Extraction of surface imperviousness from land use land cover analysis for part of Hyderabad city

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Introduction

Surface imperviousness of watershed is a vital parameter in performing all hydrologic simulations and it work as a needle to track environmental and physical changes (Deng et al. 2012). The impervious surface of a watershed is frequently expressed as percentage of total impervious surface area of watershed. Increased urbanization exerts a lot of pressure on land use which results in rise in total impervious surface (Chithra et al. 2015, Majid et al. 2013). Soil compaction of for urban development, manmade structures such as roofs, roads, pavements, driveways, parking lots, industrial areas, airports, logistics, etc. increases the impervious surface. The surface imperviousness varies from 2 to 10 percent in rural areas to 70 to 90 percent in densely populated urban areas (Schueler and Claytor 1997). The rise in surface imperviousness of a watershed initiates a chain of events affecting urban water and air resources and thus it is a prime concern to hydrologist and environmental engineers. The direct effects of rise in impermeability of watershed is foreseen on local streams and rivers and downstream water receiving ponds, tanks are affected indirectly (Paul and Meyer 2001, Arnold and Gibbons 1996). Impervious surface restricts the entry of rainfall water into natural soil thereby increasing the runoff volumes. The runoff volume of fully developed urban watershed my rise up-to six times and runoff peaks up-to 1.8-8 times leading to flooding situations (NDMA, 2010).

Several research studied in past shows the consequence of increased surface impermeability on various resources in urban watersheds and explain the need of acquiring the recent spatial information in performing analysis (Zhihong et al., 2009; Brown et al. 2005; Yuan 2008). However, getting precise information regarding land cover and surface imperviousness is very difficult and remains a challenge for urban planners and modellers (Dams et al. 2013, Lu et al. 2012). Such studies are a common task to the hydrologists in developed countries while only few studies are reported on estimation of surface imperviousness of watershed in developing countries due to lack of basic data, procedure manuals and guidelines.

The paper presents a methodology to extract surface imperviousness of an area by processing high-resolution imagery and developing land use land cover map. Zone XIII of Hyderabad being one of critical flood prone zone, is picked in this study to extract percentage permeability from land use land cover map.

Materials and Methods

Fig.1 shows the flow chart explaining the methodology to calculate surface imperviousness of watershed. The percentage permeability of watershed is determined by estimating the pervious and impervious parts of watershed surface. Manmade buildings, pavements, roads, parking lots forms impervious surfaces while pervious surfaces include vegetation, bare soil and waterbodies. Thus land use and land cover maps of study area are prepared in Arc GIS 10.1 by maximum likelihood supervised classification method to analyse which part of watershed is impervious. LISS III satellite imagery for year 2001 and 2016 is downloaded from United States Geological Survey Earth Explorer and processed in Arc GIS environment. Four training classes of land use (built-up area, barren and, water bodies and shrubs) are defined to develop land use and land cover of study area.

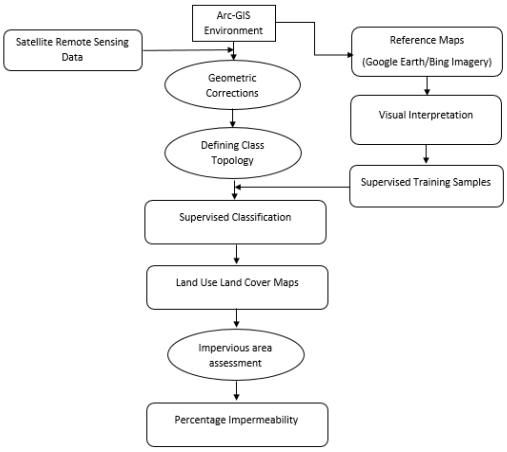
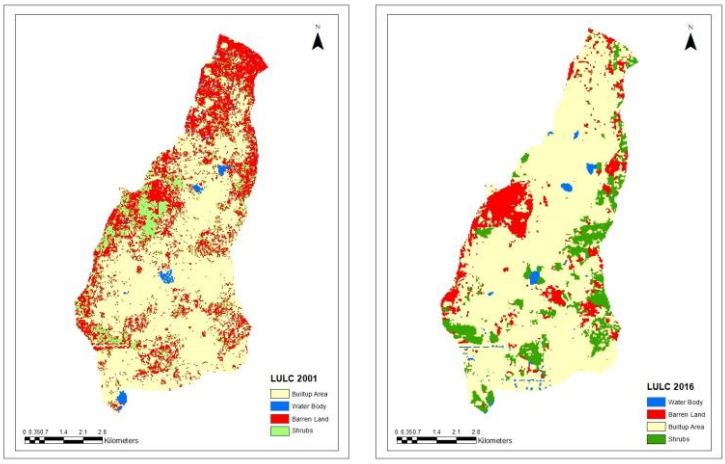


Figure 1. Flow chart of methodology.

Results and Concluding Remarks

Fig. 2 shows the land use land cover maps of study area for time period of 2001 and 2016. The area falling under each class is calculated and matched with total area of watershed to get surface imperviousness of study area for respective time period.



(a) (b)

Figure 2. Land Use and Land Cover Map for year (a) 2001 and (b) 2016

The surface imperviousness of study area for year 2001 and 2016 extracted from respective land use land cover classification results is presented in table 1. The results show rise in overall imperviousness of Zone XIII watershed from 46.73% to 65.81%.

Table 1. Surface imperviousness of Zone XIII, Hyderabad.

Zone XIII Sub-Watershed	% Imperviousness for 2001 LULC	% Imperviousness for 2016 LULC
1	37.51	75.81
2	23.30	30.13
3	11.56	17.77
4	6.08	10.04
5	29.15	36.58
6	22.53	25.23
7	34.23	42.21
8	16.06	19.69
9	19.94	20.87
10	49.73	51.92
11	22.63	27.65

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