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STORMWATER MANAGEMENT FOR PIMPARI CHICHWAD CITY USING GIS

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Abstract - One of the main challenges posed by global and local environmental changes is the In spite of step-up efforts at reducing the risks of flood, the frequency and magnitude of the floods have more than doubled in recent years. It has become more frequent and evident in major Indian cities owing to several reasons like haphazard alterations in land use–land cover (LULC), escalation in the amount of precipitation by virtue of climate change and related impacts due other hydrological changes augmented with deterioration of life and properties. Due to urbanization most of the city has gotten embedded in concrete and by the virtue of which the rainfall gets converted to runoff. Design of Strom water drainage systems in cities are very old unfitting for accommodation of increased runoff as a consequence of which Pimpari Chinchwad city is facing reckless Water Logging Problem. So, to eradicate and abolish this problem various sustainable, eco-friendly, economical and universally accepted techniques are discussed in this paper. Geographic Information System (GIS) is used to integrate the suggested sustainable technologies in the vulnerable flood spot in Pimpari Chinchwad city

Key Words: Arc GIS; SWD; Flooding.

1. INTRODUCTION

Pimpari chinchwad is the most developed industrial area in Maharashtra State. It is situated in the north western side of Pune. City is known for its industrial development. It has multiple IT, Manufacturing industries. It is located at 530 m above the mean sea level. It is located between north latitudes 18° 37' and east longitudes 73° 48'. It is surrounded by bordering limits of Pune Municipal Corporation in the South and South-east, Chakan in North, Talegaon dabhade in west. Pimpari chinchwad area has three rivers, Indrayani in north, in south it is bounded by pavana river which further meets to Mula river near dapodi. At city has catchment area of three rivers it becomes crucial to study the storm water management in PCMC area. In historic period main grounds of flooding used to be the excessive rainfall. But now a days, as the cities increasing and growing rapidly, paved areas are also increasing which is resulting into lesser infiltration and increased runoff and causing the urban flooding and water logging. Urban flooding is the situation when water overflows from the designed storm water drains and flows on roads, into houses. This has been witnessed multiple times in Pimpari chinchwad. Pimpari chinchwad city is one of fastest growing urbanization in India. Increasing urbanization has given rise to increase in surface runoff. In hydrological studies, LULC change and its hydrological impacts on design of drainage system are the major topics of research in the recent years (Amini et al. 2011; Chen et al. 2009; Fox et al. 2012; Sayal et al. 2014;).

The research is to carry out Hydrological analysis and thematic mapping of selected study area in Pimpari chinchwad city. Due to Urbanization, concrete embedded surface has increased enormously in PCMC which has reduced the infiltration of water into subsoil owing to which quantum of surface runoff has increased in study area. By the virtue of which, the city generally faces the problem of Water Logging. study has to carried out the LULC change by comparing 2003 and 2022 LULC data for catchment area for study area to understand the impact of LULC on the increase surface runoff which contributes to peak flood discharges in catchment of study area.

1.1 Landuse Land Cover

Total discharge in catchment of study area is which is analyzed with help of Rational Method as : Q=C*I*A/3.6

Q=Discharge (m3 /sec), C= Runoff Coefficient, I= Intensity of Rainfall (mm/hr), A= catchment area (sq.km)

Landuse landcover map of city indicates the manner in which land in city is getting used. Landcover of last two decade is shown in map below for the years 2003, 2013, 2022. Landcover map shows distribution in categories like built-up, Vegetation, Waterbody and barren land (Open land). Change in landcover is shown is shown in table no. 1.

Table 1 PCMC - Landuse Landcover change from 2003 - 2022

Sr. no.	Landcover type	2003	2013	2022
1	Built up area	85.74	105.76	137.26
2	Waterbody	18.37	40.63	28.15
3	Vegetation	2.14	1.92	1.25
4	Barren land	114.65	70.91	54.25

Surface runoff of PCMC city for last two decade shows around 60% increase in surface runoff. This increase in runoff creates pressure on drainage system. As PCMC city is growing city and population is expected to grow by 35% from 2021 to 2031(CDP, PCMC). Increase in population will result in increase in built-up areas creating concerns about increasing surface runoff. To deal with increasing surface runoff it is necessary to Measure and necessary action to curb the surface runoff. To curb the surface runoff strategies like retention pond, green roofs, use of pervious concrete etc are necessary.

1.2 Surface runoff

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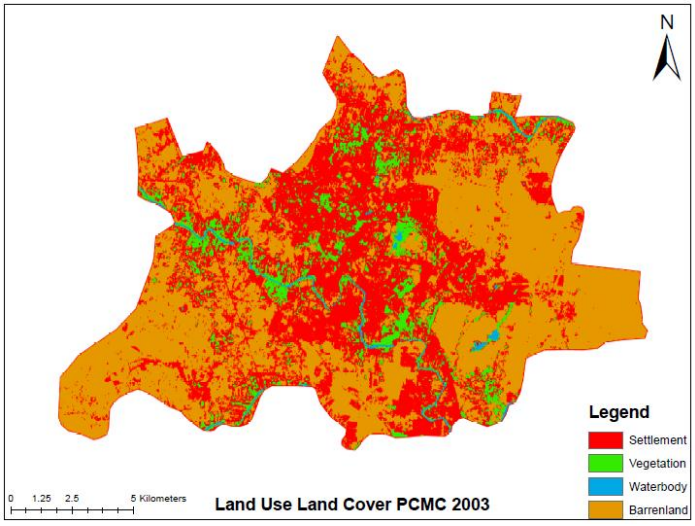
Table 2 Surface runoff calculation for PCMC.

Sr. No.	Year	Total built up area (sq.km)	Surface runoff (m3 /sec)	% Increase.
1	2003	85.75	5158.69	-
2	2013	105.76	6363.22	23.36%
3	2022	137.26	8258.47	60.08%



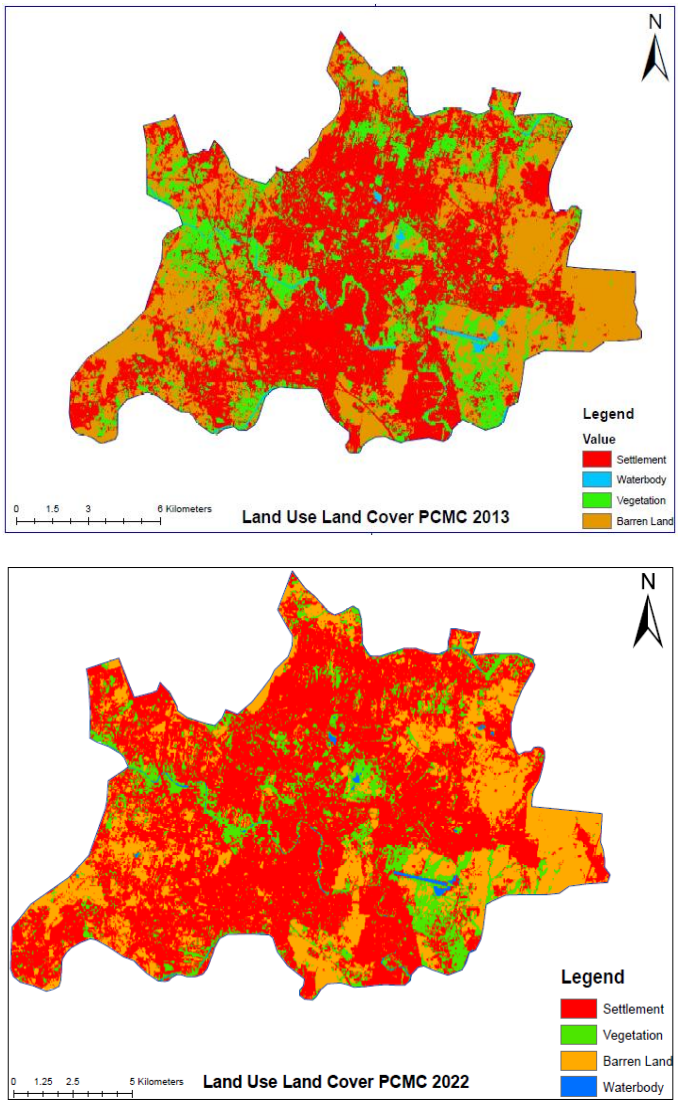
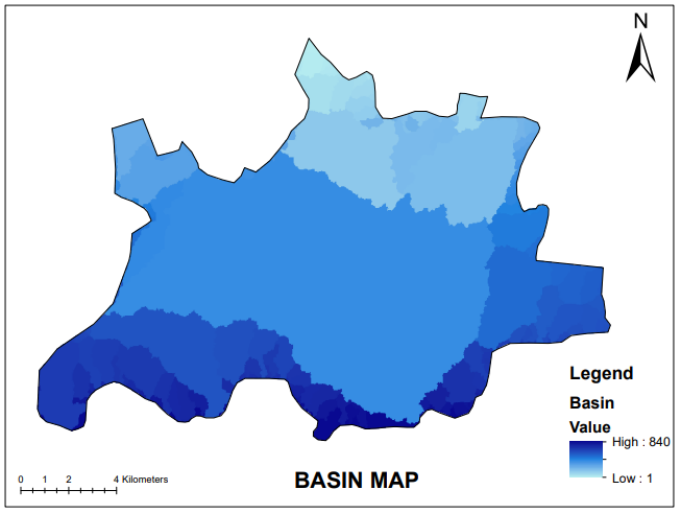


Figure 1The Image showing result of LULC of Study area for Year-2003, 2013, 2022 by supervised classification in GIS software.

2. STUDY AREA

A drainage basin is any area of land where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water. City is divided into multiple river basin on basis natural topography and drainage pattern as shown in map below. Pavana river has largest river basin due to ridges in southern and northern part of city. Multiple small basins also city area. To constraint of time and manpower it is difficult to study of city drainage issues and urban flooding problem of whole city in details. For the purpose of detail analysis and proposals only one river basin is selected as the study area.



2.1 Methodology:

Urban flooding is a natural calamity which cannot be eliminated completely to prevent the losses occurred from it alternative solution can be provided. The data collected with regard to PCMC and selected basin area comprises of satellite images, toposheets, drainage network of city. QGIS software is utilized for hydrological analysis of study area to generate Contour map of area with interval of 1 m, Flow direction map, Flow accumulation map and base map of study area. These maps and analysis are used to understands the vulnerable areas in selected basin and is highlighted in the map shown below.

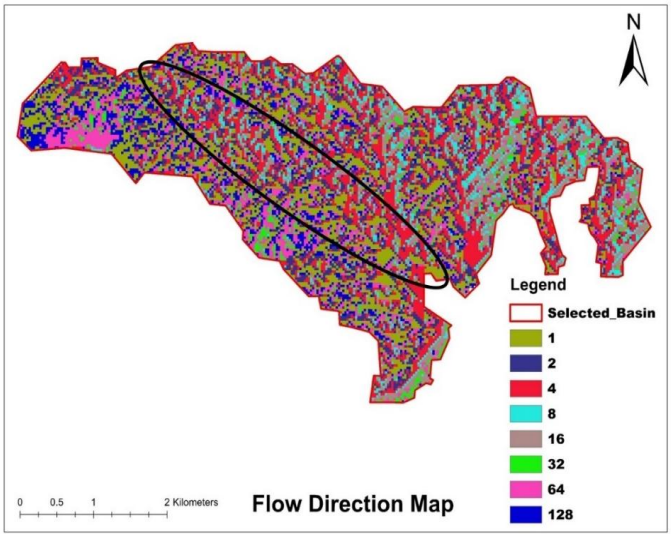


Figure 2 Map showing the vulnerable area for urban flooding in selected basin

2.2 Result and analysis:

In PCMC city, multiple reasons are contributing to storm water problems and urban flooding like lack of drainage network, lack of proper storm water drains, encroachment on catchment of water bodies, increase in built up areas. To improve the situation following proposals can be implemented;

1) Provision of proper drainage network in whole city.

2) Encroachment on the catchment areas should be restricted by means of demarcating multiple catchment zones and highlighting activities allowed and restricted in those particular zones.

3) Facilities like infiltration zone to be provided. 3 Locations are identified for proposal of retention pond in the zone identified with help of flow direction and flow accumulation as shown in map below. The table above provide the details of tranches provided. Annual maintenance of trenches will require after monsoon season to remove debris and maintain the efficiency.

Site	Technique	Length	Width	Depth	Cost required	Efficiency
1	Boundary Lining or array	300 N-S (3 trenches) 340E-W (2 Trenches)	4 Ft	1 Ft	13,94,000 rs	98 %
2	Boundary Lining	200 N-S (2 Trenches) 180E-W (2 Trenches)	2 Ft	1 Ft	6,84,000	98 %
3	Boundary Lining	200 N-S (2 Trenches) 230E-W (2 Trenches)	2Ft	1 Ft	7,74,000	98 %
	Total				28,52,000	

4) With increasing built up area non pervious surface is increasing, so along with facilities like retention ponds, use of pervious concrete should also be promoted. On all the roads falling within identified zone must be provided with pervious cement concrete curbs. Some of the roads are identified for mandatory provision of pervious cement concrete as shown in map below.

Figure 3 Map showing locations Proposed for retention pond

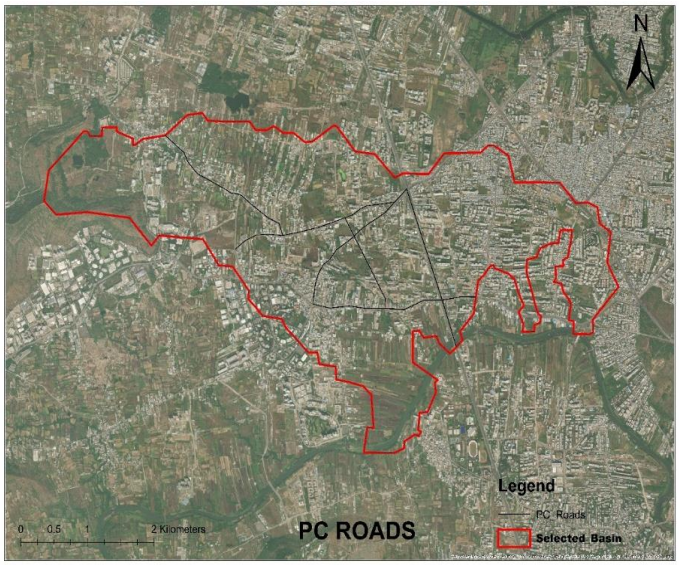


Figure 4 Roads identified for implementation of pervious cement concrete

3. CONCLUSIONS

As a result of growth in population, urbanization and industrialization, cities are getting converted into concrete jungle. This rapidly changing land cover in conjunction with limitations of drainage system and changing climatic condition are giving rise to condition like urban flooding. Difficulties in changing the infrastructure of citywide or restricting the growth of city is suggesting the need for alternate facilities. To reduce the surface runoff in the city multiple alternatives like percolation tank, infiltration trenches, use of pervious concrete can be implemented. Locations where these facilities can be implemented are by understanding topography, contour, slope, different hydrological analysis like flow direction, flow accumulation etc. This study was focused on generation of these analysis for PCMC city with help of QGIS software where different location where the alternatives can be placed are identifies. This methodology can be implemented in other cities also to identify location ot implement alternative strategies.

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