

**IMPACTS OF LAND USE LAND COVER ON SURFACE RUNOFF:
A CASE STUDY OF UPPER MALAPRABHA BASIN**

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Abstract— The main efforts of this study is to understand the land use land cover change impacts on the runoff. Land use land cover impacts on the basin hydrology can be assessed by combining the influence of land use land cover changes on water resources in the catchment. The study was carried out on Upper Malaprabha Basin. Remote sensing and geographic information system technologies proved to be a very effective means of detecting the changes in land use land cover patterns. ArcMap 10.1 is used as the user interface for detecting the changes by the process of image classification. The image classification was carried out for the years 2002 and 2009. The results of image classification reflected that the forest area decreased by 49.4%, water bodies have seen raise of 1.6%, urban settlements increased by 57.1%, agriculture lands have also increased by 25.8%. Whereas the agricultural plantation and barren land have declined by 97% and 51.7% respectively. To study the impacts of the above land use land cover changes on runoff the Soil and Water Assessment Tool (SWAT) model was used. The simulation was carried out for the study area incorporating the prepared LULC maps. The calibrated and validated model reflected the R^2 value to be above 0.7 and proved to be satisfactory. The average runoff in the years 1992 to 2002 was 38 m³/sec and for the years the average runoff was 30.4 m³/sec. The average flow trends reflect that there is decrease of about 7.6 m³/sec in runoff. The reasons for decrease in runoff is majorly due to increase in agriculture area, water body and decrease in barren lands.

Keywords— Land Use Land Cover, Image Classification, ArcMAP, SWAT, GIS

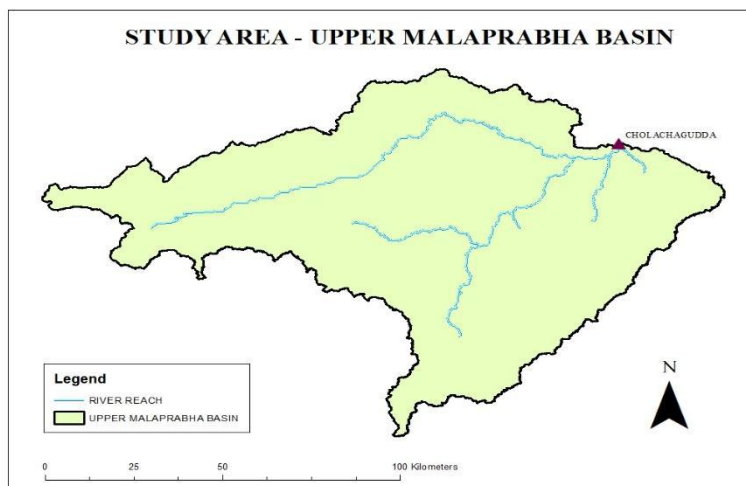
I. INTRODUCTION

Land is turning into a rare asset because of its use by increasing populace and industrialization. This results in rapid change in land covers and utilization of land. Urbanization has a huge hydrological impact on runoff and other hydrological activities. The major factor that is contributing to LULC directly or indirectly depends upon population explosion. The increase in population of a particular area increases, the requirement for built up area also increases and the other land cover such as barren lands, vegetation, etc. decreases for catering the demand for built up area. Therefore, accurate and up to date LULC details required to understand and assess the environment impacts. The remote sensing technique has the ability to capture variations and extract data for the purpose of change detection assessment. Landuse Land cover has dynamic role in water conveyance in hydrologic cycle and it mainly aids in controlling the runoff. The LULC plays a major role in energy balancing in hydrological cycle. The hydrology of watershed locally vary considerably as well as flow pattern of water is frequently dependent on LULC, combination of soil and elevation characteristics of a particular area. It is also be seen that social undertaking can affect the integrity of natural resources within the eco system. New patterns of LULC conditions can be enhanced by cautious planning the welfare of people.

Some general reasons for variations in surface runoff are as follows 1) Increase in impermeable surfaces due human activities such as paving of surfaces, consolidating top soil layers, etc decrease the natural infiltration capacity. 2) Increase in population usually leads to irregular developments in flood prone region. 3) The variations in rainfall intensities due to climate change. 4) Rise in Ocean levels due to various global concerns such as global warming, etc. hinder shore development works. 5) Failure of flood control structures owing to faulty designs and management. 6) Lack of communication between the interstate departments or transnational flood management organization, which ever the case may be.

The objective of this study was- 1) To prepare Land Use Land Cover map for two datasets : 2002 and 2009. 2) To assess the land use land cover and identify the areas of change variations using change detection method. 3) Set up the swat model for monthly surface runoff by calibrating and validating the model. 4) To assess the impact on LULC changes on surface runoff generation in the study region.

II. STUDY AREA



The study region for present research work is Upper Malaprabha river basin. The river stretch is considered till the Chloachgudda river discharge gauging station. The entire study area fall between the following latitudes 15.0° and 16.10° N and longitude 74.0° and 76.0° E. Malaprabha river originates in the Sahyadri mountain ranges at altitude of 792.40 m in Kanakumbi village which is located about 16 km from Jamboti village to the western side in Belagavi district. The region has diversified hydro-climatic zones ranging from humid region with annual rainfall of 3047mm to semi arid regions with rainfall of 477 mm. The average annual rainfall is 766 mm. Soils of this region are black or red loamy type. The catchment has two cropping seasons in a year Kharif and Rabi. The crops grown include mainly sugarcane, cotton, groundnut, jower, maize, sunflower, vegetables, etc. The topography of the study area is predominantly undulating. A rugged terrain marks the western parts of Khanapur and Belagavi district with deep cutting ravines on the foot hills of Western Ghats. The area includes tertiary basalt for major portion and also has sedimentary developments. The land use characteristics majorly include agriculture activities, industrial areas and urban zones

III. METHODOLOGY AND MATERIALS

A. METHODOLOGY

1). In the first phase, watershed extents are determined by incorporating the Cartosat DEM data with ArcMap 10.1 as user interface. 2) The second phases commences after the first phase is completed. In this phase, the landuse land cover change detection is assessed for different time period i.e 2002 and 2009. The Image Analysis plug-in is utilized in ArcMap10.1 interface. For the purpose of image classification the satellite images of landsat7 and landsat8 are utilized. The supervised classification is done using the maximum likelihood classification to prepare the land use land cover images. 3) In the third phase, the Soil and Water Assessment Tool (SWAT) model is setup using thee prepared land use land cover images. Once the model is setup, the model is calibrated against the observed mean river discharge values and then validated to know the impacts due to land use land cover variation on stream flow for different time period. 4) In the fourth phase the swat model output are analyzed to study the change trends and conclude the work.

C. MATERIALS

The data required for land use land cover change detection are as follows:

1. Satellite images of the study area for the year 2002 and 2009 are downloaded from Earth Explorer of 30.0 m resolution and the panchromatic band of 15.0 m resolution.

The data required for swat model implementation are as follows:

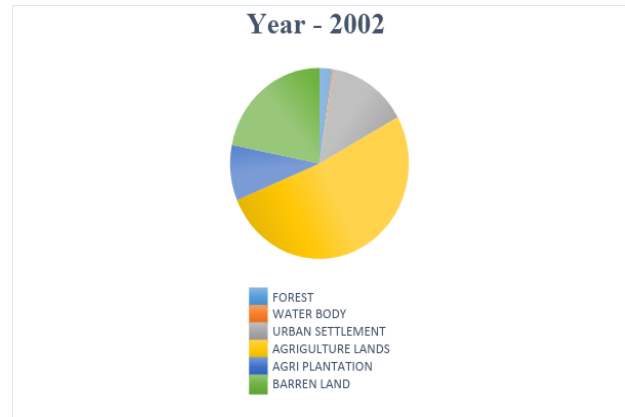
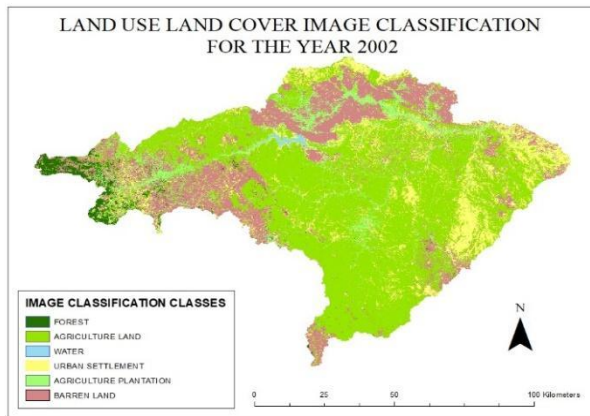
1. Digital Elevation Model (DEM) of 32.0 m resolution for the study area is procured from Indian Space Research Organization's Geoportal- BHUVAN.
2. Land use maps are taken from the end results of image classification process with respect to the year
3. Digital soil map is obtained the web portal of Food and Agriculture Organization (FAO)
4. Climate data for the time period of 1992 to 2014 were borrowed from Statistical Department and Indian Meteorological Department
5. Discharge data of Malaprabha River at Cholachgudda gauging point, for the purpose of calibration and validation of the model was taken from geoportal for water resource information system of India

IV. RESULTS

A) Image Classification

The image classification was done for two time period that is for year 2002 and 2009. The outcomes of the two time periods are compared so that the variations in LULC can be detected at same place at different time periods. Image classification was done with aid of ArcMap10.1.

1) *Image Classification for the year 2002*



The Land Use Land Cover have been classed into six major classes. The classes are as following-Forest, Water body, urban settlement, Agriculture land, Agriculture plantation, Barren land.

The scenario in the year 2002 reflects that, the forest covered is about 227.23 sq. km, water body covered 32.31 sq. km, urban settlement was 1414.64 sq.km, agriculture land was 5105.96 sq. km, agriculture plantations was 928.21 sq. km and barren land was seen to be 2157.03 sq. km.

2) *Image Classification for the year 2009.*

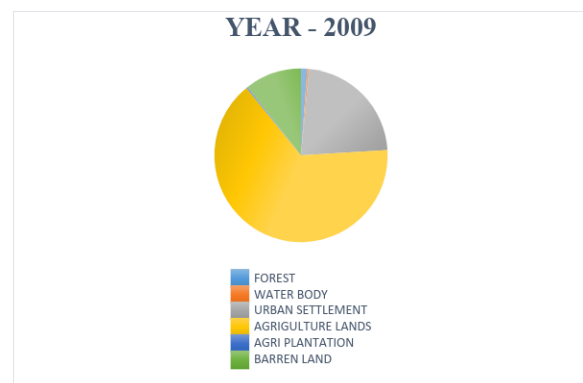
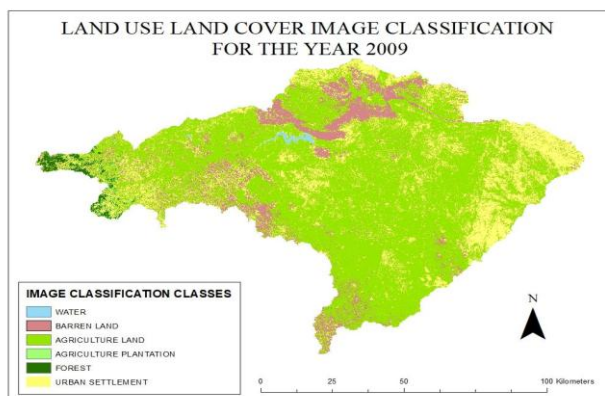


Figure 4: Land Use Land Cover Map For 2009

The scenario in the year 2009 reflects that, the forest covered is about 115.02 sq. km, waterbody covered 32.85 sq. km, urban settlement was 2222.77 sq.km, agriculture land was 6423.85 sq. km, agriculture plantations was 28.17 sq. km and barren land was seen to be 1042.77 sq. km.

B) *SWAT Model Output.*

The SWAT model was setup with the aid of Digital Elevation Model (DEM) data, Land Use Land Cover data which was prepared during the process of image classification, Soil Data of the study area and Slope profile of the study area. The calibrated and validated model reflected the R^2 value to be above 0.7 and proved to be satisfactory. Curve number, EPCO, Base flow and Ground water delay were identified as sensitive parameters.

V. CONCLUSIONS

The average runoff between the years 1992 and 2002 was 38 m^3/sec where as in the years 2003 to 2009 the runoff was 30.4 m^3/sec . There was a drop in runoff between the two time periods of 7.6 m^3/sec . The decrease in runoff was due to the following reasons. Increase in agriculture area, which means that there is a increase in agricultural activities. Increase in water bodies which tends to more storage in site and less water is allowed to flow in natural drainages. Decrease in barren lands has also affected the surface runoff there is more resistance to easy flow of waters. Increase in urban settlements has led to increased groundwater exploitation resulting in loss of moisture contents in deeper soil strata which leads to higher infiltration. Surface water resources are also depleted due high water demands for domestic and industrial use resulting in empty dams and barrages and other water storing structures lower runoff.

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