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STUDIES ON HEAVY METAL POLLUTION IN WATER OF ANASAGAR LAKE

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ABSTRACT

The aims of this thesis were to analyse and investigate social, economic and environmental aspects responsible for deterioration of environment of Anasagar Lake, Ajmer and develop recommendations to preserve the lake. To understand and ascertain the sustainability of Anasagar Lake, study and analysis of various issues and activities associated to lake sustainability were carried out which included use of Anasagar Lake as a resource, limited public awareness and understanding, insufficient governance, excessive nutrient and mineral load, contamination of water and sediment from toxic and hazardous substances, increased erosion and sedimentation, accumulation of litter and garbage, loss of natural, aesthetic and scenic beauty of lake, loss of aquatic biodiversity and habitat, health risks, transport of airborne pollutants to lake and climate. The present study effort deals with the evaluation of heavy metals in the Lake Anasagar utilising Atomic Absorption Spectrophotometer (ECIL-AAS-4141) (ECIL-AAS-4141). Total 120 samples were evaluated for seven heavy metals, namely. Fe, Zn, Cu, Pb, Cd, Ni and Cr. The sequence of heavy metals in water samples was Zn >Fe> Pb > Cd > Cu > Ni > Cr.

Keywords: *heavy metal, Anasagar Lake*

INTRODUCTION

The buildup of heavy metals in the ecosystems of freshwater bodies is an issue on a worldwide scale. In recent years, the rate of discharge of pollutants into the environment has been far higher than the rates of their purification. This is the result of the persistent growth in population, rapid industrialization, chemical use in agricultural industries, and accompanying technologies involving waste disposals. Additionally, the rate of pollution has been increasing at an alarming rate. The introduction of harmful metals into the ecosystem might potentially result in geoaccumulation, bioaccumulation, and biomagnification . In most cases, metals make their way into the aquatic environment either by atmospheric deposition, the erosion of geological matrix, or as a result of anthropogenic activity produced by industrial effluents, residential sewage, and mining wastes. According to the World Health Organization, over 80 percent of the water pollution that occurs in developing nations like India is produced by trash from homes and businesses. The metal pollutants that are found in aquatic systems often continue to exist in a form that is either soluble or suspended, and they eventually have a tendency to sink to the bottom of the system or are taken up by the organisms. Wetlands have the ability to provide neighbouring people in the lake region with a source of income, in addition to its many other ecological, social, and economic benefits. These benefits extend to the nations that make up the lake region. The dumping of trash and agricultural operations in the catchments region are now causing serious deterioration to take place in Lake Anasagar, which is a direct outcome of these activities. When it comes to crop protection, the use of pesticides that contain heavy metals is one of the factors that contribute to the contamination of soil and water by heavy metals. In addition, over the course of several decades, unplanned buildings and illegal structures have hindered the flow of the drainage system, which means

that the runoff from the catchments does not make it to the lake in enough proportions. Heavy metals including iron, copper, zinc, and nickel, as well as other trace elements, are necessary for the healthy operation of the biological system. A lack of these elements or an excess of them can result in a variety of illnesses.

Lakes

A lake is an area of variable size that is filled with water and is confined in a basin that is surrounded by land. It does not have any rivers or other outlets that help to feed or drain it, hence it is considered to be an island body of water. The term "Lake" can be used to refer to a wide variety of water bodies, including natural lakes of water, man-made bodies of water, and ephemeral bodies of water. Another definition of lakes describes them as inland bodies of water that are separated into discrete basins or depressions that are produced as a result of the natural sinking and rising of land. One of the most interesting definitions of a lake is "a depression or a group of depressions which are partly or fully filled by water, all parts of the water body having the identical surface, apart from temporary variability, resulted by wind or ice, the ratio between in-flow and volume is adequate to let nearly all of the suspended, inflowing material to form bottom sediment, and the surface area exceeds a given minimum value." This definition describes a lake as "a depression or a group of depressions which.

According to the definition provided by the International Glossary of Hydrology, a lake is "an inland water body that is of substantial size" (UNESCO and WMO, 1992). According to the definition provided by India's Ministry of Environment and Forests, lakes are defined as bodies of standing water that have a minimum water depth of three metres, typically cover a water reach that is greater than one lakh square metres, and contain no or very little aquatic vegetation . The water body, drainage basin (also known as the catchment region), inflow and outflow, nutritional content, dissolved oxygen, contaminants, pH, and sedimentation are some of the important characteristics of lakes. When seen from the perspective of the landscape, a drainage basin and the water body that makes up a lake system are two separate but connected components. The presence of lakes is critical to the health of the urban ecology. Even though they are relatively small in size, lakes carry out a significant number of environmental, social, and economic functions. These functions include serving as a source of drinking water, recharging groundwater, controlling flooding and atmospheric temperature fluctuations, supporting biodiversity, and providing livelihoods. Lakes also play an important role in the evolution of fish and other aquatic life. Lakes all over the world are facing increasing threats from human activities and have suffered environmental degradation as a result of unplanned urbanisation and increased pollution due to the input of various kinds of wastes such as municipal waste, sewage, industrial waste, pesticides and fertilisers, etc., only the degree of degradation differs from lake to lake. Urbanization has led to an increase in the number of people living in unplanned urban areas, which has led to an increase in the amount of pollution. Lakes have also suffered environmental degradation as.

Lake Sustainability

The availability of water resources is essential to the success of agriculture, industry, households, the growth of cities, and recreational pursuits. Our planet's scarce natural resources, like as our lake system, are being put under strain as a result of human activities such as industrialization, globalisation, population growth, and increased demands for food and energy. The effects of climate change and other forms of environmental deterioration are going to exert an even greater strain on our ecosystems. As a result, it is more important than ever to protect our lakes. The concept of lake sustainability offers a

means through which civilization may engage with the surrounding environment in a way that does not put these water bodies at danger or do them harm. In order to achieve sustainability, it is essential to strike a balance between social equality, ecological efficacy, and economic efficiency. It encompasses the idea of sustainable development, which defines progress as that which satisfies the expectations of the current generation without compromising the capacity of future generations to satisfy their requirements . The concept of lake sustainability acknowledges the fundamental interconnection of the community, the actions of economic actors, and the natural environment. It is a given that expansion or alteration in any one of these spheres will have an effect on the others. Researchers provide justification for the values of urban lakes by associating them with ecological, economic, social, and cultural elements, which serve as the driving force behind lake sustainability . Figure 1.1 illustrates important components that contribute to the long-term health of lakes.

Figure 1.1: Key Elements of Lake Sustainability

Status of Anasagar Lake

A man-made lake, Anasagar Lake may be found in the city of Ajmer, which is located in the state of Rajasthan (Table 1.1). The city of Ajmer has a climate that may be described as semi-arid, with dry and scorching summers and cold winters. In the summer, the minimum temperature in Ajmer city is 25 degrees Celsius, and the maximum temperature is 47 degrees Celsius. In the winter, the minimum temperature is 3 degrees Celsius, and the maximum temperature is 22 degrees Celsius The city receives an average of roughly 500 millimetres of precipitation per year During the years 1135-1150 AD, King Anaji Chauhan constructed the lake by constructing a dam across the Luni River. In earlier times, the lake served as a source of potable water for the populace. This lake is the largest and most well-known one in the city of Ajmer. At the moment, people visit the lake for a variety of activities including fishing and boating. The surrounding region contributes a significant quantity of untreated waste water to the lake on a regular basis. When the water level drops, the land around the lake is often used for agricultural purposes. The excess water from the lake flows into Khanpura Pond, where it is utilised for agricultural purposes. The environmental quality of Anasagar Lake has significantly deteriorated as a result of the effects of urbanization's pressures and people's disregard for the lake's health. There is a significant pressure on the lake and its watershed as a result of the enormous population that lives in the lake's immediate vicinity. The catchment region contributes a significant amount of untreated waste water and

municipal solid waste, both of which make their way directly into the lake, causing it to suffer from a serious issue known as influx. The lake's catchment region is continuously seeing an expansion of encroachment as well as a rise in human-induced activity. Bathing and washing clothes are popular activities that people do on the banks that surround the lake. Directly or indirectly, the pesticides and other related chemicals that originate from human activities or agricultural operations are released into the receiving waterways. The problem has been made worse by the practise of submerging statues of deities during religious celebrations and by throwing flowers and waste food products into the la

Holistic restoration of Lake Anasagar

The eutrophication of Lake Anasagar poses a challenge to the metropolitan system of Ajmer on several fronts, including the economic, ecological, and social. This is one of the obvious effects that may be seen as a result of the interactions between the natural world and human culture. The degradation of Anasagar, in conjunction with other dangers to urban ecosystems and the catchment area around cities, is expected to accelerate the collapse of urban green infrastructure, as well as the insecurity of people's livelihoods and the unsustainable growth of cities. It is suggested in this article that a larger perspective is required, one that integrates holistic restoration science, urban environmental governance, and legal interventions. This is in spite of the fact that a variety of tactics and activities are now being implemented for urban systems. In point of fact, we will be required to make use of the field of sustainability science in order to address the threatened interactions between nature and society, as well as to build a self-sustaining functional aquatic ecosystem that is able to maintain biodiversity, carry out ecosystem functioning, and supply society with ecosystem services. A comprehensive plan for restoring Lake Anasagar is going to be discussed in the subsequent sections of this article.

Image 1: Anasagar lake

STUDY AREA

Anasagar Lake, which is located to the north of the city of Ajmer (74.38'– 74.42' E and26.25'– 26.29 N), was created by constructing a dam across the river Luni. The lake was given its current name in honour of the monarch Anaji Chauhan, who built the lake between the years 1135 and 1150 AD. This lake, which is one of three that are already present in Ajmer, is the largest of the three and has the most catchment area (5 Km 2 built up area). The lake reaches …a maximum depth of 4.4 metres and has a storage capacity of 4.75 million cubic metres.

MATERIALS AND METHODS

The water samples were taken between November 2020 and April 2021from a total of five different locations, with each location contributing four samples. In order to avoid the precipitation of metals from the samples, 2 ml of nitric acid was used to preserve them. Conical flask was used to collect a sample with a volume of 100 ml and a concentration of 5 ml of HNO3. After that, the samples were boiled slowly on a hot plate until they reached the smallest volume possible (between 10 and 20 ml), which prevented any precipitation from occurring. The walls of the beaker and the watch glass were cleaned with distilled water, and the flow of flirtation was used to do the washing. The filtrate was placed in a volumetric flask with a capacity of 100 ml, and the volume was brought to a known level .

RESULTS AND DISCUSSION

Over the course of a period of six months, a total of 120 water samples from Lake Anasagar were examined to determine the levels of heavy metals (November 2020 - April 2021). Table 1 displays, in milligrammes per litre, the average amounts of many distinct heavy metals found in the lake.

Table 1. Minimum and maximum concentration (mg/L) of heavy metals

Metals	Min.	Max.	Mean	SD
Fe	0.458	1.031	0.669	0.260
Zn	0.108	2.096	0.936	0.798
Cd	0.036	0.117	0.077	0.033
Pb	0.092	0.192	0.122	0.042
Cu	0.038	0.108	0.072	0.032
Ni	0.008	0.013	0.010	0.002
Cr	BDL	BDL	BDL	BDL

According to the findings of the study, the concentration of iron was anywhere from 0.458 mg/L (in November 2020) to 1.031 mg/L (in April 2021), with a mean of 0.669+0.260 mg/ L; this value is far higher than what would be considered acceptable. April was the month that had the highest concentration of iron (1.031 mg/L), which was detected. The degree of zinc pollution found in the lake was measured to be anywhere from 0.108 mg/L to 2.096 mg/L, with a mean value of 0.936 mg/L plus 0.798 mg/L. There is a possibility that the addition of municipal rubbish contributed to an increase in the level of zinc in the lake (Facetti et al.1998). The Cd concentration ranged from 0.036 mg/L (in November 2020) to 0.117 mg/L at various times (April 2021). Throughout the course of the research, the lake had a Cd concentration of 0.077+0.033 mg/L on average. According to the results of the analysis, the level of Cd present is much greater than the allowable threshold. The lead concentration ranged from 0.092 mg/L (during the months of March and April 2021) to 0.192 mg/L (during the month of November 2020), with a mean value of 0.122 mg/L plus 0.042 mg/L. It was discovered that the overall concentration of lead was higher than the threshold limit.

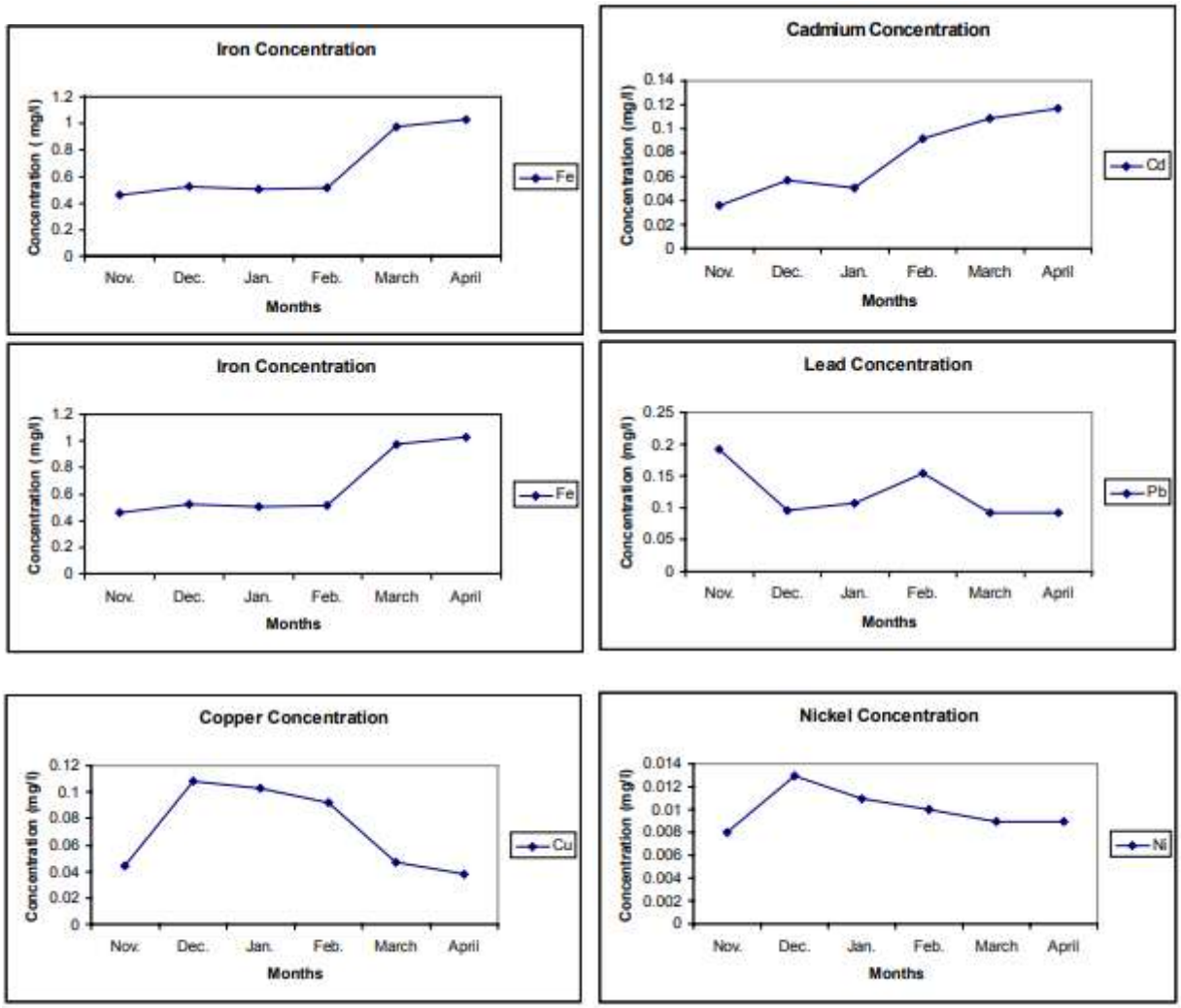

Fig.-1 (a-f) Heavy metals concentration in months (November 2020 to April 2021)

Geological investigations have shown that the rocks underneath are abundant in lead and zinc, with only trace amounts of cadmium, iron, and other metals present as impurities . As a result, the town's groundwater has a cadmium concentration that is extremely high. Runoff from agricultural fields where phosphate fertilisers are used can include cadmium since cadmium is a frequent contaminant in phosphate fertilisers. Wastes from batteries containing cadmium can also be a source of cadmium . The weathering of rocks in the central Aravalli area causes an increase in the iron content of the surface water. Iron is the primary component of the rocks in this region. The lake Anasagar is bordered on three sides by major roadways that see a great deal of foot and vehicle traffic respectively. Because lead is a prominent component of hydrocarbon fuels like gasoline and other petroleum products, its presence in the lake may be attributable to the heavy vehicle load that contributes to a rise in the amount of lead in the atmosphere. This is because lead is present in the lake. Pb has the ability to be carried by the atmosphere and may be found in lakes as a result of urban runoff. This runoff originates from the emissions of automobiles, which are then deposited on streets and roads and are washed away when it rains.

The recreational use of boats on the lake is another significant contributor to the lake's lead content. The concentration of copper in the lake ranged from 0.038 mg/L to 0.108 mg/L during the course of the study . The mean concentration of copper was 0.072+0.032 mg/L, which is significantly lower than the

maximum value that can be present. The content of nickel in the lake varied from 0.008 mg/ L to 0.013 mg/ L , with a mean value of 0.010 + 0.002 mg/ L. The amount of nickel that can be found in drinking water is also not regulated by WHO . However, the maximum concentration of nickel that should be allowed in irrigation water has been set at 0.20 mg/L. Because of this, there is very little risk of pollution from nickel in the lake. All of the samples' Cr concentrations fell below the level at which they could be detected. Further investigation into the substantial association between the concentrations of heavy metals was carried out using correlation analysis (Table 2). It has been shown that positive and substantial correlations exist between iron, zinc, and cadmium. Copper and nickel have a high positive correlation with each other. There was no link between lead and any of the other metals.

Table 2. Correlation between different heavy metals

Metals	Fe	Zn	Cd	Pb	Cu	Ni
Fe	1					
Zn	0.881*	1				
Cd	0.864*	0.867*	1			
Pb	-0.619	-0.288	-0.522	1		
Cu	-0.649	-0.729	-0.411	-0.142	1	
Ni	-0.359	-0.608	-0.252	-0.466	0.879*	1

One of the most significant wetland areas in the middle Aravalli region is found in the vicinity of lake Anasagar. The findings of the current study make it abundantly evident that the levels of Fe, Pb, and Cd are much higher than the acceptable limits (WHO 1994), which leads to a decline in the quality of the aquatic ecosystem. In order to lessen the severity of this environmental problem, consistent monitoring of Lake Anasagar should be carried out, and efforts should be taken to shield the lake from the contamination caused by heavy metals.

Conclusions

that unsustainable agricultural practises, increased deforestation and soil erosion, industrial activities, unrestrained dumping of waste, and uncontrolled land use change pattern arising from urbanisation have all had a negative impact on the long-term viability of lakes all over the world and have contributed to a degradation of the lake environment. The study, analysis, and discussion of socio-economic and environmental factors, as well as the environmental and social survey related to Anasagar Lake, reveal that increased anthropogenic pressure in lake catchment as a result of urbanisation has severely degraded the lake environment and adversely affected the lake's sustainability. This was discovered through the study of socio-economic and environmental factors, as well as the environmental and social survey related to Anasagar Lake. Because to the lake's transformation into a polluted and poisoned body of water, access to the lake, whether direct or indirect, is now severely limited It has been proposed that effective management of waste water and solid waste, restoration of vegetation and collection of rainwater in the lake catchment area, periodic removal of sediment from lake, restoration of macrophytes in lake, efficient governance and strict enforcement of rules and regulations, revenue generation for lake management systems, and environmental education and awareness programmes for local population could be the measures that are taken to preserve Anasagar Lake.

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