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AN APPRAISAL OF LAND AND WATER CONDITION IN THE DOWNSTREAM AREA OF THE KUMARI RESERVOIR: A CASE STUDY

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Abstract: A change in land use and land cover has got tremendous impact on environment. Some anthropogenic activities have altered the land use land cover. Some man made engineering construction like reservoir ,irrigation canal, dam capable for changing of a land use land cover of an area. In case of agricultural land use change, the reservoir and irrigation canals are playing an crucial role in the study area. The present investigation has got some specific objectives like i) to detect the land use land cover changes after construction of the reservoir and irrigation canal especially in the case of agricultural practice and ii) to detect and delineate new land use pattern. Interpretation of satellite imageries were used for the present investigation. It has been observed that the major changes occurred in case of agricultural land use, settlement pattern, social forestry and natural vegetation. In this back drop, the present investigation has been carried out in the upper catchment area of Kumar river basin Purulia West Bengal Eastern India. The main purpose of the reservoir and irrigation canals is to provide adequate water to the agricultural fields. These are made for multiple cropping purpose. At the same times, these are responsible for displacement of settlement and inundation of agricultural land. Ground water condition of the upper and lower catchment area have also been changed. After construction of the reservoir and irrigation canals, the soil moisture condition is also being changed as a result the natural vegetation which has become more lively and the agricultural production has been increased in the study area.

Keywords: Ground water, Change in land use, Land Cover

I. INTRODUCTION

Land is the integral component of environment. In modern times the concept of land resource is gaining much importance. According to FAO(1997a) and UNEP(1999) 'Land use is characterized by arrangements, activities and inputs people under take in a certain land cover type to produce, change or maintain it' (Brar,2013).Land use is produced by the interaction between cultural practices, state and physical needs of the society with the natural potential of the land(Chawla,2012).One can use land in different purpose like agricultural purpose, settlement purpose, agroforestry, social forestry, industrial purpose. Early humans used land with simple little modification for their food, storing, shelter, keeping their arms warm. But to fulfil the increasing population demand land is being used multi purposely (The Environment Literacy Council, 2015). Land is a process that convert the natural environment in to built environment such as settlement, road network, industrial zone etc. Land use data are needed to be analysed to understand the environmental process because it is use to formulate the solution of various land management issues like salinity and water quality which is related to land degradation. Land use land cover changes are very important for biochemical cycles, climate change and food production from regional to global scale. Land use land cover changes alone has contributed to approximately 35 percent anthropogenic carbon-di-oxide(CO_2) emission across the globe (Hongton et.al, 2012). Often improper land use is responsible various types of environmental degradation. In fact some anthropogenic activities have altered the earth

environment by changing the land use land cover (LULC) in past several centuries (Tian et.al, 2014). Some engineering construction like dam, reservoir are considered as the sources of natural security, economic stability, agricultural survival.

In the above context, the upper catchment area of Kumari River Basin (Fig.1) has been chosen for the present investigation. Kumari dam (Fig.2) was constructed for irrigation purpose in the year 1984 and the pre-post impact of the reservoir on land use change is the main concern of the present study.

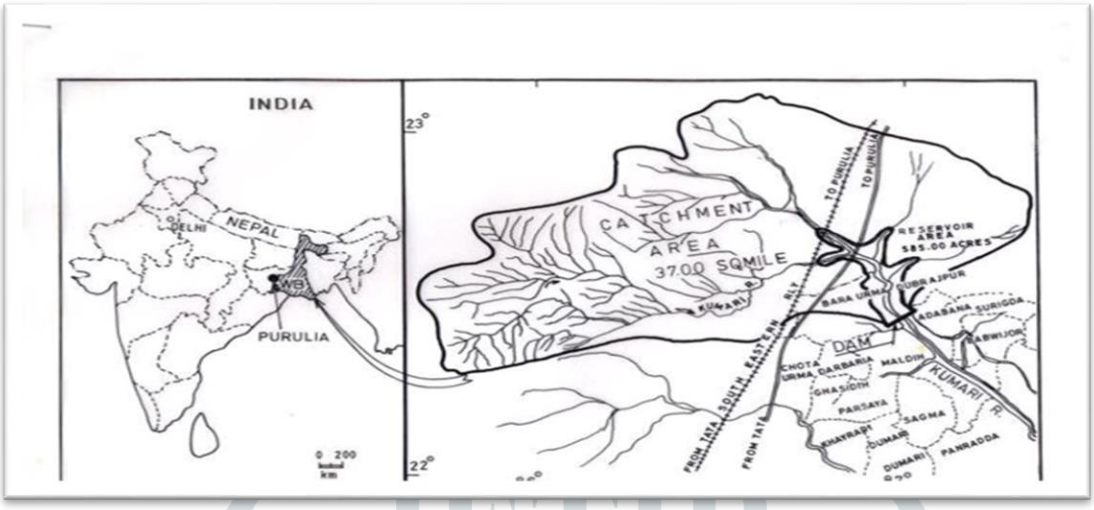

Figure 1 Upper catchment area of the Kumari River

Figure 2 Kumari dam

1.1 Study area:

The district of Purulia (Fig.3) is located in the border of Jharkhand and West Bengal. It was curved out former district of Manbhum of Bihar in 1956 and added to West Bengal. Geographically it is the part of Chhotonagpur plateau of eastern India consisting of "succession of rolling uplands with intervening hollows" and infertile lateritic soil. The study area is bounded by latitude $86^0$08´-$86^0$38´E and longitude $86^0$08´-$86^0$38´. The district has an area of 6,259.0 sq.km. As per 2011 census, the total population is about 29.30 lakhs (Census Handbook, 2011). The maximum number of the people of the district are schedule tribes (19.58 percent). The bulk of population consists of Hinduized and Semi Hinduized communities who still preserve some of the tribal life style. Economically the district is the poorest district among the sixteen district of West Bengal (Bagli, 2019). Once Sal forest dominated the district as flora now it is almost lost. Only occasional trees and shrubs attest to the past environment. The natural vegetation of the district is consists of trees, shrubs and grasses like Sal (Soria robasta), Palash (Butea fondosa), Boinchi (Flacontia n emontchi), Bharenda (Jatropa gossypifolia) etc.

The upper catchment area of Kumari River Basin is situated in the western part of the Purulia district, West Bengal of eastern India bounded by latitude $22^0$55´to $23^0$5´N and longitude $86^0$8´ to $86^0$38´E. It is actually a regenerated land mass which include variety of landscape units (Sing,1969). Tributaries of Kangsabati river are the main drainage of the area.

The district has a moderate annual rain fall i.e 1400mm (Mishra,2012). Ground water recharge is inadequate due to crystalline nature of the country rock and uneven relief of the terrain (Mukherjee and Das,1989). The climate of the district is characterized

by hot summer and cold winter. May is the generally hottest month with a mean daily minimum at 12.8^{0}C. Purulia district belongs to agro-eco sub region of Chhotonagpur plateau. The ecological condition is not so good due to improper greeneries, laterite and infertile soil. Immense care are needed for profitable cultivation. Due to continuous exploitation the soil lost its ability to absorb moisture from rainfall (Mahato, 2010).Very low agricultural productivity and deforestation are the reason of nutritional crisis. This influence the migration tendency. Migration process continued even in postcolonial period from Purulia to Assam tea garden, Bradhaman and the other places for their livelihood. Ecological crisis is the most common reason of tribal migration.

It can be said that undulated topography, high relief, slope, laterite soil, Precambrian granite gneiss country rock decline ground water, high drainage density, increasing aridity are the physical factor that are playing an important role to change the land use land cover pattern of the study area (Mahala, 2018).

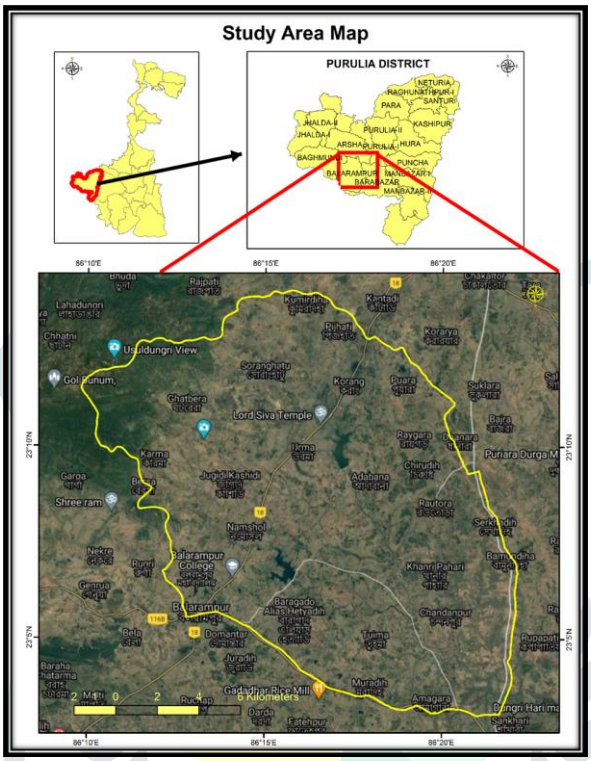

Figure 3 Study area

1.1 Physiography and land form of the study area:

The study area is an erosional landscaped developed on the Precambrian basement rock. Granite and metasedimentary are the main lithologies. Among the two physiographic divisions, high land is composed of denudational and structural hills. The rocks of the area is traversed by several sets of joints among which NNE-SSW master joints are prominent which show (dip>50^0). Low lying undulatory and forms the peneplane region. The thickness of the soil cover varies from 3m - 6m.

The soil of the study area are broadly categorized in to residual type which has been derived from weathering of pre-cambrian granite, gneiss and/or composite gneiss. Residual soil has got an extensive areal extent. Alluvial soil are present in the valleys of major stream/rivers. Reddish clay loam or simply reddish clay are very common in the study area .The ground water condition is mainly controlled by secondary porosity which is interconnected fractures, joints within the country rock. The narrow alluvial tract of main drainage have moderate to good ground water potential. The main upland of the district is Ajodhya Hill.

1.2 Geological setting:

As the study area is an erosional landscape many erosional land form like inselberg undulated valleys are the main evidence of erosional process. Peneplain pre-cambium is the most conspicuous feature of the area. Lithologically the area was composed of meta sedimentary and granite rock. It is actually the a regenerated land mass (Singh,1969) which include a variety of landscape unit. The area must have been suffered by several cycle of erosion aided by geotectonic upliftment (Mukherjee and Das,1986).The study area has some specific physical characteristics like undulated plateau, granite gneiss geology with some little soil depth, aridity etc (Mahala,2018).

1.3 Drainage and groundwater condition of the study area:

The drainage pattern of the study area is rectangular to angulate pattern as per the Survey of India (SOI) toposheet. The higher order stream like Kumari river adjoining rivers show the evidence of structural control. Joint pattern has influenced the main stream course development. The main stream shows a base flow during dry month whare as river bank full stage during monsoon time. As

the rocks are generally impervious, groundwater accumulation take place within the weathered residuum. Many water wells have been developed in the upper and lower catchment area. Wells in upper catchment area shows almost near surface water body condition and wells in the downstream shows high depth. The water table rises up to 1.00 m in the rainy season till the end of October. This is a 'White Zone' as per ground water status.

1.4 Reservoir and irrigation canal:

Tributaries of Kumari River are the main source of water in the study area. Kumari reservoir (Fig.4) has been constructed in the upper catchment area of Kumari river with a catchment area of 94.72 sq.km. The reservoir has two irrigation canals with the length of 37 km (main canal) and 24 km(subsidiary canal). The main purpose of the canal is to supply irrigation water to the adjacent agricultural plots. Many cultivated areas are seen in the both sides of the canals. Canals are constructed towards E-W alignment. And in some places the canals are branching out from the main canal.

Hanumata(Fig.5) reservoir is another important reservoir constructed in the year of 2017 which is situated in the NW part of the study area with the catchment area of 55.55sq.km (Sench Patra op.cit). Hanumata reservoir has got two major irrigation canals i.e LBMC(Left Bank Main Canal) and RBMC(Right Bank Main Canal).

Figure 4,5 Kumari reservoir (Left) and Hanumata reservoir (Right)

1.5 Objectives:

On the above back drop the objective of the present investigation are to identify the changes in land use and land cover after the construction of the reservoir and irrigation canals.

II. MATERIAL AND METHODS

2.1 Satellite data:

Satellite data used in the present investigation are acquired from various satellites and sensors. Satellite imageries like LANDSAT 5,LANDST MSS, LANDSAT 8 (Fig.6) were used to prepare land use land cover maps.

2.2 Ancillary data:

Survey of India (SOI) topographical sheets (sheet no.73I/4 and 73I/8) were used to delineate the study area boundary with 1:50,000 scale**.** SOI toposheet was also used to study land use land cover pattern and useful for ground truth verification.

2.3 Methodology:

Reconnoiter field visit plays an important role to collect primary data and field photograph as ground truth. Land use land cover maps of 1972,1995 and 2018 were created with the help of LANDSAT TM, LANDSAT MSS AND LANDSAT 8 satellite imageries. Entire steps like supervised-unsupervised image classification, digitization of various classes, area calculation under the various features etc were done by Arc.GIS 10.2.1 software. Fig.7 shows the flow chart of various steps of material and methods.

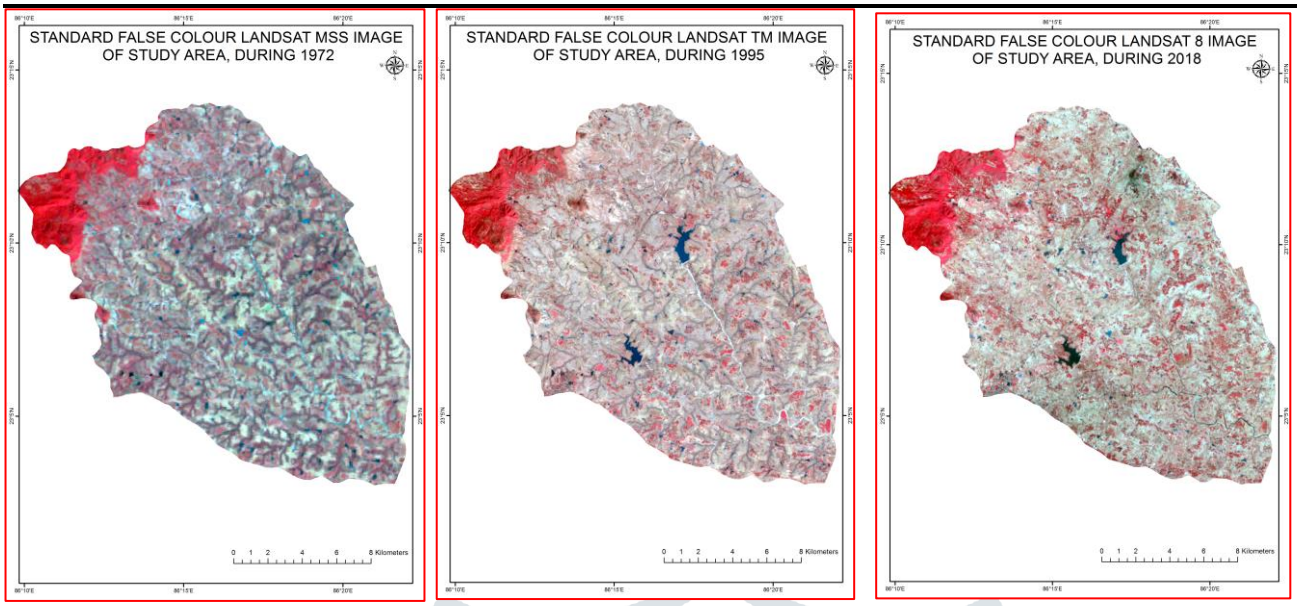

Figure 6 Landsat Imageries (MSS,TM,8)

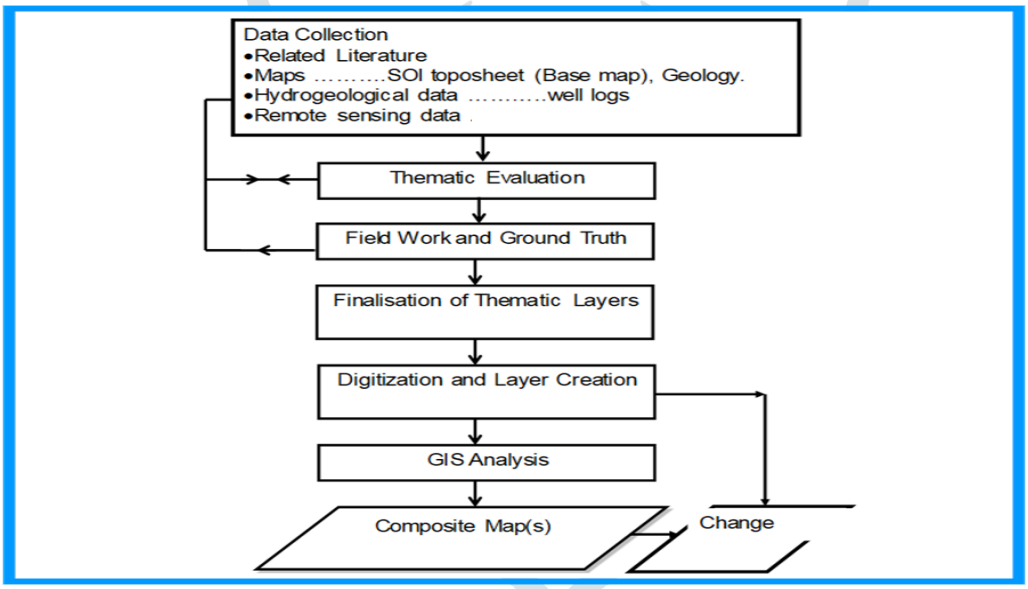

Figure 7 Flowchart of material and methods

III. Result and discussion

In the study area canals (Fig.8,9) are playing a vital role as far as the agricultural practice is concerned. The area is semiarid to sub humid in nature. Water scarcity is a common phenomena. Multiple cropping for agricultural field is now possible after the construction of the irrigation canals. After interpreting the satellite images and by field verifications it has been observed that the area of different types of land use are as follows. Ground water level in the reservoir area shows higher level than that of the lower catchment area. Water level in the well in the reservoir area is of 7ft as detected by well inventory technique. Surface drainage, water level in confined status and natural precipitation (rain fall) are the main sources of reservoir water. Average Annual Rainfall (A.A.R) of the region is 1440 mm (Mishra,1984). High evaporation in the reservoir area also changes the microclimate condition of the area.

Due to construction of the dam the evaporation rate in the agricultural area is increased and the flow of water in downstream is reduced. Increased evaporation in irrigated areas can cause stability in the atmosphere as well as increase of rainfall downwind of

the irrigated land. As a result total moisture level is increased in the surrounding atmosphere. It denotes that the proper irrigation system is the key factor to bring the long time sustainability in agriculture. Engineering construction like dam are related to the ecological degradation of the downstream section. From the satellite imagery of the year 1972, 1995 and 2018 it has been found that settlement pattern is scattered type. In fact under the geographical history of an area, settlement also is an expression of human occupation of the earth surface (Sodhganga.inflibnet.ac.in/bitstream/10603/107930/11/11-chapter%21.pdf). With the development of irrigation system, agricultural production increased and that is what affect the rural people to settle and concentrate on small village of the study area. And, this is the way how gradually village are expanding in the study area from the year of 1972 to 2018. So, from the present study, it can be denote that the land use land cover pattern is gradually changing specially construction of reservoir and irrigation canals. Thematic maps of 1972,1995 and 2018 are showing the changes (Fig.10,11,12). Fig.13 shows the year wise changes of land use land cover area.

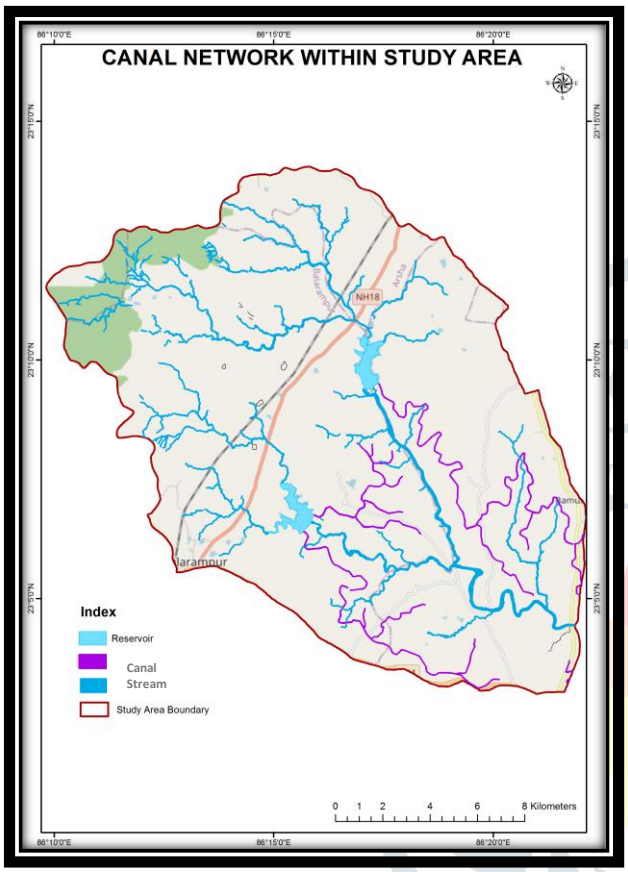

Figure 8 Canal network of the study area

Figure 9 Canal in the study area with adjacent agricultural field

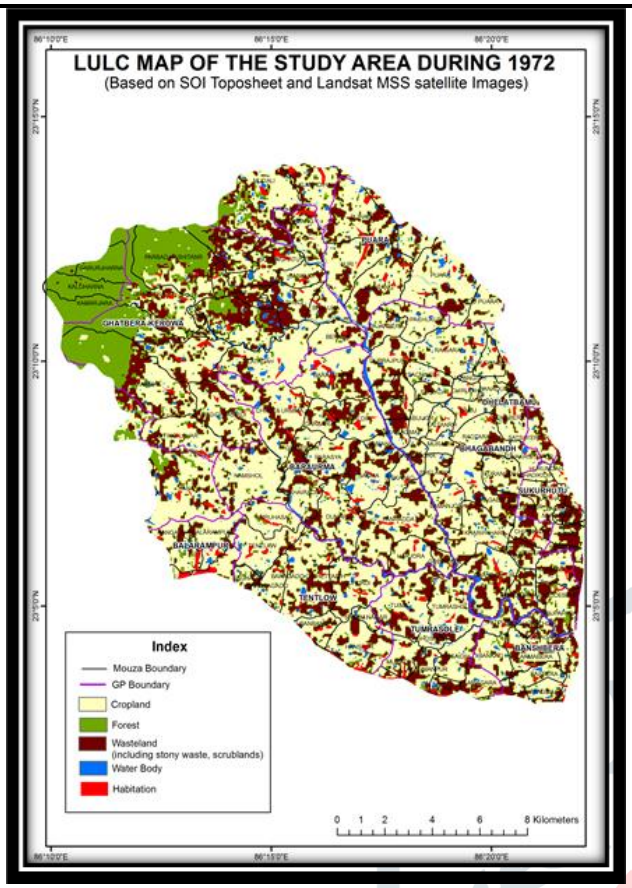

Figure 10 LULC Map during 1972

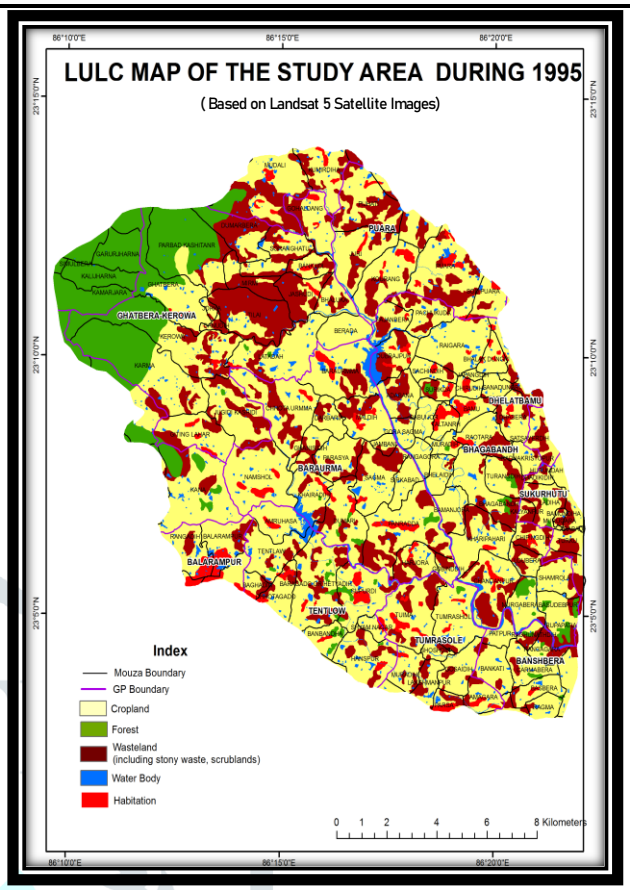

Figure 11 LULC Map during 1995

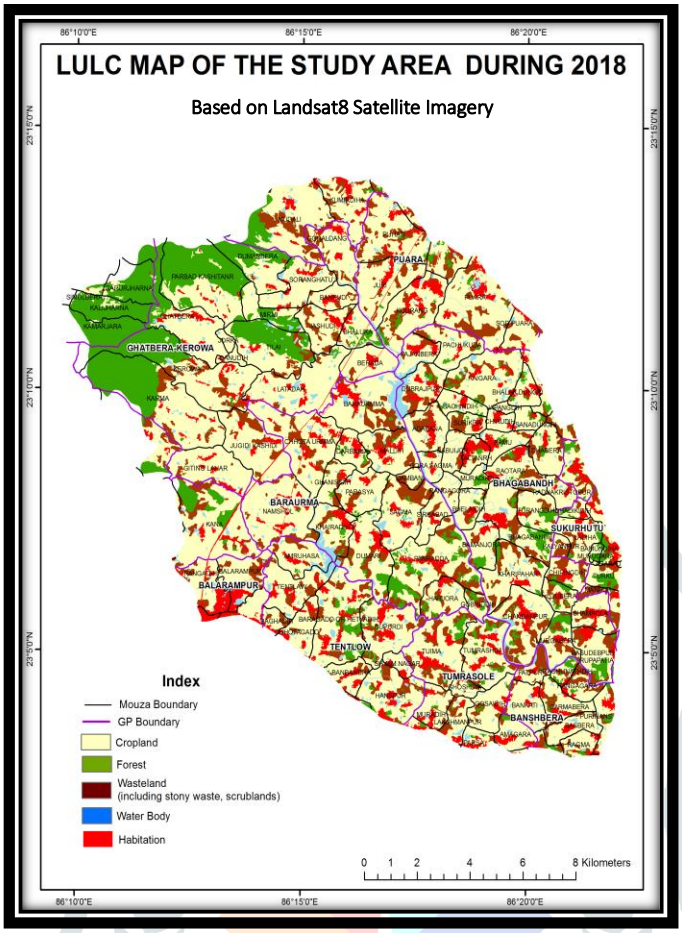

Figure 12 LULC map during 2018

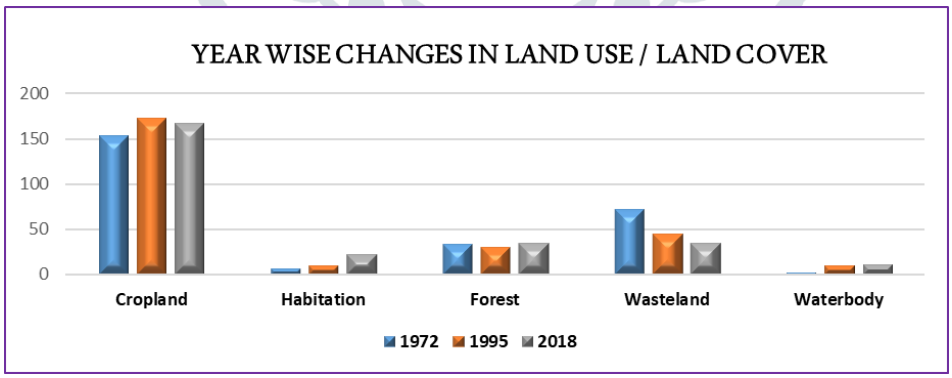

Figure 13 Year wise LULC area change of the study area

III. ACKNOWLEDGEMENT

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