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Analysis of municipal wastewater treatment facilities vis-à-vis quality of water in river Chambal at Kota, Rajasthan, India

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Abstract

It has been noticed that due to insufficient capacity of treatment plants and inadequacy of sewerage system in Kota city, the wastewater generated is directly disposed off in the Chambal River through a number of open drains located in different parts of the city. The existing capacity of sewage treatment plants is far behind the required capacity looking to the wastewater generated in the city. Therefore, an analysis of existing wastewater treatment facilities and effect on water quality by direct discharge of wastewater into the Chambal River was carried out. For this purpose, data was collected from various sources related to wastewater generation, existing capacities of sewage treatment plants and future plans of respective agencies. The influent and effluent wastewater quality of sewage treatment plants and water quality parameters of the Chambal River were collected, studied and analyzed. It has been found that the existing treatment facilities are insufficient and it will take a long time to develop required infrastructure. Till then if untreated wastewater is continued to be discharged into the Chambal River, it is going to deteriorate the water quality of the river very adversely. Hence, immediate action is required to protect the only perennial river of Rajasthan.

Keywords: Wastewater, sewage treatment plant, Chambal River, water quality.

Introduction

In India, almost all of the river basins and groundwater beds are on the edge of extinction and experiencing acute water shortages. In such a situation, the present and future demands for freshwater can be met by using water efficiently and at the same time properly managing the demands[1].

The Chambal River is the one and only perennial source of water from drinking and agricultural point of views in Hadoti Region of Rajasthan as well as it is the habitat of aquatic animals. It flows through many districts in Rajasthan to other States like Madhya Pradesh and Uttar Pradesh. Kota had been known as an industrial city. In addition to some of the well known industries in Kota like Shri Ram Rayons, Shri Ram Fertilizers and Chemicals, Shri Ram Cement Works, Chambal Fertilizers and Chemicals Ltd., Kota Thermal Power Station, there are many other small and medium enterprises functioning in and around Kota which require a lot of water for their operation and maintenance. These days, Kota is better known for its coaching institutes for pre-engineering and pre-medical entrance tests. Every year lakhs of students from all parts of India, take admissions in these coaching institutes and hence there is a reasonable floating population of students and their parents in Kota.

At present, the Chambal River is undergoing huge pressure of public encroachment, disposal of untreated municipal as well as industrial waste, direct dumping of municipal solid waste and unauthorized diversion of other wastewaters into it[1]. Hence, the objective of this study is to carry out an analysis of existing sewerage system of Kota City as well as to study the effect of direct discharge of wastewater on quality of river water and to suggest the necessary steps that should be taken for the preservation of the river from getting polluted.

Materials and methods

Study Area: The study area is within the city of Kota. Kota is situated along the eastern bank of the River Chambal, which is situated in the southern Rajasthan. The education city Kota is the third largest city of Rajasthan after the capital city of the state i.e. Pink City Jaipur and the Sun City Jodhpur respectively. The Kota district is situated between 24°25' and 25°51' North latitudes and 75°31' and 77°26' East longitudes having an area of approximately 5768Sq Kms. Kota city is situated towards the extreme south of the district at 25.18°N and 75.83°E. The district Kota shares it boundaries with other districts of Rajasthan like Sawai Madhopur, Bundi and Tonk in North West, Chittorgarh in West, Jhalawar in South and Baran in East[2].

Population Growth: As Kota is the leading hub of educational institutions and home to various industries, the population of the city is increasing year by year. The population of Kota city in the year 1991, 2001 and 2011 were 537371, 694316 and 1001694 respectively as per Census data of India. The population of the city is increasing at a high rate after year 2011

due to the fact that lakhs of students and their parents are coming to Kota for education, especially engineering and medical entrance aspirants from all over the country to take admission in various coaching institutes located in the city.

Wastewater Generation: Effective treatment of wastewater is a critical issue in a developing country like India. According to the present population and water supplied to the public, wastewater generation in Kota city is approximately 312 MLD against a treatment capacity of 50 MLD through STPs installed in the city3. Furthermore, in the next 10 years, wastewater generation in the city will further increase which cannot be allowed to dispose directly in the river due to its massive volume. Most of the small drains in the city finally discharge to a main drain. For example, Sajidhera drain carries large volumes of wastewater through various drains in the city. The length of Sajidhera drain is about 5 Km and approximately, 55 MLD of wastewater is directly discharged into the Chambal River through this drain.

The peculiar feature of Kota is that there is very less network of sewer lines in the city. Being hard strata beneath the ground, neither the executive agencies nor the general public have ever cared before for laying of sewer lines and connect them to the STPs. In absence of proper distribution of sewer network, the wastewater generated is disposed of through area wise small drains, which join together into big open drains. These big drains carry wastewater as well as storm water during rainy season, often get over flooded, create havoc and finally head their path towards the River Chambal. Figure-1 and 2 show Indra Vihar and Sajidhera drains.

Figure-1: Indra Vihar drain in Kota city.

Figure-2: Sajidhera drain in Kota city.

Existing Wastewater Treatment Facilities: The present-day scenario of Kota's wastewater treatment is far from being ideal. Kota is one of the few cities in India having 24 hours water supply in most of the city or at least two times supply in a day. There are two water treatment plants in city, named as Akelgarh (270 MLD) and Mini Akelgarh (Sakatpura, 130 MLD) distributing about 390 MLD water to the public. Out of this supplied water, about 80% of water is converted into wastewater i.e. approximately 312 MLD of wastewater is generated in Kota city[2]. There are only two sewage treatment plants of capacity 50 MLD, which are working at present in Kota city at Sajidhera (Kishorepura) and Dhakarkheri. The remaining wastewater of 262 MLD is directly disposed off into the River Chambal. Wastewater is discharged directly into the Chambal River through a number of open drains (more than 26) due to undeveloped sewerage system for the present population and hence the water of Chambal River in the city is getting polluted every day[3]. The disposal of city's solid waste into the river worsens the situations.

A visit to the existing STP at Sajidhera was made so as to understand the functioning of the treatment plant. It was noticed that the STP is working efficiently as per design standards. A flow diagram of the STP Sajidhera with all its units/processes is shown in Figure-3.

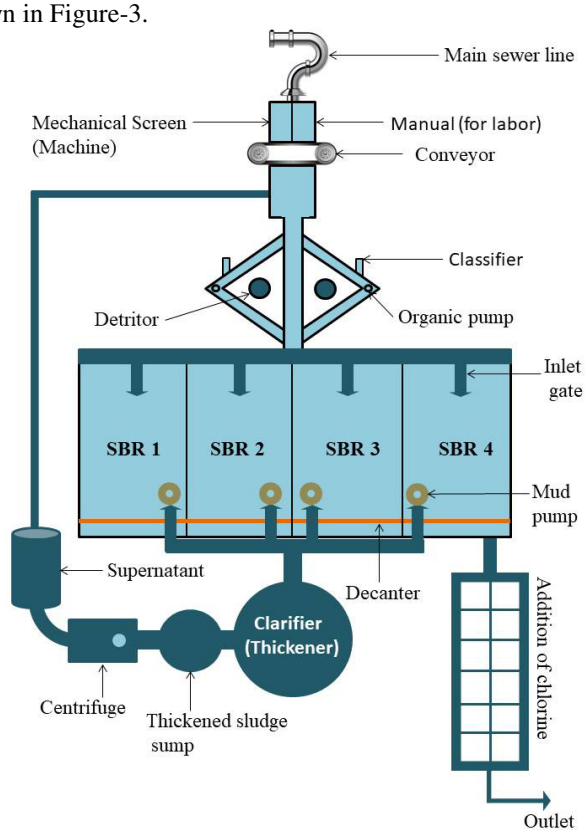

Figure-3: Flow Diagram of STP, Sajidhera, Kota city.

The important units of STP like inlet, screening, sequential batch reactor and outlet chamber are shown in Figure-4 to Figure-7.

Figure-4: Inlet Chamber at STP, Sajidhera.

Figure-5: Screening Chamber at STP, Sajidhera.

Figure-6: Sequential Batch Reactor (SBR) at STP, Sajidhera.

Figure-7: Outlet Chamber at STP, Sajidhera.

Wastewater Sampling: The locations for collection of wastewater samples were identified as the main drains whose wastewater is directly discharging into the River Chambal as well as some locations of the river itself. The sampling locations of drains which are falling in the Chambal River are shown in Table-1 whereas Table-2 shows the locations of the Chambal River itself, from where water samples have been collected to analyze the water quality of the river.

Table-1: Sampling Locations for Collection of Wastewater Samples from Open Drains[4]

Sampling Location	Sample Code
Godawari Dham	S1
Dadabari Circle	S2
Jawahar Nagar Petrol Pump	S3
In front of RAC Office	S4
St. Paul School	S5
Sajidhera	S6
Ramdas Circle	S7
Bhitariya Kund	S8

Table-2: Sampling Locations for Collection of Water Samples from Chambal River[4.]

Sampling Location	Sample Code
Chambal Garden	S9
Bhitariya Kund	S10
Railway Station	S11

Results and discussion

Results: The wastewater samples collected from drains and the Chambal River were analysed for their physical and chemical parameter as per the standard methods for the examination of water and wastewater, APHA (2005)[5]. Only the most important parameters of wastewater i.e. dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total dissolved solids (TDS) were analysed. Table-3 and 4 show the important parameters of wastewater samples collected from open drains and the Chambal River respectively.

The above parameters have been compared with the prescribed limits as per the Indian Standards IS: 4764-1973 and IS: 2490-1981. Table-5 and 6 show the tolerance limits of different parameters for discharge of sewage and industrial wastewater into inland surface sources of water after proper treatment as per the Indian Standards.

Table-3: Important Parameters of Wastewater Samples Collected from Open Drains[4].

Sample Code No.	Dissolved Oxygen (DO) in mg/l	Bio-chemical Oxygen Demand (BOD) in mg/l	Chemical Oxygen Demand (COD) in mg/l	Total Dissolved Solids (TDS) in mg/l
S1	3.8	254	652	1176
S2	0.63	500	95	1478
S3	1.57	305	848	1123
S4	3.46	255	786	1358
S5	0.79	407	1089	1440
S6	1.12	326	879	1540
S7	2.76	194	539	1703
S8	3.3	117	294	547

Table-4: Important Parameters of Wastewater Samples Collected from the Chambal River[4].

Sample Code No.	Dissolved Oxygen (DO) in mg/l	Bio-chemical Oxygen Demand (BOD) in mg/l	Chemical Oxygen Demand (COD) in mg/l	Total Dissolved Solids (TDS) in mg/l
S9	5.92	25	74	320
S10	6.32	20	46	287
S11	3.78	82	185	727

Table-5: Limits of Tolerance for Sewage Effluents discharged into Inland Surface Water[6].

Characteristics	Tolerance Limits
Total Suspended Solids	Max. 30 mg/l
BOD (5 day at 20^0C)	Max. 20 mg/l

Table-6: Limits of Tolerance for Industrial Effluents discharged into Inland Surface Water[7].

Characteristics	Tolerance Limits
Total Suspended Solids	Max. 100mg/l
pH	5.5 to 9.0
Temperature	Temperature of wastewater should not exceed 40^0C in any section of the river within 15 meters downstream from the effluent outlet.
BOD (5 day at 20^0C)	Max. 30 mg/l
Oil and grease	Max. 10 mg/l
Sulphides (as S)	Max. 2.0 mg/l
Total residual chlorine	1.0 mg/l
COD	Max. 250 mg/l

Discussion: Upon analyzing the results, we can say that all the parameters of wastewater samples collected from drains i.e. DO, BOD, COD and TDS are much more than the permissible limits and if such wastewater is directly discharged into river water without any treatment, it is going to ruin the potable quality of water therein. Further, it can be seen that the BOD of water of the River Chambal at sampling locations S9 and S11 is beyond the permissible limits showing a clear sign of water pollution. Also the DO level at location S11 is below 4mg/l, which is harmful for aquatic life to survive. Based on above analysis, we can infer that open drains discharging their wastewater into the River Chambal are deteriorating its water quality at an alarming rate.

Similar kind of results have been found by many researchers in past also. For Yamuna River in Agra city, it was found that the river is highly polluted and not safe for human consumption due to contamination of water due to disposal of untreated sewage[8]. Studies for Ganga[9-10] and Narmada[11-12] Rivers have also concluded that anthropogenic activities are primarily responsible for polluting the water quality of the rivers.

Conclusion

This study highlights the fact that important wastewater characteristics like DO, BOD, COD and TDS of wastewater samples from various locations are alarmingly higher than the tolerance limits prescribed by the Indian Standards. Approximately 312 MLD of wastewater is produced by the city,

out of which only 50 MLD is treated daily through 2 STPs in the city and the remaining 262 MLD is discharged directly into the Chambal River through open drains. The present-day scenario of Kota regarding wastewater treatment is far from being ideal. Although a 6 MLD STP is under construction by UIT, Kota and another 40 MLD STP is proposed at Dhakarkheri in near future, but with these two more STPs, a total of only 96 MLD treatment capacities will be there against the required 312 MLD. Hence, there is an urgent need for some more sewage treatment plants (STPs) in the city.

The study shows that Kota city lacks proper system for treatment and drainage of wastewater, consequently leading the wastewater from household and industries to the lifeline of the city, the Chambal River. There is high need for laying of sewer lines throughout the city so that the wastewater can be easily carried to the STPs for proper treatment before discharging it into the river. In absence of immediate action, the continuous discharge of untreated domestic and industrial wastewater in the Chambal River for some more years may result in adverse pollution making the river poisonous for human consumption and at the same time causing serious problems for aquatic life also.

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