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LAND USE LAND COVER CHANGE AND ASSOCIATED LANDSCAPE ECOLOGICAL DEGRADATION IN LOWER AJAY RIVER BASIN

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ABSTRACT

Since the advent of human civilisation, the natural landscape has been continuously altered by anthropogenic intervention. The pressure of growing population has direct impact on the landuse character of the lower Ajay River basin. The study area has rich deposits of Gondwana coal and lateritic duricrust covers the upland areas. So, open crust mining and lateritic quarries are the greatest threats of land degradation in the area. The sand quarries in alluvial tracts have degraded the river health. A vast tract has been deforested for horizontal expansion of agriculture and development of human settlements. The visual interpretation of satellite imagery and SOI topographical maps between 1970- 2017 has been carried out for detecting and mapping of the land use / land cover changes. The different land use / land cover classes like, agricultural lands, rivers, forests, settlements, plantations, scrub, degraded forest, barren rocky / stony waste, streams and tanks were demarcated based on the image characteristics. Comparisons of land use/ land cover category shows the decrease in forest cover, river channel and increase of agricultural land and built up land pointing towards growing urbanisation. The land use/ land cover changes adversely affected the landscape ecological scenario of the lower Ajay River basin. Therefore proper monitoring and planning is needed for preserve the land from adverse effect of degradation.

Key Words: Environmental Degradation, Sustainable Land Resource Management, Land Potentiality

1. INTRODUCTION

Land use is the modification of the natural landscape into built environment or semi-natural environments. Land use/ land cover change (LULC) imparts tremendous impacts on the functioning of environmental and socio-economic systems with important emphasis on sustainability, biodiversity, food security, and the vulnerability of people and ecosystems to global change impacts (Lesschen et al., 2005). The continuous change of natural landscape to cultural landscape with intervention of human induced activities negatively impact the climatic patterns, change the intensity and frequency of natural hazards and bears marked importance in influencing the socio-economy at local and global scales (Reis, 2008). The lower reaches of Ajay River basin is storehouse of a number of important minerals and had thick forest cover, which attracted the mining economy and lumbering industry in the region. As a result, in lower Ajay basin due to change in different geo-environmental features during 19thand 20thcentury resulted in drastic change in land use/ land cover pattern. The landscape got continuously modified under the influence of morpho-climatic as well as anthropogenic issues. Landscape ecology has been extensively altered with increasing human demands for more available land for agriculture, water management, resource extraction and urbanization. Land degradation is associated with other environmental issues. "Land depletion and environmental changes are major threat to the utilization of land in most of the semiarid regions of the world" (Arnous et al., 2017). The land resource degradation has led to quantitative as well as qualitative aspects of land resource deterioration and alteration of the morpho-environmental settings of the lower

Ajay River basin. Therefore, it is essential to formulate the sustainable environmental management plan to protect the landscape from the threat of degradation and in this regards it is essential to know the extent and location, natural characteristics of land use land cover change. The high spatial, spectral and temporal resolution of remotely sensed data provides synoptic view of vast areas of the earth repeatedly, which has effective use in land use/land cover mapping and is efficient tool for change detection (Thakkar et al., 2017). So, in this paper, a remote sensing GIS based approach has been taken to assess the spatio-temporal evolution of the land use/land cover patterns and to ascertain the intensity and impact of land use/ land cover change. The threats to the landscape ecology are determined and probable solutions have been prescribed.

2. OBJECTIVES

The study has been taken up to satisfy the following objectives

1. To assess diachronic land use/land cover dynamics in the lower reaches of Ajay River basin between 1970 and 2017.
2. To assess the landscape ecological degradation associated with the land use/land cover change
3. To suggest some remedial measures for controlling land degradation and improving landscape ecological health of the study area.

3. DATABASE AND METHODOLOGY

In the present study, the land use / land cover maps were prepared using satellite images of Precision Geocoded False Colour Composites (FCCs) of 2017 and SOI Topographical sheets of 1970 on 1:50,000 scale in conjunction with other collateral data. The LANDSAT TM+ data were consulted for generating the land use/land cover categories. Various land use / land cover classes were delineated by standard visual interpretation techniques based on the image characteristics like tone, texture, shape, size, pattern, association *etc.* Supplementary field checks have been conducted during the interpretation. The changes in the land use and land cover category were investigated and supplementary field observation was conducted where drastic land use land cover change has taken place.
The diagrammatic representation of the methodology is as under (Figure 1)

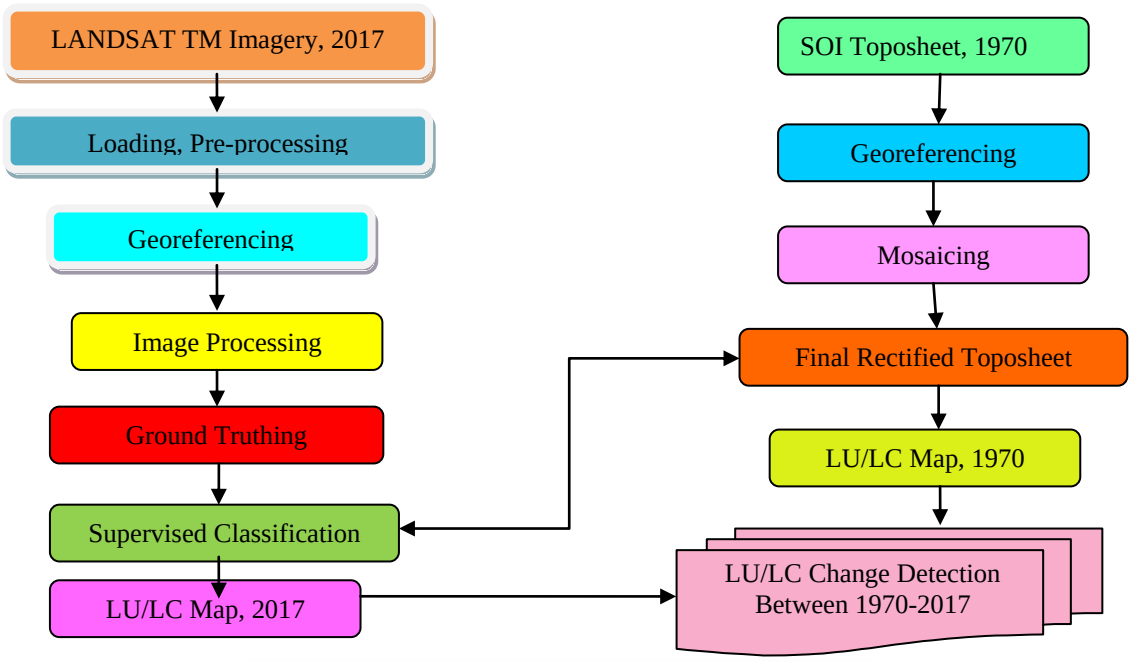
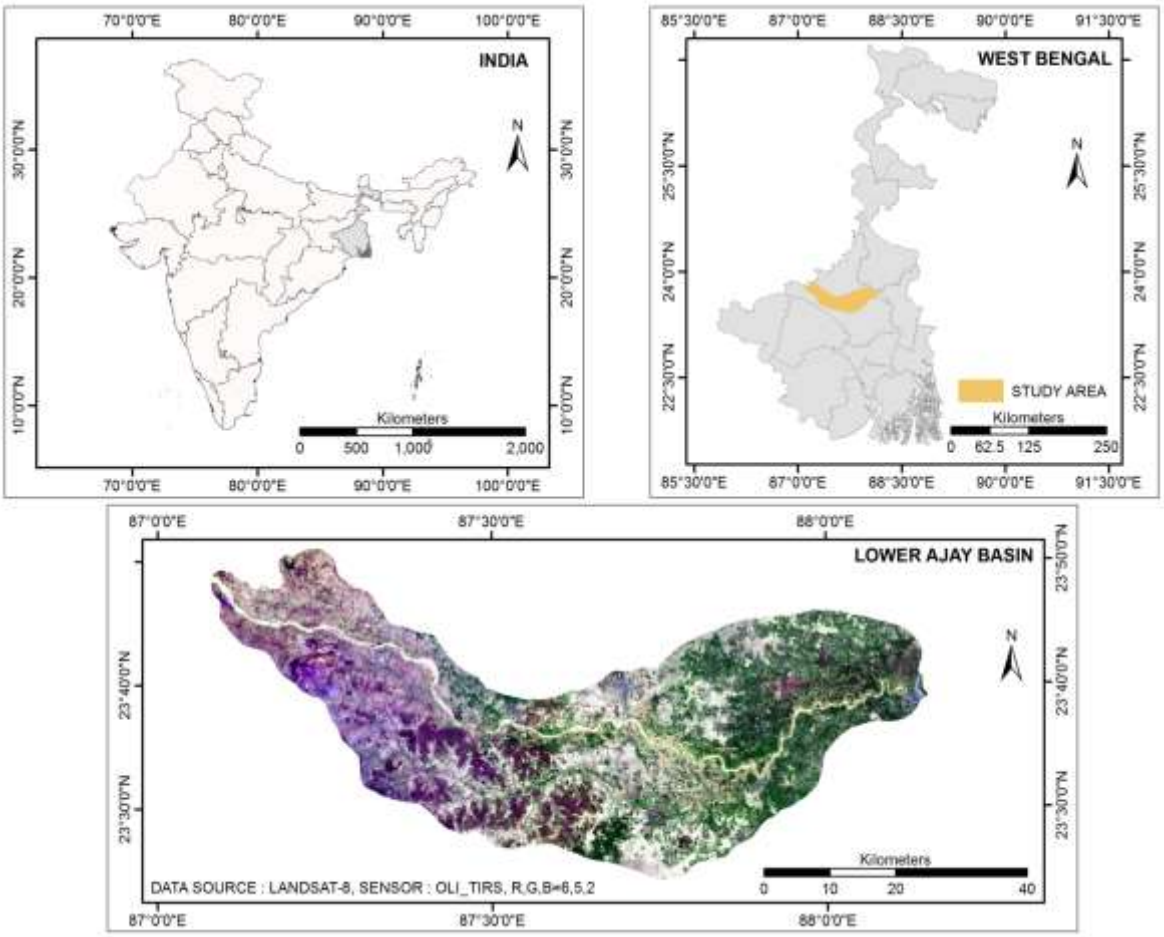


Figure 1: Flowchart of Research Methodology

4. STUDY AREA:

Lower Ajay River basin extends between 23°25´00" N to 23°50´00" N latitudes, and 87°10´00" E longitude to 88°12´00" E longitude covering an area of 3034 Km² engulfing 48.4% of the total geographical area of the Ajay River basin (Map 1). Lower Ajay River basin lies partly in five C.D. blocks of Birbhum District namely, Khoyrasole, Dubrajpur, Illambazar, Bolpur, Nanoor and ten C.D. blocks of East and West Burdwan District namely, Jamuriya, Pandabeshwar, Faridpur, Durgapur, Kanksa, Ausgram-I, Ausgram-II, Mangolkot, Ketugram-I, Ketugram–II and Katwa–I. The region has agro based and mining based economy, imparting great importance to the land use and land cover pattern. Agricultural land is predominant land use, which is followed by forest cover and settlement areas. About 4-5% change has been noticed with extension of agricultural land and built up area.



Map 1: Location Map of the Study Area

5. RESULTS AND DISCUSSIONS:

The term land use describes the type of uses (e.g., forest, residential areas, mining and conservation areas, etc.) to which the land has been subjected, whereas land cover describes the biophysical appearance, features and characteristics of that land (Byrne 2001). The land use/land cover of lower Ajay River is analysed to bring up the amount of degradation of its land resources and to come up with sustainable management plans. Land use and land cover changes are the result of the interplay between socio-economic, institutional and environmental factors (Li et al., 2009). Exact classification of land use/land cover is the key to natural resource management priorities worldwide, especially in complex and heterogeneous landscapes of the semi arid regions (Alrababah and Alhamd, 2006). So, the land use and land cover categories have been made on supervised classification of LANDSAT TM+ data. Though the earliest hints of land use/land cover

patterns points towards early civilisations of the Chalcolithic era, but the written documents of the later pattern started during later half of 19th century, which is evident from the writings in the old books and scripts. The land use/land cover pattern between a period of about 47 years (1970-2017) has been taken for the present study to analyse the impacts of the change on landscape ecological pattern of the region. Land degradation involves two interlocking systems: the natural ecosystem and the socio-economic system. Land degradation risk has become one of the most important ecological issues at the global level (Bazocco et al., 2012). The Land use and land cover statistics of the lower Ajay River basin has been analysed in the next section and the landscape ecological degradation has been marked.

5.1: Land Use/ Land Cover Change Analysis:

The land cover to landuse alterations affects the surface of the earth and holds major implications for sustainable development and livelihood systems and also contributes to changes in the biogeochemical cycles of the earth, affecting the atmospheric greenhouse and other trace gases (Turner et al., 1995). So the LU/LC changes have been analysed under the following categorical heads-

(i) Agricultural Land: This class constituted about 73% of the study area and the major part of agricultural land comes under single crop cultivation. But in 2017 the percentage coverage of agricultural fields decreased to about 69%. The quantity of active agriculture field has lessened from 1872.04hectare in 1970 to 1766.58 hectare in 2017. This can be attributed to the unavailability of ample amount of irrigation water that has taken place due to drying of river channels. Fertile lands have destroyed due to urban encroachment in the lowermost reaches of the study area.

(ii) Forest Land: Forest Land constituted about 9.74% of the study area in 1970, with forests consisting predominantly of Sal (*Shorea Robusta*) and the common associations of Sal are Mahua (*Madhuca Longifolia*), Kend (*Diospyros Melanoxylon*), Sidaha (*Iagestraemia Parviflora*), Neem (*Azadirachta Indica*), Arjun (*Terminalia Arjuna*), Pea-sal (*PterocarpusMarsupium*), Palas (*Butea Monosperma*), Asan (*Terminalia Elliptica*), Gamar (*Cmelina Arborea*), Pial (*Buchanania Latifolia*), Rahara (*Soymida Febrifuga*), Parasi (*Cleistanthus Collinus*), etc. The forest stretch was to the right bank of the basin coming under Durgapur Protected Forest, Ukhra Protected Forest, Kanksa Protected Forest, only a large forest path is noticed along the left bank near Illambazar, known as Illambazar Protected Forest. Due to high agricultural expansion in the fertile lands, there is no reserve forest in the lower part of the basin. In lower most stretch of the basin particularly downstream of Bolpur, no forest land is noticed. In 2017, the forest covered decreased by about 0.3% than that of 1970 and the species variety have lessened to some extent. A thin patch of forest clad area has disappeared from the south-west section of the study area decreasing the continuity and density of the jungle. The north-western part has also undergone some loss in forest cover.

(iii) Fallow Land: Fallow Land covers 5% of the lower Ajay River basin. It is prominent in the north and south central section of the basin. The physiographic set up of this landis made up of kankar (laterite residue) and duricrusts. These places are now intensely used as laterite quarries for morrum, which are utilized material for road construction. These fallow lands previously were within forest land (Map-1) as witnessed by the number of root structure within laterite quarries. But in 2017 the fallow lands have spread to a greater extent due to uncontrolled mining of laterites in the area. In the western most part of lower Ajay river basin some occasional fallow lands have emerged, which are basically rocky barren land and mostly unused.

(iv) Built-up Land: This includes residential settlements (urban and rural), commercial and institutional centre, and constructed areas, industrial built up land and land for transportation network. Built up land coverage of the study area has got the highest hike during the period 1970-2017. It increased from 9.47% coverage in 1970 to 14.1% coverage in 2017, with intense change of 4.6%. The south western part of the lower Ajay River basin around Durgapur and Panagarh region, central and south easterly part around Bolpur-Santiniketan and Katwa are high density built up area. The industrial built up land includes mainly sponge iron factory, cement factory, fertilizer factory, brick kilns and open crust quarry. Several brick kilns and quarries are located along right bank of River Ajay. Durgapur city expanded drastically along the southern boundary of the basin. The unplanned urban growth around Bolpur city is main reason for conversion of land use from land cover in the north central part of the basin.

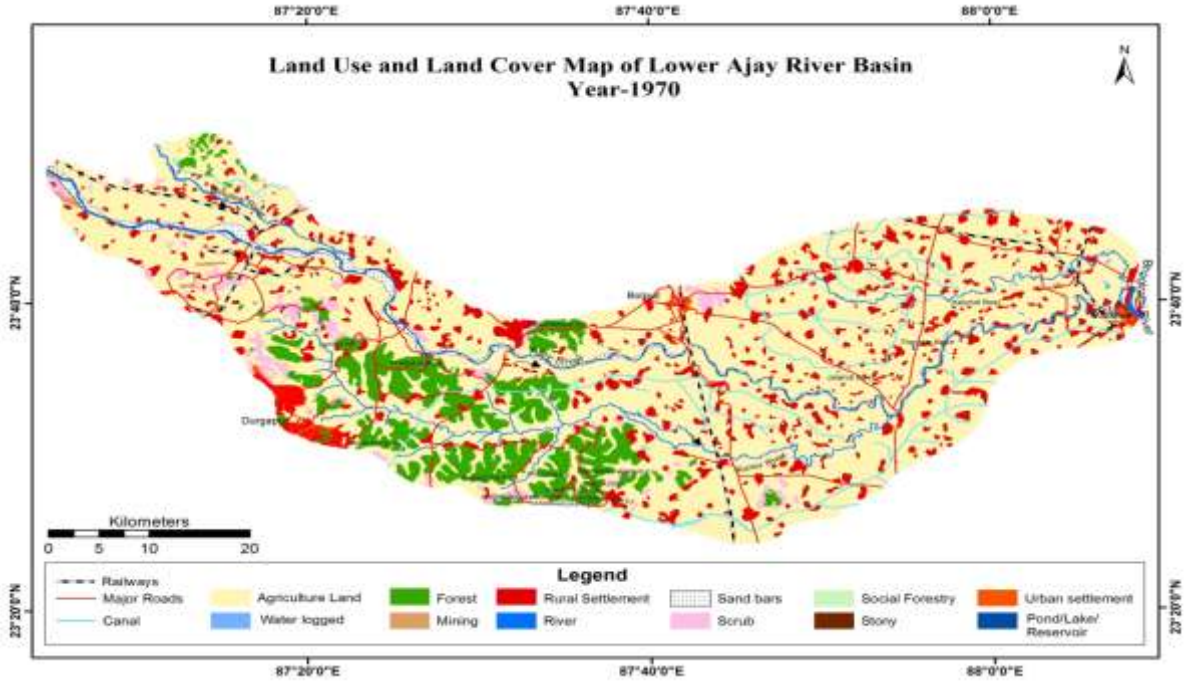
(v) Water Bodies: This includes ponds, tanks, rivers, canals and rivulets. The principal drainage Ajay River remains almost dry with flowing only along the thalweg in a sinuous pattern in the lean period but becomes over flowing during monsoon. The coverage of river channel has decreased from 32.13 hectare in 1970 to 26.40 hectare in 2017. The reason of deteriorating of the channel health is due to dam induced inundation and siltation and uncontrolled lifting of water for irrigation purpose. The numbers of waterbodies have increased by about 6.69% during the period between 1970 and 2017. This increase is due to the expansion of the irrigation canal networks and digging of ponds under government schemes for supplying water to the agricultural fields.

Remote Sensing based studies permit the evaluation of regional level land use and land cover structures and their trends; it also permits demarcation and analysis. Changes in the land use and land cover and their possible impacts can be easily visible from satellite information and GIS analysis. The land use pertaining to the year 1970 and 2017 are shown in the Map no. 2 and 3 respectively and the area under different land use categories and their areal and percentage change are given in the table 1.

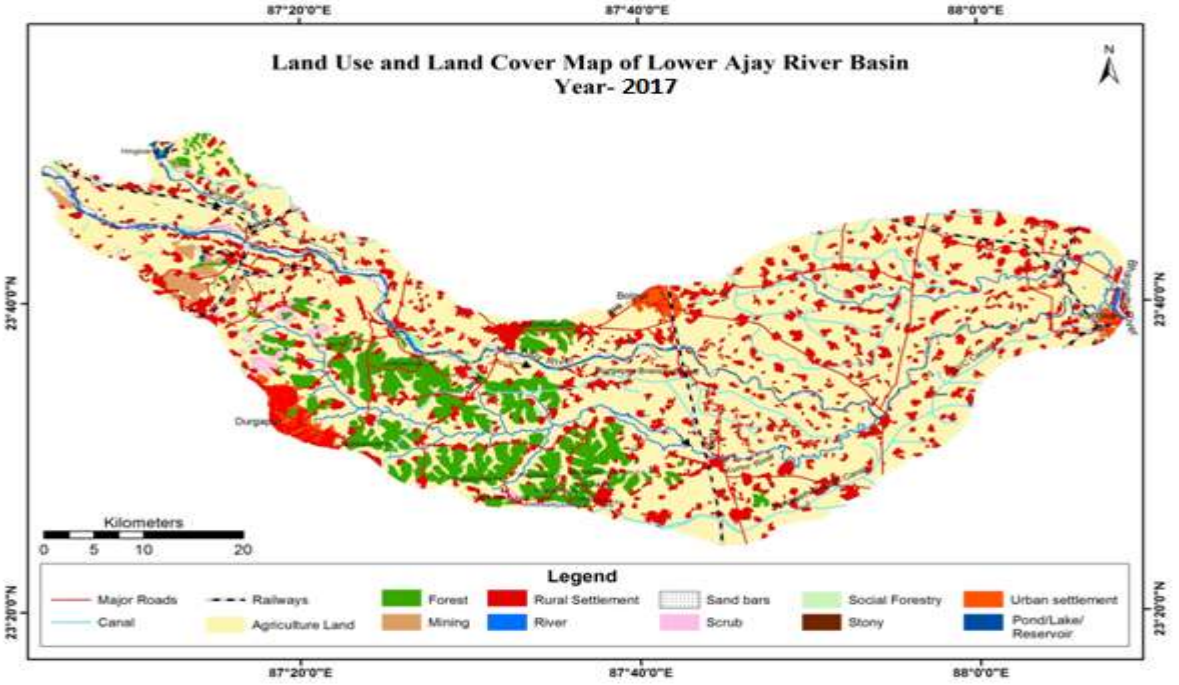
Table 1: Land Use and Land Cover Change (1970-2017)

Landuse / Land Cover Category	Landuse / Land Cover 1970		Landuse / Land Cover 2017		Landuse / Land Cover Change (2017-1970)	
	Area(ha.)	Area (%)	Area(ha.)	Area (%)	Area (ha.)	Area (%)
Agricultural Land	1872.03949	73.358	1766.58266	69.226	-105.4568	4.132
Built Up Land	241.674674	9.47	359.367138	14.082	117.692	4.612
Forest	248.58387	9.74	241.564731	9.466	-7.019139	0.274
Open Scrub	69.72328	2.732	22.941892	0.9	-46.78139	1.832
Water Body	2.63425	0.1032	9.322041	0.365	6.68779	0.2618
Rocky Area	0.35516	0.0139	0.46818	0.0183	0.11302	0.0044
Sand Bars	51.82969	2.031	39.93457	1.565	-11.89512	0.466
River	32.13183	1.26	26.39761	1.0344	-5.73422	0.2256
Urban	24.00514	0.9406	49.35119	1.934	25.3461	0.9934
Waterlogged	0.98171	0.0385	0	0	-0.98171	0.0385
Social Forestry	2.39860	0.094	14.195121	0.556	11.7965	0.462
Mining	5.55689	0.218	21.789882	0.854	16.233	0.636
Total	2551.91457	100	2551.91457	100	0	0

Source: Computed by author by visual interpretation of Satellite Data (LANDAT TM+ 2017), Topographical sheets and field investigation.



Map 2: Land Use and Land Cover Map of Lower Ajay River Basin, 1970



Map 3: Land Use and Land Cover Map of Lower Ajay River Basin, 2017

6. LANDSCAPE ECOLOGICAL DEGRADATION RELATED TO LAND USE/LAND COVER CHANGES:

Land Use/ land cover change and associated environmental degradation is outcome of many highly interlinked direct and indirect underlying causes, like, natural, socio-economic, and related agricultural practices (Li et al., 2015). The anthropogenic intervention on the river regime reveals the fluvial ecological degradation. The river gradually turned into an ephemeral stream and this ephemerality is mainly due to the improper use of land resources associated with the destruction of forest cover in lateritic patches and horizontal expansion of the subsistence agricultural practices in this lower part of the Ajay basin. Healthy land ecosystem is the key for sustainable livelihood, but the

land has been taken for granted and continually degraded. The south central part of the basin is susceptible to deforestation; specially vast extent of *Sal (Shorea Robusta)* has been cleared off for lateritic quarries in Gopalpur and Kanksa region. The reddish brown sandy latosol obtained from Gondwana Lateritic Upland is used for road construction and colouring of earthen house in villages. So morrum and lateritic quarries impart great influence to the degradation scenario. Uncontrolled amount of coal extortion for serving the need of industries and society from the mines are associated with degradation of the ambient air quality and causes surface soil to get destructed and deteriorated in adjoining areas. The flora and fauna of the area has got altered in large scale due to these landscape degradations. The threats and solutions to the persisting deteriorating condition of landscape ecology have been pointed out and solutions are provided in table 2.

Table 2: Present Threats and Solutions to LU/LC related Landscape Ecological Degradations

SL NO	LU/LC Category	Threats	Solutions
1	Forest Cover	Deforestation, Introduction of Invasive Species, Soil erosion, Rill and Gully Erosion	Plantation of indigenous variety of species, Social Forestry Monitoring
2	Water Bodies	Overuse, Water Pollution	Controlled use of water for specific purposes, Rain water harvesting, Wetland Conservation
3	River Channel	Inundation, Drying	Entrenching, Proper use of available water, Proper plan for dam building
4	Agricultural Land	Waterlogging in lower flood plain region, Water scarcity in western pedimental complex	Entrenching, Irrigation facilities to be made available in all parts
5	Fallow Land	Uncontrolled mining, Pollution, Solid Waste	Sustainable mining plans, Proper disposal grounds for mined end products
6	Built-up Land	Industrial waste, Pollution	Enforcing laws for proper management of industrial waste products

Source: Assessment by Author

7. CONCLUSION:

Land use and land cover analysis is important for exploring human nature interaction. The continuous human intervention on the natural regime has led the lower Ajay basin to be more susceptible to geo-hydrological hazards like flood, drought and soil erosion. The rapid change in the pattern of land use and land cover is strongly following the pattern of urbanisation. Agricultural land, forest cover, built up land and urban areas has experienced major changes in their pattern. The patterns of land use/land cover of the two years, i.e. 1970 and 2017 has been analysed and interpreted on the basis of map 2 and map 3. This reveals a number of interesting factors about the lower Ajay River basin. Highest change

has been noticed in built up land (4.612%), followed by agricultural land (4.132%) and open scrub (1.832 %). The other noteworthy change is noticed in urban expansion. Other categories have gone through changes that are not as much as the previously mentioned categories. The lowest change has been encountered in rocky areas, which may be attributed to the fact that the hard portion of the plateau fringe section of the Bengal Basin is formed by hard igneous and metamorphic rocks, which are unsuitable for human settlement and agriculture. The forest area has decreased by about 7.02 ha, implying towards havoc rate of deforestation at the south central and south –western part of the study area. The greatest negative change is noticed in open scrub coverage (46.78 ha). The scrub areas are now converted to social forestry regions or built up land. The mining areas also have shown a surge in percentage coverage (0.636%). The amount of waterbodies in the area has increased due to the high rate of sand quarrying in the river bed and implementation of government projects for providing irrigation. The positive impacts are found in the percentage of water logged areas. The backswamp formation and water logging was a persistent problem during the 1970s, but in the recent times the channels have been entrenched for passing out of the extra volume of flood water, which prevented the waterlogging problem to a greater extent. The river has shrunk in dimension during the study period. Many channels have dried and the river has faced inundation due to the storing of river water in several dams. Uncontrolled ground water lifting has caused water scarcity in many parts of the basin in the summer months. The mixing of seepage and industrial waste from the nearby important towns like Bolpur and Durgapur has led to water quality degradation and water pollution in river Ajay and its tributary systems, especially Kunur. The natural settings has undergone irreversible change that can not be re-established to past form, but the sustainable use of land resources of the basin can help in preventing the lower Ajay River basin from further landscape ecological degradations. It is suggested that various management strategies like afforestation, contour bunding, and agroforestry may be adopted for protection of the landscape of the basin from the further degradation. However, the management plans are insufficient measures for addressing this degradation unless the active participation of the local people in the management and planning programme is ensured. Therefore Participatory models should be implemented for coping up with the landscape ecological degradations in the lower Ajay River basin.

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