International Research Journal of Human Resources and Social Sciences
ISSN(O): (2349-4085) ISSN(P): (2394-4218)
Impact Factor- 5.414, Volume 5, Issue 11, November 2018
Website- www.aarf.asia, **Email** :editor@aarf.asia , editoraarf@gmail.com

GEOGRAPHICAL ASSESSMENT OF THE URBAN SEWAGE SYSTEM: A CASE STUDY OF THE NORTHERN NANDED CITY

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Abstract

The sewage system is one of the prime amenities of the urban places. The dynamic nature of citiesnot only have the major challenges but also create the urgent need for the sustainable service of the sewage system. Basically, the proper planning has the base for to achieve such sustainability in the same. In this, the geographical feature of the land has the major consideration for such kind of strategy. Present study trying to evaluate the geographical perspectives and challenges of the sewage system. For this, Northern part of the Nanded city, the district headquarters of the Nanded, governing body of Maharashtra, India have been selected as a study area. Study indicates that, the flat surface and black cotton soil may responsible for the low sewer gradient and sewer deterioration respectively. In addition to this, the southern part of the city has major sewage crises due to the high density and number of the population and built-up, location at flood zone region, old core zone of the city, narrow street etc.

Keywords

Sewage System, Slope, Topography, Flood Zone Region, Urban Sprawl

Introduction

The artificial network of sewer design to catch, convey, collect, treat and discharge the generated sewage or wastewater and stormwater from source point to the final disposal site (Butler and Parkinson,1997; Patil, and Kulkarni, 2012). Such sewage system plays a vital role in city sanitation (Otaki et al., 2007). Now a day, the dynamic nature of the urban centres become the major challenge for to maintain the proper system of city sewage (Lüthi et al., 2010).With this problem, the term sustainable urban sewage system arises to make a balance between the issues and solution which is much closer to the environmental aspects, human wellbeing and economical balance (Lundin et al., 1999; Balkema et al., 2002; Tucci, 2008; Poleto and Tassi, 2012).Such sustainable urban sewage system only can possible with the nearly accurate, proper and appropriate planning of the same. Basically, such planning based on the present and future scenario of the city (Leopold,1968; Gupta and Nair, 2011). In case of sewage system, the geographical profile of the city has mainly considered to attain the specific goal of the urban sewage system. The features of landscape, characteristics of the nature drainage system, geomorphological attributes, dynamic of the climate, population, urban built-up, LULC etc geographical factors are very much important in the planning of urban sewage system(Carruthers and Ulfarsson, 2003; Haile, 2009; Salvan et al., 2016; Tavakol-Davani et al., 2016).

Thetopographical features of the land allow to understand the characteristics of the slope, elevation and terrain of the surface. such detail topographical prolife of the city not only helps to design the proper plan of the sewage system but also supports to understand the vulnerable sites of the settlement related with the future crises of the same i.e., urban flooding (Alho et al., 2009; Morgan et al., 2016; Salvan et al., 2016; Hong at al., 2017). While the natural drainage system is the prime factor of the total planning of the urban drainage system i.e., water supply and wastewater system. Thenatural drainagesystem has always utilized as the ultimate discharge point of the city sewage systems. While such drainage pattern provides the base map for stormwater system of the city. Whereas, the selection of sewer material and constructional depth planned with the different geomorphological attributes i.e., type and characteristics of soil, depth of bed rock and groundwater table etc. The type and amount of wastewater discharger, geographical location, length and size of the sewer etc factors of sewage system are primarily built on the kinds of geographical available and forecast data of LULC, climate, population etc (Bertrand-Krajewski, et al., 1993; Ghosh and Maji, 2011).

Many times, the unique and heterogeneous features of theland geographybecome the challenging task for the city sewage system i.e., it become quite difficult to maintain the sewer gradient in the flat, steep or undulating topography (Chughtai, and Zayed, 2008), settlement residing at flood zone region (Flood and Cahoon, 2011), unplanned growth of the city (Graham et al., 2004), population growth (Asoka et al., 2012) , groundwater and river pollution (Sonune and Ghate, 2004; Tredoux et al., 2004; Dan’azumi and Bichi, 2010; Kuroda et al., 2012), public awareness (Ringo, 2016; Singh et al., 2017) etc. Based on this, the present study trying to analyse the basicgeographical opportunities and challenges to the engineering-based system of sewage. For this, Nanded city, the district headquarters of the Nanded, governing body of Maharashtra, India have been selected as a study area. The following objectives have design for acquiring the major aim of the study.

Objectives

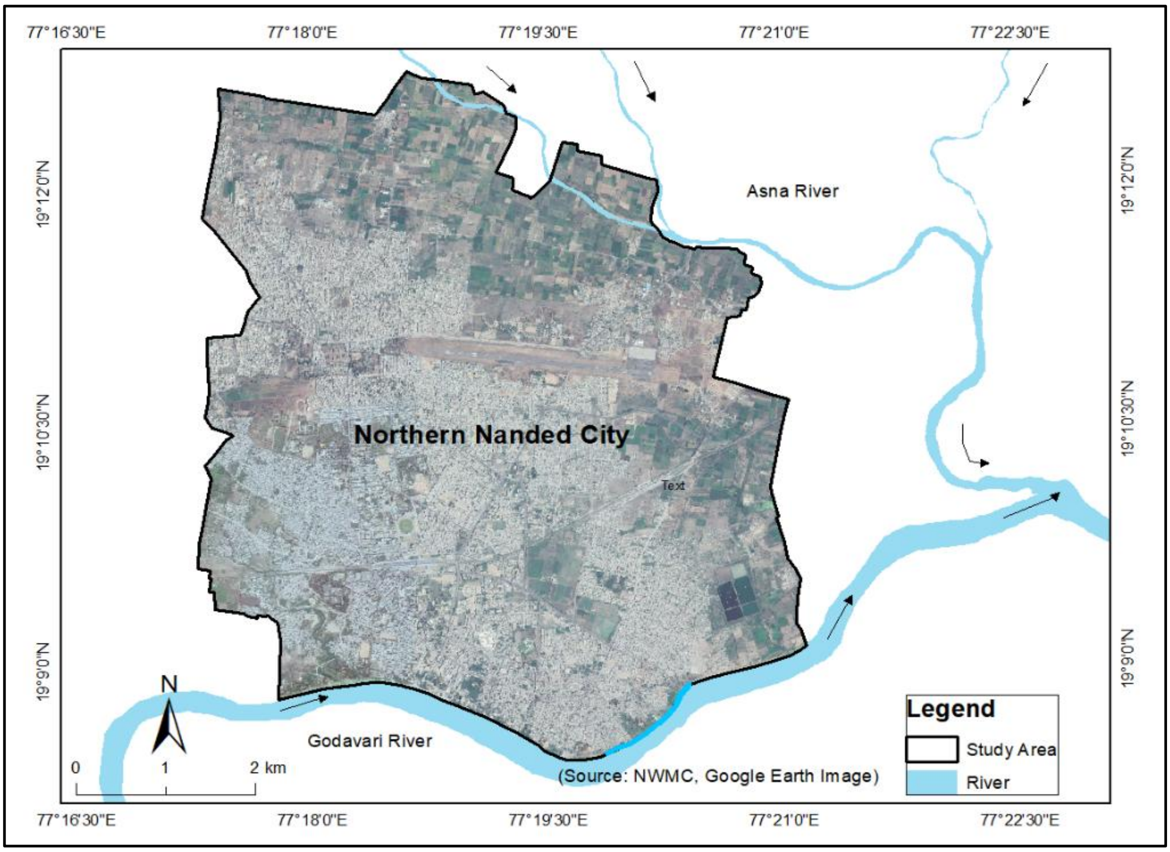
- To understand the geographical set up of the study region.
- To find out the correlation between the geographical set-up and sewage planning.
- To assess the geographical challenges and opportunity of the sewage system.

Study Area

The Nanded district is the governing body of state of Maharashtra, India. The city of Nanded is the districts headquarter of the same. Geographically the Nanded city is divided into two parts with respect to the Godavari River i.e., north and south.

For the present evaluation the northern part of the city is selected as a study region, which is situated between 19° 8’ 25” N and 19° 12’ 44” N latitude and 77° 17’ 18” E and 77° 21’ 18” E longitude (Figure 1). Total Geographical Area (TGA) of the study region is 39.11 sq km which is about 55.67 per cent of the TGA of Nanded city.

Figure 1: Location of the Study Region



Research Methodology and Techniques

The available secondary data and maps which is based on the NWMC reports, toposheets, satellite and google earth image have utilized to understand the in-depth geographical profile of the present study region. Addition to this the sewage system of the city observed and analysed with the help of sewage system maps, field visit, survey and in-depth discussion with engineers, workers and users. The correlation between the such aphysical profile and the different aspects of the storm and sanitary sewer systems of the city allows to evaluate the geographical assessment of the sewage system for the selected study region.

Result and Discussion

The geographical challenges of the sewage system have discussed as follows

1. Slope and Topography

The ideal sewer gradient gives adequate flow velocity (CPHEEO, 2013). Primarily, such ultimate standard of sewer gradient designed and correlates with the available landscape characteristics of the city. while during planning and construction of the conventional or gravity sewage system, to maintain such ideal gradient of the sewer become challenging task with the extremely higher or lower slope and undulating or flat topography. To overcome on this different techniques and method invented i.e., Vacuum and pressurized sewage system (Smith and Liu, 2017; Terryn et al., 2017)

In case of present study, the slope profile illustrated the average level topography of the city i.e., 0.12° (figure 3). while, study region having 305 to 320 m highest elevation at the middle northern part, which become narrow towards the eastern direction (figure 2). From this highest part of the city, elevation decreasing towards the rivers.

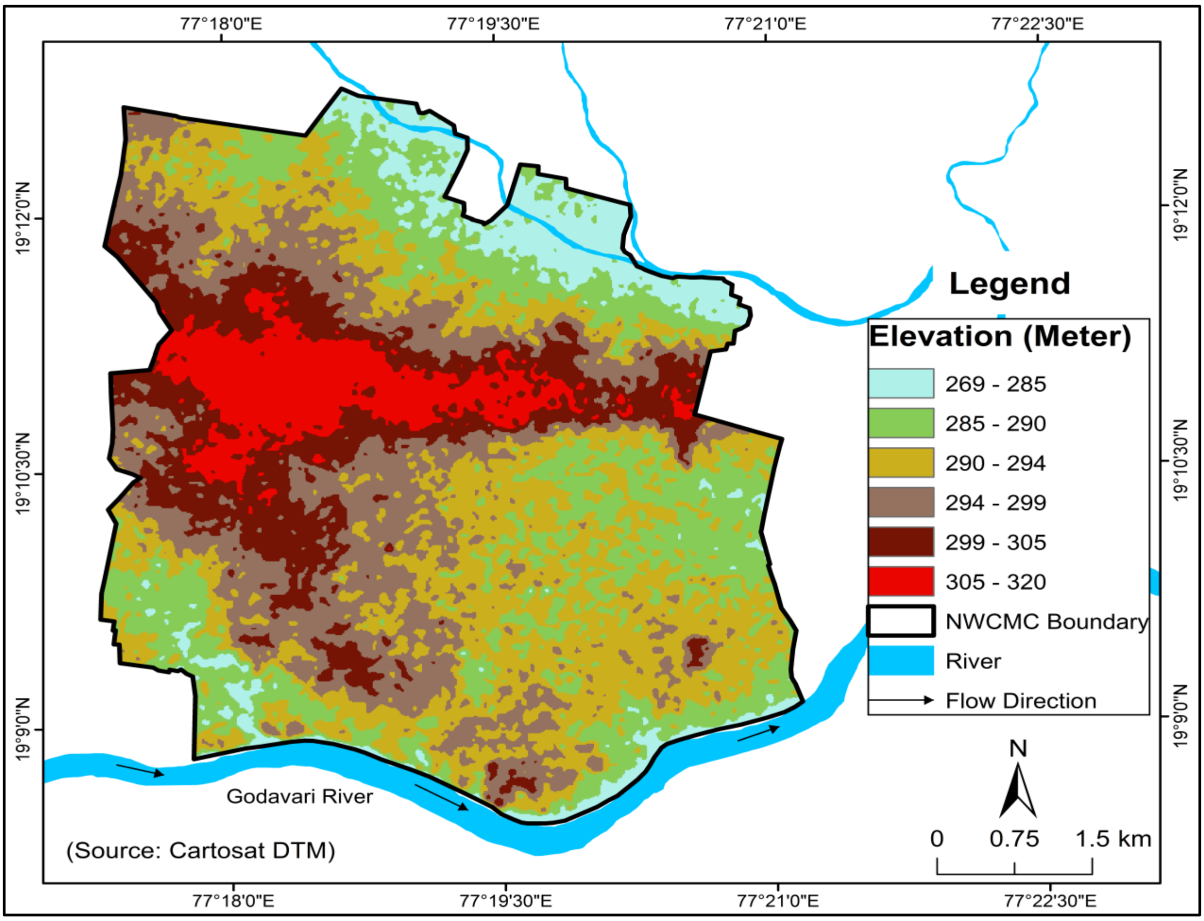


Figure 2: Elevation Map

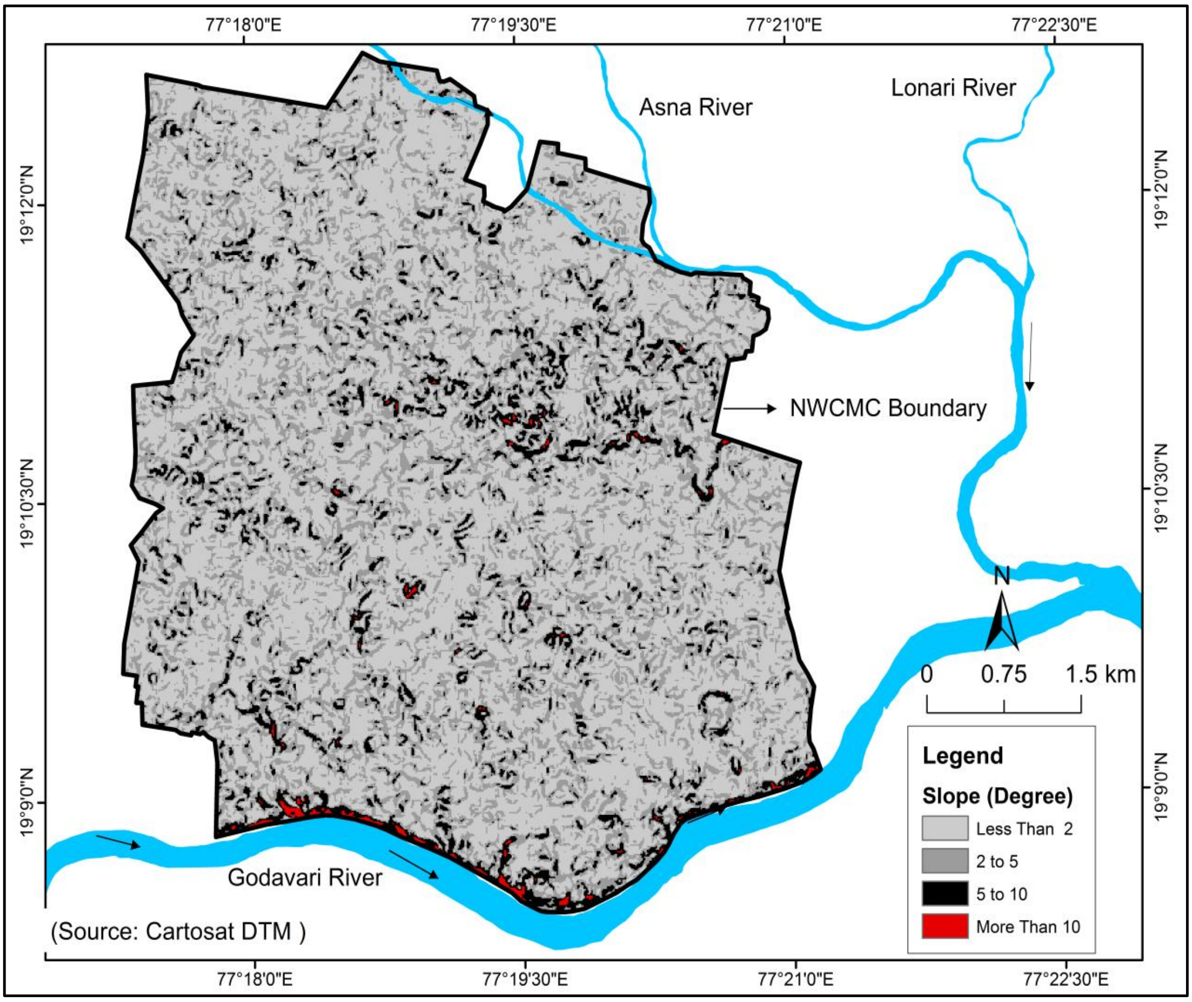
(Source: Proposed Ph.D. work by Vidhyatai Patil, SRTM University)

As an average city having the plain and or flat topography with the characteristics of the low slope surface. Based on the analysis and experience of the previous studies, the present study region may have the adequate sewage flow related challenges during the before and after construction of the city sewage system.

2. Natural Drainage System

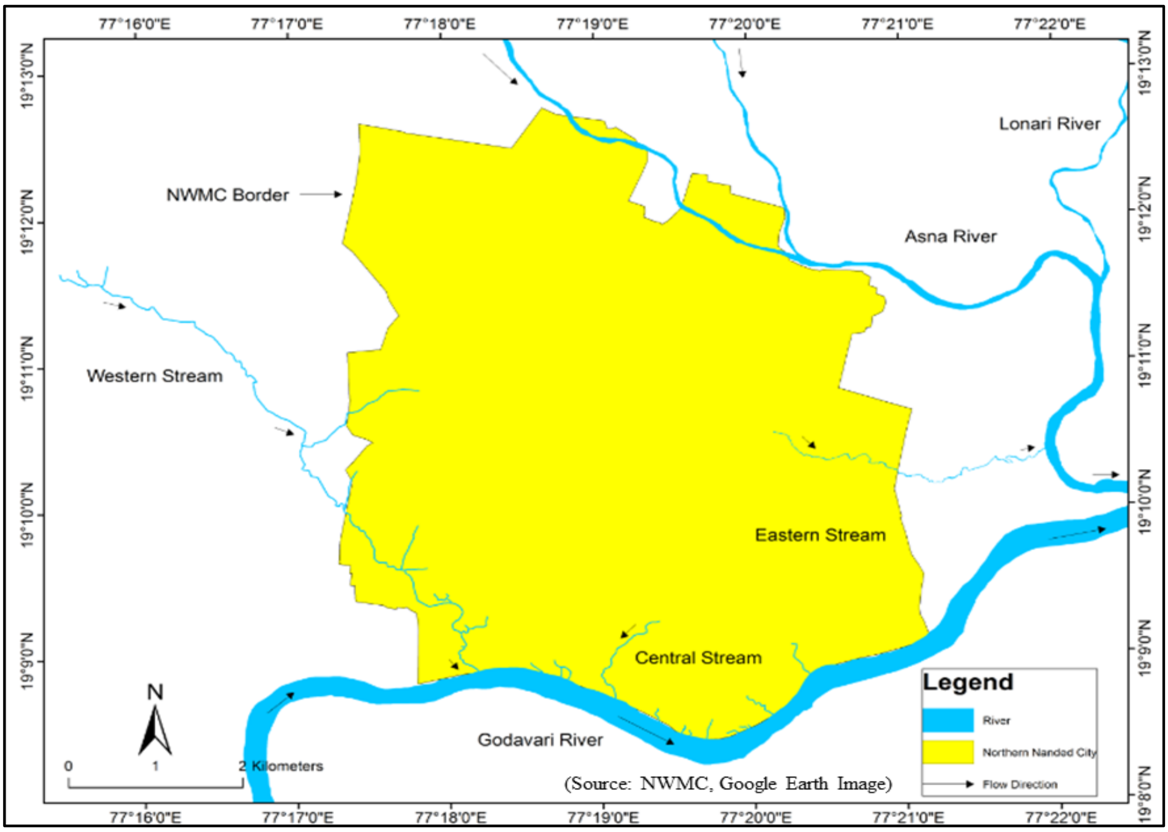
It has the close correlation among the available natural drainage and the planning and construction of the city sewage system (Butler and Parkinson,1997). As shown in figure 4, the present study region situated under the vicinity of Godavari River and its tributaries. The study area divided in to five catchment areas of the sub-streams of the Godavari and Asna Rivers. Specially, total planning of the storm water system of the city has designed with reference to such geographical natural drainage profile of the region. In the present study, such correlation has found between the natural drainage and artificial network of the sewers (NWCMC, DPR, 2009). Particularly, such natural drainage profile helps to provide the accurate direction of the sewer flow and the site for STP location.

Figure 3: Slope Map



(Source: Proposed Ph.D. work by Vidhyatai Patil, SRTM University)

Figure 4: Natural Drainage System



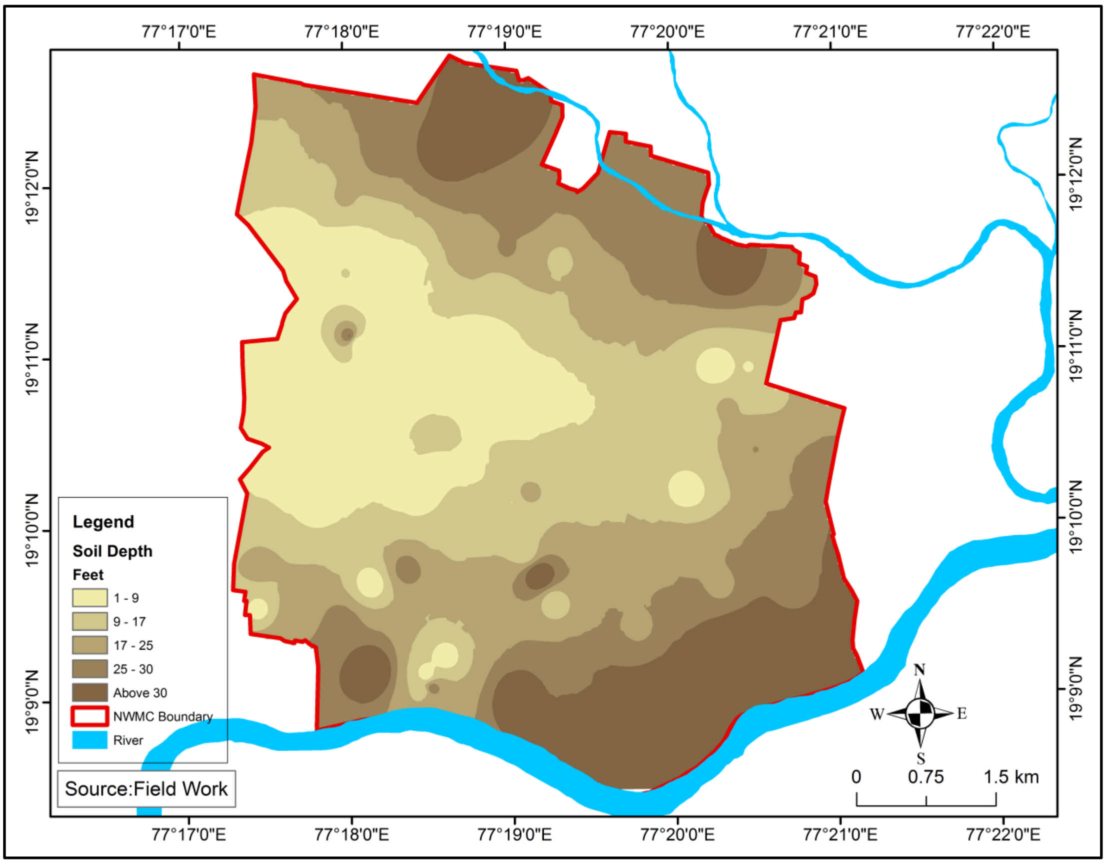
3. Geology

The geological characteristics of the region i.e., depth of bed rock and ground water level are become extremally important while the planning and construction of the underground sewer systems. Figure 5 shows the geological profile of the study region, indicates the depth of bed rock has increased from the northeast part pf the city toward the rivers. Whereas, the pre- and post-monsoon water level observed between 10 to 15 and 4 to 10 m respectively (source: Nanded Microzoning Study by SRTMU, Nanded; NGRI, Hyderabad, IIT Hyderabad and Scicence Collage Nanded, 2010-2013, Unpublished Report). The depth of bed rock close to the crises related with excavation and construction cost while the ground water level subjected with the infiltration issues of the sewer.

4. Soil

Like the geological factors, the characteristics soil i.e., type and depth both are important for the assessment of structural crisis of the sewer (Kley and Caradot, 2013). The present study region covered with black cotton soil. The soil depth increased towards the rivers, where the southwestern part of the city has found the highestdepth i.e., 25 to above 30 m. Basically the characteristics of such black cotton soil is become the challenge task for the construction and before age deterioration issues of the sewer (Mutua and Agwata, 2017).

Figure 5: Soil Depth Map



(Source: Proposed Ph.D. work by Vidhyatai Patil, SRTM University)

5. Climate

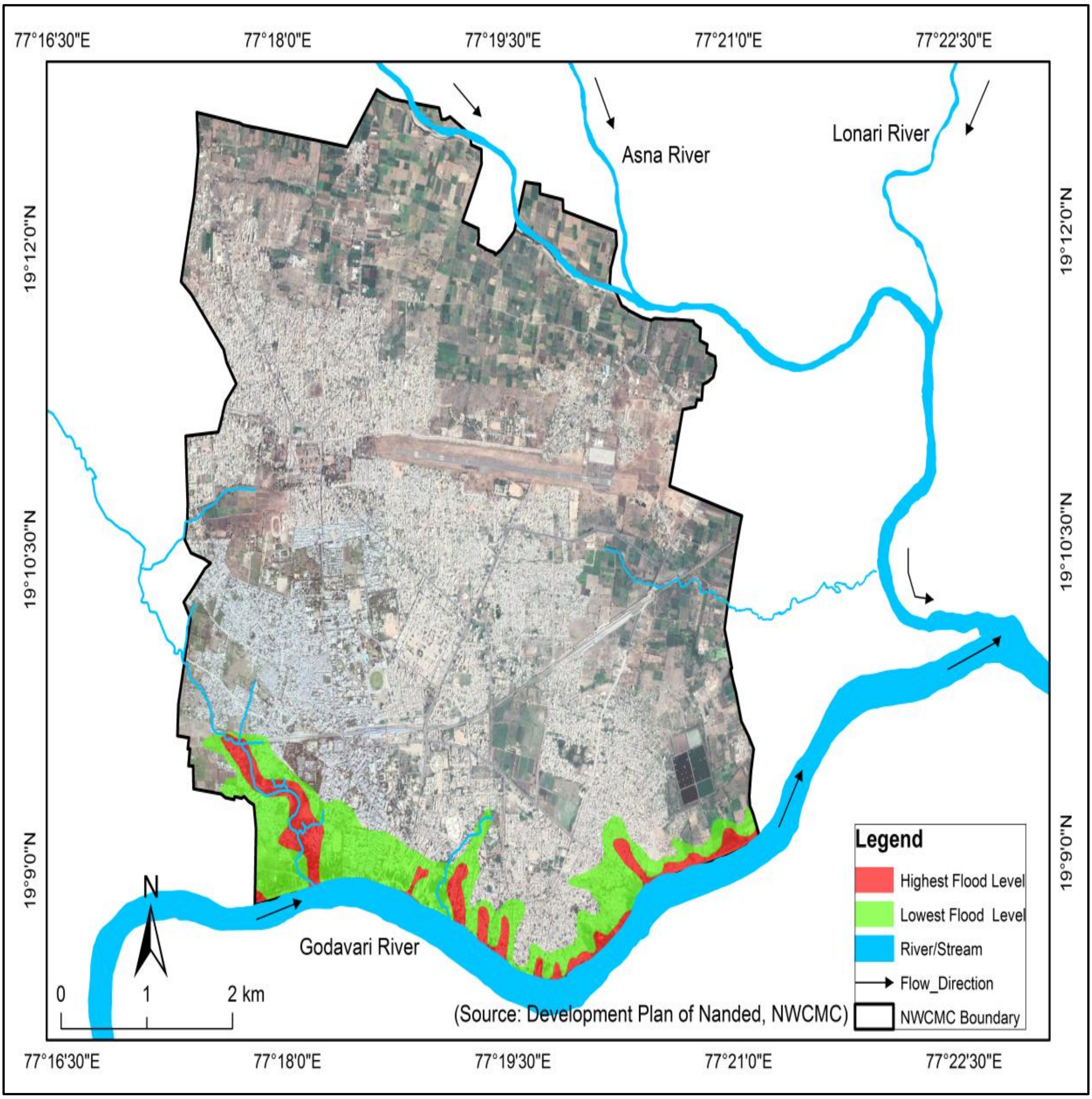
The average temperature and rainfall graph of the region has directly and indirectly correlate with the hydraulics of stormwater and sanitary sewer systems (NWCMC, DPR, 2009). In the present study region, from June to September about 93.08 per cent precipitation received by the monsoon wind. While the lowest rainfall observed during December, January and February months [https://en.climate-data.org; 2) IMD, Pune]. Such climatic data become extremely important for the pre-planned sustainable design of the sewage hydraulics.

6. Urban Flood Zone Region

According to the flood zone map, the per-urban settlement has situated vicinity of the Godavari River, which is known as the old core zone of the city (figure 7). With this respect, the city has expanded around same. With such kind of city growth, the majority of residential, public and semi-public, educational areas have residing the effect of flood zone region (figure 7).

In the planning of urban flood risk management, the flood zone region is the most vulnerable area of the sewage catchment. the southern part of the city, specially located along the left bank of the Godavari River come under the effect of flood zone region (Figure 7). As shown in figure 7 about 1.04 and 2.49 sq km region of the total geographical area of the study region covered by the highest and lowest flood zone.

Figure 6: Flood Zone Map



(Source: Proposed Ph.D. work by Vidhyatai Patil, SRTM University)

7. Urban Sprawl

Similar to the other geographical factors, the unplanned growth of the built-up and the present and will be enlarged restricted municipal corporation boundaries are the vital consideration of the long-term sewage system planning (Roux, et al., 2011). Figure 7 and 8 showing the past year changes and expansion of the urban sprawl and municipal corporation bounders of the study region. Due to the natural frontiers of Godavari and Asna Rivers, city has expanded towards the west and northwest direction (figure 7). Such geographical profile of the city helps to figure out the potential number and location of the new connections and possible linking to the old sewer.

Figure 7: Built-up Expansion

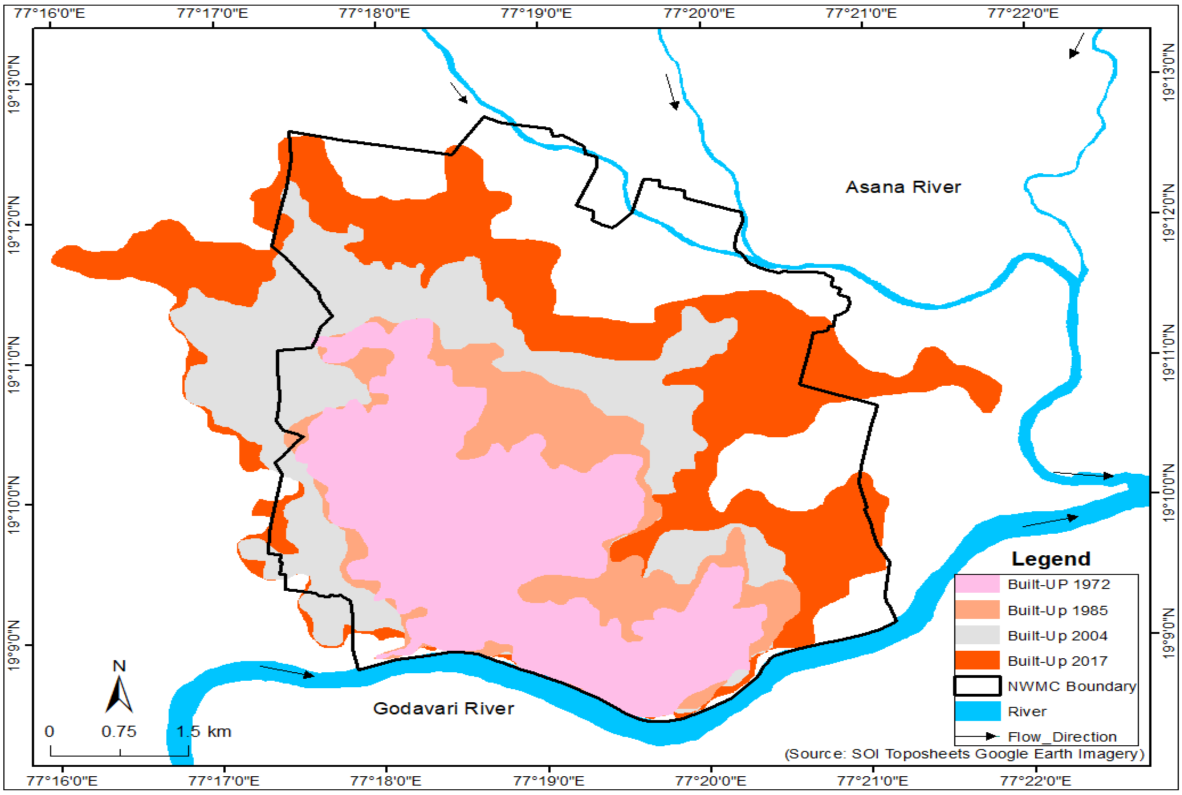
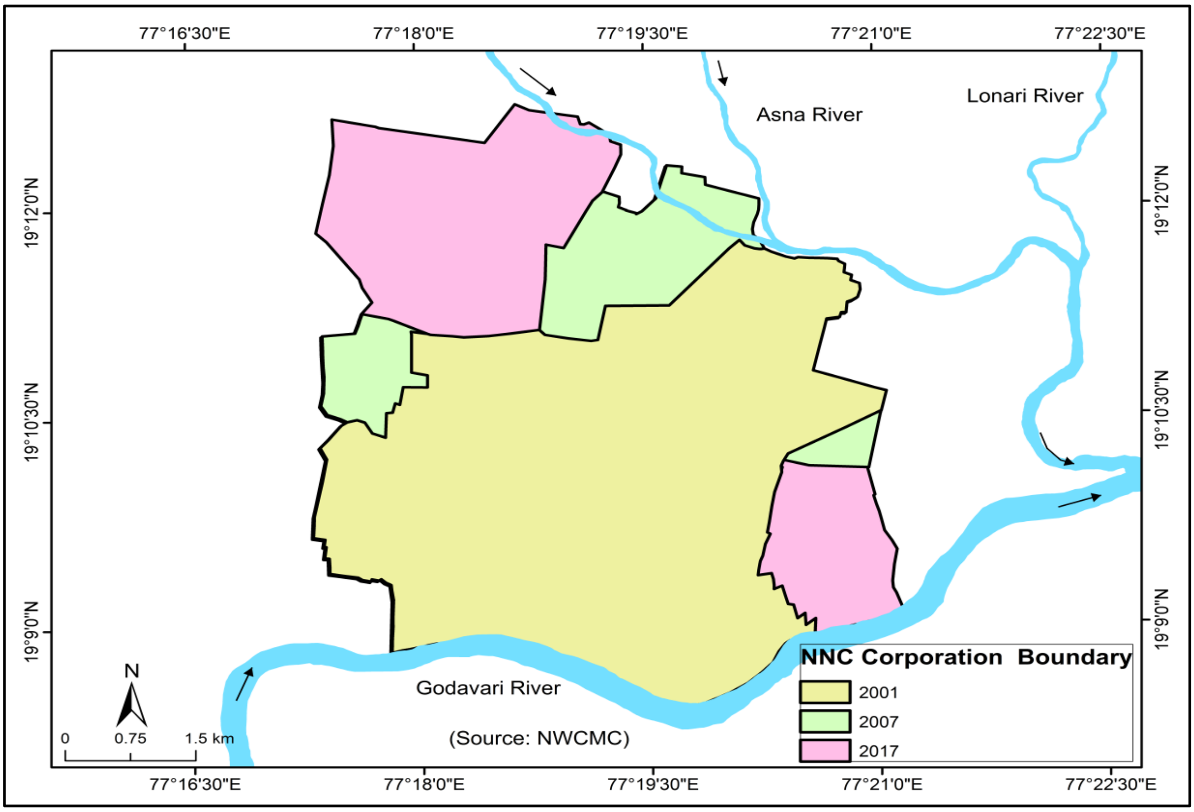


Figure 8: Corporation Boundaries of the Study Area

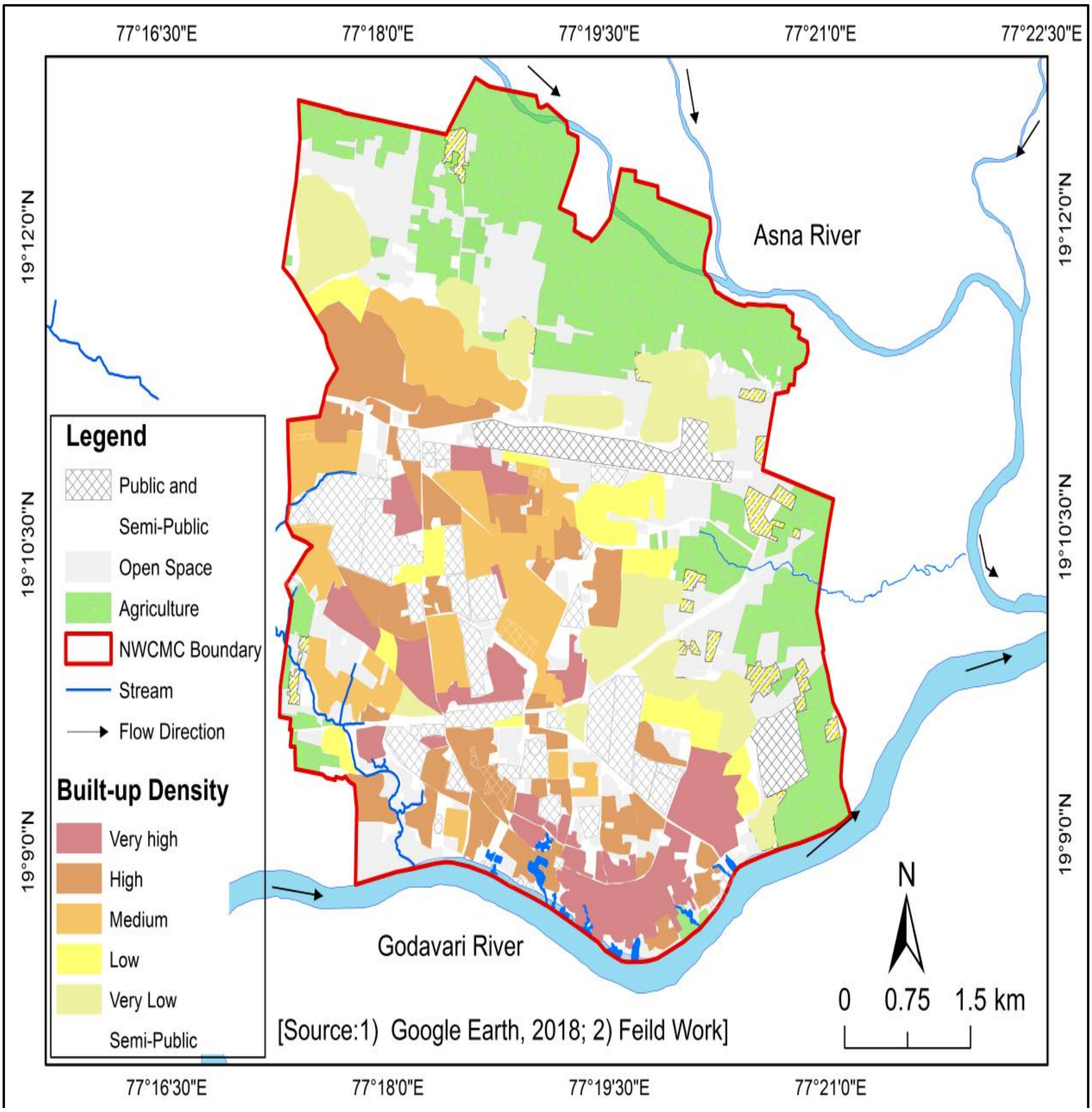


(Source: Proposed Ph.D. work by Vidhyatai Patil, SRTM University)

8. Morphology of urban Built-up and population

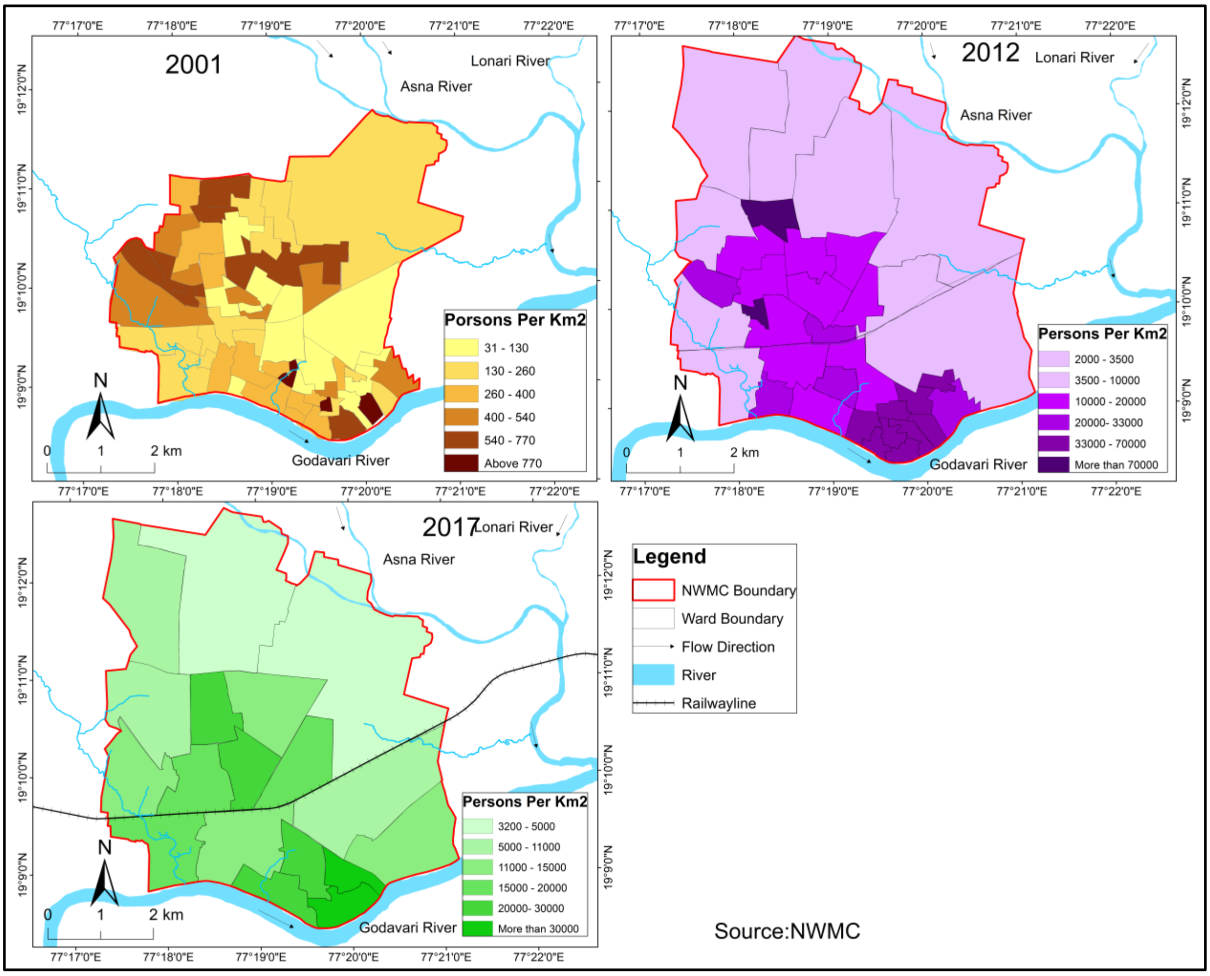
The in-depth distribution and density analysis of the urban built-up and population allows to find out the exact sites where have the heavy load or burden of the wastewater on the available network of the sewer (Roux, et al., 2011). The present study region, the south-eastern part of the city had found the higher density of buildings and population, along with some patches of also been observed towards the central and eastern part of the city (Figure 9 and 10). Basically, the south-eastern part of the study region has the old core zone of the city. Due to this region have narrow road network and relatively older sewer lines construction.

Figure 9: Built-up Density



(Source: Proposed Ph.D. work by Vidhyatai Patil, SRTM University)

Figure 10: Ward-wise Population Density of the Study Area



(Source: Proposed Ph.D. work by Vidhyatai Patil, SRTM University)

Conclusion

The study shows that the geographical profile of the city is the basic consideration of sewage planning, construction, maintenance, cleaning and upgradation. Many times, the unique and heterogeneous geographical characteristics of the urban land become the challenges for the sustainable city sewage system. The in-depth geographical assessment of the study region indicates that,the extremely flat surface and coverage of black cotton soil may create the direct and indirect effects on the physical structure of the sewer i.e., low sewer gradient, deterioration etc. Specially, the southern part of the study region, which is the old core zone of the city observed as a vulnerable region regarding the sewage crises i.e., the higher density of population and built-up creating the overload on the system, effect of flood zone region, higher depth of soil, old sewer line, complicated network of the street etc.

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