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URBAN SPRAWLS IMPACT ON HYDROLOGY OF SANGLI-MIRAJ-KUPWAD CITY

K. C. Ramotra
Professor, Department of Geogrpahy, Shivaji University, Kolhapur.

Short Profile

K. C. Ramotra is a Professor at Department of Geogrpahy in Shivaji University, Kolhapur.

Co-Author Details :

R. G. Jadhav[2] and Pradip A. Saymote[3]
[2] Research student, Department of Geogrpahy, Shivaji University, Kolhapur.
[3] Department of Geogrpahy, Willingdon College Sangli.

ABSTRACT:
Cities are very dynamic and growing at very fast rate. It is just like an organism that never remains static. Growths of cities are creating the urban sprawls which are unauthorised, undesirable form of development. Even sometimes they are unhygienic slums and polluted environment due to loss of open space by the population pressure and unhealthy not only for the city dwellers but also for the tourists. The present paper intends to analyse the construction of buildings for residential purpose over the natural streams that creates hydrological effects such as blockages for the natural flow and limit their capacity to convey floodwaters. The changes in the natural drainage system by sprawls are demarcated with the help of satellite image and buffer zones developed with the help of GIS. It endeavours to identify changes from urban built-up area that have increased frequency of high flows, redistribution of water from base flow and changes in stream directions. The study carried out for Sangli-Miraj-Kupwad (SMK) city which is only one Municipal Corporation and the biggest urban centre in Sangli district of Western Maharashtra. The confined study concluded that the hydrologic effects of urban development must be addressed for restoration of urban streams which is the main intent of this paper.

KEYWORDS
Urban sprawl, Hydrologic impact; Problems and Town plan.

INTRODUCTION

Cities being a dynamic organism never remain static. Dynamic and growing cities are creating an alarming situation in all countries of the world. In 2014, more than 54 per cent people in the world resided in urban areas as a result of rapid urban growth (United Nations, 2014). Growing cities have been creating an urban sprawl. The urban growth and sprawl phenomenon had raised challenges for many countries in both the developing and developed worlds.

Sprawls are unauthorised, undesirable form of development, haphazard and unrestricted growth of a city which gives rise to problem like unhygienic slums, polluted environment, patternless development of residential, industrial and commercial areas. It creates traffic bottle neck and many other problems all known and felt by resident of the city. It has also led to serious landuse problems such as loss of agricultural land, unauthorized urban sprawl (Shekhar, 2007), high land values, speculation in land, energy challenges, climate change, hydrological modification, ecological change and other related problems. Among the many aspects of sprawl the stream modified by urbanization, changes in hydrologic regimes (i.e., the timing and rate of streamflow) and development of flood are the main focus of this paper.

"Urbanization" is not a single condition; instead, it is a collection of actions that lead to recognizable landscape forms and, in turn, to changes in stream conditions. No single change defines urbanization, but the cumulative effect of human activities in urban basins profoundly influences streams. The influence of hydrologic modification is likely to vary from stream to stream and region to region.

STUDY AREA

Sangli-Miraj-Kupwad Municipal Corporation (SMKMC) is located at Sangli District in the western part of Maharashtra state, India. Sangli city is the district headquarters of Sangli district and is one of the prosperous growing cities in Western Maharashtra. This city is located on the left bank of Krishna River and extends between 74031'08" E to 74040'51" E longitude and 16046'28" N to 16053'45" N latitude. The town is well connected to nearby cities like Kolhapur, Satara, Belgaum, Bijapur etc. It is located 50 km off N.H. No 4 (Mumbai-Bengaluru). In 2001 population of SMK city recorded 4,46,303 and 5,02,697 with growth rate 12.63% in 2011. Sangli city recorded minimum temperature 14.0 Celsius and maximum temperature 42.0 Celsius. The average rainfall is received 400-450 mm and city has flat terrain topography.

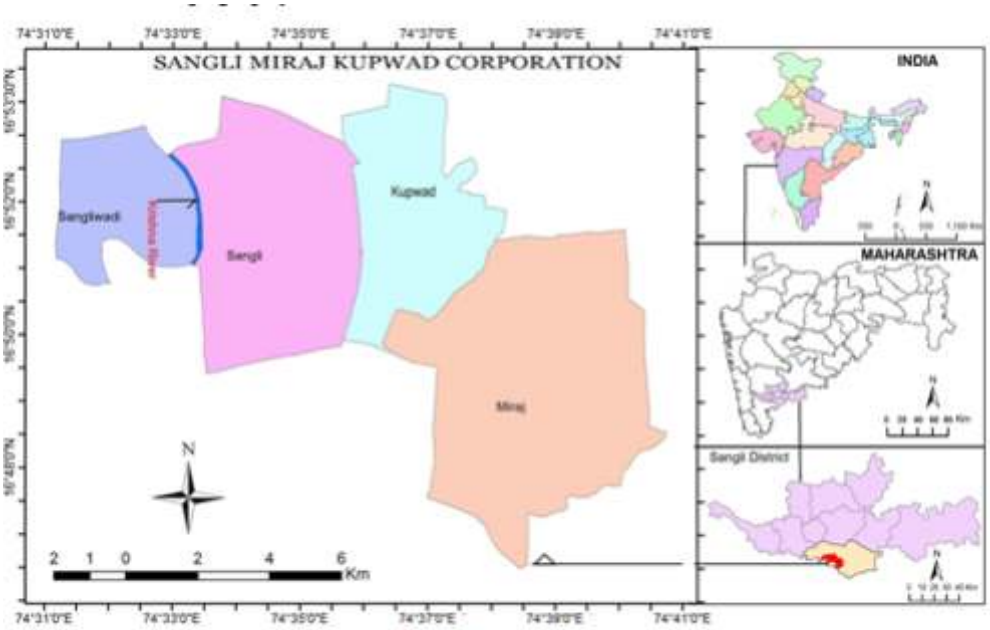

Fig.1 Study Area

Objectives

The main objective is to comprehend the hydrological impact of urban sprawls in Sangli-Miraj and Kupwad city. The related objectives are:

- To demark and identify the urban sprawl on the stream.
- To examine existing drainage system to highlight its lacunas for devising a suitable development planning for the study area.
- To assess the flood condition and its causes and control to prevent livestock and property loss of city dwellers and others.

DATABASE AND METHODOLOGY

In this study both primary and secondary sources of datasets are obtained and analysed. The study of drainage system and streamflow in Sangli-Miraj and Kupwad city is carried out with a comprehensive survey conducted on 16-Jan-2014. High resolution Satellite datasets are used for analysis of urban sprawl in the buffer of the stream and mapping purpose. The collected data is tabulated in proper order and graphical representation is carried out. The GIS is used for analysis and cartographic representation of sprawl. City area water quality and the health problem occur due to settling of mineral water bottles of tourist and visitors to the city along with in use of plastic bags. Such uses causing hovels in the city and bringing the city's functioning stand still.

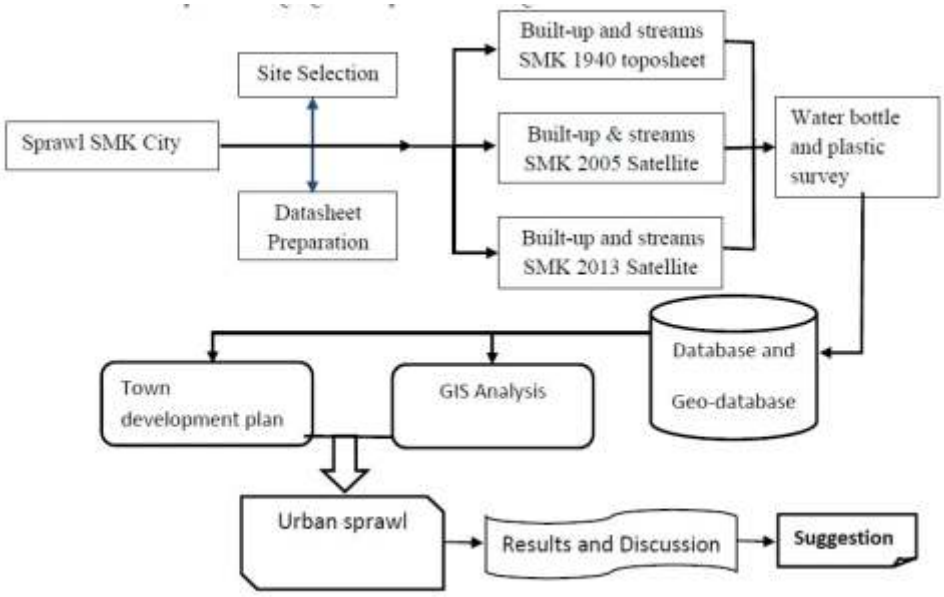

Fig.2

RESULT AND DISCUSSION

Streams are not simply storm water conveyances. Streams are complex ecosystems with morphological characteristics that are dependent on appropriate geomorphic dimension, pattern, and profile as well as biological and chemical integrity. Proper stream function also includes the transport of water and sediment produced by the stream's watershed in dynamic equilibrium. Dimension includes a stream's width, mean depth, width/depth ratio, maximum depth, floodprone area width, and entrenchment ratio. Pattern refers to a stream's sinuosity, meander wavelength, belt width, meander width ratio, & radius of curvature, and profile includes the mean water surface slope, pool/pool spacing, pool slope, & riffle slope. Natural stream channel design addresses the entire stream system. It is based on fluvial geomorphology, local climate, geology, topography, vegetation, and land use, how a river carves its channel within its landscape.

DRAINAGE:

Fig 3 Source: SOI Toposheet 2005

In study area Krishna is the main River. The Krishna River is one of the most important peninsular Rivers in central-southern India. The Krishna River is the third longest river in India after the Ganges and the Godavari River. The river is almost 1,300 km long.

Sheri Nala is originating at Kupwad at an elevation of 590 m and flows through Budhgaon, Madhavnagar and Sangli city. It is a fourth order nala with a length of 18.21 km. Kupwad to Budhagon it flows in south to north direction and east to west from Budhgaon to Madhavnagar and turns in north to south direction in Sangli City. It has dendritic pattern. It is a perennial stream due to the discharge of industrial pollutant water. Major area of Sangli city is drained by Sheri Nala .

Miraj Odha (stream) originates in the village Manmodi at an elevation 635 m above mean sea level. It flows through Manmodi, Kanadwadi, Savali, Miraj MIDC and Miraj City and joins Vaddi Odha. It is a third order stream and the total length of this river is 13.21 km. Miraj Odha has only one tributary and it is in the western part of Miraj. Miraj Odha has parallel drainage pattern. Major area of Miraj city is drained by Miraj Odha. In study area the length of the 1St order streams is 48.28 km and 3rd order stream is 23.42 Km. The length of the 4th order streams is only 11.39Km. These streams eroded the urban land and creating undulating land surface.

Table- 2.2 Stream Order

Order	Stream Length (m)	Name	Stream Length (km)	Order
1	48283.85	Sheri Nala	18.210	4
2	31205.97	Miraj Odha	13.213	3
3	23427.71			
4	11396.22			

Source: Calculated from SOI Toposheet 2005

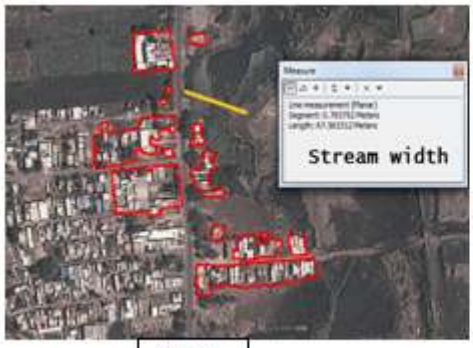

Plate1

Plate2

These streams were surveyed in the rainy season and calculate the width of the streams. Based on the stream order and average width for perticular stream, the buffer zone define as 1st order stream is 10 metre, 2nd order stream is 20 metre, 3rd order stream is 40 metre and 4th order stream is 60 metre. This buffer zone is created in GIS environment and 954 houses are shown in the river buffer zone which accupy builtup area 226.21 hectores.

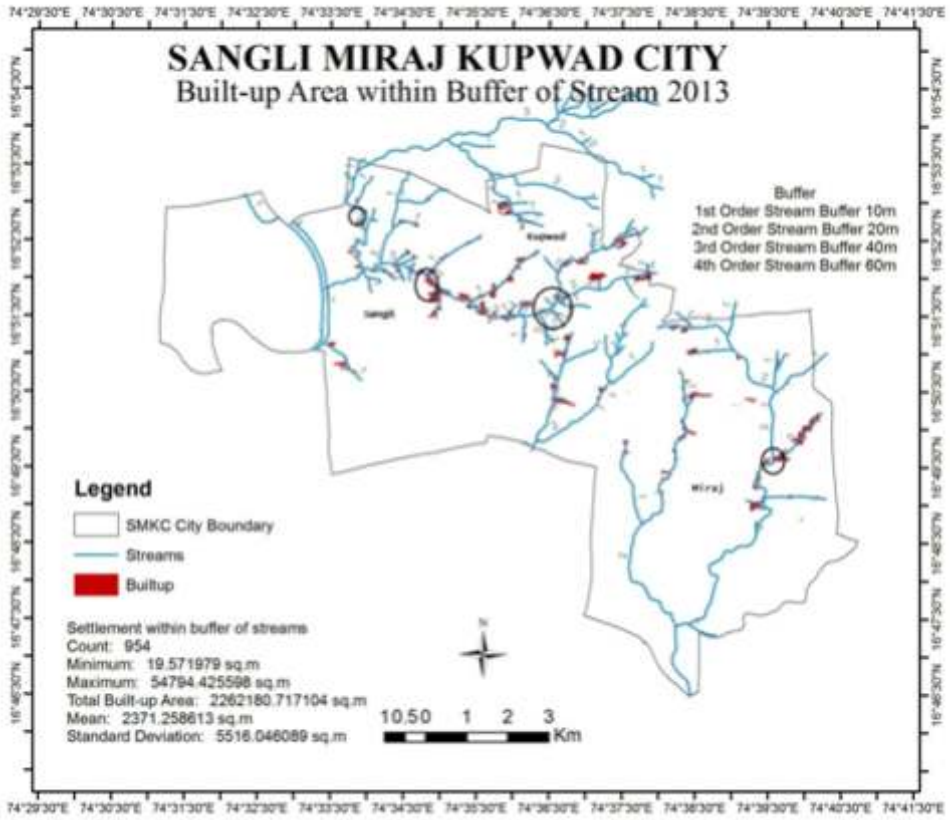

Fig. 4 (Source: Based on Satellite image 2013)

The urban development has hydrologic effects. Streams are fed by runoff from rainfall. Floods occur when large volumes of runoff flow release into streams and rivers. The peak discharge of a flood is influenced by many factors, including the intensity and duration of storms, the topography and geology of stream basins, vegetation, and the hydrologic conditions preceding cyclone rain.

Land use and other human activities such as waste dumping in stream also influence the peak discharge of floods. It is modifying path of natural streams and surface runoff (plate 6). In undeveloped areas such as forests and grasslands, rainfall is stored on vegetation, in the soil column, or in surface depressions. In the north of Sangli city at Sheri Nalla the natural vegetation protect the stream width particularly in rainy season.

Some of the streams are totally leveled or filled using earth material by the developers or owner for sold as residential plots in SMK city (plate 2). Building connstruction patches are observed on streams of SMK city, as a result roads are blocked at several places. The muddy, polluted water of flood also affect the pure water. The plate 4 shows the roads are constructed on the streams which creats the flood condition in residential area.

Plate3

Plate4

When this storage capacity of stream is filled by the urban waste then runoff flows become slow through soil as subsurface flow. On the contrary, urban areas, where much of the land surface is covered by roads and buildings, have less capacity to store rainfall.

Plate5

Plate6

The changes in land use associated with urban development affect flooding in many ways. Removing vegetation and soil, grading the land surface, and constructing drainage networks increase runoff to streams from rainfall. As a result, the peak discharge, volume, and frequency of floods increase in nearby streams. Changes to stream channels during urban development can limit their capacity to convey floodwaters. It is observed that the settlement were estblished near or within the stream which is shown in plate 1. In the rainy season such residential areas facing a problem of flood which is shown in the plate no 3,4,5 and 6. The roads and buildings constructed in flood-prone areas are exposed to increased flood hazards, including inundation and erosion, as new development continues. Construction of roads and buildings often involves removing vegetation, soil, and depressions from the land surface. The permeable soil is replaced by impermeable surfaces such as roads, roofs, parking lots, and sidewalks that store little water, reduce infiltration of water into the ground, and accelerate runoff to ditches and streams. All successful natural stream channel designs achieve sediment transport, habitat enhancement, and bank and channel stabilization.

In Sangli-Miraj-Kupwad (SMK) Municipal Corporation, 51 wards out of the 68 have underground drainage (UGD) facility with some wards being only partially covered. Consequently, about 99 per cent of the sewage generated by the Municipal Councils and over 50 per cent of sewage discharged by Municipal Corporation goes untreated. In many cases, the sewage treatment plants (STP) constructed long back which have less capacity. Today they are overloaded now. Thus, the untreated sewage discharged into the river pollutes drinking water sources of many towns downstream. SMK is highly polluted due to release of effluents, mainly from sugar industry and Sangli MICD industries. All these pollutants are release in the Miraj Odha and Sheri Nala origin of the diseases.

Table- 2.2 Yearwise Attacks and Deaths due to Waterborne Diseases in SMK

Disease	1999-2001		2001-2002		2013-2014	
	Attack	Death	Attack	Death	Attack	Death
Gastro	22	3	15	3	23	7
Diarrhoea	16	2	10	1	12	2
Infected Hepatitis	12	1	10	0	18	0
Typhoid	33	0	19	1	12	0
Cholera	12	0	26	2	21	1
Total	95	6	80	07	86	10

Source: PHD GoM (2014)

These figures explained increases in the waterborne diseases in SMK due to pollutant water. Unauthorised construction (urban sprawl) in the streams buffer area created water chockup and flood problems which is one of the major causes of the said diseases. It indirectly reflected on the tourism of the SMK city and around places. In the 2013-14 year the Gastro disease deaths were appeared in the newspapers which generated the demand of mineral water bottle. The sale trend and price inflation of water bottles was observed through intensive survey. The survey conducted at the Sangli and Miraj bus stand. It was also marked price of the mineral water bottle was twice in period of diseases and demand increases due to fear of diseases, tourist avoiding the local water.

To overcome such problem information about streamflow, project design of conservation of natural stream and reduce future vulnerability of floods and diseases. The natural stream channel design is to use a stable natural channel as a blueprint. This blueprint, or reference reach, will include the pattern, dimension, and profile for the stream to transport its watershed's flows and sediment as it dissipates energy through its particular geometry and in-stream structures. It also focuses account for the stream's ability to transport water and sediment. Structures used in natural stream channel design such as vanes, cross-vanes, and root-wads create and maintain pool habitat, which is often minimal in degraded channels. The blue print is mentioned the boundary of the residential area and stop the encroachment of the sprawl. It is also infers that minimum use of plastic bags and bottles need to be alone more cleaning the streams bed to make its smooth flow within its banks.

Natural flow of stream in the city has to be maintained. The solid waste thrown out by the urban dwellers into the streams need to be addressed by educating the local and people especially the people residing nearby the river and streams.

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258/34 Raviwar Peth Solapur-413005,Maharashtra
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