Forest Encroachment and Agriculture Land Abandonment in the Context of Land Cover Change in Kailali

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Abstract: Land use land cover (LULC) area has been changing for many decades in the Kailali district but has little been researched. The study aims to examine the spatial and temporal changes of LULC from 1978 to 2021, carrying out major driving factors of forest cover change regarding forest encroachment and abandonment. The researcher employed a mixed-method approach to accomplish this study. Field observation, household survey with 45 participants, Key Informant Interviews (KII) with three participants, and five Focus Group Discussions (FGD) were used as research tools to collect the data. Moreover, the researcher used books, journal articles, official reports, and related previous empirical studies as secondary data [Land Resource Mapping Project (LRMP) data were used to screen LULC status of 1978 and 1990, and digitization on Google Earth Pro to prepare LULC data for 2000 and 2021]. The findings of the study revealed that the forest cover area of the Kailali district was in a decreasing trend [for instance in 1978 the area of forest cover was 75.38%, in 1990 it was 66.51% in 2000, and was 65% in 2021]. In contrast to forest cover, the agricultural [settlements and infrastructures] land area was on an increasing trend which was followed by 21.77%, 30.28%, 31.75%, and 32.25% in each period. The study also found that the changing rate of forest cover and the agricultural land have been decreasing. Further, the research found the major drivers of forest cover change were encroachment and agricultural land abandonment. In addition, population growth, migration, poverty, development activities, natural hazards, resettlement, public utilities, weak implications of policy, and illegal activities were also the major causes of forest cover change. The research implies that both forest encroachment and land abandonment should be controlled, and are to be considered by the stakeholders.

Keywords: Forest encroachment, agriculture land abandonment, land cover change, driving factors, Kailali district.

1. Introduction

Land use and land cover have been taken as the most significant challenges at present time. It is a process mainly attributed to human activities and has a profound impact on various systems of the Earth, including climate, hydrology, and global biodiversity (Mustard et al., 2012). Furthermore, it threatens the long-term sustainability of our lands. In recent times, the most significant changes in agricultural land have occurred due to the adoption of intensive farming practices, which aim to increase productivity while reducing the cost of production. As a consequence, farming systems in mountainous regions, both small and large-scale, have been abandoned and marginalized due

to their lower productivity compared to the more fertile and accessible lowlands (Blaxter & Robertson, 1995; Gardner, 1996; Robinson & Sutherland, 2002; Zakkak et al., 2014). In Europe, farmland abandonment has been identified as the primary cause of land use change at the local level, posing a significant challenge to the conservation of the natural environment (Ameztegui et al., 2016; Plieninger et al., 2016; Mantero et al., 2020). However, the loss of forests in Southeast Asia has been occurring at a faster rate compared to other regions. Food and Agriculture Organization (FAO, 2020) report shows that between 1990 and 2020, the region lost 376,000 km^2, or nearly one-sixth of its forests, with Indonesia and Cambodia being the two worst-affected countries, losing one-fifth and one-quarter of their forests, respectively (Hansen et al., 2013; Imai et al., 2018; Estoque et al., 2019). The research conducted by Paradis (2021) showed that the Southeast Asian region lost 105,490 km^2 during 26 years, and the rate of forest cover change, although still negative, has globally decelerated.

Nepal is a small country located in the Himalayas, bordered by China to the north and India to the south, east, and west. Nepal covers 147,516 square kilometers (Paudel, 2022), and has a population of 29,164,578 people as per the Central Bureau of Statistics (CBS, 2021). The terrain of Nepal ranges from the Indo-Gangetic Plain to the Himalayan range, with Mount Everest being the highest point at 8,848.84 meters above sea level. Due to its varied topography and elevation, Nepal has a diverse climate that ranges from tropical to tundra/nival (Paudel et al., 2021). Department of Forest Research and Survey (DFRS, 2018) Nepal has a forested area of 44.74 percent, with the mid-hill region has the most forest cover at 37.8 percent in the Tarai. Nepal's forest sector has implemented effective policies, legal frameworks, strategic plans, and initiatives, resulting in the expansion and improvement of the country's forested area. The most recent land cover monitoring report by the Forest Research and Training Center (FRTC, 2022) shows that Nepal's total forest cover area is 41.69 percent, with the inclusion of 3.5 percent of wooded land resulting in a total of 45.26 percent of the nation.

Kailali is a district situated in the southwestern part of Tarai and is one of the nine districts of Sudur Pashchim province. It shares its southern border with India. The district has an elevation range of 114m to 1965m above sea level. The total population of this district is about 911,155 with a growth rate of 1.62%, and density is about 281.7/sq.km (CBS, 2021). The total forest area in this district was about 2097.24 km^2, which was 64.8 percent of the land from the total land area of the district (DDCK, 2015). The majority of the forested region is occupied by trees species of significant commercial and natural value. The community has been entrusted with a total of 40,767.69 hectares of forest land, which is divided into 294 communal forests. Women's community forests make up approximately 14 percent of this area. About 91,148 households are directly involved in community forestry initiatives.

However, due to forest encroachment, the number of people using forest resources illegally is increasing. According to the Five-year Forest Management Plan (2014-2019) Kailali district, 81 cases against forest invasion were filed in Kailali district (DDCK, 2015). It is the fourth-highest populated district of Nepal. Therefore, people need more land to establish settlement, cultivation, and infrastructure development, which directly or indirectly impact forest cover change. In 2014, the United Nations Development Programme (UNDP) reported that the per capita income in this district was $583, which suggests that the poverty level was high (UNDP, 2014). Moreover, the residents of this district primarily depended on forests for forest products. Because of the growing city, the LULC change rate was very high which caused social and geographical issues (Balayar, 2022). There were very few researches and updates about the change and drivers behind it. Thus,

the Kailali district was selected to analyze the forest cover change and major driving factors within the context of land use and land cover change.

2. Method and Materials

2.1 Study Area

The study area of this research was Kailali district, Sudur Pashchim province, Nepal, located at 28^0 41'N and 80^0 52'E (Fig. 1). The total area of this district is 3291.62 sq. km, with 40 percent covered by plain Tarai and 60 percent covered by Hills of Chure range. The Chure region is environmentally vulnerable, fragile, and sensitive and is referred to as the store of water and nutrients for the Tarai region, which is called the food store of the country (Rijal, 2021). Many kinds of flora, fauna, mammals, reptiles, fisheries, and birds can be observed in this area. Furthermore, Kailali is the fourth-highest populated district of Nepal, with a high development growth rate (CBS, 2021). Therefore, people need more land to establish settlements, cultivate, develop infrastructure, and build social utilities, which impacts forest cover and other land use.

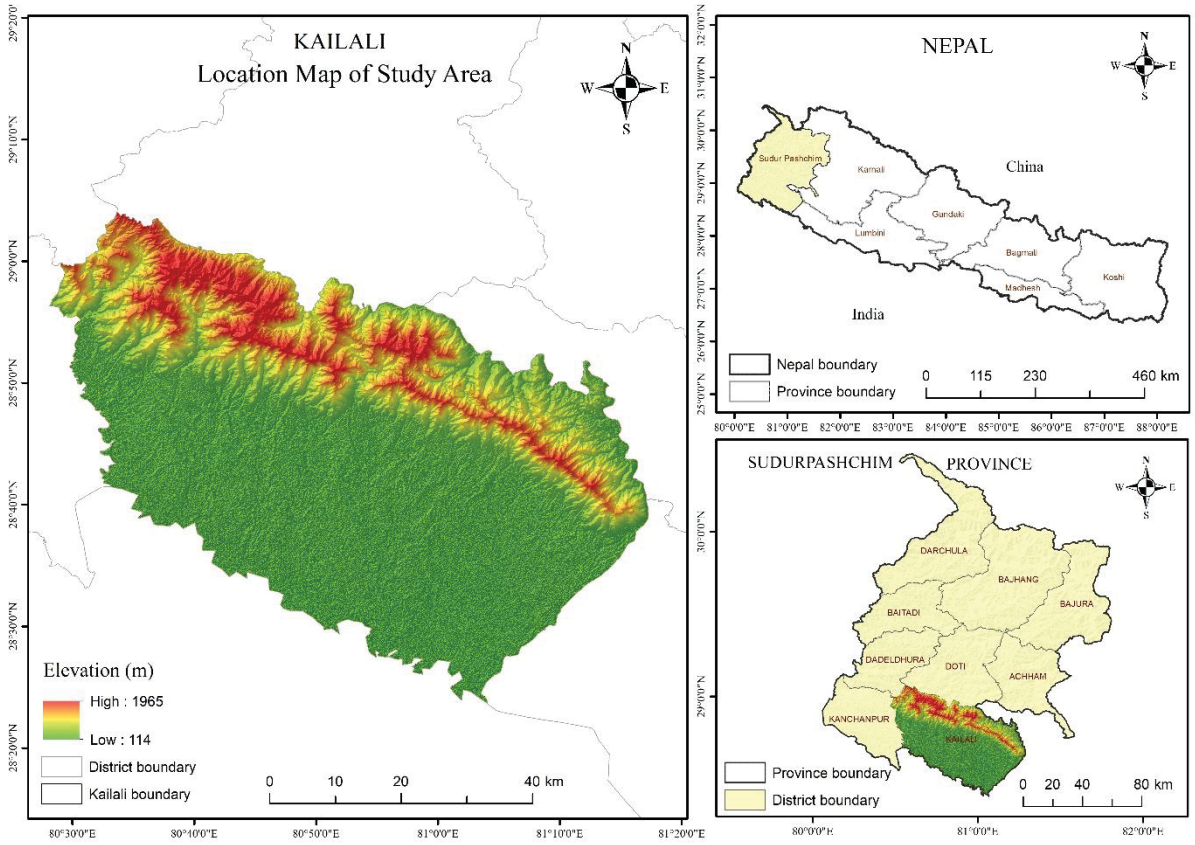

Figure 1. Location Map of the Study Area

2.2 Research Design

The research was designed using exploratory and descriptive research. Qualitative and quantitative research methods are used for the data collection to meet the research objectives. In this study, the researchers used a mostly quantitative approach to analyze the spatial and temporal change in land use and land cover of the study area from 1978 to 2021. Additionally, the researcher used the same approach to examine the process of forest encroachment and land abandonment. Similarly, a qualitative research method was to identify the driving factors of forest cover and other LULC changes in the study area.

2.3 Tools and Techniques for Data Collection

Before the field, the researcher worked on secondary data such as; a literature review, and prepared different four time periods LULC data layers with the help of Google Earth Pro, and ArcGIS 10.8 (ESRI, 2020). Land Resource Mapping Project (LRMP) data were used for the 1978 and 1990 data layers (LRMP, 1986), whereas the 2000 and 2021 data layers were prepared by digitization on Google Earth Pro. Forty-five major forest and land cover change areas were selected for field verification. For every study, data collection tools and techniques are most important in obtaining reliable data. Hence, this study also used various tools and techniques for primary data collection such as; field observation, questionnaire survey, key informant interviews, and focus group discussion.

2.3.1. Field Observation

Field observation is one of the important methods of the data collection procedure. It is also very useful for geographical research. Participant and non-participant observations were used in this study. Observation was conducted to analyze the spatial and temporal change of LULC. Moreover, it was also used to find out the major drivers of LULC change. More than 45 LULC the most change areas were visited for field observation and verification which were already selected before the field study based on secondary data. Field observation was conducted from 31st Jan. 2021 to 19th Feb. 2021 to check the accuracy and validation of the data.

2.3.2. Household Survey

Forty-five households (HH) were randomly selected from most LULC changed areas for the HH survey before fieldwork. Mostly, interviews were conducted with the household head. For HHs, a questionnaire was prepared which contained 20 open and closed questions related to the objectives of the study. Respondent's profile, years of migration, major occupation, fuel use, status of land use/land cover change, encroachment and abandonment situation, causes of the change, and other related questions were developed in the questionnaire.

2.3.3. Key Informant Interview (KII)

Three key informants were selected for the study. Among them, one was staff of the Division Forest Office, Dhangadhi and the other two were locals. They were familiar with the LULC change of the district. They helped to identify and visit locations. Also, they gave a lot of information related to research such as; migration trends, the situation of LULC change, the status of abandonment, encroachment, and their key causes.

2.3.4. Focus Group Discussion (FGD)

Focus group discussion is one of the best methods to gather detailed information. Thus, FGD was organized in five different locations of the district, they were; Khairala-02, Chure rural municipality, Olani-11, Godawari municipality, Khanidanda-05, Chure rural municipality, Likma-08, Gauriganga municipality, and Devkaliya- 05, Ghodaghodi municipality. There were 8 to 12 participants in each FGD. A short checklist was developed for the FGD which contains some queries such as; the origin of the settlement, mostly migrated from, status of LULC change, its major drivers, and impact on livelihood. Also, respondents shared precious experiences, local needs, and stakeholder suggestions.

2.4 Data Source

Population refers to the set of people, events, or objects to which the result of the research wishes to be generalized, and sampling refers to the selection of some part of an aggregate or totality

(Kothari, 2004). Hence, in this study, the population consisted of all the LULCs of Kailali district. The study was based on both secondary and primary data. Secondary data were collected from secondary sources such as; official reports, books, journal articles, literature, dissertations, Google Earth Pro data, and LRMP data. Whereas primary data were collected through fieldwork using observation, household surveys, key informant interviews, and focus group discussions.

3. Results and Discussion

3.1. Temporal Changes in Land Use and Land Cover Area

The LULC change trend from 1978 to 2021 is presented in Table 1. The periods are divided into four duration which are 1978, 1990, 2000, and 2021. Regarding the data, LULC was categorized into major six layers such as; forest cover, agriculture land, encroached forest, abandoned land, shrub area, and riverbed. All the different trends are expressed in Fig. 2.

According to the data, the forest cover area was 2481.18 km² which means 75.38% in 1978. In 1990, it was decreased and reached 2189.41 km² (66.51%) in total. Again, it decreased in 2000 which covered 2146.66 km² area which means 65.22%. Similarly, the area of forest cover was shrunk in 2021 reached 2139.61km² (65%). The data exposed that forest cover area decreased in all the period because of poverty (more dependency on the forest for fuel, firewood, timber, etc.), agriculture (grazing animals, collecting grass, leaves, etc.), legal and illegal encroachment of forest (growing settlement and resettlement, infrastructure development, community utilities). In contrast to forest cover, the data showed that agricultural land (including settlements and infrastructure) increased in all periods. In 1978, the total agricultural land was 716.55 km² which was 21.77%. It was 996.82 km² (30.28%) area in 1990. Chronologically, it was increased in 2000 (1045.16 km²) and 2021 (1061.64 km²) which were 31.75% and 32.25% which means agricultural land was increased till 2021. The agricultural land has been increasing day by day because population growth needs more land for cultivation, infrastructure development, community utilities, and resettlement.

Most of the encroached forest area was mixed with agricultural land area because of the types and reasons for forest encroachment. Thus, the table disclosed only illegal forest encroachments (forest encroached without government permit) data which were highlighted in Maps. According to the table, the highest area of encroached forest was in 1990 which was 5.92 km² (0.18%) of the total because in this era migration from different districts in Kailali was highly increased, weak policies for forest conservation and arbitrary of locals. In 2000 the rate of forest encroachment was decreased which got 0.42 km² (0.01%). Again, in 2021 it was increased and reached 3.03 km² (0.09%).

Regarding Table 1, the rate of land abandonment increased in all the timelines, mostly in the hill area. There were a lot of causes for land abandonment such as; the trend of migrating to Tarai or city-centered areas, the young generation going to India and overseas countries for higher study and labor, problems for cultivation in hill areas because of the lack of irrigation, fertility, chemical fertilizer, and market, lack of facilities and opportunity. In 1990, it was 0.12 km² which was 0.47 km² (0.01%) in 2000 and 1.62 km² (0.05%) area in 2021.

As of the data, it was estimated that the shrub area was 3.09 km² (0.09%) in 1978 which was increased in 1990 and 2000 which was 12.73 km² (0.39%) and 17.52 km² (0.53%) area respectively. On the other hand, it was decreased by 13.65 km² (0.41%) in 2021. Rivers and streams play a major role in increasing and decreasing of shrub area. The table shows significant changes in the riverbed according to different periods. In 1978, it was 90.80 km² (2.76%) which was always in decreasing trend. It was followed by 86.63 km² (2.63%), 81.39 km² (2.47%) and

72.08 km² (2.19%) in 1990, 2000 and 2021 respectively. The major reasons for decreasing riverbed area were; public awareness, the construction of walls or barriers on the riverbank, also the started seasonal cultivation in the riverbed area.

Table 1. Land use/Land Cover Change Status from 1978 to 2021

SN.	Land use/ land cover	1978 (Km²)	%	1990 (Km²)	%	2000 (Km²)	%	2021 (Km²)	%
1	Agriculture land	716.55	21.77	996.82	30.28	1045.16	31.75	1061.64	32.25
2	Forest cover	2481.18	75.38	2189.41	66.51	2146.66	65.22	2139.61	65.00
3	Shrub area	3.09	0.09	12.73	0.39	17.52	0.53	13.65	0.41
4	Riverbed	90.80	2.76	86.63	2.63	81.39	2.47	72.08	2.19
5	Encroached forest	0.00	0.00	5.92	0.18	0.42	0.01	3.03	0.09
6	Abandoned land	0.00	0.00	0.12	0.01	0.47	0.02	1.62	0.06
	Total	**3291.62**	**100**	**3291.62**	**100**	**3291.62**	**100**	**3291.62**	**100**

Source: LRMP, 1986, and Google Earth Pro.

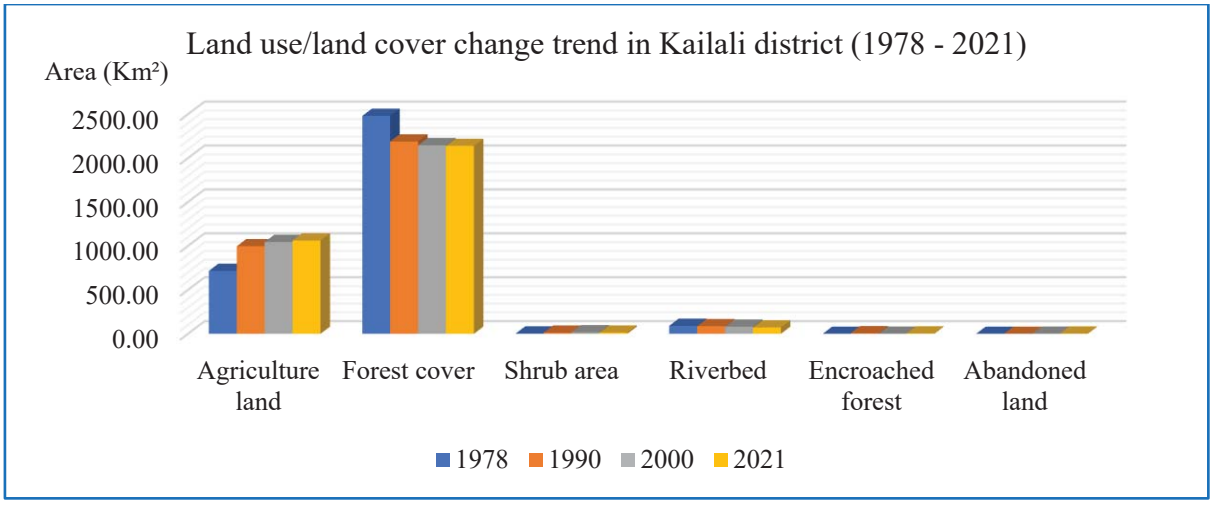

Figure 2. Temporal Trend of Land Use and Land Cover Change from 1978 to 2021

3.2 Spatial Changes in Land Use and Land Cover Area

LULC area has changed in different time periods at various rates of change. They were categorized into six different periods which are; 1978 – 1990, 1990 – 2000, 2000 – 2021, 1978 – 2000, and 1978 – 2021. All the spatial changed data were detail explained in Tables 2, 3, 4, 5, 6, and 7. Also, the data are presented in Fig. 3.

Table 2. Land Use/Land Cover Change Area from 1978 to 1990

SN.	Land use/land cover	1978 (Km²)	%	1990 (Km²)	%	1978 - 1990 (Km²)	Change %
1	Agriculture land	716.55	21.77	996.82	30.28	280.27	8.51
2	Forest cover	2481.18	75.38	2189.41	66.51	-291.77	-8.87
3	Shrub area	3.09	0.09	12.73	0.39	9.63	0.30
4	Riverbed	90.80	2.76	86.63	2.63	-4.17	-0.13

5	Encroached forest	0.00	0.00	5.92	0.18	5.92	0.18
6	Abandoned land	0.00	0.00	0.12	0.01	0.12	0.01

Source: LRMP, 1986, and Google Earth Pro.

Table 2, illustrates the LULC change data of the study area between 1978 to 1990. According to the data, the total LULC area was about 3291.62 km² categorized as Forest cover, Agriculture land, Encroached Forest, Abandoned land, Shrub area, and Riverbed. Regarding the table, forest cover area was highest in both time durations. In 1978 it was 2481.18 km² (75.38%) but in 1990 it decreased by 291.77 km² which was 8.86% area and reached 2189.41 km² (66.51%). Similarly, the second highest area was agricultural land which was 716.55 km² (21.77%) out of the total in 1978. In 1990 it increased by 280.27 km² (8.51%) and reached 996.82 km^2 (30.28%). At the same time encroached forest area was increased by 5.92 km^2 (0.18%) and abandoned land also increased by 0.12 km². Likewise, the shrub area was increased by 9.63 km² (0.30%) which was 12.73 km² (0.39%) in 1990. It was 3.09 km² (0.09%) area in 1978. However, the area of the riverbed was decreased dramatically by 4.17 km² (0.13%) which was 86.63 km² (2.63%) from 90.80 km² (2.76%). Overall, data shows that the area of forest cover and riverbed area decreased, and the remaining agricultural land, abandoned land, encroached forest, and shrub area increased till 1990. Because of this, land use was changed in the district.

Table 3. Land Use/Land Cover Change from 1990 to 2000

SN.	Land use/land cover	1990 (Km²)	%	2000 (Km²)	%	1990 - 2000 (Km²)	Change %
1	Agriculture land	996.82	30.28	1045.16	31.75	48.34	1.47
2	Forest cover	2189.41	66.51	2146.66	65.22	-42.74	-1.29
3	Shrub area	12.73	0.39	17.52	0.53	4.79	0.14
4	Riverbed	86.63	2.63	81.39	2.47	-5.24	-0.16
5	Encroached forest	5.92	0.18	0.42	0.01	-5.50	-0.17
6	Abandoned land	0.12	0.01	0.47	0.02	0.35	0.01

Source: LRMP, 1986, and Google Earth Pro.

Table 3, demonstrate that the forest cover area was 2189.41 km² (66.51%) in 1990 and it decreased by 42.74 km² (1.30%) which was 2146.66 km² (65.22%) in total till 2000. Similarly, the area of encroached forest and riverbed also decreased by chronologically 5.50 km² (0.17%) and 5.24 km² (0.16%) which means 0.42 km² (0.01%) encroached forest and 81.39 km² (2.47%) riverbed in total. Besides that, the area of agricultural land, abandoned land and the shrub area increased in 2000. In 1990 it was followed by 996.82 km² (30.28%), 0.12 km², and 12.73 km² (0.39%). At the end of 2000, they were increased by 48.34 km² (1.47%), 0.35 km² (0.01%), and 4.79 km² (0.15%). Then it covered 1045.16 km² (31.75%), 0.47 km² (0.01%), and 17.52 km² (0.53%) individually in total till 2000.

Therefore, in the period of 1900 to 2000 forest cover area decreased and cultivated land area increased. This means that forest cover was used in cultivation and other human activities, which changed the forest cover area of the Kailali district. Similarly, the encroached forest area decreased and land abandonment increased, which impacted on LULC change of the study area.

Table 4. Land Use/Land Cover Change from 2000 to 2021

SN.	Land use/land cover	2000 (Km²)	%	2021 (Km²)	%	2000 - 2021 (Km²)	Change %

1	Agriculture land	1045.16	31.75	1061.64	32.25	16.47	0.50
2	Forest cover	2146.67	65.22	2139.61	65.00	-7.06	-0.22
3	Shrub area	17.52	0.53	13.65	0.41	-3.87	-0.12
4	Riverbed	81.39	2.47	72.08	2.19	-9.31	-0.28
5	Encroached forest	0.42	0.01	3.03	0.09	2.61	0.08
6	Abandoned land	0.47	0.02	1.62	0.06	1.15	0.04

Source: LRMP, 1986, and Google Earth Pro.

Table 4, depicts the significant changes in LULC of the Kailali district between 2000 and 2021. It is estimated that forest cover in 2000 was 2146.67 km² (65.22%). It decreased by 7.06 km² (0.21%) till 2021, which covered 2139.61 km² (65%) area. Similarly, the shrub area and riverbed areas also decreased by 3.87 (0.12%) and 9.31 (0.28%) km² respectively. In 2000 shrub area was 17.52 km² (0.53%) and the riverbed was 81.39 km² (2.47%) which were 13.65 km² (0.41%) and 72.08 km² (2.19%) at the end of 2021. At the same time agriculture land area was opposed to them, which was increased by 16.47 km² (0.50%). It covered 1045.16 km² (31.75%) in 2000 and 1061.64 km² (32.25%) area in 2021. In the same trend encroached forest and abandoned land were also increased by 2.61 (0.08%) and 1.15 km² (0.03%). Similarly, in 2000 encroached forest was 0.42 km² (0.01%) and grew up by 3.03 km² (0.09%) area till 2021. Regarding land abandonment, it was 0.47 km² (0.01%) in 2000 and 1.62 km² (0.05%) area in 2021.

Table 5. Land Use/Land Cover Change from 1978 to 2000

SN.	Land use/land cover	1978 (Km²)	%	2000 (Km²)	%	1978 - 2000 (Km²)	Change %
1	Agriculture land	716.55	21.77	1045.16	31.75	328.61	9.98
2	Forest cover	2481.18	75.38	2146.67	65.22	-334.51	-10.16
3	Shrub area	3.09	0.09	17.52	0.53	14.42	0.44
4	Riverbed	90.80	2.76	81.39	2.47	-9.41	-0.29
5	Encroached forest	0.00	0.00	0.42	0.01	0.42	0.01
6	Abandoned land	0.00	0.00	0.47	0.02	0.47	0.02

Source: LRMP, 1986, and Google Earth Pro.

Table 5, reveals the LULC change in the Kailali district between 1978 to 2000. Among all, forest cover area was highest in both time durations. In 1978 it was 2481.18 km^2 (75.38%) but in 2000 it decreased by 334.51 km^2 (1.16%) area and reached 2146.67 km^2 (65.22%). Similarly, the second highest area was agriculture land which was 716.55 km^2 (21.77%) out of the total. In 2000 it increased by 328.61 km^2 (9.98%) and reached 1045.16 km^2 (31.75%). At the same time, the encroached forest increased by 0.42 km^2 (0.01%) and abandoned land also increased by 0.47 km² (0.01%). Regarding the shrub area, it was increased by 14.42 km² (0.44%) which was 17.52 km² (0.53%) from 3.09 km² (0.09%) area. However, the area of riverbed was decreased dramatically by 9.41 km² (0.29%). It was 81.39 km² (2.47%) from 90.80 km² (2.76%). Overall, data shows the area of forest and riverbed decreased and remaining agricultural land, abandoned land, encroached forest, and shrub area increased till 2000. Because of this, the land use was changed in the district between 1978 to 2000.

Table 6. Land Use/Land Cover Change from 1990 to 2021

SN.	Land use/land cover	1990 (Km²)	%	2021 (Km²)	%	1990 - 2021 (Km²)	Change %
1	Agriculture land	996.82	30.28	1061.64	32.25	64.81	1.97
2	Forest cover	2189.41	66.51	2139.61	65.00	-49.80	-1.51
3	Shrub area	12.73	0.39	13.65	0.41	0.92	0.02
4	Riverbed	86.63	2.63	72.08	2.19	-14.55	-0.44
5	Encroached forest	5.92	0.18	3.03	0.09	-2.89	-0.09
6	Abandoned land	0.12	0.01	1.62	0.06	1.50	0.05

Source: LRMP, 1986, and Google Earth Pro.

Table 6 shows, the LULC change from 1990 to 2021. According to the data, the forest cover area was 2189.41 km² (66.51%) in 1990 and it was decreased by 49.80 km² (1.51%) which was 2139.61 km² (65%) in total till 2021. Similarly, the area of encroached forest and riverbed also decreased by chronologically 2.89 km² (0.09%) and 14.55 km² (0.44%) which means 3.03 km² (0.09%) encroached forest and 72.08 km² (2.19%) riverbed in total. On the other hand, the area of agricultural land, abandoned land, and shrub areas were increased by 2021. In 1990 it was respectively 996.82 km² (30.28%), 0.12 km² and 12.73 km² (0.39%). At the end of 2021, they were increased by 64.81 km² (1.97%), 1.50 km² (0.05%) and 0.92 km² (0.03%). It covered 1061.64 km² (32.25%), 1.62 km² (0.05%), and 13.65 km² (0.41%) out of total area.

Therefore, in the period 1990 to 2021, the forest cover area decreased, and the cultivated land area increased. It means the forest cover was mostly used in cultivation and other human activities, which changed the forest area of Kailali district. Similarly, the encroached forest decreased and land abandonment increased which proved that the process of LULC change was active in the study area.

Table 7. Land Use/Land Cover Change from 1978 to 2021

SN.	Land use/land cover	1978 (Km²)	%	2021 (Km²)	%	1978 - 2021 (Km²)	Change %
1	Agriculture land	716.55	21.77	1061.64	32.25	345.09	10.48
2	Forest cover	2481.18	75.38	2139.61	65.00	-341.57	-10.38
3	Shrub area	3.09	0.09	13.65	0.41	10.55	0.32
4	Riverbed	90.80	2.76	72.08	2.19	-18.72	-0.57
5	Encroached forest	0.00	0.00	3.03	0.09	3.03	0.09
6	Abandoned land	0.00	0.00	1.62	0.06	1.62	0.06

Source: LRMP, 1986, and Google Earth Pro.

Table 7 illustrates the significant changes in LULC between 1978 to 2021 in the Kailali district. Based on data, the forest cover area was 2481.18 km² (75.38%) in 1978. It was decreased by 341.57 km² (10.38%) area till 2021 which got 2139.61km² (65%). Similarly, the riverbed was also decreased by 18.72 km² (0.57%) which got 72.08 km² (2.19%) till 2021 from 90.80 km² (2.76%) area in 1978. In contrast to forest cover and riverbeds, the area of agricultural land, encroached forest, abandoned land, and shrub area increased. They increased by 345.09 (10.48%), 3.03 (0.09%), 1.62 (0.05%), and 10.55 km² (0.32%) respectively at the end of 2021. In 1978 agriculture area was 716.55 km² (21.77%) and the shrub area was 3.09 km² (0.09%). However, agriculture land covered 1061.64 km² (32.25%), encroached forest 3.03 km² (0.09%), abandoned land 1.62 km² (0.05%), and shrub area 13.65 km² (0.41%) area till 2021.

Therefore, the data shows that forest cover, land abandonment, and riverbed area were changed into agricultural land, forest encroachment, and shrubland.

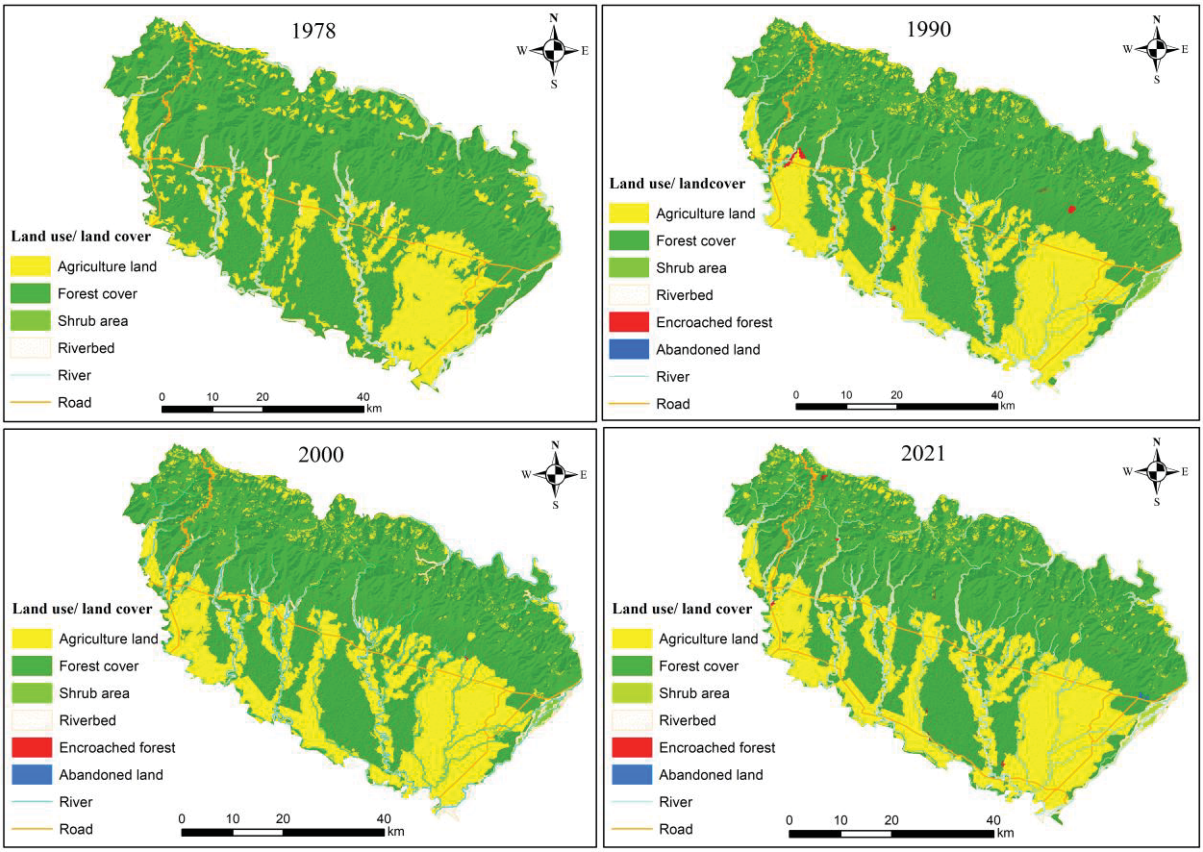

Figure 3. Land Use and Land Cover Map of 1978 to 2021

Figure 3 shows the four different periods LULC data on maps. The figure contrasts the changed area of the Kailali district. All the LULC were categorized in different layers with appropriate colors. Whereas, the forest cover area decreased in all periods, the agricultural land area increased in each period. Regarding shrub areas, riverbeds, encroached forests, and abandoned land fluctuated in various periods. Thus, the study declared that land use and the land cover area were changed in the study area.

Table 8. Land Use Land Cover Change Status

SN.	Land use/Land cover	Change 1978-1990	Change 1978-2000	Change 1978-2021	Change 1990-2000	Change 1990-2021	Change 2000-2021
		Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)	Area (km^2)
1	Abandoned - Agriculture	0	0	0	0	0	0.03
2	Abandoned - Forest	0	0	0	0.01	0.01	0.01
3	Agriculture - Agriculture	2.27	2.36	2.35	3.11	3.06	3.27
4	Agriculture - Encroached	0.01	0	0	0	0.01	0.01
5	Agriculture - Forest	1.79	1.78	1.78	2.76	2.8	1.29

6	Agriculture - Riverbed	0.21	0.21	0.19	0.19	0.19	0.19
7	Agriculture - Shrub	0	0.01	0	0.02	0.01	0.02
8	Encroached - Forest	0	0	0	0.03	0.03	0.05
9	Forest - Abandoned	0.01	0.02	0.03	0.02	0.03	0.02
10	Forest - Agriculture	3.38	3.78	3.92	3.43	3.54	1.02
11	Forest - Encroached	0.04	0.01	0.05	0.01	0.05	0
12	Forest - Forest	3.71	4.16	4.32	3.87	0.52	0.66
13	Forest - Riverbed	0.87	1.01	0.86	0.77	0.7	0.86
14	Forest - Shrub	0.08	0.13	0.08	0.03	0.02	0.01
15	Riverbed - Agriculture	0.39	0.44	0.45	0.27	0.29	0.19
16	Riverbed - Forest	0.89	0.95	0.95	0.78	0.81	0.8
17	Riverbed - Riverbed	0.57	0.54	0.47	0.84	0.67	0.89
18	Riverbed - Shrub	0.01	0.02	0.02	0.09	0.05	0.12
19	Shrub - Agriculture	0.01	0.01	0	0	0	0
20	Shrub - Forest	0.03	0.03	0.03	0	0.01	0
21	Shrub - Riverbed	0	0	0	0.08	0.09	0.05
22	Shrub - Shrub	0	0	0	0.07	0.05	0.08
	Total	**14.27**	**15.5**	**15.51**	**16.38**	**12.94**	**9.57**

Source: LRMP, 1986, and Google Earth Pro.

Table 8 shows the LULC change area from 1978 to 2021, categorized into different six time periods. According to the data, the area was 14.27 km^2, which changed from 1978 to 1990. It increased by 2000 and 2021, covering 15.5 km^2 and 15.51 km^2 respectively. The most LULC cover change in 1990 to 2000 which was 16.38 km^2. It decreased from 1990 to 2021 and from 2000 to 2021, which followed by 12.94 and 9.57 km^2 area.

3.3 Major Drivers of Forest Cover Change

The change in forest coverage involves different practices such as deforestation, reforestation, afforestation, and enhancing the quality of existing forests by increasing the number of trees in a given area, which may lead to the deterioration of forested lands (FRA, 2000; Tripathi et al., 2020). Moreover, forest cover change means the area of forest cover changed into other land use or land cover such as; agricultural land, shrubland, goths, government/institutional use, community utilities, religious sites, tourism sites, and infrastructure development activities. There are a lot of causes behind forest cover change in general but the major drivers are forest encroachment and farmland or settlement abandonment.

3.3.1. Forest Encroachment

Legally or illegally, directly or indirectly, forest encroachment in Nepal has been for many decades. It was 751 ha from 2000-2010 and 380 ha from 2010-2019 in the country (Budhathoki et al., 2020). People want to migrate to the Tarai area for a good quality of life and to improve their living standards. Mainly, Tharu and Bote people began in the 1920s, but after the 1950s and 60s eradication of malaria in the Tarai belt and started east-west highway, the trend to migrate in Tarai from hill and mountainous districts also boosted the forest encroachment. Tarai is also called the store of granaries because of the fertile soil, good quality of irrigation, and easy of harvesting and transport. Therefore, people want to migrate to Tarai. CBS, 2021 shows that only 6.09% of people live in the mountain region, 43.01% in the Hilly region, and 40.25% in the Tarai region.

Because of the high population growth, they need more land for cultivation, settlement, infrastructure development, and other purpose which attracts them to forest encroachment.

The research found that forest encroachment in the study area was 3.09, 12.73, 17.52, and 13.65 sq km in 1990, 2000, and 2021 respectively. The major causes of forest cover change in the starting phase were the high migration rate in Kailali from upper districts, development activities, burn and slash cultivation, natural hazards, resettlement, and weak supervision of stakeholders in rural forests. Later, the rate of encroachment was decreasing because of some effective policies. Similarly, forest encroachment has been triggered by poverty because poor people were more dependent on forests for fuel, food (fruits, animals, and birds), firewood, grazing land, grass, timber, etc. According to CBS, in 2021, 101,657 HHs used firewood for cooking out of 195,872 HHs in Kailali.

Furthermore, it was found that national and community forests existed in that very district which was accessed differently by the local users. As the study intended to explore the reasons behind the change in forest cover, easy access to forests was one of the major reasons. As the interviewed data, participants responses disclosed that they were free to use the resources that they got in the forests which caused the rapid change. Some places such as Khairala, Khanidanda, Garbha, and Chaitanpur were found access free to use. In contrast, some places like Fulbari, Lalpur, and Chaukidanda were allowed to cut only grass and dry branches for firewood, as it was responded by 12 participants. The rest of the respondents were not allowed to graze or use any kinds of forest products from public forests. As they responded, they grazed their animals in private areas, open fields, and on road side. Moreover, it was found that to collect green leaves, grass, and firewood, local people should pay fees at different rates for various purposes otherwise, they were strictly prohibited from collecting forest products in Bhajani and Devkaliya.

The number of pets that people keep at their homes can be taken as the major reason behind the changing nature of the forest cover. The more pets people keep, the more resources they use. The researcher collected data from those, who have cattle, buffalo, goats/ships, or chicken/ducks. Among all the participants 77% of participants used private forests, private areas, or roadside areas in the offseason of agriculture and 23% of participants used the public forest for grazing in the Kailali district.

3.3.2. Agriculture Land Abandonment

Agricultural land abandonment significantly changes the ecosystems in a particular area. In Nepal, we often observe agricultural land abandonment in rural hilly, and mountainous regions (Paudel et al., 2020). Over the past thirty years, a high rate of migration has led to land abandonment in these areas. People tend to leave mountainous areas due to challenging living conditions and seek better opportunities in more central or lowland regions. Factors contributing to this trend include the lack of irrigation, difficulties in agriculture, high poverty rates, and limited infrastructure in hilly areas. The complex geography of these regions makes it challenging for the government to develop infrastructure. As a result, rural farmland in Nepal has been left unused. Between 2001 and 2010, a total of 97,060 sq. km, which is 23.9% of Nepal's cultivated farmland, were abandoned (Chaudhary et al., 2020).

Likewise, population growth, development activities, and forest encroachment were increasing in Kailali district. However, there was land abandoned in some of the northern parts of the study area. According to the local people, migration trend in Tarai, most of the young were in India or foreign countries for jobs and higher education which caused the labor shortage for agriculture which created land abandonment. People were leaving the hilly areas because of the difficult geography in rural areas and the lack of opportunity. Scattered settlements, lack of agricultural

input, poor implementation of development policy, and losses by wild animals were the major causes of land abandonment as well. Natural hazards (erosion, flood, fire, irregular rainfall, and drought), land fragmentation, and plotting also play a significant role in land abandonment. Thus, the abandonment of land has negative consequences on societal, economic, and cultural aspects, along with its influence on mental health and established social norms and values.

4. Conclusion

The study concludes that the forest cover area has been decreasing each time. From 1978 to 1990, the total area of forest cover loss was 291.77 km², which decreased by 42.74 km² area until 2000. Similarly, the forest cover decreased by only 7.06 Km² area in 2021 from 2000 which shows that the rate of forest cover loss was also decreasing. The second highest land cover area was agricultural land which increased every period. It was 280.27 km² area increased in 1990 from 1978, which was 48.34 km² area in 2000 and 16.47 km² area in 2021. The rate of forest encroachment has fluctuated over various periods. It increased till 1990 but decreased in 2000. Again, it was increased in 2021. The shrub area increased till 2000 from 1978, but it started to decrease in 2021 because of the changing direction of the river, which changed into agricultural land and community forest. Regarding riverbeds, the trend was always decreasing trend because people implemented many activities to minimize it such as; making walls along the riverside, bio-engineering, and starting seasonal farming. Forest encroachment and land abandonment have been the major causes of forest and agricultural land cover change. Among them, forest encroachment was the most serious driving factor. After the eradication of malaria and the start of the east-west highway, population growth has increased significantly. According to CBS, 2012, the total population of Kailali district was 775,709 and it was 911,155 in 2021. People need more land for settlement, cultivation, pasture land, and development infrastructure which promotes legal and illegal forest encroachment. Natural hazards, forest fires, dependency on forest products, illegal activities, and poor implementation of policy or limited institutional capacity were the major causes of forest encroachment. Mostly, in hilly areas of Kailali land abandonment was increasing day by day which caused severe problems. It also impacts the socio-cultural and psychological health of locals. The trend to migrate to Tarai or city areas, study or labor migration in India or overseas countries, low productivity of soil, and difficult livelihood in such areas were the major causes of land abandonment.

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