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Effects of Land use Land Cover Changes on Surface Water Quality of Mithi River, Mumbai

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Abstract:- The key factor responsible for deteriorating the water quality of river is various land use activities and land use land cover changes(LULC) in that area. Surface water quality plays vital role in protecting the aquatic ecosystems. Mithi River in Mumbai is strongly affected due to urbanization. Unplanned urbanization deforestation like such phenomenon is strongly associated with water quality parameters. Hence to prevent the pollution at the source level it is important to find out the pollutant sources of river. The objective of this research was to relate the LULC parameters with water quality parameters to find out the nonpoint sources of pollution of Mithi river. Three sampling station point was selected on river and all the LULC analysis was performed using geographic information system and remote sensing tool and spearman rho's correlation analysis has been used to find out the relation between LULC parameters and water quality parameters. This statistical analysis was performed in (SPSS) software statistical package of social science. The results indicated that built-up area , water body and slum areas has showing increasing trends in LULC changes while open land and vegetation showed negative trends from the year 2004 to 2017. Open land are decreasing at the fastest rate which might have a very negative impact on water quality of river.

Keywords:- *Land use Land cover, Mithi river, Water quality, Spearman's rho correlation, Google earth imagery.*

I. INTRODUCTION

Land use land covers both are different phenomenon and they can be used interchangeably. Land use can be defined as the land used by humans for habitats concerning various economic activities while land cover refers to various physical characteristics or features on earth it may include vegetation, soil water etc.

Water quality problems are found to be associated with land based developments, impact of rapid urbanization on catchment protection zones, such adverse effects, as result of poor or unplanned land use planning and unsustainable land management practices tend to badly affect catchment areas that protect surface and groundwater resources. Adverse effects of land use on water quality threats to human water as well as their life supporting capacity. Watershed management is very important because it is not only hydrological unit but also play important role in socio-ecological perspective by providing food, social safety, as well as provision of basic needs to local residents .The land use within watershed has great impact on water quality. Point sources that affect the water quality include wastewater treatment facilities while non-point sources include runoff and farming activities. Anthropogenic activities are becoming a key environmental concern as they deteriorate water quality hence understanding the relationship between LULC parameters and water quality parameters helps in identifying threats to water quality.

To prepare the land use maps high resolution satellite images are required but free satellite imagery provided in global land cover facility which are used to prepare such maps has certain limitations as attempted in many studies such free satellite imagery have very less or medium resolution also it is difficult to obtain the latest image hence to overcome this problem Google earth imagery which gives clear view of building, roads and other uses can be used.

Mithi river watershed area was selected because of its uncontrolled urbanization unmanageable sewage discharge apart from this the river is treated like open drain by citizens .Also the illegal activities of washing oily drums, discharge of unauthorized hazardous waste are also carried out along the course of the river .the water with mixture of sewage and industrial waste is threat to marine life and river is showing sign of total loss of such support system. Surveys indicated that the pollution levels have reached an alarming stage. Also there is limited information on land uses which might have an effect on water quality. The river consists of different land uses that are indicated to progressively negatively impact the water quality. There is major land use changes in Mithi river catchment during 2004 to 2013 (IITreport2015).The objectives of this study ate to examine the potential sources of pollutants in Mithi river between 2004, 2012 and 2017;identifying the different LULC classes and pattern changes in watershed from 2004 to 2012 and 2012 to 2017;and determine the connection of LULC changes in contributing to pollutant sources in the Mithi River.

II. MATERIALS AND METHODS

A. Study area

The Mithi river is also known as "Mahim River" is. It flows for a total of 15 km before it meets the Arabian Sea at Mahim Creek flowing through residential and industrial complexes of Powai, Saki Naka,Kurla, Kalina, Vakola, Bandra-Kurla complex, Dharavi and Mahim. The catchment has an area about 7295hectares the mean annual precipitation is about 2430mm. As the river has been polluted by dumping of raw sewage, industrial waste and municipal waste into the river. The illegal activities like discharge of hazardous waste washing of vessels and oily drums, are also carried out along the course of this river. When the river was not as polluted as

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it is today, it used to serve as an important storm water drain for Mumbai but as it has been used as a sewer over the years, its importance as a storm water drain has reduced and on the contrary, it poses as a hazard during high tide bringing polluted water into the city and flooding the city.

Fig 1:- Red boundary showing study area of Mithi river

B. Data Collection

The research required collection of existing land use information ,conducting field water sampling and measurements, analysis of water quality sample for the selected physiochemical parameters.

Historical data collection: Three water sampling station were selected along the Course of Mithi river .First is at upstream side i. e at the origin of Mithi river. Second is at mid-point i. e Mithi river bridge and third one is at downstream side i.e at the point where river meets Arabian sea Mahim creek. Historical data for the year may 2004, 2012 and 2017 were collected from the Maharashtra pollution control board, Mumbai and from the previous research studies. The physicochemical parameters selected for the study are pH, DO, TDS, salinity, nitrates, total dissolved solids, chlorides, sulphate, lead, turbidity, chemical oxygen demand, suspended solids and total phosphorus, biochemical oxygen demand. The remote sensing imagery for the year may 2004, 2012 and 2017 was obtained from the Google earth. The Google earth imagery collected in Elshayal software .the individual 334 tiles was collected in Elshayal software.

Table 1: Sampling station point along the river

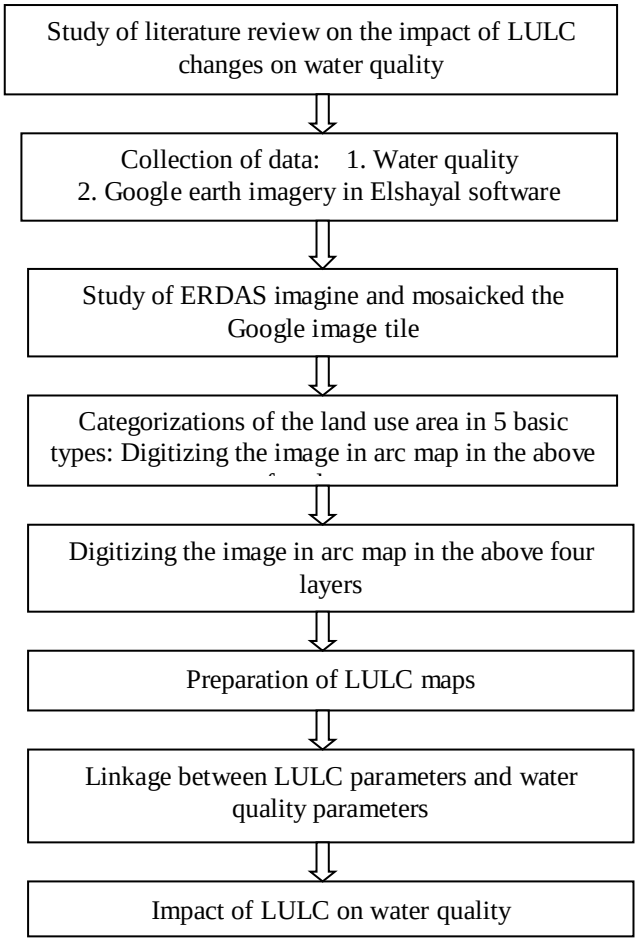
Station point	Name	Geographical Coordinate(Lat, Lon)
1	Mithi river origin	19° 8'37.01"N, 72°53'51.27"E
2	CST bridge	19° 2'53.81"N, 72°50'12.07"E
3	Mahim creek	19° 4'19.05"N, 72°52'22.25"E

C. Data Analysis:

Land use land cover analysis

In this research Google earth imagery is used for preparing the land use land cover maps. firstly the centerline was marked on river and 4km buffer area was marked from this center line in global mapper As the Google earth images does not give us geographical reference if it is saved directly hence to overcome this problem and to get the geographical reference the 334 individual Google earth imagery tiles for the year May 2004,2012 and 2017 were collected in Elshayal software .Elshayal is the first Arabian software which is connected to Google earth and can collect the images from Google earth with geographical reference. The Google earth images are free of cost and also provide clear latest image of the area. All the satellite images required image processing hence these 334 individual tiles was mosaicked in single image by use of ERDAS software.

D. Flow Chart Of Methodology



➢ *Lulc Classes:*

- Built Up Area: Including All Residential, Commercial, Industrial And Transportation.
- Vegetation: Including Forest Area, Mangroves, Open Shrub
- Water Bodies: Including River, Lakes, Streams (All Natural and Artificial Water body).
- Open Land: Including All The Areas Exposed To Soil, Barren Lands Influenced By Humans.
- Slums: Including the Slum Area Present In the Area.

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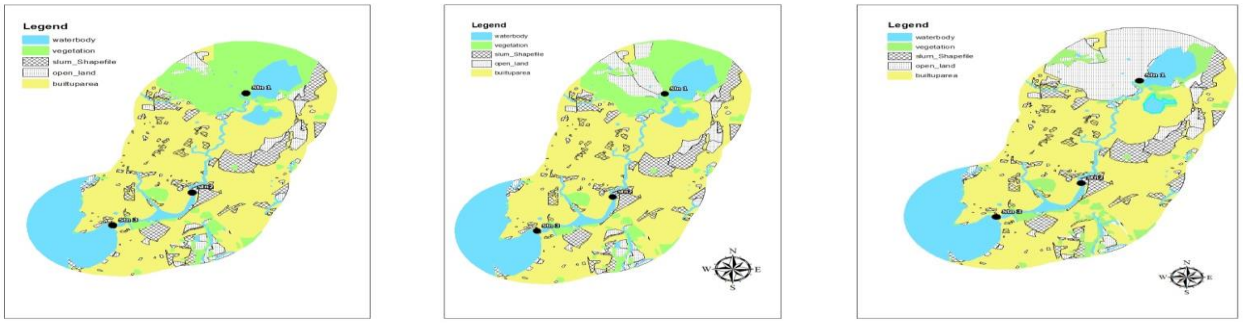

Fig 2:- LULC map of May2004, May 2012 and may 2017

➢ *Water quality monitoring*

The samples were collected and analyzed for Ph, total dissolved solids, total suspended solids, dissolved oxygen,turbidity,alkalinity,chlorides,nitrate,sulphate,lead,ph osphate,biochemical oxygen demand(BOD), and chemical oxygen demand(COD).The techniques and methods followed for collection and analysis are as per the laboratory procedures.

➢ *Relationship between Land Use Changes and Water Quality*

A correlation analysis was conducted to examine the relationships between water quality variables and land use changes. The dataset was tested for normality through Shapiro Wilk's test and it concluded that the dataset is not normally distributed. Based on the normality results, the Spearman correlation coefficient was employed showed in Table 14. The most commonly used techniques to determine the relationships between land uses in watersheds and water quality indicators are correlation or regression analyses (Hwang et al., 2016).The Spearman's rho, also known as the Spearman's Partial Rank Correlation is a non- parametric coefficient of rank correlation between two variables (X, Y) used to determine whether or not an association exists between the two variables.

III. RESULTS AND DISCUSSION

Year	Built up	Open land	Vegetation	Water body	Slum
2004	83.99	16.03	27.44	22.53	17.01
2012	86.09	12.69	26.51	23.76	17.95
2017	89.54	9.96	24.82	24.67	18.01

Table 2. Trends for lulc for year may 2004.2012 and 2017(km²)

➢ *Current water quality status of Mithi riiver*

Parameters	Station 1	Station2	Station3
Ph	6.70	6.83	7.34
D.O	0.3	0.8	1
TDS	2200	1722	20120
Turbidity	8.8	48.2	5.8
Alkalinity	180	184.2	344
Chloride	42.75	95.01	139.66
Sulfate	9.28	28.02	1719
TSS	NIL	51	143
Lead	0.03	0.01	0
Phosphate	NIL	NIL	NIL
COD	177	230	173
BOD	74	66	105

Table 3. Spearman'rho correlations between land use and water quality indicators

Variables	Built-up area	Vegetation	Water bodies	Open land	Slums
pH	-0.026	0.685	1	1	-0.026
D.O	0.348	-0.429	0.348	-0.513	0.348
TDS	0.685	-0.685	0.535	0.615	0.505
Alkalinity	-0.429	0.685	-0.519	0.415	-0.685
Chlorides	0.129	0.400	0.105	-0.105	0.105
Sulfates	-0.162	0.417	-0.158	0.149	-0.153
TSS	0.896	0.733	0.890	0.899	0.889
Lead	0.420	-0.200	0.422	-0.422	0.419
Phosphate	-0.139	0.318	-0.135	0.132	-0.132
COD	0.530	-0.300	0.515	-0.522	0.516
BOD	0.820	-0.843	0.840	-0.843	-0.843

Table 4.2 shows that the correlation between two variables is as follows

➢ *Very Strong positive correlations are between*

- pH, chlorides with water bodies and open lands.
- TSS and BOD with built-up area
- BOD with water bodies.

➢ *Very strong negative correlations are between*

- BOD with vegetation, open land, slum area
- TSS with vegetation

➢ *Strong positive correlations between*

pH and alkalinity with vegetation and TDS with built up area.

IV. CONCLUSION

- Based on the water quality results, the some of the water quality parameters are not within the water quality target. However, some parameters that are not may lead to deterioration of the water quality in Mithi River.
- Also the current water quality status of river shows that BOD is high at the origin and end point .And Chlorides and Total dissolved solids are found in large amount at Mahimcreek. The amount of sulfate is higher at end point there is lower salinity at first and second point.
- Based on LULC Analysis conducted. it is found that built up area has been increasing at faster rate while the vegetation and open land decreasing from 2004 to 2017.
- Land cover and land use are impacting on the water quality of Mithi River. There was a strong significant relationship between some water quality parameters and LULC. The parameters that had strong relationship were 6 out 12 i. e pH, chlorides, TSS, BOD, TDS, alkalinity.

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