka Taal which has much historical and architectural significance. Guru ka Taal consists of a water body known as "Taal". The Tall was last seen filled with water in 2003.*

But now, this Taal has been drying up, and the concern is to find the possible reasons which made the Tall dry and suggest methodologies which help rejuvenate the Taal. The team has chosen Guru Ka Taal for the project because, firstly, the team is well aware that Agra is suffering from water scarcity, so even this small step can help to some extent for the collection of water and rejuvenation of these water bodies, provides an alternate opportunity of water management and secondly to maintain its significance and Beauty.

The main objectives of this study are to examine the Taal and to decide the process of rejuvenation, study and understand the issues faced by the visitors, and study the scope for further development in the surrounding area of Guru ka Taal after the rejuvenation of the Taal. The research has been done through data collection (primary data) and case studies (secondary data). In this Research paper, the team has collected data through observation, satellite maps, and field studies. This research paper summarizes the problem of Taal, the measures instituted to correct the problem and the result. The concern of the team is to make this place a good scope for tourism.

Keywords *– Ground water, Survey.*

1. Introduction

Water plays an essential role in the functioning of human life. It is required for laying economic, social, cultural and environmental activities. Lakes, ponds, rivers, kunds, and Taals are essential components of surface water resources. As there is a growth in industrialization and urbanization, this results in a heavy deterioration of water bodies that include the discharge of sewage, industrial solid and liquid waste and chemically rich agriculture runoff. Due to this, the deterioration is visible in the form of loss of biodiversity and low-grade water quality.

The site, Guru ka Taal, is facing issues like loss of catchment area, cutting-off of aquifer inlets, increasing water quality problems, Encroachment, Illegal constructions, lowering the water table and Insufficient groundwater recharge. All these reasons are sufficient enough to make the taal dry. Urbanization results in the growth of urban areas, which causes the lowering of agricultural areas, elimination of water bodies, and irregular laying of drainage systems, resulting in a quick decline in water resource availability. Because of the lowering of environmental considerations in development plans, a large amount of area and importance is given to physical planning, which leads to the decaying of water resources available in India, and causes the reduction of the identity of other resources for existence. Rejuvenation of water resources is comprehensive of many policies and strategies for commanding hydrosphere protection to meet the demands of the upcoming generation. The main reasons for the rejuvenation of water in the Water Bodies are as follows:

- For future generations, safeguard the accessibility of water
- Conservation of energy due to pumping of water and treatment of polluted water constitutes an essential role in collecting energy in a specific amount
- Minimizing the water consumed by human beings and conserving their habitats also helps save freshwater habitats for animals and migrating humans, including water quality.

Fig. 1 Aerial view of projected water reservior

2. Literature Review

Several similar findings helped us with this research directly or indirectly. Some are the followings -

Vinod Kumar (2018) described the groundwater condition of State Agra. The quality of groundwater of district Agra has been categorized under the twelve water quality that is total dissolved solids, pH, chloride, bicarbonate, silicon, sulphate, electrical conductivity, iron, sodium, magnesium, aluminium, and calcium. Piper Diagram and Wilox, with the help of software Aquachem 2011.1 used to investigate the data.

The paper helped the team to develop the thought process to work upon the guru ka taal and develop strategies.

Amit Kumar (2010) - published a paper dealing with the worsening water quality (WQ) of the spiritual north-flowing perennial Indian River, Ganga.

Performed the physiochemical characteristics of quality of water of river Ganga at five main locations (Uttarkashi, Rudraprayag, Tehri, Devprayag, and Rishikesh) of the state Uttarakhand, the system involved namely as "environmetrics" and "India using comprehensive pollution index" (CPI).

The mentioned method sum- up the data and grouping the close polluted areas along the river stretches. During COVID-19 and boot-up in the country, a river pollution reduction was observed due to the river Ganga's rejuvenation capability.

This paper can lead the eco concern policymaker and water resources, planners & managers to prepare the planning in advance and help us maintain the greenery of the taal.

Patil (2018) described the rejuvenation of Yashwant Lake- tracking the impact of rejuvenation of Yashwant lake on the surrounding settlement, many ways to collect the data regarding rejuvenation, namely "observation", "satellite map", "field studies". The site is a topographical depression growing with overgrown grass in the current scenario.

Since the research work of a team is very similar to the above literature, the presented paper sums up the problem of Yashwant lake, its issue and its challenges. This research's expected outcome helps the team understand the generosity infrastructure and friend scope for tourism in our area.

Centeral Ground Water Board - described the paper to understand the aquifer layers in the Agra region. The major part of the aquifer system is alluvial deposits, and Aeolian is considered the older alluvium comprised of sand and clay. At deeper depths, clay and sand are noticed in many places. The sand with saline water is found in the bearing zone at a deeper depth. Toward South-East Basement is hard, and the depth varies from 62m to 181m below the ground level. Mainly composed of Vindyan Sandstone and limestone.

This paper helped the team to reach out at various aquifers' depth which were very useful to understand the different zone of ground level.

2.1. Central Public Health and Environmental Engineering Organization (CPHEEO) August 2013 - published a paper containing the obtainability of the water for the survival of the life, factors for the degradation of the lakes, namely as the "exhaustive lifestyle", "population increment", "industrialization". The paper involved the techniques of the lake rejuvenation mainly showing the top was the find out the lake, the surrounding contains the source like the stormwater, Shoreline of the water bodies, Inlet and outlet of the water bodies, cleaning of the water body like de-silting, mainly is the awareness among the people. The paper informs the team about the steps that should not be taken to revive the pond.

3. Objectives and Scope

The main objectives of the study were to find:

1. The issues that made the Taal dry.
2. The challenges that will come across in rejuvenating the Taal.
3. The methodology and strategies required to make the execution work easy so the Taal can be rejuvenated.

The scope of this study includes-

Local Water Bodies in urban spaces traditionally have embodied a strong socio-cultural ethos unique to the Indian experience. Therefore their conservation as valuable natural assets must be pursued by the local community and integrated into urban life. This initiative aims to restore and protect the health of urban local water bodies, which will help conserve Indian natural resources and the environment and provide an immense social good, thereby positively impacting the quality of life in Indian urban spaces.

4. Methodology

For the present study of Taal, the Documentation method is used to document and evaluate how many activities influence the focus area's rejuvenation. For the documentation, Secondary Data is used to collect the information which affects the life of the water body and its rejuvenation. Also, some group discussions of team members were carried out to gather information from different perspectives.

Various authentic data have been collected from genuine sources, and the inferences & interpretation of data have been done to understand why the taal is dry and how it can be rejuvenated through the information collected.

4.1. Site Analysis

The team visited the site, did a survey, and analyzed the current site condition. The geo-tagging of the waterbody with its latitude and longitude has been done. The water body is in a lost condition. A lot of vegetation is present at the site in the current scenario. Also, the team conducted a total station survey at the site and drew the

site's contour. From the contour map, it can be inferred that the ground surface is uneven and de-silting and levelling off the ground needs to be done as the first step in rejuvenating the guru ka taal.

Fig. 2 Team conducting survey at the site

A lot of challenges came across while conducting the site survey as the site had excessive vegetation, and some points were inaccessible to approach to get the points for the total station. Still, the team managed to take almost all the points successfully and contour the site showing the present elevation condition of various points in the taal.

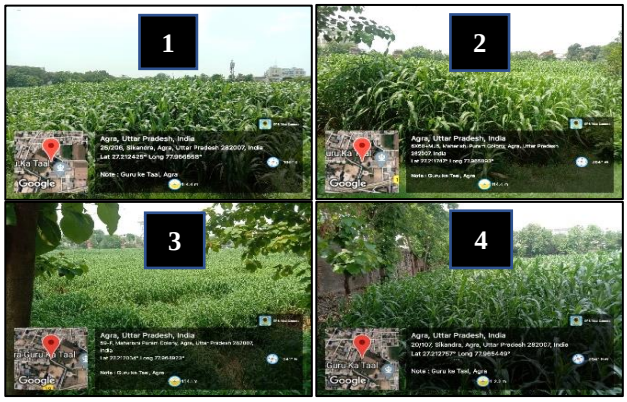

Fig. 3 Geo-tagging of the points of the taal.

Fig. 4 Google Earth Images of the waterbody showing the positions of the geo-tagged location.

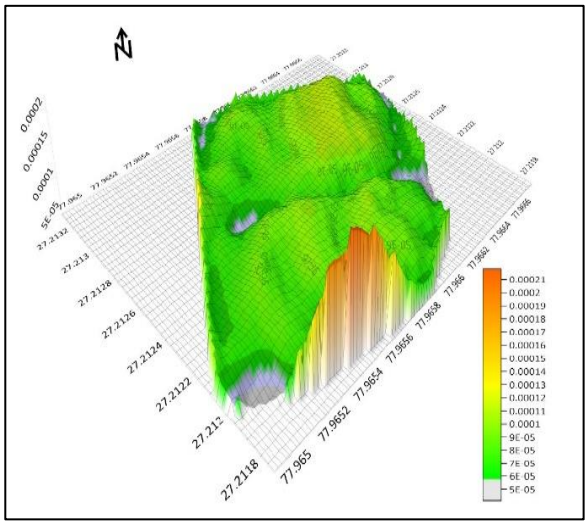

Fig. 5 Contour Map of Guru ka Taal

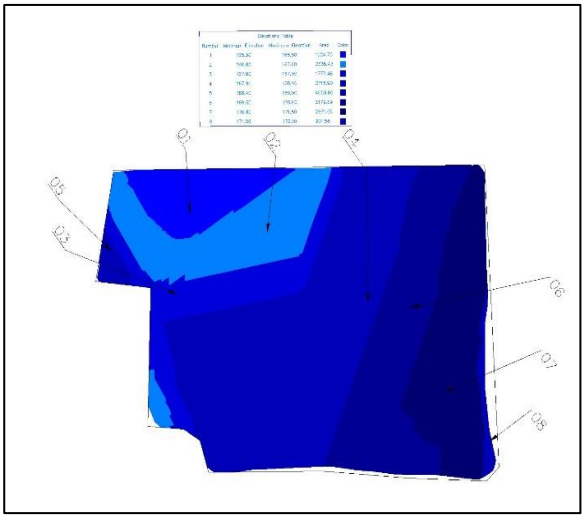

Fig. 6 Elevation profile of taal

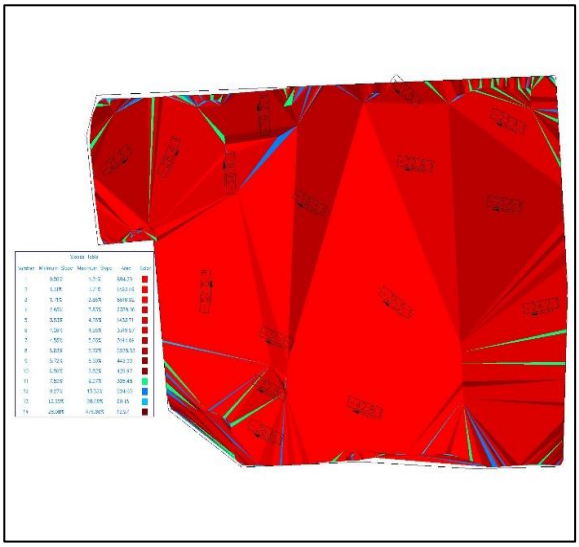

Fig. 7 Slope profile of taal

4.2. Ground Water Condition of Agra

Groundwater is playing a vital role in the fulfilment of drinking, irrigational and industrial needs of the area, as it is a highly dependable, safe and replenishable natural resource. But, It has been observed that the ground water table is declining gradually, which means the water table below the ground level is increasing yearly.

The major issues and problems of groundwater in Agra are as follows:

i. Significant decline in the water level due to an increase in the population
ii. Groundwater quality problem; the presence of fluoride elements in the water beyond the permissible limit.
iii. Salinity in the groundwater in the deeper zones at so many places.
iv. Less groundwater recharge and more surface runoff of the rainwater due to the formation of Impermeable (concrete) surfaces.

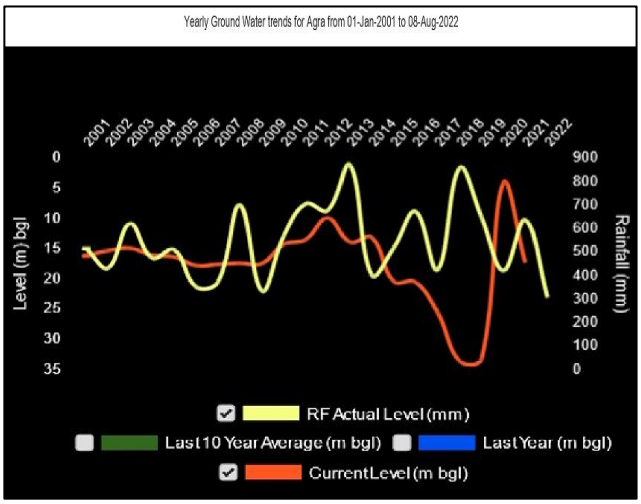

Fig. 8 Last 22 years' groundwater table data

The chart showing the groundwater table level for the last 22 years is shown:

The issues a, b and c were found at the investigation site (guru ka taal). The techniques that have been proposed on the basis of groundwater table data are the following:

- Weep-holes
- Recharge Wells
- Percolation pits
- Injection wells
- Rainwater harvesting
- Infiltration galleries

The above artificial groundwater recharge methods are very useful in increasing the groundwater table level. These methods can be adopted at the investigation site (Taal).

4.3. Agra's Rainfall Data and Evaporation Analysis

The normal annual rainfall of Agra is 751.37 mm. The chart of Rainfall data for the last 22 years is shown:

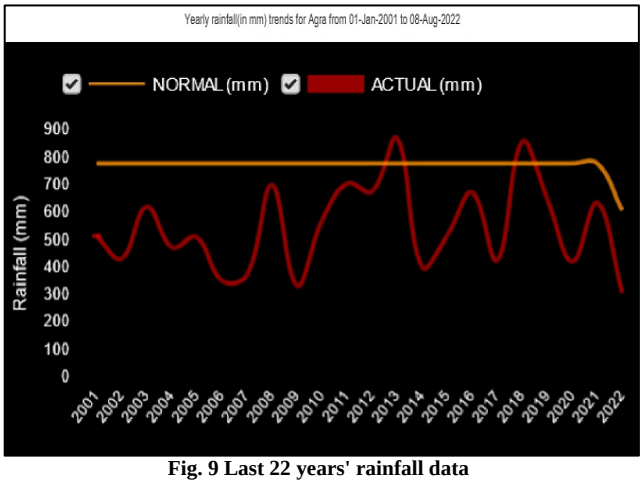

Fig. 9 Last 22 years' rainfall data

The reports of the Central Water Ground Body (CGWB) indicate that the major problem of rainfall or monsoon water in Agra is that most of the rainfall water in Agra is drained out as surface runoff by different rivers and suffers evaporation losses. This loss is almost 80% of the total rainfall. It means only 20% of the rainwater is recharging the sub-surface aquifers.

Also, the actual rainfall intensity in Agra has been decreasing. The same surface runoff and evaporation problem has been observed at the investigation site (Taal). The rainfall and groundwater table data show that it is very difficult to revive the water body at Guru ka Taal considering the surface runoff and evaporation losses. There is a need for strategies which can reduce the surface runoff losses and evaporation losses, and these strategies could be increasing the infiltration capacity of the soil using vegetation and bio-intensive farming so that water does not retain on the surface and percolates directly into the groundwater table in less time and helps in reducing the groundwater deficiency. To reduce the evaporation losses, the ecosystem of the taal area and area near the water body can be improved.

Also, the evaporation data chart has been incorporated to show the yearly variation of evaporation loss at Gurudwara Guru ka Taal, Agra.

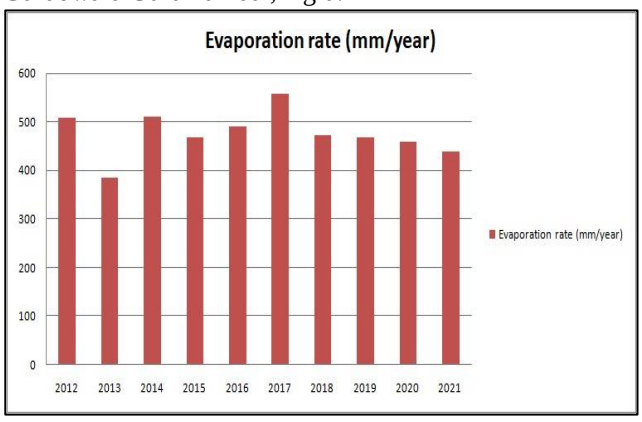

Fig. 10 Last 10 years' evaporation rate data

4.4. Soil Testing

The soil testing at the investigation site has been done. A Sieve Analysis test on the soil has been performed, and the soil classification is Sandy soil. The analysis table has been attached herewith:

Table 1. Fineness modulus of soil sample

Sr.No.	I.S Sieve Size (in mm)	Wt. Retained (in g)	% Wt. Retained	Cumulative % Wt. retained	% Finer
1	4.75	25	5	5	95
2	3.35	33	6.6	11.6	88.4
3	2	73	14.6	26.2	73.8
4	0.425	179	35.8	62	38
5	0.212	29	5.8	67.8	32.2
6	0.075	95	19	86.8	13.2
7	Pan	66	13.2	100	0

The analysis table shows that only 5% of the soil particles are retained on a 4.75 mm sieve which means 95% of particles are finer than 4.75mm. Hence, the soil classification is sand. The above analysis is the analysis of the present soil.

The inferences drawn from the testing of soil samples taken from the guru ka taal, which is the investigation site, are as follows:

a) The soil present at the site is sandy soil.
b) The soil of the investigating site has high permeability.
c) The water retention capacity of soil is very less. It can not hold the water for a long time. It is the main issue of this waterbody which is acting as a hindrance to its rejuvenation.

If it is required to retain water on the soil at guru ka taal, excavation or cutting of the soil needs to be done until an impervious (clay) layer is observed below the ground level so that water can retain on it. As clay is a fine-grained soil, it can retain water.

Also, lining at the bottom surface can be done if it is not required to retain water on natural layers. Lining by bricks or by cement can be a way to retain water artificially in the water body.

Suppose the excavation depth is too much to achieve or economical. In that case, it is suggested that an impervious (clay) layer should be placed at a certain depth below the ground level with soil stabilization so that water can be retained on the clay layer without going into much depth.

4.5. Catchment area of Taal (waterbody)

The catchment area to collect all the rainwater or stormwater has been taken from the property of Gurudwara itself. The catchment area has been marked on the google earth image.

Fig. 11 Catchment area of Guru ka Taal

Although the actual rainfall intensity is less in Agra, some rainwater will collect in the catchment area, and due to the slope, it will directly lead to the taal.

The calculations shown are as follows:

Table 2. Analysis of catchment area and rainfall

Analysis of Catchment Area and Rainfall (Guru ka Taal)	
Runoff Losses	20%
Evaporation Loss	68 %
Normal Rainfall Intensity	779 mm/year
Total Catchment Area Volume	121346 cum
Volume or Quantity of water to be stored in Taal	63997.3 cum
Total Catchment Area volume	25715.21518
No. of years the Taal take to get filled by rainwater	2.5

4.6. Aquifer System

If there is a significant decline in water level, aquifers are the most crucial hope to reduce this deficiency in water table level. Aquifers are geological formations which are porous as well as permeable. The above cross-section has been found in the Aquifer mapping report of Central Ground Water Body. It has been found by overlaying Agra's map over the aquifer depth map in the report. The top depth range of the first aquifer layer is about 20 to 30 m below the ground level, and the bottom depth range is 30 to 40 m below the ground level. The first layer is fresh. Water can be extracted from this layer by making a deep well. The top depth range of the second aquifer layer is 50 to 60 m below the ground level, and the bottom depth range is 60 to 70 m. This layer is also fresh.

4.7. Rainfall Projection

Based on available Hydrological data (Rainfall data), the rainfall prediction has been done for the upcoming *two decades* by *Arithmetic Increase Method* to account for the mitigation projects needed in the future scope. This analysis does not include practical losses such as Evaporation and Percolation.

4.8. Strategies

The strategies have been made by incorporating all of Taal's issues and ground realities. So far, the issues are:

a) Significant Decline in Water Level;
b) Ground Water Quality Problem;
c) Less Ground Water recharge and more surface runoff of monsoon rainfall;
d) Dumping waste has led to the cut-off the water from the aquifers (natural inlets)
e) High Evaporation Rate

5. Result and Conclusion

Water bodies are decreasing in Agra. Government has to take proactive measures to preserve these water bodies. These water bodies can be identified and mapped by surveying. In this project, various water sources are identified as the source of the reservoir. Water bodies for rejuvenation basically depend on rainfall water.

A maximum of old water bodies in India are dried due to encroachment, siltation, garbage dumping, and depleted water sources. Various calculations have been made to fill this projected *Guru ka Taal* reservoir as a total source of intake water and losses. This study concluded that increasing soil impermeability, similar to clay properties, will stop the percolation of rainfall water. It will live again within 4-5 years, up to a significant depth, as discussed earlier. The proposed plan of *Guru ka taal* has been made and incorporated recreational ideas to re-imagine the area as a vibrant public place, including gardens.

Fig. 11 Site Overview of Guru ka Taal

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