HYDROPOWER DEVELOPMENT AND LAND USELAND COVER CHANGE: A CASE STUDY OF ALAKNANDA BASIN, UTTARAKHAND, INDIA

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Abstract
Since the beginning of human civilisation, mankind has lived in a close relationship with nature. While mankind's interdependence on environment is greater than that of any other organism; his restless pursuit of progress, comfort and security has resulted in increased stress on the environment which led to land use and land cover changes over a period of time. Information on existing land use and land cover, its spatial distribution and change are essential pre requisite for planning. The present study is based on primary as well as secondary sources of data. The study aims to analyse the changes in land use and land cover attributed to human induced developments. The present study highlighted changes attributed to development of seven selected hydropower projects in Alaknanda basin.
Keywords: Hydropower, Development, Land Use Land Cover Change

1. Introduction:

The Himalayas have already been disturbed by various anthropogenic activities, change in land use/land cover and consequent geological hazards i.e. landslides, rock fall, soil erosion and tree falling are of worth mentioning. The major ecological degradation such as deforestation is accelerated due to hill road construction, mining activity, hydropower, landslides and soil erosion, which collectively create several environmental problems. The Himalayan terrain provides cost-effective conditions for dam construction deep gorges with deep valleys on the upstream and meeting the ever increasing needs of domestic, industrial and power sector dams are being constructed for harnessing water resources (Rautela et. al; 2002). Mountains are fragile ecosystems, which are globally important as water tower of the Earth, reservoirs of rich biodiversity, a popular destination for recreation, tourism and culture heritage. Mountain provides direct life support base for humankind (Roy and Tomar, 2000). Therefore, it is important to study the land use and land cover changes in the area due to reservoir and its overall impact upon the life support system of the masses (Rautela et. al; 2002).

Thus land use planning and land management strategies hold key for development of any region (Jaiswal et.al; 1999). Land use change, as one of the main driving forces of global environmental change, is central to the sustainable development debate. Concerns about land useland cover change emerged in global environmental change several decades ago with the realization that land surface processes influence climate. In the mid-1970s, it was recognized that land cover change modifies surface albedo and thus surface-atmosphere energy

exchanges, which have an impact on regional climate (Lambin et.al; 2003). Land use and land cover change is critically linked to the intersection of natural and human influences on environmental change. The change in the state of biosphere and bio-geochemical cycles are driven by heterogeneous changes in land use and continuation of those uses (Turner quoted in Jaiswal et.al; 1999).

The land use and land cover changes play pivotal role in environmental and ecological changes. The status of land use land cover not only influences the natural basis of human survival and development, but also closely relate with evolution of the ecological environment. It also has close connection between humanity and environment which interacts with each other. The changes in land use pattern are key component of physical resources to understand the spatial-temporal dynamics of land use. Hydropower development is the most sensitive influence of human social activities on LUCC; it brings chain-reaction such as the reduction in forest cover, agricultural land and human settlement etc.

2. Study Area

The Alaknanda river, after originating from the Bhagirath Kharak and Satopanth glaciers, it is joined by many tributary streams before meeting the Bhagirathi river at Devprayag to form the Ganga river. It runs a distance of 224 km till its confluence with Bhagirathi. The basin extends between 30° 0' N to 31° 0' N and 78° 45' E to 80° 0' E representing the eastern part of the Garhwal Himalaya (Fig.1). The Alaknanda catchment is subdivided into Alaknanda, Mandakini, Nandakini, Pindar, Dhauliganga and Birahiganga sub-catchments. The basin comprises eighteen development blocks in Bageshwar, Chamoli, Rudraprayag, Tehri and Pauri districts. The Alaknanda valley is U-shaped in its upper reaches and becomes V-shaped in its lower reaches. It is characterised by difficult terrain, wide variation in slopes (Rajvanshi et. al., 2012). The mountain peaks such as Nandadevi, Kamet, Trisul, and Chaukhamba etc. are located here.The river Alaknanda has a radial and rectangular drainage pattern. It flows from Mana just upstream of Badrinath and confluences with Dhauliganaga immediately downstream of Joshimath. Most of the catchment areas of the Alaknanda and its tributaries are covered with snow and glaciers. The Khular Bank, Khuliagarvia Gal, Anadev Gal, Dakhini Nakthoni Gal, Paschimi Kamet Glacier, Tara Bank, Luri Glacier and Bhagnyu glacier etc are other major glaciers present in the catchment. There are four major lakes present in the basin viz. Arwa Tal, Rishi Kund, Sankunni and Satopanth Tal. In the Alaknanda basin the lowest place is Devprayag (500 m) and Nandadevi peak (7817 m) is the highest point (Devi, 2015).

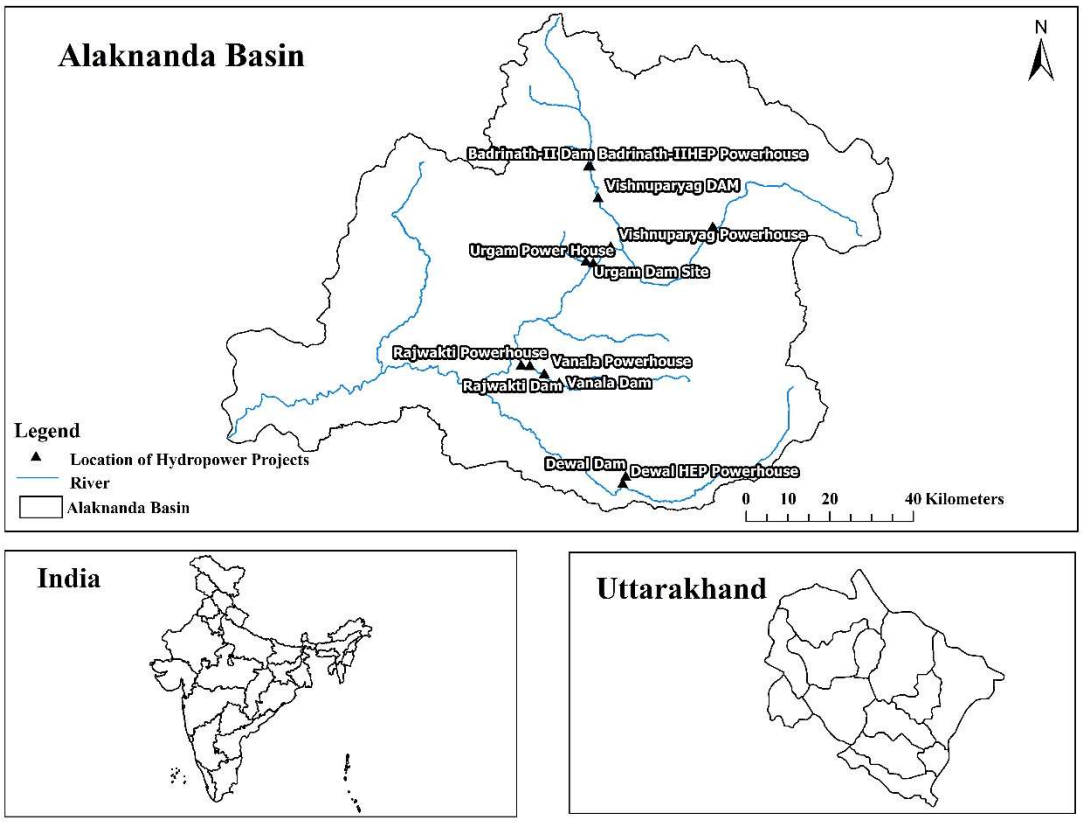

Fig.1. Location of the study area Alaknanda basin, Uttarakhand

3. Database and Methodology:

The present study is based on both primary and secondary data sources. The primary data was recorded through reconnaissance survey. The land use land cover was studied with the help of geographic information system and LANDSAT TM images 1990, 2000 and LANDSAT 30m ETM+(2018) data was used.The change has been analysedthrough attribute table and ground verification have also been done.

4. Results and Discussion:

The human activities are attributed to induce changes in physical resource base in terms of deforestation, agriculture, constructional works, mining, quarrying, settlement etc. The increasing population pressure and ever increasing demand for resource especially energy resources are prerequisites to hydropower generation. The development of hydropower project is attributed to enormous changes in environment, socio-cultural and physical resources in terms of land use and landcover. The study analysed the LANDSAT data of 1990, 2000 and 2018 to draw landuse landcover changes with special reference to seven selected hydropower projects in Alaknanda basin which is an integral part of Indian Himalayan Region (IHR). The data shows thatthe proportion under dense forest areahas been decreased from 28.65 percent to 25.73 percent during the 1990 & 2000 (Table 1).

Table-1

Change in Land use&Land cover during 1990, 2000, 2018

Land use Land Cover Classes	Period of Study					
	1990		2000		2018	
	Area (Sq. km)	Percentage	Area (Sq. Km)	Percentage	Area (Sq. Km)	Percentage
Dense Forest	3265.78	28.65	2933.31	25.73	3573.45	31.35
Scrub Forest	4340.38	38.08	3949.71	34.65	3149.62	27.63
Water Bodies	123.4	1.08	118.26	1.03	107.42	0.94
Barren Land	1519.99	13.33	1745.68	15.31	1390.27	12.19
Agriculture	1016.55	8.92	1382.87	12.13	833.48	7.31
Built up Area	531.75	4.66	587	5.15	1215.2	10.66
Glaciers	598.22	5.24	679.23	5.96	1126.64	9.88
Total	**11396.07**	**100**	**11396.07**	**100**	**11396.07**	**100**

Source: LANDSAT Images,1990,2000,2018

A slight increase i.e. 31.35 percent has been under dense forest in 2018. It is attributed to afforestation programs and public awareness towards plantation of trees in order to avoid any disaster like situation, because the study area is too much fragile and faced series of disaster in a very short time span. It is evident from the data that proportion under scrub forest/scrubland/grassy patches area to has been decreased from 38.08 percent (1990), 34.65 percent (2000) and 27.63 percent (2018) (Fig.2A&B).

Fig. 2 (A)

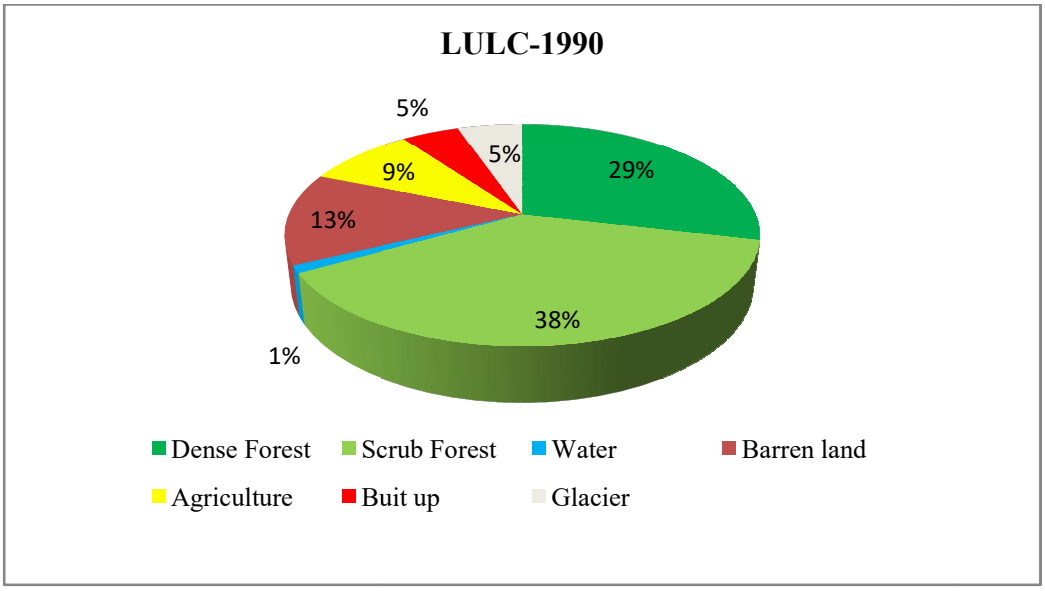

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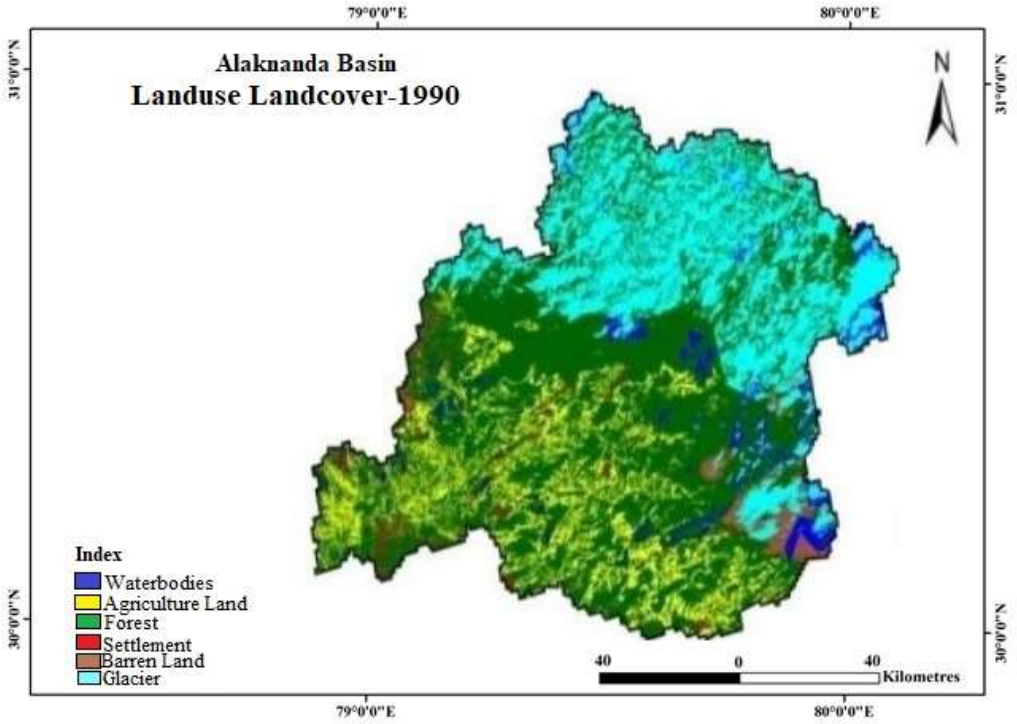
Fig 2 (B)



Source: LANDSAT Satellite Data,1990

The share of scrub forest is decreasing consecutively during the study period which is attributed to the increasing human induced developments i.e. settlements, hydropower development and construction of roads etc. The area under water bodies have been decreased over years, it is decreased from 1.08 percent (1990), 1.03 percent (2000) to 0.94 percent (2018) during the study period, thus run off area of the natural drainage system has been decreased due to construction of a series of hydropower projects in the river basin. it leads to adverse impact in the downstream areas.

Fig. 3 (A)

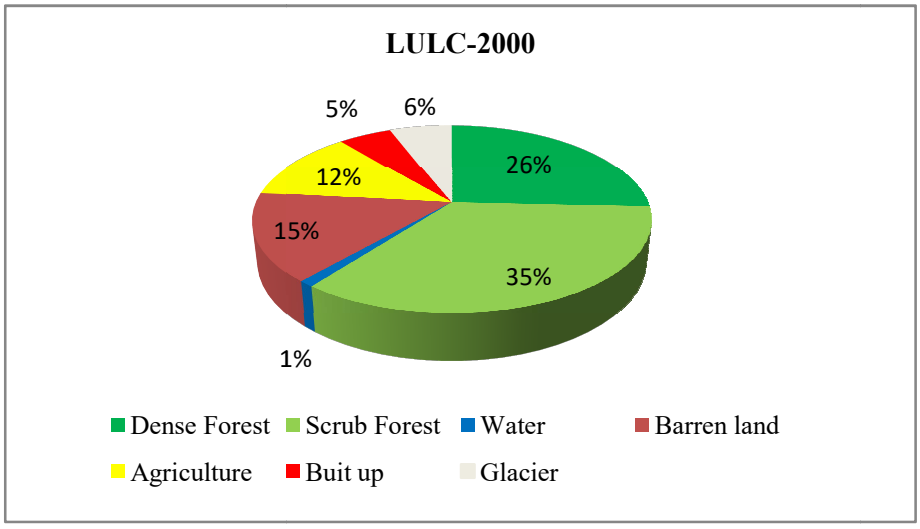
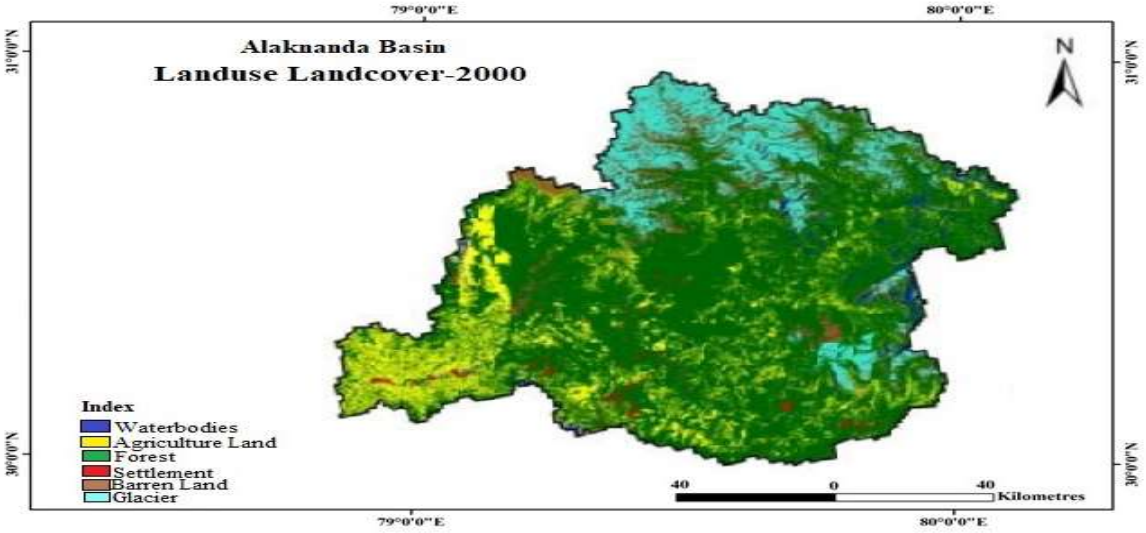


Fig. 3 (B)



Source: LANDSAT Satellite Data,2000

It is evident from the data that the area under barren land shows an uneven trend which is 13.33 percent (1990), 15.31 percent (2000) to 12.19 percent (2018) during the study period. The declining trend in barren land shows that large area under this category has been diverted to human induced developmental activities i.e. construction of roads, settlements and hydropower development etc. It is observed that the area under agricultural land has been decreased from 8.92 percent (1990) to 7.31 percent(2018). The area designated as built up area has been increased from 4.66 percent to 10.66 percent area during 1990 to 2018. Built up area includes roads, buildings, constructed dams, hydropower projects, settlements etc. (Fig.3A&B, Fig.4A&B,)

Fig. 4 (A)

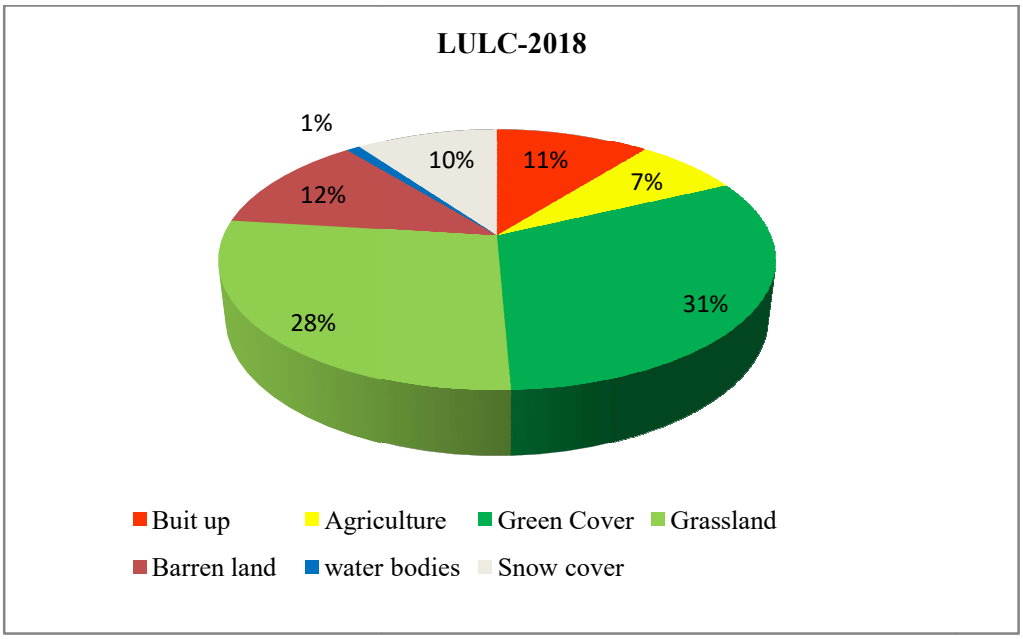
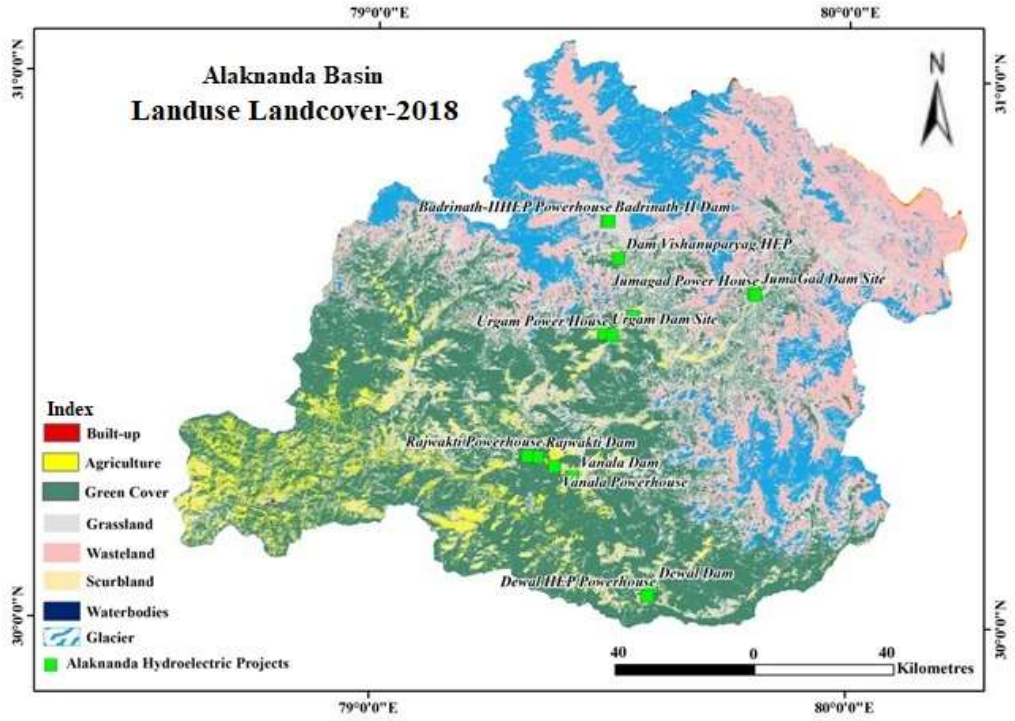


Fig. 4 (B)



Source: LANDSAT 30m ETM+ 2018

Built up area has been increased due to increasing population pressure which leads to increase in human settlements, construction of hydropower projects and construction of roads etc. After becoming a separate state in 2000, the government focused on development of hydropower projects to utilize the available vast potentials in the state. In this developmental phase a series of hydropower projects were commissioned in Alaknanda basin. The present study focuses on impact of seven large and small commissioned hydropower projects i.e. Badrinath-II (1.25 MW), Vishnuprayag (400 MW), Urgam (3 MW), Rajwakti (3.6 MW), Vanala (15 MW) Jummagad (1.2 MW) and Debal (5 MW). Being small hydropower project these projects does not posed any serious threat to the prevailing environment of the study area except Vishnuprayag hydropower project. It was noticed during the field survey that only two villages i.e. Lambgad, &Chayeen faced minor implications during the construction phase. It was further observed during the field survey that the study area experienced enormous changes in its physical resources base especially in land use land cover, the changes correlated with high human interference such as increased agricultural encroachment, forest resources extraction, grazing and to some extent to hydropower development. The impact of these hydropower projects have been clearly visible on landslide, soil erosion and magnitude of flash floods. The field observation shows that the human activities have been increased recently in higher elevations as a response to increased population pressure.

5. Conclusion

It is evident from the forgoing discussion thatthe selected hydropower projects have not bring any noticeable change to the land use land cover of the study area but other aggravating factors contributed huge changes in most of the land use land cover classes. The excessive anthropogenic activities i.e. construction of road, settlements and cutting of trees and conversion of agriculture land into settlements etc have been attributed to the changes in land use and land cover. The conversion and shrinkages of these limited resources surely have serious consequences towards sustainable development of the study area.

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