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Review

A Synopsis of Farmland Abandonment and Its Driving Factors in Nepal

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Abstract: Farmland abandonment is considered as an important phenomenon for changing eco-environmental and sociocultural landscapes of mountainous rural landscape. Many studies have analyzed farmland abandonment, its driving factors, geophysical processes and consequences at landscape: however, very few have focused on mountainous developing countries such as in Nepal, which is a rapidly urbanizing country suffering from serious farmland abandonment. Therefore, our study was an attempt to (i) assess the spatiotemporal extent of farmland abandonment in Nepal, (ii) explore driving factors of farmland abandonment, and (iii) discuss on the eco-environmental and sociocultural consequences in Nepal. We reviewed various literature, documents, and national reports to obtain a dataset pertaining to the overall status of farmland use and changes along with political and socioeconomic changes, economic development processes, and policy and governance in Nepal. Our results showed that farmland abandonment is widespread; however, it is more prevalent in the hilly and mountainous regions of Nepal. A total of 9,706,000 ha, accounting for 23.9% of the total cultivated farmland in Nepal, was abandoned during the period of 2001 to 2010. The driving factors included population growth, scattered distribution of settlements, urbanization, socio-economic development, poor access to physical services, and poor implementation of agriculture development policies. Furthermore, the increasing extent of natural disasters, malaria eradication, land reform and resettlement programs, the complex system of land ownership, land fragmentation, political instabilities, and the intensification of trading in agricultural products also acted as drivers of farmland abandonment in Nepal. Farmland abandonment generates negative effects on rural societies eco-environmentally and sociologically. Abandoned plots were subjected to different forms of geomorphic damage (e.g. landslide, debris flows, gully formation, sinkhole development etc.). Farmland landscape fragmented into a group of smaller interspersed patches. Such patches were opened for grassland. Furthermore, farmland abandonment also has effects on the local population and the whole society in terms of the production of goods (e.g., foods, feed, fiber), as well as services provided by the multi-functionality (e.g. sociocultural practices, values and norms) of the agricultural landscape. Therefore, this study plays an important role in planning and implementing eco-environmental management and social development processes in Nepal.

Keywords: farmland abandonment; driving factors; eco-environmental consequences; mountain region; Nepal

1. Introduction

Farmland abandonment is considered an important phenomenon in the eco-environmental and sociocultural landscape change process [1–3]. Since 19th century, farmland abandonment is primarily occurred in European or in developed and industrialized countries [4–6], particularly in Western Europe [7–9], former Soviet Union [4], Southeast Asia [10], United States of America [11], Australia [12], Japan [13] and the Mediterranean regions [14–16]. However, many south Asian developing countries such as Nepal, India, Pakistan and Bangladesh, have also been subjected to farmland abandonment in the recent years [17–20]. According to historical database, the global farmland abandonment area was estimated at approximately 385–472 million square kilometer, accounting for 8–10% of the total cultivated land of the world in 2008 [21]. Some scholars view farmland abandonment as an opportunity for reversing the long term declines of forest, provision of ecosystem services, and habitat enhancement that re-naturalization of landscape provides [22–25], while others regard farmland abandonment as a threat to rural biodiversity that can cause serious environmental security, such as natural hazards and habitat loss [26,27]. Regardless of the environmental impacts, farmland can lead to socio-economic effects, especially in terms of weakened farmers livelihoods, goods production (e.g. food, fiber etc.) [28], and socio-cultural practices (e.g. indigenous practices, norms and value) in rural communities [29,30]. In the case of Nepal, most Nepalese scholars insist that increasing farmland abandonment tend to have negative impacts both on the environment and socio-economic condition, especially on mountainous closure, agricultural production, poverty alleviation and food security [31–33]. In response, Ministry of Agriculture and Livestock Development, Nepal government updated national agriculture-forest policy to control farmland abandonment, which began being enforced in 2019 [34]. This was necessary in order to promote agricultural production that remains in harmony with the environment without compromising rural development, food security, alleviate poverty and biodiversity conservation thereby leading to the healthy development of agriculture.

Farmland abandonment is manifold, reciprocal, complex, and operates at different spatiotemporal scales [35]. Empirical studies have elucidated that the industrialization process and the end of World War II were the main causes of farmland abandonment in the 19th century [36]. Currently, the driving factors are eco-environmental and socioeconomic, including the climate, topography, soil conditions, urbanization, and physical infrastructure development [37]. In particular, the rough terrain associated with steep slopes, poor soil conditions, harsh climates, and long commuting distance from settlements makes the use of machinery more difficult or prevents the adoption of market-oriented farming practices, resulting in a low-intensity farming system [38]. A socioeconomic status expressed by low farm viability and stability, family characteristics with high rates of non-agricultural employment, and a shortage of agricultural labor leads farmers to give up their cultivated farmland [39]. Market expansion and urbanization create diverse non-farm jobs, driving rural outmigration towards cities [40]. Land use policies, taxation, and ownership systems can decelerate the process of land abandonment by encouraging modern agricultural practices that enhance the market value of superior quality productions [41]. Similarly, a breakdown of prevailing social cohesion due to the division of the society into different political groups, ongoing feuds throughout national politics, and frequent institutional changes also led to farmland abandonment [42]. This diverse causes is reflected not only in the spatial location of abandonment but also in the regional variations in the characteristics of socioeconomic development and land use practices [43,44]. Such information supports regional planners and policymakers to implement effective countermeasures, such as controlling possible environmental impacts of farmland abandonment or preventing its expansion by issuing new laws and regulations [45].

Nepal is a mountainous developing country located along the southern slopes of the Himalayan mountain range. More than two-thirds country's population resides in the rural area and most of

them on agricultural activities. Subsistence form of agriculture is common in Nepal. Rural area and agro-activities are interrelated; like two parts of the coin. The contribution of agriculture to Gross Domestic Product (GDP) is also remarkable, however; farm activities is declining, in regard to the increasing problem of farmland abandonment over the decades [46,47]. In fact, the agricultural sector cannot attract young people; the trend of migration from rural to urban is significantly increasing. The poverty is exceedingly marked in rural Nepal. However, there is a conspicuous lack of research focusing on a quantitative and qualitative assessment of the processes involved, the driving factors, and the consequences of to farmland abandonment in this country [48–51]. Further, future management directions of these abandoned areas have also been outside the scope of any research work conducted to date [52].

With this background, our study attempted to: (i) provide an idea of the spatiotemporal extent of farmland abandonment, (ii) explore the driving factors thereof, and (iii) discuss the eco-environmental and sociocultural consequences of this phenomenon in Nepal. To accomplish these objectives, we first reviewed the long and well documented land use history in Nepal and the various shock events including changes in political settings, land ownership, and political insurgency over the past few decades. Subsequently, we explored the co-occurring drivers of changes in the broad prototypes of land use and management. Land use encompassed all socioeconomic activities that controlled or altered the flows of energy on a given piece of land, and land management was defined by the combined legal, fiscal, and political or other institutional arrangements (e.g., land reforms, protection schemes, and subsidies) that affected land use, as well as the inputs of land, labor, and capital. The comprehensiveness of the present study is unique, and it is therefore expected to serve as the baseline and as a guide for future research and the implementation of eco-environmental management and management of social processes in Nepal.

2. A Theoretical Framework of Farmland Abandonment

Farmland abandonment is simply defined as the cessation of agricultural activities on a given land surface [53,54]. Farmland abandonment involves both eco-environmental components of the earth system and gradual socioeconomic process of local and global systems [4,55], thus leading to undesirable changes in the agricultural landscape, biodiversity [56,57], ecosystem services [58], and sociocultural landscape [59]. A broad number of studies have identified a set of components that commonly act to transfer land and cause farmland abandonment [17,21,60,61]. These are referred to in the following categories: (i) environmental components such as soil quality, slope, elevation, fertility, soil depth, seasonal climate, etc. that constrain agricultural production; (ii) the socioeconomic situation, such as the farm size, household labor, age of farmers, productivity levels, market facility, farm investment, farm industrialization, trades, etc., which expresses the lack of economic and demographic viability and stability; (iii) the regional or nearby surrounding context, such as the distance to markets, road networks, major settlements, forests, etc., which measures the level of access to infrastructure, services, and markets; (iv) policy instruments, urbanization, population distribution, and migration; and (4) the management practices of soil and water resources leading to land degradation, soil erosion, overexploitation of groundwater resources causing water scarcity, and the salinization of croplands. The terms “drivers”, “driving forces”, “(spatial) determinants”, and “factors”, and verbs such as “causing”, “influencing”, or “affecting”, are used extensively in explaining farmland abandonment. Causes often appear in simple combination with other variables that have a high likelihood of explaining an outcome [62]. In social and earth systems, the use of “causes” is insufficient to describe a “contributory” or “combinatory” outcome [63]. Thus, the words “driver” and “driving force” have been widely used in many recent analyses explaining farmland abandonment [64]. These are appropriate and specific to the factors of environmental or social change processes being forced by socio-ecological or land system processes [65].

As shown in Figure 1, several factors play a role in farmland abandonment at the regional and national levels [36,64,65]. The proximity to infrastructure, such as schools and hospitals, and the related

accessibility of opportunities, activities, or assets, such as retailers and input suppliers, are proximate drivers, which are either human-induced or originate based on the local conditions. Biophysical and social drivers, such as the topographical and geomorphic processes, weather and climate variations, demographic changes, and their effects on geo-environmental and natural ecosystems, such as biodiversity, water sources, surface runoff, and solar radiation [40,66–69] underpin farmland use and changes [18,21,70]. Similarly, complexes of technological, political, institutional, and urbanization factors act as the underlying drivers of abandonment that operate indirectly from a remote distance and/or act at the regional or even global scale [71,72].

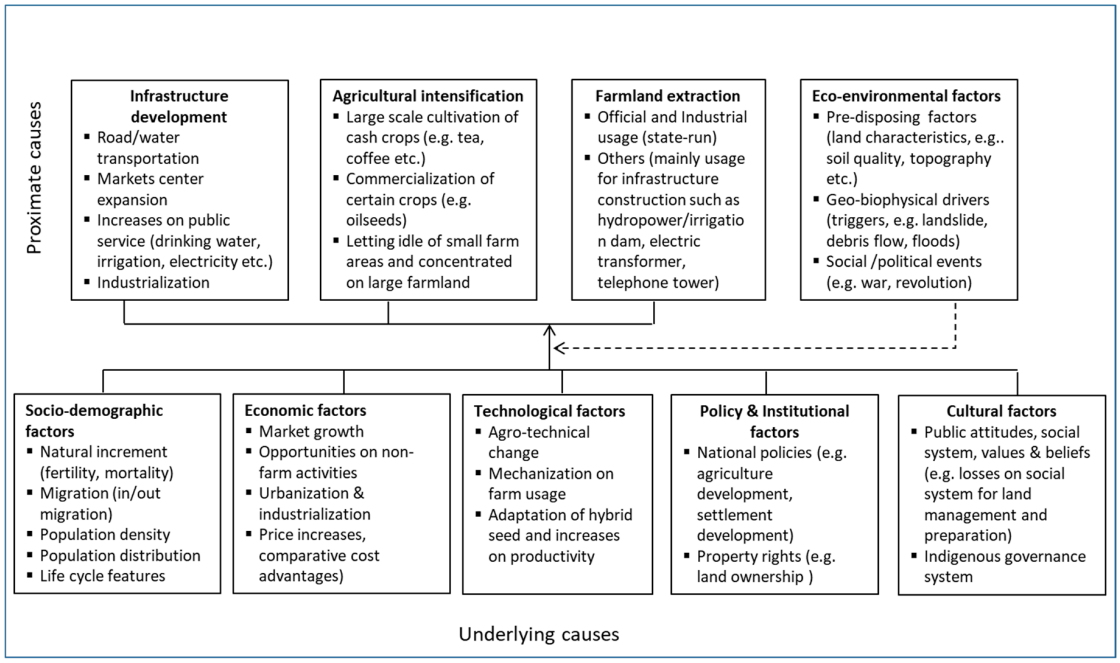

Figure 1. Frameworks for the causes of farmland abandonment and the underlying driving forces, adapted from Reference [64].

Larger holdings can benefit from lower production costs and are more competitive for farm practices (the use of machinery or a better input use efficiency). They are more frequently associated with innovation and are usually more competitive and viable in economic terms [73]. Small farmers are more likely to have difficulty accessing credit and the other institutional services required to increase their competitiveness. This prevents the reconstruction of viable farming units through land consolidation [74]. Training and information exchange enables farmers to adapt to changing economic circumstances and to guarantee the integration of the different functions of agriculture at the farm level [8].

Land tenure and the price of land play a supplementary role, as they express the property rights or the demand for land [75]. A weak land market usually translates as low transaction prices (selling or renting), however, is a good proxy for a higher risk of land abandonment [76]. This plays a role in the regional and national context, as well according to laws and local usage, which vary between regions [77]. In such conditions, the transition phase faces difficulties regarding land ownership (registration), insufficiently defined property rights, and the lack of operation land sales markets [75].

3. Material and Methods

3.1. Study Area

This study on the problems of farmland abandonment covered the entire part of Nepal. Nepal is a landlocked country located between the world's two most populous countries, namely China

to the north and India to the south, east, and west (see Figure 2). The country covers a territory of 147,181 km^2 and is stretched between the 26°22′–30°27′N latitudes and 80°04′–88°12′E longitudes. It appears roughly rectangular in shape, with the length from east to west about 1024 km and the width ranging from 130 to 192 km. The elevation of country increases dramatically from about 60 mean average sea level (masl) in the southern plains to the world's highest peak of Mt. Everest at 8848 masl. Such relief in the country is divided into three broad eco-environmental regions, namely (i) the High Mountains, constituting the mighty Himalayas in the north; (ii) the Middle Mountains (Pahad), which includes the intervening hills, intra-montane valleys, and the frontal range (called Siwalik); and (iii) Tarai, the southern belt of plains land, which is the northern extension of the Indo-Gangetic plain. The High Mountains, Middle Mountains, and the Tarai regions are home, respectively, to 7%, 46%, and 47% of Nepal's population [51]. Agriculture is the major livelihood source of households: approximately 66% of people are directly engaged in farming [78]. Administratively, Nepal is divided into 7 provinces, 77 districts, 6 metropolitan cities, 11 sub-metropolitan cities, 276 urban municipalities (Nagar Palika), and 460 rural municipalities (Gaun Palika).

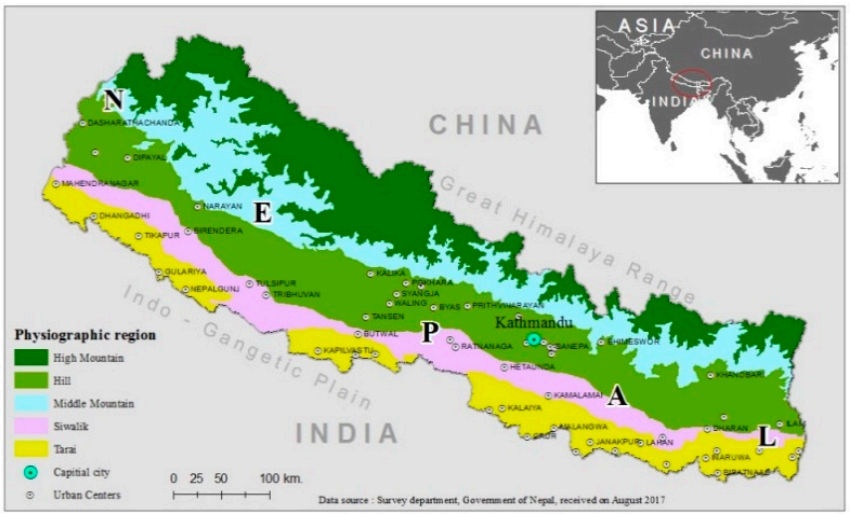

Figure 2. Map of Nepal.

The country experiences a seasonal summer monsoon rainfall with cloudy skies from June to early October. Nearly 80% of the annual precipitation in the country falls between June and September. In general, the amount of monsoon rains declines from the southeast to the northwest. The success of farming is almost fully dependent on the timely arrival of the summer monsoon. At the same time, landslides, floods, and debris flows, with subsequent losses of human lives, farmlands, and infrastructure, occur largely during the monsoon months. Conversely, severe drought and famine often result when prolonged breaks in rainfall occur during the summer monsoon period. Agriculture is affected by the occurrence of dry spells (for the duration of 2–10 weeks per year), delayed onset of the monsoon, or early cessation of the monsoon. Drought occurs very frequently and is recorded once every three years in the region [79].

3.2. *Sources of Data and Methods for Analysis*

We reviewed various literature, documents, and reports to obtain a dataset pertaining to the overall status of the spatial and non-spatial farmland use and changes along with political and socioeconomic changes, economic development processes, and policy and governance in Nepal. In particular, three statistical surveys were reviewed: the population census published by the central bureau of statistics (CBS); agricultural statistics of Nepal published by the Ministry of Agriculture and Livestock (MoAL), the Government of Nepal; and the Economic Bulletin published by the Nepal Rastra

bank. The population census collected information on the demographic and economic characteristics of farmers and their farmland environmental characteristics. An initial quality check of the available CBS data revealed ambiguities in the 1961/62 data. Consequently, data from the period of 1961/62–2010/11 were selected for this study, and the rate of changes during this period was calculated.

The agricultural statistics were annual surveys collected for almost all farms (or almost the entire utilized agricultural area) during the agricultural census. Additionally, the economic bulletin of Nepal provides a record of all agricultural holdings above a minimum size of two ropani (1 ropani is equal to 508.74 sq m). The record is updated annually and the agricultural activities in each parcel are collected using the technique of a sample survey which is conducted every four months. Various published and unpublished scientific research documents obtained from websites (Google Scholar, Web of Science (WOS), Google search, Research Gate, and specific journal sites—Elsevier, Springer, Science Direct, and Nature), governmental offices, and academic and research institutions, such as the Central Library of Tribhuvan University (TU), Nepal; the Central Bureau of Statistics (CBS), Government of Nepal; the Central Department of Geography (TU); the National Society for Earthquake Technology-Nepal (NSET); the International Centre for Integrated Mountain Development (ICIMOD); the International Union for Conservation of Nature (IUCN); the Department of Forest and Research Division, Government of Nepal; the Department of Soil Conservation and Watershed Management, Government of Nepal; and the Survey Department, Government of Nepal were reviewed. The details of the datasets are listed in Table 1.

Table 1. List of data and sources for shaping of farmland abandonment in Nepal.

Serial Number	Data Source	Data Type	Time Period	References
1	Population Monograph of Nepal, Volume I, Population dynamics	Statistics	1961,1971,1981,1991, 2001, 2011	Central Bureau of Statistics (CBS), Government of Nepal
2	Population Monograph of Nepal, Volume II, Social Demography	Statistics	1961,1971,1981,1991, 2001, 2011	Central Bureau of Statistics (CBS), Government of Nepal
3	Population Monograph of Nepal, Volume III, Economic Demography	Statistics	1961,1971,1981,1991, 2001, 2011	Central Bureau of Statistics (CBS), Government of Nepal
4	Land use land cover map of Nepal	GIS	1986	Land Resource Mapping Project (LRMP), Survey Department, Government of Nepal
5	Land use land cover map of Nepal	GIS	2000 and 2010	International Centre for Integrated Mountain Development (ICIMOD) (http://rds.icimod.org)
	National Living Standard Survey	Statistics	2010/11	Central Bureau of Statistics (CBS), Government of Nepal
7	Statistical Information on Nepalese Agriculture,	Statistics	2012/2013	Central Bureau of Statistics (CBS), Government of Nepal
8	Quarterly Economic Bulletin of Nepal Rastra Bank	Statistics	2015, 2016, 2017	Nepal Rastra Bank, Central office, Kathmandu, Nepal

Simple statistical methods were used to process and analyze the farmland statuses and their dynamics, including abandonment. First, all spatial and statistical datasets were collected and processed with the help of ArcGIS 10.5 and Microsoft Excel tools. Second, we produced a sample narrative to illustrate the changes of structure of farmland use. This sample summarized the land management in Nepal over the selected years and was divided into subsections, including the technological, institutional, and economic forces involved in the land use changes over the years, The national level narratives were then analyzed on two levels based on a qualitative comparative analysis: (i) a driver-centered analysis, focusing on the trends in land use changes, and (ii) a regime-centered analysis, identifying groupings of similar land management transitions. For the driver-centered analysis, a list of all drivers mentioned in the narratives was created. All narratives were then re-examined and the occurrence of drivers by country was noted. Land management regimes were then identified

by combining information on these sets of drivers with a qualitative heuristic text analysis of the narratives, where all narratives were read and the direct or indirect mentioning of periods with any land management were noted. The review of the literature helped to explore numerous narratives for understanding the historical changes in land systems in Nepal. The detailed methodology of information synthesis used for this study is depicted in Figure 3.

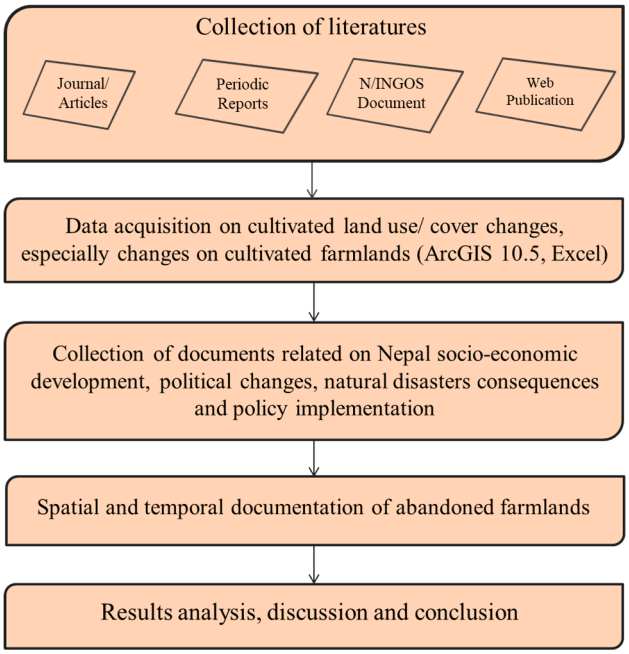

Figure 3. Collection of literatures to collect and extract information for farmland abandonment and its driving factors in Nepal. (INGOs indicates International Non-governmental organizations).

4. Results

4.1. The Spatiotemporal Distribution of Abondoned Farmland in Nepal

Numerous studies conducted in the mountainous districts of Nepal have reported that the concentration of farmland abandonment is noteworthy [46,47]. According to Khanal et al., farmland abandonment initially became notable in the high slopes of the mountain areas, particularly in regions that were remote from villages [19]. Abandonment was associated with difficulties in the use of modern agricultural machines on steep slopes and even on small patches that were relatively distant from villages as well as with low yielding capacity [80]. Farmers have been forced to use alternative strategies for increasing their food supply [81]. Whereas, farmers are often confronted with the scarcity of non-farm employment opportunities in the mountain regions [82,83]. Such low crop yields and the limited opportunities available for using the new machinery cannot support the ever-increasing population pressure, which exceed the farmland abandonment in many areas. Moreover, traditional land management systems (e.g., Parma) and irrigation canal management practices have virtually vanished now [84]. Therefore, farmland abandonment is high in the mountainous region of Nepal (see Figure 4).

In earlier parts of the studied period, the volume of land under agricultural cultivation in Nepal and the rate of abandonment appeared to be much less. The main episode of farmland abandonment was first recorded in 1971/72, indicating a 1.86% abandonment of total cultivated farmland. The period was attributed due to the natural growth of the human population and migration (primarily between the 1960s and 1970s). Since the 1970s, the population in the mountainous areas of Nepal has migrated extensively to the lowland plain areas of Nepal, reducing the pressure on cultivated farmlands. Thus, most mountainous farmland coverage changed into forest or shrub land over this period [85].

During the time periods of 1981/82, 1991/92 and 2001/02, increases were seen in the extent of total land cultivated in the proportion of 49.0%, 20.5%, and 36.8%, respectively. Table 2 shows the temporal variation of cultivated area and farmland abandonment in Nepal.

The principal period of industrialization and population migration occurred in the middle of the 1960s and 1970s, although a decrease in the population in agricultural areas was already evident in the beginning of the century, particularly in the middle mountain districts. In 2001/02, the extent of cultivated farmland was recorded at 59.27%, which is the highest rate of cultivated farmland recorded in Nepal to date. During this time, agriculture was the highest priority as economic growth was totally dependent on the extent of crop production. Fertile lands in the Terai region and hardworking peasants in the mountain region provided great supplies of raw materials for industry. Moreover, irrigation facilities increased from approximately 6200 hectares in 1956 to nearly 583,000 hectares by 1990 [86]. However, a slowdown—an abandonment of 23.9%—was reported in 2010/11 in comparison to the results of the previous census. Cultivated farmland was abandoned by 970, 63,000 hectares in 2010/11. Some authors also noted a decline in the area of farmland terraces, which have been rapidly invaded by shrubs and trees in the recent years [87].

Table 2. Temporal variation of cultivated area and farmland abandonment in Nepal (1961–2017).

Year	1961/62	1971/72	1981/82	1991/92	2001/02	2010/11	2014/15	2015/16	2016/17
Cultivated land (10^4 ha)	1685.4	1654.0	2463.7	2968.0	4061.6	3091.0	2599.2	2579.1	2548.8
Farmland abandonment ('000 ha)		31.4				970.6	491.8	20.1	30.3
% of change as compared to cultivated land during the time period		−1.9	49.0	20.5	36.8	−23.9	−15.9	−0.8	−1.2

Data source: Agriculture Census of Nepal (1961–2010), Central Bureau of Statistics (CBS) 2014, and Economic Indicators of Nepal 2015–2017, Nepal Rastra Bank (note: negative values indicate a rate of abandonment in association with the previous year of total cultivated farmland. There is no record of abandonment during the period of 1981–2001).

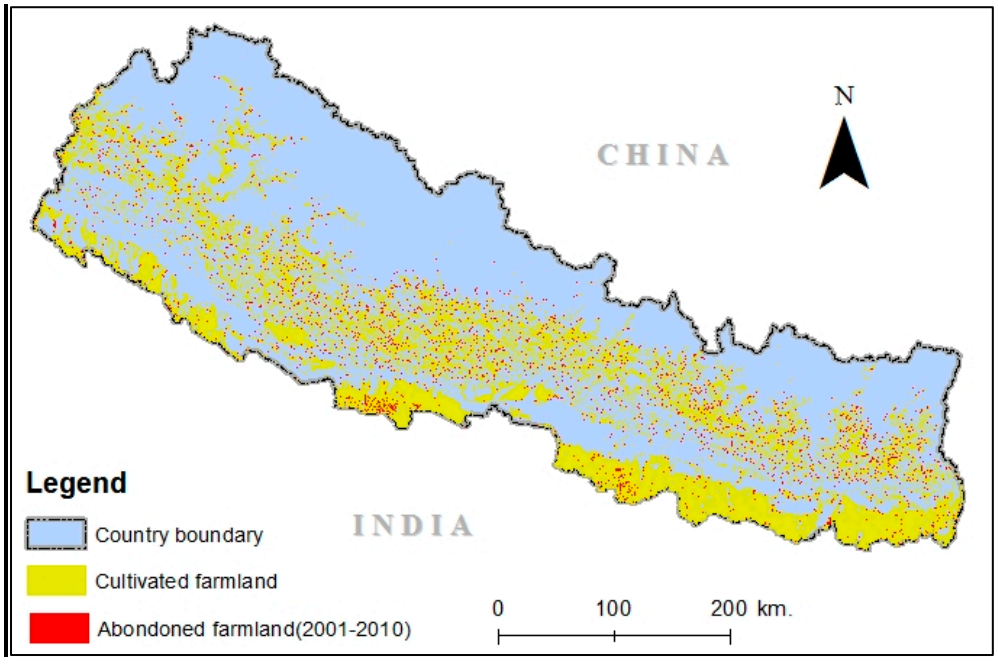

Figure 4. Spatial distribution of farmland abandonment in Nepal, 2010/11.

4.2. Driving Factors of Farmland Abandonment

A review of the pertinent literature demonstrated that there are four main types of driving factors in Nepal. These are (i) the biophysical characteristics of farmland (e.g., high elevation, steep slope, and aspect), (ii) demographic factors (e.g., population growth and urbanization), (iii) economic and technological factors (a low level of production or the prices of mode of production), and (iv) institutional factors (i.e., land reforms and other policies enforced by organizations at various levels). Within the group of drivers, land reforms were the most frequently mentioned, followed by malaria eradication, resettlement, and land management policies. The details of each driving factor are given below.

4.2.1. Population Growth, Migration, and Urbanization

Population growth and migration towards urban areas are the major driving factors for farmland abandonment in Nepal. In the last five decades, the population of the country increased from 10.22 million to 26.49 million, and the density shot up from 131 person/ km^2 to 180 person/ km^2 [88,89] (see Figure 5). The migration of population from remote and mountain villages into large- and middle-sized cities located at lower elevations increased dramatically [51]. On average, four persons per 1000 in the population migrated, crossing regional boundaries, and six persons crossed the district boundaries every year. Mountainous and hilly regions constituted the main area for the origin of internal migrants and experienced a net loss of population [90]. Certain districts from the hills lost up to 50% of their populations [91]. The urban populations, in the meantime, increased rather energetically from 3% of the total population to 17% [92]. These demographic shifts led to the process of deactivation and re-peasantization as well as structural changes in household labor [85]. In particular, these structural changes in the demographic conditions (i) provided diverse livelihood strategies, leading to the negligence of subsistence farming [93,94] and (ii) eroded the local support for the continuation farmland activities [95]. Furthermore, the long-term population migration from rural areas caused psychological stresses that intensified the depression and anxiety for the remaining farmers continuing farm activities [96].

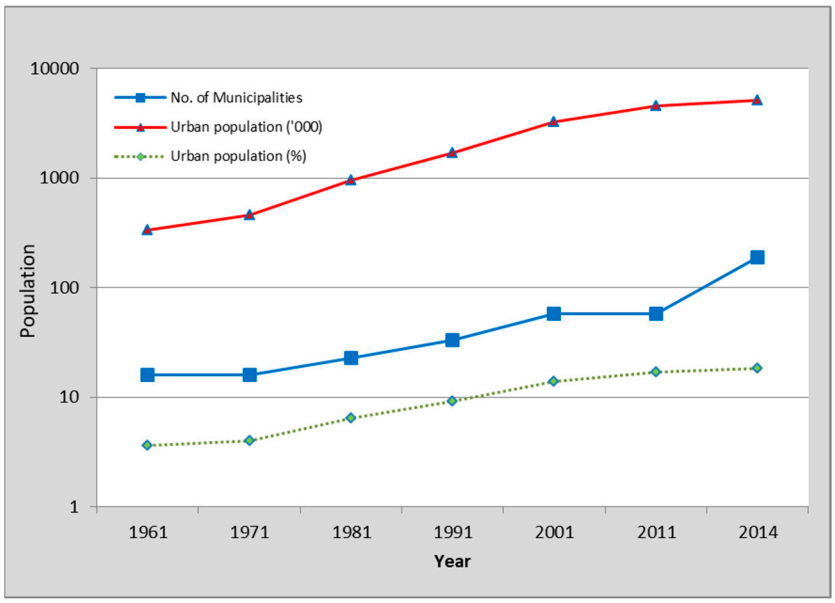

Figure 5. Urban centers and the population in Nepal, 1961–2014. Data Source: Central Bureau of Statistics 2019, Government of Nepal.

4.2.2. Settlement Patterns and Accessibility

Settlement patterns and the accessibility of physical services are also considered driving forces for farmland abandonment. In Nepal, elevation and slope were two basic factors that affected the distribution, scale, and form of rural settlements [97]. Settlements are oriented towards low altitudes and to low slopes and are significantly close to rivers and towns; thus, they formed a special pattern of being dense on the plains, and sparse in the mountainous region. In addition, administrative headquarters, major market towns, roads, basic facilities such as schools and health centers, religious monuments, and other amenities are generally located in major population clusters [98]. Thus, people who live in scattered communities or away from the major settlements, are unable to access basic facilities such as health services, schools, roads, transport, markets, and communication [99].

As there are high costs associated with its deployment, something that is beyond the capacity of local communities, poor access to basic infrastructure appeared in almost all the mountainous settlements [45]. Consequently, this impacted farmland usage in the mountain region, and the roles of regional migration, mobility, and diffusions [100]. Moreover, livelihoods far away from the centers of power and decision-making contributed to the households being socially, economically, and politically isolated [101], and shifting from the mainstreams of cultivators. This was particularly true and prominently conspicuous for communities with farming-based livelihoods in the mountainous regions of Nepal [33].

4.2.3. Socioeconomic Development

Socio-economic development has been another important driving factor for farmland abandonment in Nepal. In the past, human poverty was high, with a human development index of 0.463 [102]. The level of literacy was also only 2% [103]. In addition, systems of civil service, national accounting, records of public welfare, or social, economic, and demographic indicators, such as schools and hospitals, were very sluggish and regionally biased [104]. However, the construction of an improvement in educational and engineering infrastructure, including roads, airports, and hydropower stations throughout the country increased intensively after 1950. For instance, there was a total of only 376 km of road highways in Nepal in 1955, and all were in the north–south direction. By 2014, the road network had extended to all directions, and the highway mileage reached 24,000 km (http://dor.gov.np/road_statistics.php). Further, construction of large hydropower stations has been a significant feature of recent decades [105].

Similarly, there was a marked improvement in human development indicators (HDI) in Nepal as compared to previous years [106]. The latest Nepal Living Standard Survey (NLSS) 2003/04 conducted by the Central Bureau of Statistics revealed that Nepal's poverty level had declined to 30.85% in 2003–2004 compared to the 41.75% reported in the previous NLSS survey of 1995–1996 [107]. Such development projects enhanced the access to education, health, communication, electricity, transportation, etc. resulting in an increased availability of electric power for use in agricultural irrigation and other usage [50]. These projects also empowered farmers and income projects, especially microcredit schemes, led to their families experiencing better survival [108]. This improvement in livelihoods, the gradual growth of livelihood alternatives such as trade and tourism, and the limitations posed by low-income yielding, traditionally operated farmlands caused a significant decrease in the cultivation of farmland terraces uphill [31].

4.2.4. Natural Disasters

Nepal is a disaster prone country—it faces a multitude of natural disasters, which cause an exceptional number of casualties and amount of property loss [109–111]. Historical accounts show that devastating earthquakes occurred in Nepal in 1255, 1810, 1833, 1866, 1934, 1980, 1988, and 2011. The Great Bihar–Nepal Earthquake of 15 January 1934, measuring 8.4 on the Richter scale, shook Kathmandu with intensities of IX and X on the Modified Mercally Intensity (MMI) Scale, raising

the ground of more than half of the existing buildings. It claimed >8500 lives in Nepal. Similarly, the 1988 Udaypur Earthquake, with a magnitude of 6.6 on the Richter scale and a maximum intensity of VIII MMI, affected 24 districts of central and eastern Nepal, claiming 744 lives and seriously injuring 6566 persons. Although this was a medium-sized event, it inflicted a significant number of injuries and huge damage to approximately 30,000 residential houses in east Nepal.

Indirect and secondary effects of these extreme events on the local and national economy must be considered, including reduced family income, declines in the production of business and industrial enterprise, inflation, unemployment, increased income disparities, and declines in the national income. Likewise, the devastating flood of 1993 claimed about 1160 lives and affected 70,000 people in the central regions of Nepal. The Kulekhani hydroelectric plant, Bagmati barrage, several bridges and irrigation canals, and check dams were severely damaged [110]. A severe flood on 18 August 2008 in the Koshi River basin directly damaged 17,275 hectares of croplands, affecting 16 village development committees in the Sunsari district [112].

All of this led ultimately to a significant abandonment of farmlands hitherto cultivated on upper hill slope terraces and put tremendous pressure on land resources, leading to abandonment after numerous disaster events. In particular, floods, landslides, and debris flows have been found to be responsible for the reduction of farmland areas due to undercutting and erosion adding to the hardships of farming activities [113]. Frequent river diversions and bank breaches during heavy flooding along the riverbed farmlands as well as in flat-terrain farmlands are another reason for abandonment. Soil erosion, river bank-cutting, and sediments deposited on croplands have often led to the idling for years of cultivated lands [112,114]. Destruction of infrastructure such as buildings, roads, and agricultural irrigation infrastructure has resulted in a significant number of migrants from settlements uphill to the emerging road-side markets on river banks of the affected mountain districts [115].

4.2.5. Land Ownership, Distribution, and Fragmentation

Land ownership and fragmentation is a worrying problem for farmland abandonment in Nepal. A regional analysis of land distribution indicated that one third of the total households owned more than half of the total agricultural farmland in Nepal [78]. Approximately 1.5% of these households held more than five hectares of land, which represents 14% of the total farming area of Nepal. Two thirds of the total land holdings had less than one hectare of land, and they accounted for only 30% of the total farm area of Nepal. Increasingly, the current land holding systems are becoming highly fragmented. The majority of farmers are smallholders, with an average holding of 0.79 hectares [78]. Approximately 8% of households had more than two hectares of land, fragmented into an average of six parcels (CBS, 2011a). See Table 3 for detail land ownership and fragmentation in Nepal.

Table 3. Land ownership and fragmentation in Nepal. Data Source: Reference [78].

Farm Size Class (ha)	High Mountains		Middle and Low Mountains	
	% of Households	Distribution of Agricultural Land (%)	% of Households	Distribution of Agricultural Land (%)
Less than 0.1	3.4	0.3	8.1	0.7
0.10–0.25	17.2	4.1	18.6	5.2
0.25–0.50	28.3	15.0	28.5	17.0
0.50–1	31.3	30.8	29.0	34.1
1–2	16.7	31.5	13.2	30.0
2 and over	3.2	18.4	2.6	13.0

This reduces the efficiency of agricultural production as well as discouraging the use of cropland [116]. In particular, agricultural producers encounter difficulties in accessing the necessary machinery, obtaining agricultural credit, receiving extension advice, and purchasing inputs [45]. Farmers are not incentivized to seek larger parcels due to the limited available resources with which to cultivate crops [101]. In addition, small farm sizes and their distribution raises the costs of production,

as producers cannot use large machinery and lose time traveling between dispersed parcels. Farmers are hindered from adopting productivity-enhancing technologies in the farmlands of small parcels, resulting in abandonment in despair at the constraints of modernization [117].

4.2.6. The Intensification of Agriculture and the Increasing Trade in Agricultural Products

The intensification of cultivation has also been observed as a driver of cultivated farmland abandonment in Nepal. Studies have indicated that there has been increasing access to technical inputs (irrigation and road) and credit in recent years [118]. The production of highly valuable crops, such as cardamom, ginger, potatoes, fruits, tea, coffee, milk, vegetables, and spices was generally introduced near market centers and district administrative headquarters [52,81]. Farmers have started adopting inter-culture practices of growing two or more crops [119], such as maize with beans and/or potato, and the double cropping of staple crops, such as rice and wheat or corn (maize) in one single cultivated field. The most visible impacts seen on the agriculture system have been that staple foods and vegetables such as cabbage, cauliflower, tomato, radish, etc. are imported from the Tarai to the mountains; and crops such as Akabare chili, ginger, fruits (orange, lemons), potatoes, tea, large cardamom, etc. are imported from the mountain regions [52]. This has allowed farmers to discontinue cultivating certain crops that had production constraints. Moreover, importation of subsistence staples such as cereal crops has reduced their local production due to their replacement by high-value cash crops, leading to a substantial reduction of the scattered cultivated areas in the mountain slopes [47].

4.2.7. Malaria Eradication and Land Reform Program

The malaria eradication program has also acted as a driver of farmland abandonment in Nepal. Particularly after the advent of the malaria eradication program in 1956, the Nepalese government recognized the lowland areas as a source of tax revenue, food production, and supplies throughout the country. Tenancy rights were protected under the anti-peasantry land tenure system. Jagir (lands assigned to the state functionaries in lieu of salaries or allowances), Birta (land obtained or possessed in such a way that the land is wholly exempt from the State Land Tax), and the Zamindari (landholders of demarcated areas, responsible for collecting revenue for the monarchy) system were abolished and the responsibility and authority for collection of revenue was shifted to the district revenue officers [120]. Meanwhile, several projects for economic development and planned resettlement programs were introduced in parallel [90]. This motivated many mountain farmers to move towards lowland plain areas, abandoning cultivation in their ancestral farmlands.

According to the statistics, in 1971 the annual migrant population to the Terai was 399,925 people. However, this increased to 686,178 people in 1981, and grew to 1,085,862 people in 2001 [45,49,120]. These enormous population surges into the Terai, regional urbanization, and reduction in household sizes contributed to the increased demand for new houses [121]. This initial migration resulted in the conversion of forests or rangelands to agriculture, and later led to the development of many small city centers with expansive urban sprawls, all of which have resulted in the continuing conversion of mountainous agricultural farmland into forest and grassland [122].

4.2.8. Political Instabilities and Implications

Continued political instability is another major driver of farmland abandonment in Nepal. From the 1950s to recent times, the political environment in Nepal has been defined by highly fragmented, unstable, and zero-sum decision-making practices in the government [123]. Rather than trying to build the country's economy and disperse its benefits more equitably, political leaders and the ruling elite seemed to be interested in making money for themselves and rewarding their supporters and family members. Corruption has risen at all levels, together with growing inter- and intra-party conflict [124]. Governments have failed to deliver jobs and the necessities of life to disadvantaged groups, particularly in the rural and remote areas, and significantly increased the inequality between

the elite and non-elite. Poverty, inequality, anger, and frustration have grown, particularly among the youth in rural and remote areas [49].

Furthermore, the emergence of the Maoists in 1996 created a politico-economic crisis and halted opportunities for socioeconomic development. This development augured a barrier for the socioeconomic growth of in the country [125]. Insurgency led to a political transition, which was followed by further instability in governance along with a huge mobilization of the population towards cities or out of countries. This motivated many landowners to migrate to cities or urban areas mostly in the low-height plain areas [98,121]. Furthermore, the bureaucracy and public administration were constrained by patronage and corruption, low capacity, little coordination or policy coherence, low accountability, and a questionable bureaucratic culture [124].

The private sector was held back by low investment in farm activities and sociocultural development. Consequently, the inadequacy of planned programs for agricultural development, ad hoc land utilization, and conflict management policies as well as the laxity of enforcement of land degradation control measures took over, causing an increase in farmland abandonment in Nepal. Moreover, the performance of the Nepalese economy remained less than satisfactory, owing to unfavorable weather conditions and political tensions, People's expectations rose—particularly among the disadvantaged youth—and thus farmland abandonment continued over the years.

4.2.9. Poor Implementation of Agricultural Development Policies and Their Impact

The Nepalese government put several acts and policies aimed at sustainable land use and the conservation of existing farmland resources. For instance, the Agriculture Perspective Plan (1994/95–2017/18), Plant Protection Act 2048, Pesticides Act 2049 and Regulation 2050, Food Act 2023, Consumers' Right Act 2054, and Environment Protection Act 2053 were all considered to constitute a guiding strategy toward the agricultural development in the country [126,127] However, these plans, acts, and guidelines were not successful, and led to a consistent decline in food production and soil fertility [45]. In particular, there has always been a lack of coordination at intra-governmental levels, as well as between the state, private sector, and development partners. Agricultural associations have been unable to identify sectors where collective action would have the highest payoff, and "herd behavior" in the private sector undermines industry-wide competitiveness [128]. These trends have a direct relationship to the abandonment of cultivated farmlands.

4.3. The Eco-Environmental and Social Consequences of Farmland Abandonment

Farmland abandonment most often generates negative effects on rural societies eco-environmentally and sociologically. Studies conducting plot-level analysis of 149.6 ha terraces near the village of Sikles in the Nepal Himalaya showed that nearly 10% of all Khet land had been extensively damaged by landslides and floods. Nearly 41% of all abandoned plots were subjected to different forms of geomorphic damage. As geomorphic processes (e.g., landslides, debris flows) continued to expand, the farmland landscape fragmented into a group of smaller interspersed patches as cropland [19]. Such patches were opened for grassland, which decreased the numbers and abundance of birds and woody plant species [129].

Farmers began to extend their cropland, which led to the further encroachment of the forest and marginal lands [130]. Soil erosion was attributed to greater runoff concentration. In comparison of erosion in an abandoned field to that in a prior cultivated field; the presence of rills and the expansion of deep gullies with very active head-cuts was intensive in the abandoned field [131]. In particular, steep hydraulic gradients between terraces encouraged sub-superficial erosion at the terrace edge, and were sensitive to contraction and swelling with respect to gully formation [114]. A failure to maintain network ditches tended to produce reorganization of the drainage system through the incision of new channels across terraces and re-establishment of the natural drainage network [132]. Finally, terrace abandonment enhanced the piping in terraced fields, which was previously destroyed by annual livestock trampling [133].

Farmland abandonment also has effects on the local population and the whole society in terms of the production of goods (e.g., foods, feed, fiber, and biomass production), as well as other services provided by the multi-functionality (e.g., sociocultural practices and norms) of the agricultural landscape. As more and more households abandon their farmland, the rural populations cannot continue their social and cultural norms and practices [134]. The organizational and institutional mechanisms for the management of farmland, the drinking water supply system, irrigation canal management, and forest resources, such as Parma (indigenous land management system, have disappeared or become less practiced [82]. Some of the practices used to encourage environmental protection as well as the protection, regeneration, and management of local resources are now not employed effectively [135]. Farmland abandonment has also been linked to the modification or degradation of the rural landscapes and the loss of a unique identity, including the traditional features, culture, and characteristics of the mountains of Nepal [136].

5. Discussions

National- and international-level projects and organizations, such as the Land Resource Mapping Project (LRMP) and Integrated Center for Mountain Development (ICIMOD) have undertaken agricultural land use studies at the national scale in Nepal [137], whereas, the IGBP DIS-Cover [138], UMD land cover [139], and GlobeLand30 [140], have been undertaken surveys regarding the dynamics of farmland changes, on a global scale. These projects have produced agricultural land cover maps on various scales based on remote-sensing technologies. However, the exact extent of farmland abandonment in Nepal is not known precisely in quantitative terms, as there is no system of formal inventory for such lands. Maps of land abandonment and figures on the amount of abandoned farmland at the district or provincial scale have not been produced thus far [87]. This partly is because abandoned farmland does not appear as a statistical category in the agricultural census process. Additionally, there is no formal definition of abandoned farmland, which makes its accounting in the census problematic in Nepal. Thus, the exploration of indications and evidences of changes, declines, or increases in land coverage by agricultural activities, and the analysis thereof, was the main objective of this study.

The results demonstrated that there are many factors driving the creation and further increase of farmland abandonment in Nepal. Some of the driving factors (e.g., human population growth, migration, and urbanization) are of natural processes, while others are due to the socioeconomic conditions (poor accessibility, scattered settlements, poverty, and the lack of basic physical services) and were generated by a lack of appropriate policies. These factors are expected to exacerbate if left unattended and uncontrolled. Moreover, the implementation of any comprehensive conservation strategies, including improvement in land use, settlement, agricultural planning and development, forest and biodiversity conservation and restoration, hazard and disaster risk management, sustainable use of land resources, etc., in the long run, cannot be implemented successfully without understanding and addressing the issues of farmland abandonment in the mountainous regions of Nepal. Therefore, a much wider discourse on the topic is acutely necessary, especially if one considers that there is no formal inventory of abandoned farmlands or any systematic study of the underlying dynamics both quantitatively and qualitatively in Nepal.

Farmland abandonment is considered a major phenomenon that has transformed the eco-environmental and sociocultural landscape [5,17,30,141,142]. However, Nepal's farming is unique and the labor-intensiveness involved makes our case different than other mountainous countries of the world [143]. Sloped terrains that are mostly more than 20% gradient are divided into narrow and graduated steps (typically 2–3 m wide and 10–20 m long across the slopes) for farmlands [137]. Farmers adopted the terracing system to control surface runoff, minimize soil losses, and stabilize the farmland slopes. The agricultural terraces were carved out and most slopes are supported with the aid of buttresses. Terrace risers, beds, and waterways are repaired regularly before the sowing/transplanting of crops and during weeding. Every year, farm households spend at least 16 days

on the maintenance of terraces [134]. Therefore, when such terraces are abandoned, the supporting structures fail, leading to accelerated slips that generate a series of geomorphological hazard disasters, such as landslides and debris flows, in the mountainous landscape of Nepal.

An abandonment of farmland does not lead to plant succession, as geomorphic damage is intensified prior to succession, although the amount of geomorphic damage in fields abandoned earlier is greater than that in plots abandoned recently [19]. The stage of dense shrub cover may be delayed by several decades or may even not occur [144]. A fall in infiltration and poor nutrient conditions are some of the most important factors constraining the evolution of plant cover. Livestock trampling enhances the formation of gullies, connecting different terraces between hill slopes and channels [118], which also hinders the growth of woody species and delays plant succession. However, it is interesting to note that if grazing is controlled, the abandoned farmland remains free of thorny shrubs for only a few years: (i) the invasion of herbaceous plants and shrubs occurs during the first years of abandonment, (ii) woody shrubs spread between 2 to 5 years after abandonment, (iii) the retraction of woody shrubs and a new expansion of herbaceous plants occurs between 5 and 10 years, and (iv) the entry of young trees occurs after more than 10 years of abandonment. The succeeded woodlands, although of a limited extent on Nepal's mountain landscape, support diverse plant, large mammal, and bird species [145] that ultimately influence the mountain biodiversity, tourism, and economic productivity [146].

Moreover, farmers have been practicing diverse sociocultural systems (e.g., Parma) for the management of irrigation canals, drinking water supply services, and farmland terraces [82]. The systems are practiced at the community level with local rules and regulations regarding the use and management. There was a strong social cohesion among the members of each household; thus, it is also feasible to use the available labor force in the village for the maintenance of terraces and irrigation canals, as well as the control of gullies, landslides, and floods on cultivated fields, through community-guided management systems, without paying cash for labor services. Thus, if the land abandoning practices continue, the mountainous rural landscape and its associated eco-environmental, social, and cultural norms and value will be lost gradually. In addition, the new eco-environment and social landscape that is formed may not continue the erstwhile existing tradition, culture, and customs, and may not be as hospitable as the previous society with its rich historical traditions.

6. Conclusions

Based on the secondary data from 1961–2017 from the Central Bureau of Statistics (CBS), the Ministry of Agriculture and Development (MoAD), and the Nepal Rastra Bank, and from the perspective of farmland use and changes in Nepal, this study demonstrated the quantitative value of farmland abandonment and its impact on the eco-environmental and social landscape of Nepal. This study (i) assessed the spatiotemporal distribution of abandoned farmland, (ii) explored the driving factors of farmland abandonment, and (iii) discussed the social and eco-environmental consequences of farmland abandonment. Thus, this study enhanced our understanding of the relationship between the topographic, socioeconomic, physical infrastructure developments, development policies, and farmland use and abandonment in Nepal.

The results of this study provided empirical evidence that policy-makers should work to solve the problems of food and eco-environmental security and that the processes therein could contribute to initiatives including the "land bank" of Nepal. Such knowledge on the spatiotemporal distribution and causes of farmland abandonment could yield different explanations and preferences for interventions, which could be used as input to find a common ground for landscape management, and serve as a starting point for a more spatially targeted and nuanced management approach.

Nepal is one of the world's highest mountainous countries, and this review on the process of farmland abandonment demonstrated a variety of interrelated adverse consequences (e.g., the loss of agricultural farmland, triggering of natural hazards, changes in the socio-cultural landscape, and the loss of a unique identity) in the mountainous landscape of Nepal. Therefore, the study invites researchers and policy-makers to think about the future of mountain farmlands and societies where

a huge number of mountain people are migrating away to enhance their household economic and livelihood security, or are seeking to participate in non-farm activities.

Regarding this, we suggest that focus be placed on (i) enhancing the access to markets and government incentives for farmers to cultivate high-profit commercial crops on abandoned farmland and (ii) developing risk-mitigation strategies through agro-advisory systems and information technology infrastructure to make market, climate, and crop management information accessible to farmers. Incentives could be provided for the new farming community in Nepal, which may increase agricultural productivity. Awareness campaigns could be undertaken to ensure that high quality agricultural inputs, such as certified seeds, fertilizers, and pesticides, are available at reasonable market prices.

Finally, there were some deficiencies in this study that may be addressed in future studies: (i) This study discussed overall eco-environmental and socio-cultural consequences; however, it is necessary to carry out site-specific investigations on this issue, and to gain a deeper understanding of the consequences in Nepal. (ii) The factors of topographic, socioeconomic, and other demographics are increasingly evident for farmland abandonment in Nepal. Due to limitations of the data, this study did not discuss these relationships. Moreover, the relationships may be dynamic. Thus, future research could use this concept to analyze the relationships in greater detail.

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