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AN INTEGRATED APPROACH TO HYDROLOGICAL PATTERN: A CASE STUDY OF ANASAGAR LAKE, RAJASTHAN

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Abstract: India is very rich in wetland resource. The importance of wetland along with the groundwater resource in meeting the ever-increasing demand of fresh water is highly appreciated. However, this is a great challenge for regions where water is scarce and excess of human activities have plunged deep into the resource irrespective of the confirmation of replenishing them later. The present paper is focused on the hydrologic and morphometric analysis of lake which deals with the hydrological disturbances and water resource management. Hydrological analysis of Anasagar Lake examine the high inflow and outflow of water from different drainage channels. Through this study, we analyse that the status of lake water is very toxic, and the aquatic life is in danger because of human activities which are degrading the lake water tremendously. The quality of lake water has detoriated because of the drainage system of the city which drains in the Lake. Peak discharge and sedimentation processes have affected the lake hydrology.

Keywords: Hydrological modelling, water resource, water quality, morphometry

Introduction

Wetlands are one of the most productive ecosystems, comparable to tropical evergreen forests in the biosphere and play a significant role in the ecological balance. They are biologically diverse ecosystems, which cannot be replaced by other ecosystems. Wetlands are the transitional zones between permanently aquatic and dry terrestrial ecosystems where the water table is usually at or near the land and is covered by shallow water (Parikh, 2003). There are many functions of wetlands such as hydrological function, which includes groundwater recharge and groundwater discharge. It also helps in flood control and flow regulation. Ecosystems isolated from the nearby river for most of the year acquire a lentic character that promotes autogenic, mainly organic matter cycling. During low water periods, non-flowing ecosystems have been recognized as having limited conditions for light penetration and thereby limited photosynthesis. Therefore, hydrological analysis is important for the assessment of the water budget and healthy status of the lake. Water regimes of Anasagar are determined by inflow from direct precipitation and flooding in nearby areas. Direct precipitation is significant to the overall inflow into the lake. There is no outflow mechanism present around the lake area except the drainage channel. Hydrological analysis helps us to know about the morphometry of the Anasagar Lake which determines the water-carrying capacity of the lake.

Methodology

For the study of hydrological analysis of the lake, secondary data have been used from various institutions such as the Indian Metrological Department, Flood Forecasting Department, Govt. of Rajasthan. By analysing the different hydrological data, the characteristics pattern of water output and input ultimately give the idea of water balance. The questionnaire includes both responses – fixed and open-ended for gathering data on the consumptive use of the Lake such as fishing, fodder, grazing, plant use and non-consumptive use. To know about the resource base, formal and open-ended interviews with the district agriculture officer, and staff of

the block have been conducted and a comparative analysis has been done. For Morphometric Analysis, a number of formulae have been used for the analysis of Anasagar wetland which are as follows:

Development of Volume (DV) is a measure of departure of the shape of the lake basin. Majority of lakes will be greater than 1. DV is greatest in shallow lakes with flat bottom.

$$\text{Development of Volume (DV)} = \frac{3\text{Mean depth}}{\text{Maximum depth}}$$

Shore line Development reflects the potential for development of littoral communities. If DV is equal to 1 then circular shoreline. It is measure as follow

$$\text{Shoreline Development (DL)} = \frac{\text{Length of Shore line}}{\text{Length of the circumference}}$$

The index of lake basin permanence reflects the littoral effect on basin volume. A large, deep lake would have large permanence index. This is the ratio between basin volumes to shoreline length.

$$\text{Index of lake basin Permanence} = \frac{\text{Basin volume}}{\text{Shoreline length}}$$

Mean depth of lake is calculated with help of the volume and surface area. It is ratio of the volume and surface area.

$$\text{Mean Depth of lake} = \frac{\text{Volume}}{\text{Surface area}}$$

Descriptive statistical method is used for the representation of the result which helps in the analysis of the resources base.

Result and Discussion

Hydrological regime

The hydrological regime of Anasagar Lake has covered a detailed account of the outflow and inflow of water, sediments, source of water and flooding in the nearby lake. Government agencies have been working on the monitoring of the hydrological aspect of Anasagar Lake.

Morphometric analysis

Morphometry deals with the measurement of the significant morphological features of the Basin and includes water mass. The lake has a maximum length and width of 9.3 km and 6.6 km respectively. The water level is shallow. The total surface area of Anasagar Lake is 70.55 sq km. The shoreline is developed which indicates the potential for the development of the littoral community. The values of Lake Permanence reflect a certain degree of stability of the Lake against susceptibility to extinction forces. However, the values are not satisfactory and indicate the aging status of the lake.

Morphometry of Anasagar

Parameters	Values
Total area of Ajmer	8481 sq km
Total area of Anasagar lake	70.55 sq km
Total circumference	12.88 km
Max Length	9.3 km
Max Width	6.6 km
Average Depth	5 meter
Mean Slope	Steep slope with low vegetal cover
Storage Capacity of Lake	2052 million litres

Source - Ajmer Development Authority Report 2013

Inflow and Outflow

At present water comes into the Anasagar lake from its catchment area. In Anasagar Lake, there are three main stormwaters known as Kazi ka Nallah, Bandi Nadi and Anasagar escape channel. The first two feed into Anasagar Lake. Kazi ka nallah generally discharges water from the hills and nearby areas into Anasagar Lake. Bandi River discharges stormwater from the hills and carries overflow from the Foysagar Lake to Anasagar Lake in case of heavy rainfall. The overflow from Anasagar Lake is conveyed by the Anasagar escape channel to Khanpura Pond. It is noticed that all drains in this Zone, have a major problem of wastewater inflow and dumping of solid waste. Due to the absence of a proper sewerage system, the drains carry municipal wastewater and finally discharge into Anasagar Lake, thus resulting in poor water quality in the lake. Mostly the drains are choked with municipal solid waste, silt and sullage**.** Apart from this, it is noticed that the hills surrounding Ajmer, have very steep slopes and do not have adequate vegetation cover causing heavy run-off and soil erosion, which results in the silting of drains and subsequently of the Anasagar Lake. There are primary stormwater drains measuring up to a length of approximately 11 km in the Anasagar Zone. Apart from this, six secondary stormwater drains, feed into the primary drains in this Zone. A brief description of these drains is presented below:

Bandi River (Nadi): The rivulet runs for a length of 5.5 km and has a catchment area of approximately 16.80 sq. km. Bandi Nadi functions as an overflow channel for Foysagar and discharges into Anasagar Lake and it also collects stormwater from the hills. The catchment area and the length of the drain are the highest among other drains of the Anasagar zone. The drain has three tributaries namely Kazi Pura Drain, Hathi Khera Drain and Kotra Drain. The drain is lined for only 7.20 percent of its total length. The major issue with this drain is it does not have a defined alignment. Hence during rainy season run-off gets diverted. Finally, it discharges into Anasagar Lake near the Vishram Sthali in Ajmer Pushkar Road.

Kazi ka Nallah: This drain runs for a length of approximately 2.5 km and has a catchment of approximately 6.72 sq. km. It has two main tributaries namely the Bhopon ka Bara drain and the Mehndi Khola-Shastri Nagar drain. It is observed that of the total stretch, only 420 m (approximately 16.80% per cent) of the drain is lined. The drain channelizes stormwater from the hilly terrain, plains and built-up area ultimately discharging into Anasagar Lake. While passing through the built-up area drain receives wastewater and solid waste from the colonies. Thus the drain is choked with municipal solid waste, silt & sullage. Police lines located in low-lying areas get flooded by this drain during monsoons.

Mahaveer Nagar Arihant Colony drain: The total catchment area of the drain is 0.88 sq. km, running up to a length of approximately 1.5 km. The drain has two main tributaries namely Boraj drain and Nagphani drain. It is observed that, of the total stretch only 50 percent of the drain is lined. The drain collects surface run-off from Taragarh Hill and Nagphani and receives water from the Boraj drain and Naghphani drain in its course. Field visits indicate that the drain is generally choked with municipal solid waste, silt and sullage. Wastewater

from nearby colonies finds its way through open drains into the Mahaveer Nagar drain and finally discharges into Anasagar Lake.

Anted Chatri Yojna Drain: The total catchment area of the drain is 0.761 km. The drain has three tributaries namely Kazi Pura Drain, Hathi Khera Drain and Kotra Drain. The channel does not have a proper alignment hence the surface run-off spreads onto the low lying area before Sagar Vihar Colony.

Flooding in the lake

Ajmer city is surrounded by three hills of Aravali Ranges i.e. Nagphani Hills, Madar Hills and Taragarh Hills on three sides. These hills help prevailing winds in the occurrence of high-intensity storms and rains, resulting in flooding in many parts of the city given the saucer-shaped topography of the City. Past record of flooding indicates the occurrence of heavy floods in the years 1975 and 1979, apart from floods of much lesser intensities which occurred in the years 1981 and 1997. There are however cases of short-term flooding causing inconvenience to traffic and creating unhygienic conditions, even during normal monsoons as well. The identified flood-prone areas in the city are (i) Station Road and Railway Station yard, (ii)Kutchery Road, (iii) Gujar Dharati, Jhalkari Nagar, (iv) Sector III of Housing Board Colony of Vaishali Nagar.

Siltation

The water of Anasagar Lake is slightly saline as the average values were found to be above 1000 ppm throughout the monitoring period. The range of values observed was 1400-1700 ppm. The problem of sedimentation is more pronounced in the reservoir, resulting in the reduction of their water-holding capacity and a decrease in the Lake area.

Hydrological Cycle of Anasagar Wetland

The hydrological cycle is one of the key elements in the aquatic environment. Water (moisture) constantly revolves between the wetland, sky, land and wetland again. Water in the wetland evaporates into the atmosphere through evaporation and falls back on the land and in the wetland as precipitation. With the help of infiltration of water on land, the water table around the wetland is maintain. Copious rainfall causes overflow of water from wetland to land area and causes flood. In this wetland, water comes through direct precipitation and runoff from upland.

Groundwater

Almost the entire district is facing the problem of groundwater scarcity, though water supply from Bisalpur dam solved drinking water problems to a certain extent in urban areas. Over the greater part of the district occupied by hard rock formations, the well yields are very poor. As such the depth of the weathered zone is generally restricted up to 50m, which controls the occurrence and movement of groundwater. Deep-seated fractures below 100m are very rare. This causes a reduction in the well yield drastically during the summers creating an acute water shortage of domestic water supply. However, in selective areas located on structural weak planes connected to some recharge source wells continue to yield a moderate quantity of water. Deeper levels are either devoid of water or of poor quality ground water (brackish to saline). Alluvium occurs at limited places along the major drainage/ valley fill and has shallow thickness. The well yield varies considerably from year to year in different parts of the district and over the season. Thus the availability of surface as well as ground water is very scarce in low rainfall years & especially in summer months.

Use of water

Around the lake local people are using this resource for their own consumption, household tasks (washing clothes, bathing etc.). and some uses for fishing and boating purposes. Mostly the lake water is been used for non-consumption purposes.

Consumption Use

Anasagar Lake is the most important ecosystem for not only human beings but also animals. Most of the activities associated with the Lake system in these areas are distributed equally but there are slight variations in the portfolio of activity amongst neighbouring villages. Primarily the livelihood of these villages is significantly dependent on agriculture and livestock production and evidently, the consumptive use of Anasagar resources in terms of fodder varies between 24.1 to 43.3 percent. In other words, people in the surrounding villages majorly use the Anasagar Lake system for fodder growing. Since these areas have been used as a resource to grow, a substantial share of it goes into grazing purposes. Nevertheless, a Lake system

is a rich source of fish production and consequent consumption of it. Again substantial share of production around this lake system uses this for fishing purposes which varies between 13.3 to 25 percent. Apart from these activities, a significant share of households are involved in plant production activity as well as in different derivatives activities. The distribution of consumptive use of Lake Anasagar is almost homogenous across the area. The simple inference one can draw from it is that the population around this lake system, on average, is very much involved in agriculture and livestock production and consequently they show a homothetic preference for the likely dependence on the Anasagar lake system.

Non Consumption Use

The non-consumptive use of the Anasagar system does not show the same pattern as that of the consumptive use. Across the area, non-consumptive activities like bathing, recreation, boating, religious ceremony and other sort of activities are not evenly distributed. In a nutshell, Jaimanglagarh is showing minimal use in terms of non-consumptive use of the Anasagar Lake resources. On the other hand, Khajahnpur and Parora show a higher inclination towards the non-consumptive use of the wetland system. On the bathing activity, Parora people are using relatively more than others, which may be because of cleaner water in that adjacent area or because of the low number of hand-pumps in that area and hence may be due to low affordability in those villages. This signals linked poverty in the Parora area but cautiously this is mere speculation about the correlation of non-consumptive use activity and socio-economic conditions. Vaishali Nagar population are better at using it for recreation (39.7%) purpose than any other area, this may be just because of the proximity or because they are relatively richer to afford recreation activities rather than putting themselves into other economic activities. Not surprisingly, the religious activity by population around this wetland system in different areas is also evenly recorded.

Hydrological Alteration

Alteration in the hydrology can change the character, functions, values and the appearance of wetland. Construction of unauthorised structures around rivers, railway embankments unregulated flow of water, and farming practices can cause the alteration to hydrology of Anasagar.

Conclusion

Analysis of the hydrological aspect of the Anasagar Lake system revealed that the construction of a drainage canal system, which was initially for controlling flood and using water for agricultural practices in the vicinity of the area, has caused the shrinkage of the water body in the Lake area. Lake resources are utilized by rural people in unsustainable ways, which causes serious challenges for natural resource conservation. The challenge that the lake faces stems from the overutilization of Lake resources for survival as well as cultural activities that are practised. Villages, which are more connected with the urban area, are indulged in commercial use of wetland products. Development work like the construction of roads, and railway embankment has been responsible for the hydrological alteration.

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