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Assessment of Surface Water Quality: A Case Study of Zirakpur Municipal Corporation

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Abstract

In the present day scenario when population is increasing at rapid rate, agricultural areas are being converted into built-up areas and industrial developments can be seen all over the world. It has become very difficult to protect and maintain the quality of there water resources. Water covers almost 71 per cent of the earth surface, out of which only 3 per cent is in the form of fresh water. But out of this 3 per cent of fresh water resources only 0.3 per cent is available in the form of surface water. Because of this scarcity of surface water is felt throughout the world. Zirakpur Municipal Corporationis developing as a city centre, is no exception in this. High growth rate of population, rapid growth of urban land, uncontrolled growth of pollution have depleted the quality of water resources keeping in view above facts the present study is aimed to access the present situation of the surface water sources in Zirakpur. For the purpose sample were collected from the field and then were analysed in the lab. The results presented in this paper from the study show general pattern of poor quality of surface water resources in the area.

Keywords: Water, Water Sources, Quality of Water.

Introduction

Earth being known as the blue planed is supposed to have abundant water sources as almost 71 per cent of the total surface area of the earth is covered under it. When we look at the distribution of the water sources its highly uneven almost 96.5 per cent is stored in the form of oceans which is not available for human use and only 3 per cent of the water on the surface of the earth is available in the form of fresh water (United States Geological Survey, 2018). Further, majority of the fresh water is trapped in the form of glaciers (68 per cent), ground water (30 per cent) and other forms (1 per cent) (National Aeronautics and Space Administration, 2018). Less than 0.3 per cent of the fresh water sources in available in the form of surface water resources. When we look at the surface water resources, almost 87 per cent of the water is stored in lakes, 11 per cent in swamps and only 2 per cent in the form of rivers.

Rainfall is the major source of water availability in the country. On average India receives around four thousand billion cubic meters of water in the form of rainfall. Out of which almost three fourth is received during the monsoon season i.e. from June to September (Chand, 2016). India receives on average 116 cm of rainfall majority of which is lost to the evaporation and percolation of water into the soil (Sinha, 2014). Although due to the uneven topography and disparity of distributioin of water resources large tracts of the land face scarcity of water in the country

Punjab being located in the foothill zones of Himalayas particularly Shiwalik hills have abundant supply of fresh water in the form of many perennial rivers (i.e. Satluj, Beas, Ravi, Ghagger). Majority of its land area is under agricultural land use which utilizes large amount of fresh water throughout the year. For majority of the state the depth of ground water varies between 10 to 20 meters below ground level (Gupta, 2011) which is constantly declining with the time.

Zirakpur is located along the Chandigarh-Ambala Highway and has average annual rainfall of 615 mm (Central Ground Water Board, 2018). It is one of the fastest growing urban centre of Sahibzada Ajit Singh Nagar District of Punjab. Due to the proximity of Chandigarh it is being developed as the satellite town of it. Due to rapid growth of population and urbanization natural resources have come under high stress and are being contaminated at greater levels.

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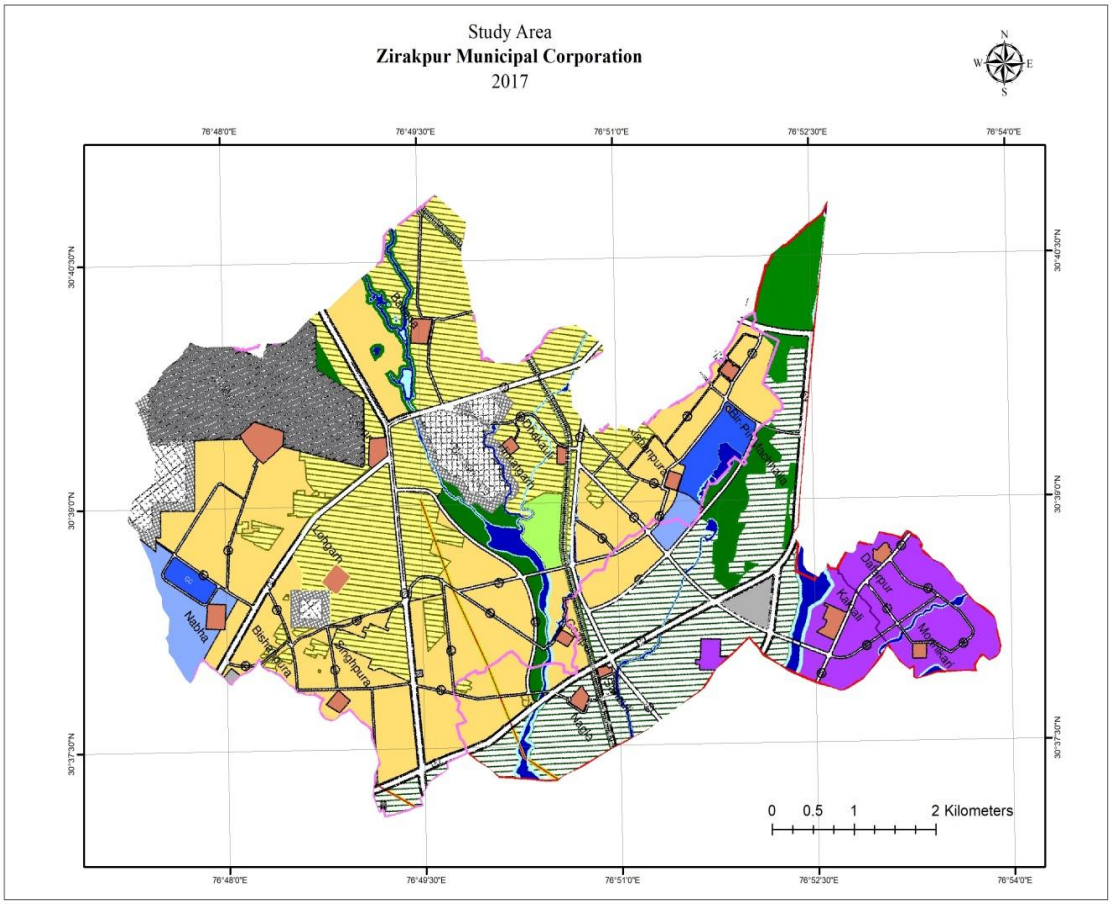
Map: 1



From the above discussion it is evident that the water we use for our daily purposes is very scares resource. We need to access the condition of the presently available surface water resources so that we can plan accordingly for our future. Water sources being constantly used for domestic, agricultural, commercial and industrial needs to be keep check for its quality.

Review of Literature

Surface water quality has always been the matter of concern for the researchers and administrators throughout the time. Numbers of studies have been conducted at both regional and local level to assess the quality of water sources. Following section of the study investigates and presents few studies that have been carried out on the present theme.

Around ninety seven present of the total water requirements of the fresh water are fulfilled by ground water sources either in the form of surface water or subsurface water sources (Hussain, et. al., 2003). In the past half century the quality of ground water have developed as one of the most challenging issue in sustainable environment development (Kumar, et. al., 2003). Poor management and lack of technologies along with over exploitation of water sources make water unfit for human consumption and domestic use.

Mary, et. al. (1997) carried out a study in Gandhigram village of Tamilnadu and observed that majority of the samples collected from the field have water hardness levels much more (above 575mg/l) than the permissible limit of 300mg per litre of water. At the same time in Jammu district Jain and Sharma (1997) also conducted a detailed analysis of drinking water that was being used of domestic and agricultural use.

Shrestha and Kazama (2007), worked on water quality of Fuji river basin for the period of eight years. They have collected samples from thirteen sites and categories the entire area into three sections i.e. relatively less polluted, medium polluted and highly polluted. The study focused on identification of multivariate statistical technique for analysis and interpretation of complex data sets.

In a similar kind of study by Simeonova, et. al. (2003) on Northern Greece for the duration of three years quality of water was analysed in the major river systems (Aliakmon, Axios, Gallikos, Loudias and Strymon). In the study twenty five key sampling locations were analysed on monthly basis. They collected the data on twenty seven indicators and then the data was treated using cluster analysis. The study concluded with the identification and highlighting the usefulness and necessity of multivariate analysis in the water quality assessment studies.

Tomas, et. al. (2017) assessed the status of surface water quality in pannonian eco-region. In their study they developed a water quality index model to generate patterns of surface water quality in the region. They developed two linear prediction models i.e. multivariable linear regression and piecewise linear regression for assessment of water status in the region. They study concluded that better results can be obtained for the assessment of water quality with piecewise linear regression model.

Su, et. al. (2017) attempted to develop surface water quality standards in China. In their study they pointed out that there were very few studies on lake nutrient criteria and water body classification system in China. Further they emphasised on the amendment of surface water quality standards in China. The study developed a new methodology of water quality assessment with the combination of structure equation model and expert elicitation. The study concluded with the application of these methods for setting nutrient standerds in yungui eco-region and the results were found to be feasible in the region.

Zeinalzadeh and Zeinal (2017) investigated the ability of Principle Component Analysis technique in directing the effects of discharges from diverse activities on the environment. In their study of Shahr Chai River located near Lake Urmia basin, they extracted various majot indicators of water quality analysis. The results showed the variation among the different parameters of water quality assessment in case of low medium and high pollution levels at a location.

Yang, et. al. (2018) studied the relationship among the quality of the water and the water surface temperature in the Dianchi Lake and presented the spatial and temporal variations of it. They found that the temperature of the water in the lake have significant impact on the ecological environment and biological levels. In their study fifty four water quality indicators were collected and analysed from ten monitoring stations for the period of ten years. They used various methods such as Support vector regression, Principal Component Analysis and Back Propagation Artificial Neural Network to develop a hybrid forecasting model.

Carlson (2018) in his book wrote a chapter on quality of water and its contaminants. In his work the author pointed out the importance of water availability and accessibility in an area. Author further stressed that the quality of water and its suitability for a specific purpose should be accessed using appropriate water quality standards.

Aim of the Study

In the light of the above discussion the present study is aimed at assessing the quality of the surface water resources located within the Municipal Corporation limits of the Zirakpur town. The present paper will discuss the indicators of water quality in general and will specifically focus on the quality of water samples collected from the various parts of town.

Methodology

The present work utilized the primary data collected from the field. Samples of surface ground water sources were collected from the ground. Data of water quality was generated using Voltammetric and Spectro-photometer methods to determine the various characteristics of the water such as Physico-chemical, Biochemical and Biological attributes from different parts of the town. Indicators of water quality such as pH (pouvoir hydrogène), Electric Conductance (EC), Dissolved Oxigen (DO), Total dissolved Solids (TDS), Salinity of Water (in mg/l)), Hardness (in mg/l), Alkalinity (in mg/l), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Trace element & Microorganism were analysed for the purpose. The collected samples were then analysed using water quality testing kit provided by the Industrial Toxicology Research Centre (ITRC), Lucknow. Then the data was plotted on the maps and patterns of water quality were generated. Results are presented in the form of maps and tables.

Tools and Techniques

For the purpose of the present investigation portable water quality assessment kits provided by the ndustrial Toxicology Research Centre (ITRC), Lucknow and some tests of quality of water were performed at Water Testing Laboratory, S.A.S. Nagar, Mohali, Phase-V.

Sampling

The samples of the water were collected from the different parts of the town. The town was first divided into parts i.e. Industrial, Commercial, Residential, Agricultural, Near Airport and Near choes. Then five samples of surface water were collected in the clean plastic water bottles. The collected samples were than sealed and sent to the water testing lab for further analysis.

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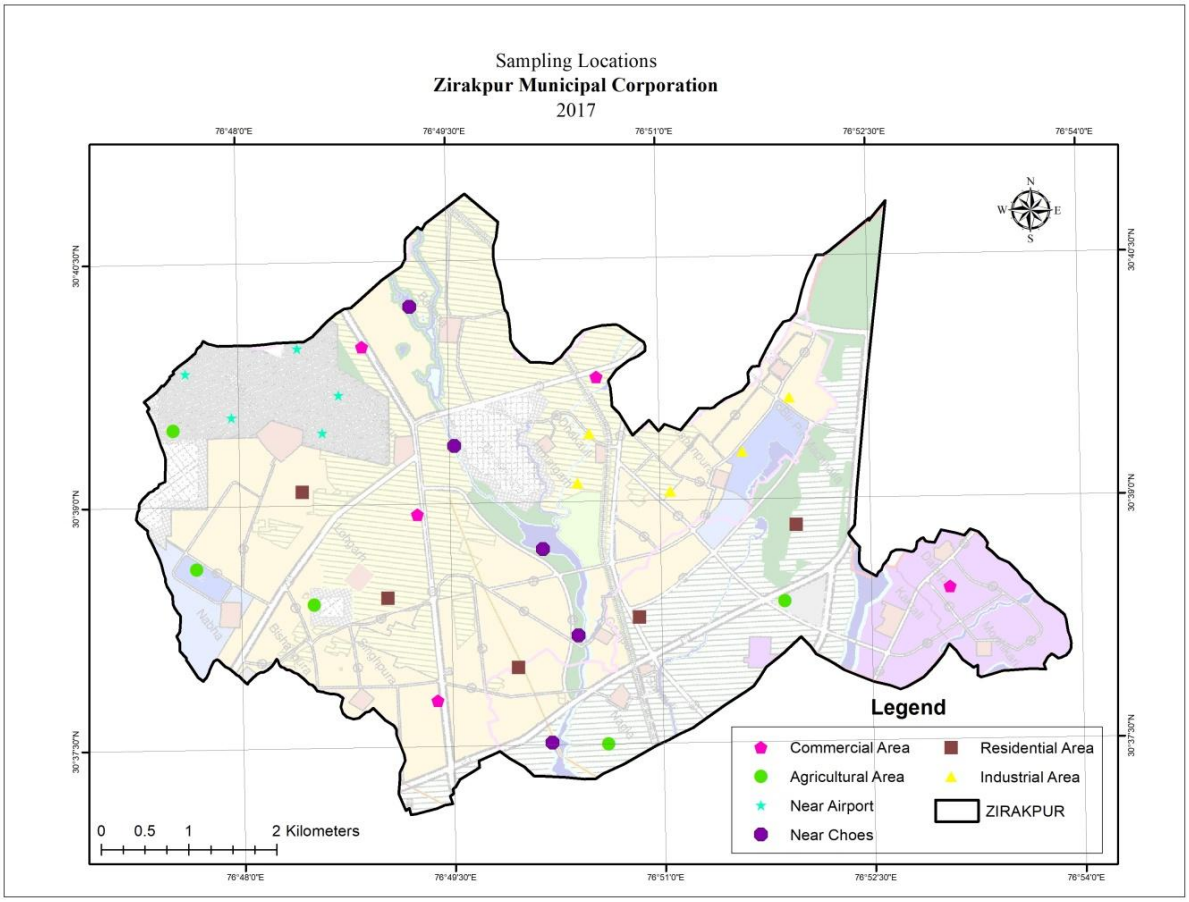
Map: 2



Results and Discussion

The results obtained from the primary data collected from the field revealed that the quality of water sources in the area is very poor. It was found that majority of the area is dependent on the gournd water resources for the purpose of their domestic as well as other uses. Industries were located on the margins of the Municipal Corporation limits in the north that utilizes majority of the ground water resource and are source of the water quality degradation in the area. There are seasonal choes in the area which receive water in rainy spell i.e. from June to September and through occasional showers received during the winter season.

From the map it can be seen that majority of the region is occupied with built-up area followed by the agricultural land. Both the human activities ultimately results in over utilizing the water sources in the area. It was found that the water sources near the human settlements are being degraded gradually by micro-organisms. The results obtained from the sampled water are shown in table 1 to 3. Table 1 shows the bio-chemical properties of the sampled location. When we look at the pH value of the samples it is evident that locations near the airport (7.5) and in proximity of the seasonal choes (7.2) shows high values that means pollutants are being dumped into the open spaces near the International Airport area and in the dried course of choes. The EC values were found to be high in the residential areas (1.43) followed by the industrial area (0.96) which shows the purity of the water sources. It is due to the fact that there areas are high consumption areas and use high quantities of water daily which dilutes the polluting elements in the water.

Similar picture can be seen in the amount of Dissolved Oxygen (DO) in the water both the locations (Residential; 3.41 and Industrial; 4.22) were found high levels of DO. The levels of Total Dissolved Solids (TDS) in the water were low in the agricultural areas(1.60) and commercial areas (1.20) as these areas were located away from the source of pollution or contamination of water sources. The Salinity of the water was found to be high near the airport (276.79) and in the industrial belt (408.01) of the region. On the Hardness scale maximum hardness was recorded in industrial area (814) followed by areas near airport (482) and residential areas (412).

Table: 1
Bio-chemical characteristics of water

S. No.	Location	pH	EC(e/MS)	D.O. (mg/l)	**TDS** (mg/l)	Salinity (mg/l)	Hardness (mg/l)
1	Residential Area	6.5	1.43	3.41	2.61	276.79	412
2	Industrial Area	6.7	0.96	4.22	2.98	408.01	841
3	Commercial Area	6.7	0.37	2.19	1.20	18.09	229
4	Agricultural Area	6.5	0.15	2.58	1.60	69.66	128
5	Near Airport	7.5	0.67	2.61	2.12	153.44	482
6	Near Choes	7.2	0.55	2.41	2.20	81.24	321

Source: Primary Field Work, 2017

When we look at the biological characteristics of the water it is quite evident from table 2 that industrial areas and areas near the airport are very high on alkalinity because these areas use high quality of water as well as they dump many pollutants in the area. The minimum values are observed in agricultural areas followed by the commercial areas as these two locations do not dump any pollutants in the surroundings. Same pattern is observed in the distribution of Chloride and Fluoride in the water sources. Mainly areas located within the industrial areas and close to the industrial area have shown high concentrations of these elements. Nitrates were also found to be highest in industrial area (0.33) followed by the areas located near the airport (0.23). Highest levels of free carbon dioxide were found in the in samples collected from the agricultural areas (69). Normal rain water have the level of carbon dioxide around 0.66 mg per one litre of water. Concentration of Iron was recorded to be high in commercial areas (1.25) followed by industrial areas (0.94).

Table: 2
Biological characteristics of water

S.No.	**Location**	**Alkalinity (mg/l)**	**Chloride (mg/l)**	**Fluoride (mg/l)**	**Nitrates (mg/l)**	**Free CO2 (mg/l)**	**Iron (mg/l)**
1	Residential Area	112	224	2.41	0.18	0.11	0.46
2	Industrial Area	271	149	2.12	0.33	0.15	0.94
3	Commercial Area	42	12	0.22	0.07	0.22	1.25
4	Agricultural Area	39	0.11	0.62	0.06	0.69	0.61
5	Near Airport	271	686	1.21	0.23	0.12	0.30
6	Near Choes	189	44	1.09	0.12	0.50	0.15

Source: Primary Field Work, 2017

The quality of water can be assessed using the indicator of biological oxygen demand, chemical oxygen demand and by statistically testing the most probable number of microorganisms in the water. All the samples show high levels of biological demand as water with biological oxygen demand of 3 to 5 parts per million is considered moderately clean (Global Water Sample Project, 2018). At the same time Chemical Oxygen demand is and indicator of how much oxygen can be utilised by chemical reactions which was observed heights in industrial area followed by area near airport and residential areas. Most Probable Number method is an effective method to access the quality of water. It shows the possible content of the bacterial organisms present in the water sample. All the areas in the limits of the municipal corporation recorded MPN below 4000 which shows moderate quality of water.

Table: 3
Characteristics of water sources

S.No.	**Location**	**BOD**	**COD**	**MPN**	**MPN Coliform**
1	Residential Area	15	32	-ve	2800
2	Industrial Area	19	35	-ve	3200
3	Commercial Area	12	28	-ve	4000
4	Agricultural Area	14	24	-ve	3000
5	Near Airport	16	32	-ve	3900
6	Near Choes	13	35	-ve	3600

Source: Primary Field Work, 2017

Conclusion

The water being an important part of our day to day life needs proper management. We have very limited resource of fresh water which we can utilise to fulfil our needs. The present study being focused on the analysis of quality of water in the Zirakpur municipal corporation area have presented the fact that majority of the sources in the area are under serious stress and are polluted to the great extent. Especially areas located in the industrial area and in proximity of the international airport are more polluted than other areas. The level of pollutants is from high to very high. The present study is concluded with the hope that this will help to understand the depleting state of the vulnerable water resources and the authorities and local residents will unite to improve the quality of water in the region.

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