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Assessment of Forest Cover Change in Luang Prabang Province, Lao P.D.R.

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Abstract

Through the development policies of the Lao government, particular attention has been given to the forest sector in order to achieve the objectives of the Forestry Strategy 2020, which was implemented from 2005 to 2020. One of the main goals of this strategy was to increase forest cover to 70 percent by 2020, with the longer-term objective of maintaining or increasing forest cover toward 2035. This research concerns changes in forest cover in Luang Prabang Province, Lao P.D.R. The study aims to assess changes in forest cover over different periods. A quantitative research method was used to describe the characteristics and trends of forest cover changes. The results indicate that forest cover in Luang Prabang Province changed significantly during the period from 2002 to 2010. During this period, forest cover increased by approximately 3.11% per year, indicating significant forest recovery. Approximately

31.10% of the area had strong potential for natural forest regeneration, while the remaining areas required forest restoration and development activities, such as tree planting. During the period from 2010 to 2015, the proportion of primary forest cover increased by approximately 22.34%, representing an average annual increase of 4.47%. In contrast, the proportion of secondary forest cover decreased by approximately 18.95%, equivalent to an average annual decrease of 3.79%.

During the period from 2015 to 2019, forest cover showed an overall negative trend, with tree-cover loss occurring each year in Luang Prabang Province. The years 2016, 2017, and 2019 experienced particularly high levels of forest loss, with losses exceeding 50,000 hectares in each of these years.

Keywords: Assessment, Forest Cover Change, Luang Prabang Province

1. Introduction

The Lao government has made considerable efforts to develop and implement various policies for forest management. Lao forestry policy has developed through three main aspects. The first aspect, referred to as the “experimental process,” involved government efforts to address forestry-related problems by establishing basic forest management measures under orders issued by the Prime Minister. The second aspect, referred to as the “enforcement process,” involved the establishment of a basic legal framework for land and forest management and control. The third aspect, referred to as the “next process,” was developed based on the first and second aspects of forest policy, with the legal system concerning forests expected to continue developing in the future (Inoue and Hyakumura, 1998) ^[12]. The government also developed various instruments for forest management, particularly legislation to support sustainable forest management. The Forest Law (2019) was introduced to facilitate forest management and classified forests into three main categories: protected forests, conservation forests, and production forests (Assembly, 2019) ^[1]. At the national level, the government also sought to increase forest cover and recover areas affected by forest loss. This objective was incorporated into the Forestry Strategy 2020, which established a target of increasing national forest cover to 70 percent (Lao 2005) ^[16]. To promote sustainable forest management, the government also adopted participatory forest management approaches. These approaches involved local villagers in different stages of forest management, including planning, implementation, monitoring, evaluation, and benefit sharing. Several models were developed, including state production forests, village forests, and models for the utilization of non-timber forest products (NTFPs). These approaches were designed to support forest management with multiple objectives across different forest types (Manivong and Sophathilath, 2007) ^[19]. However, the Lao government later shifted its development strategy toward “land as capital,” with the aim of promoting private-sector investment through land development, generating national income, and

increasing the economic value derived from land use in rural areas. This approach intensified pressure on land and forest resources. Consequently, Laos became an important destination for large-scale land investment and transnational capital, particularly during the last decade, contributing to increased rates of deforestation and forest degradation (Fern, 2016) [8]. Forest decline in Laos has been associated with various internal and external factors. Internal factors include issues related to the livelihoods and economic activities of the Lao population, while external factors are strongly influenced by market demand. In addition, underlying causes include widespread poverty and rapid population growth, particularly in remote areas (Lao, 2005) [16]. In response to these challenges, new policies were developed to address illegal logging by promoting legal timber production and exports, as well as domestic timber processing. These policies aimed to encourage the utilization of plantation resources as an alternative source of timber and thereby reduce dependence on timber harvested from natural forests (Smith, Ling, and Boer, 2017) [23]. The transformation of the forestry sector can be understood through three major pathways: economic development, land-use intensification, and forest policy. These pathways have contributed to increasing interventions in smallholder livelihoods and the forest sector. Therefore, it is important to understand how changes in livelihood systems and alternative pathways of household-level development can improve the efficiency of forest use and support rural livelihoods (Newby, Cramb, and Sakanphet, 2014) [21]. Since the 1990s, the Lao government has prohibited illegal logging. Nevertheless, forest degradation has remained a persistent issue, with continued pressure from logging activities, government policies that have permitted the conversion of degraded forest land for agricultural production, and population migration (Thapa, 1998) [25]. Following the economic reforms implemented by the Lao government, national development policies have continued to focus on the agriculture and forestry sectors, particularly on land management and land and forest allocation, as important strategies for rural development. Since the 1990s, the Land Use Planning and Land Allocation (LUP/LA) program has been implemented throughout Laos. However, the program has had limited influence on local livelihoods. In some cases, the implementation of land allocation was not sufficiently strict or consistent. For example, some land plots located near roads were registered, while plots located in more remote areas were not registered. As a result, local people continued to practice shifting cultivation (Bouahom *et al.* 2011) [2]. Government development policies have also contributed to a considerable reduction in the number of people practicing shifting cultivation and producing opium poppy. Nevertheless, several challenges have remained in the implementation of land allocation and the relocation of people from remote villages to new resettlement areas (Douangsila and Pongchompu, 2012); Furthermore, differences in the implementation of government policies and regulations have contributed to conflicts within local communities. Villagers living close to district offices were generally subject to stricter enforcement of government policies and regulations. In contrast, villagers living farther from district offices often faced difficulties in accessing sufficient land for agricultural production. These differences in access to land and the implementation of regulations contributed to conflicts that district authorities were not

always able to resolve effectively. Consequently, some villagers continued to pursue livelihood activities that were inconsistent with government policies and regulations (Phengsopha and Morimoto 2003) [22]. These issues are particularly relevant to the present study. Although the Lao government has implemented various development policies, including land allocation programs, it remains important to understand their impacts on forest resources. In particular, Luang Prabang Province provides an important case for examining changes in forest cover following the implementation of land allocation programs. An assessment of forest cover change can provide useful evidence for understanding the outcomes of land allocation and supporting more effective forest management in Luang Prabang Province.

Therefore, the objective of this study is to assess changes in forest cover following the implementation of the Land Use Planning and Land Allocation (LUP/LA) program in Luang Prabang Province, Lao P.D.R.

2. Methodology

2.1 Conceptual framework of the study

The conceptual framework of this study was developed based on the literature review and begins with the Lao government's forest development policies, particularly the Forestry Strategy 2020, which aimed to reduce deforestation and increase national forest cover to 70 percent by 2020. Under this policy framework, the provincial level functions primarily as the planning unit, while districts and villages serve as implementation units. The framework also considers the socio-economic conditions of local communities and the role of local people in forest management and land-use practices. Initially, forest development and management in Laos largely followed a top-down approach, in which the government emphasized land-use planning, forest management, and biodiversity conservation. However, relatively limited attention was given to the perspectives, needs, and participation of local communities in decision-making processes. Over the past two decades, this approach has gradually shifted from a predominantly government-led development model toward a bottom-up approach involving multiple stakeholders. From a multi-stakeholder perspective, landscape management emphasizes participation in decision-making and the integration of different interests and objectives within a landscape (Van der Horn and Meijer, 2015) [26]. The integrated landscape approach has subsequently emerged as a method for addressing multiple objectives simultaneously, particularly economic development, biodiversity conservation, and the sustainable management of rural landscapes. This approach seeks to connect different stakeholders, interests, and activities across multiple spatial and institutional scales in order to promote integrated landscape management (Milder *et al.* 2014) [20].

Based on these concepts, changes in forest cover may be influenced by both internal and external factors, including government policies, land-use practices, socio-economic conditions, market forces, population dynamics, and other environmental or institutional factors. However, the present study does not attempt to identify or quantify all of these factors. Instead, it focuses primarily on assessing changes in forest cover following the implementation of the Land Use Planning and Land Allocation (LUP/LA) program in Luang Prabang Province.

Therefore, the conceptual framework of this study is based on the relationship between government forest and land-use policies, the implementation of land allocation, local socio-economic conditions and land-use practices, and changes in forest cover. These relationships provide the basis for analyzing forest cover changes in the study area, as illustrated in the conceptual framework below:

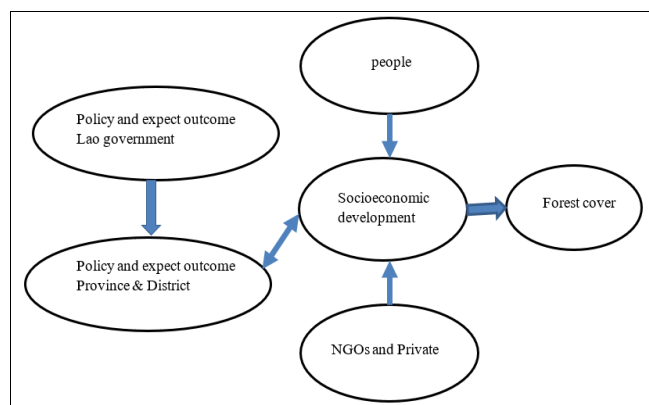


Fig 1: Conceptual framework for the study

2.2 Methods

This research employed a quantitative descriptive research approach based on the synthesis and analysis of secondary data. The study used information from research findings, official reports, policy documents, and relevant online data sources related to changes in forest cover in Luang Prabang Province, Lao P.D.R.

First, relevant findings from domestic and international studies were reviewed and synthesized, particularly research concerning forest cover change in Luang Prabang Province and Laos. Relevant documents included reports assessing changes in forest cover in Laos, government policy documents, and documents related to forest restoration and management.

Second, the study used secondary data obtained from official sources, including reports from the Department of Forestry for 2010 and 2015. Additional forest-cover data were obtained from online sources, including Global Forest Watch: <https://globalnaturewatch.org>.

Third, the analysis divided the study period into three periods to examine changes in forest cover over time: 2002–2010, 2010–2015, and 2015–2019. Comparing these three periods enabled the study to describe trends and patterns of forest cover change in Luang Prabang Province.

3. Results and Discussion

3.1 Change of forest cover in period 2002-2010

This study found that forest cover in Luang Prabang Province changed considerably during each study period. Based on the data for 2002–2010, forest status changed over the eight-year period in terms of both forest area and proportion. A comparison between 2002 and 2010 showed that forest cover increased by approximately 3.11% per year. In addition, the proportion of areas with the potential for natural forest recovery also increased, as illustrated in the figure below:

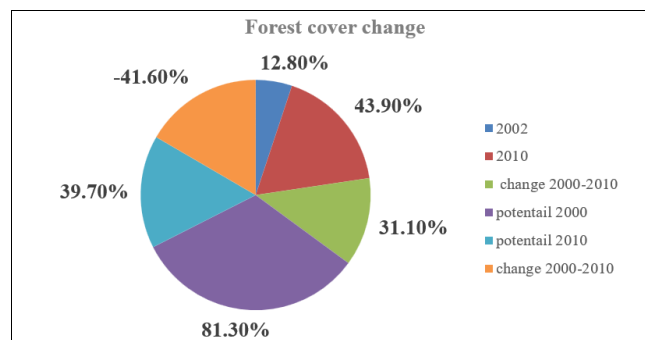


Fig 2: Change of forest cover

The results show that approximately 31.10% of the area had strong potential for natural forest recovery, while the remaining areas required forest restoration and development activities, including planting. During the eight-year period from 2002 to 2010, forest areas were restored significantly, resulting in an overall increase in forest cover. Nevertheless, negative changes in forest cover were also observed. Some forest areas were converted to other land-use types, particularly for resettlement and development activities. Most of these changes occurred in areas located close to communities, municipalities, and resettlement areas (DAFO, 2010) [4].

Distribution of forest area by forest type in 2010

The distribution of forest areas by forest type was calculated as a percentage for the year 2010. Forest areas within the boundaries of the three forest categories established by the government and local authorities consisted of production forests, protection forests, and conservation forests. For production forests, the total area was approximately 145,000 ha. Of this area, 38.14% was under forest cover, 32.48% had potential for forest restoration, and the remaining 29.38% was classified as other land. For protection forests, the total area was approximately 1,218,700 ha. Of this area, 33.95% was under forest cover, 39.82% had potential for forest restoration, and the remaining 26.22% was classified as other land.

For conservation forests, the total area was approximately 145,000 ha. Of this area, 38.49% was under forest cover, 45.25% had potential for forest restoration, and the remaining 16.26% was classified as other land.

Distribution of tree-cover gain by District, 2000–2012

The distribution of tree-cover gain was examined for each district during the period from 2000 to 2012. The following definitions are based on the terminology used by Global Forest Watch. Tree cover is defined as vegetation greater than 5 meters in height. It may include natural forests or plantations and is characterized by a certain level of canopy density.

Tree-cover gain is defined as the establishment or growth of tree canopy in an area that previously had no tree cover, as identified through satellite imagery. Tree-cover gain may result from several processes, including natural forest growth, natural regeneration, or the growth and rotation of plantation forests. Tree-cover gain and tree-cover loss

cannot be directly compared as equivalent statistical measures. Therefore, net tree-cover change cannot be calculated simply by subtracting tree-cover loss from tree-cover gain, because the two measures may represent different processes and occur at different times and locations. Tree cover is not equivalent to forest cover. Tree cover refers to the biophysical presence of trees and may occur in both natural forests and plantations. Therefore, tree-cover loss may result from various causes, including deforestation, fire, and logging associated with sustainable forest management operations. Similarly, tree-cover gain may indicate the growth or regeneration of tree canopy within natural forests or plantation forests.

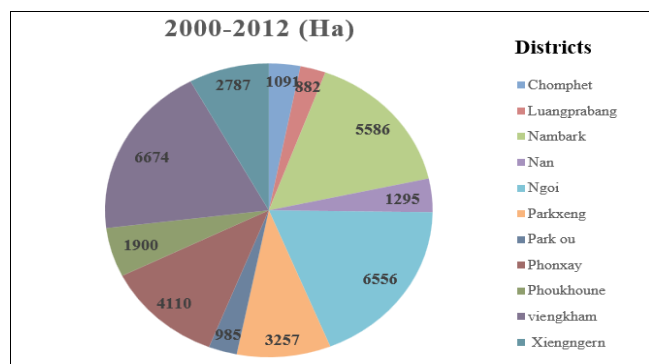


Fig 3: Change of tree cover

Tree cover gain in Luang Prabang, Laos (Global Forest watch 2020)

It was found that the distribution area of tree cover gain increased more in some districts of Luang Prabang Province than in others. Viengkham District had the largest increase, covering approximately 6,674 ha, followed by Ngoi District with approximately 6,556 ha and Nambak District with approximately 5,586 ha, respectively. As shown in the graphic below, tree cover increased over the study period. This finding is consistent with a report from the Department of Forestry, which revealed that the plantation area in Luang Prabang Province has continuously expanded over time. Tree planting has also been integrated with upland rice cultivation, particularly teak plantations. (DAFO, 2015) [5].

3.2 Change of forest cover in period 2010-2015

According to data from the Department of Forestry, Ministry of Agriculture and Forestry (2015), the proportion of primary forest cover in Luang Prabang Province was approximately 55%, while secondary forest cover accounted for approximately 40.7%. Compared with 2010, the proportion of primary forest cover increased by approximately 22.34%, representing an average annual increase of 4.47%. In contrast, the proportion of secondary forest cover decreased by approximately 18.95%, representing an average annual decrease of 3.79%. These changes in forest cover are shown in the graphic below.

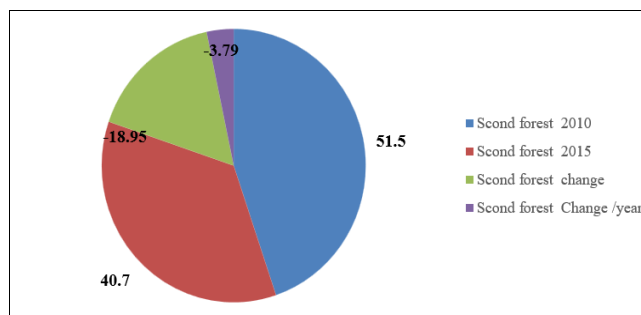


Fig 4: Change of forest cover 2010-2015

3.3 Change of forest cover in period 2015-2019

As part of the analysis of tree cover loss, according to the terminology used by Global Forest Watch, tree cover loss is defined as a change in tree canopy cover or the removal of tree canopy at the Landsat pixel scale.

Tree cover loss can result from various causes, including human activities such as forestry practices, timber harvesting, deforestation, and the conversion of natural forests to other land uses. It can also be caused by natural phenomena, such as disease outbreaks, storms, and other forms of natural disturbance. In addition, fire is another widespread cause of tree cover loss and can occur as a result of either natural processes or human activities.

It is important to note that tree cover loss is not synonymous with deforestation. Tree cover loss includes changes occurring in both natural forests and tree plantations and does not necessarily result from human activities. Therefore, tree cover loss represents a broader measure of changes in tree canopy cover than deforestation.

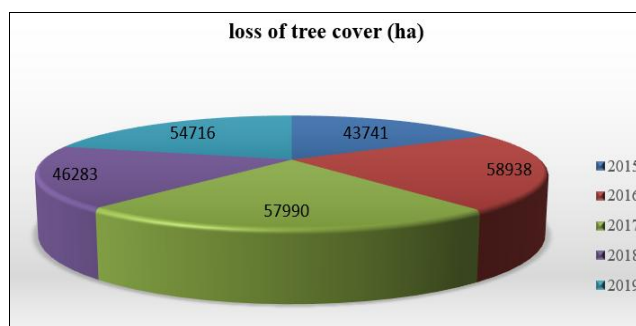


Fig 5: Forest cover loss

Tree cover loss in Luang Prabang, Laos (Global Forest watch)

The distribution of tree cover loss across the districts of Luang Prabang Province is shown in the figure above. The data indicate the area of tree cover loss for each year from 2015 to 2019. In 2015, the area of tree cover loss was approximately 43,741 ha. This increased to approximately 58,938 ha in 2016. In 2017, the area was approximately 57,990 ha, followed by approximately 46,283 ha in 2018 and 54,716 ha in 2019, respectively.

When comparing forest cover between 2010 and 2015, the results indicate that the overall forest cover increased during this period. According to the Department of Forestry (2015), forest cover in the northern region increased by approximately 1.22% per year (DAFO, 2015) ^[5]. Several factors may have contributed to the increase in forest cover in Luang Prabang Province.

First, government policies played an important role in promoting forest conservation and restoration. The government established a policy framework and set a target of achieving 70% forest cover by 2020 (MAF, 2005) ^[18]. This policy direction was further reinforced by the 10th Congress of the Lao People's Revolutionary Party in 2016, following which the government identified four main goals and 20 priority roadmaps. The third goal was directly related to forest conservation and included three key roadmaps: (1) protecting the environment and natural resources to ensure sustainability; (2) preparing for and responding to climate change-related disasters; and (3) reducing risks to agricultural production caused by disasters. In addition, the increase in forest cover was consistent with the Sustainable Development Goals (SDGs), particularly SDG 15, which emphasizes the protection, restoration, and sustainable use of terrestrial ecosystems, sustainable forest management, combating desertification, and halting and reversing land degradation and biodiversity loss" (Icsu, 2015) ^[11]. Another important factor was the government's efforts to reduce and eventually eliminate shifting cultivation as a response to deforestation and forest degradation. The government promoted the transition from shifting cultivation toward more biologically stable and sustainable land-use systems at the village and household levels. These approaches aimed to improve land-use practices while reducing pressure on forest resources (Douangsavanh, Polthane, and Katawatin, 2006) ^[6].

Second, the intention and commitment of local authorities to forest conservation have also contributed to the increase in forest cover, particularly through the restoration of forest zones and the identification of areas with potential for natural forest recovery. In addition, local communities have become increasingly aware of the importance of forests for environmental conservation and the protection of steep-slope areas, which can help reduce the risks of soil erosion, landslides, and other natural disasters. This finding is consistent with the results of Kim and Alounsavath (2015) ^[14]. Who pointed out that the increase in forest cover in northern Laos was most likely influenced by reductions in rural poverty and slash-and-burn shifting cultivation in the northern provinces. Nevertheless, timber logging and the conversion of forests to other land uses remain critical issues in Laos. These problems are associated with incomplete national land-use zoning, a lack of forest management plans for many natural forests, and weaknesses in law enforcement. Furthermore, simulations of future forest-cover change in Luang Prabang Province using the MCA model under business-as-usual (BAU) and pessimistic scenarios projected that current forest areas would decrease, while unstocked forest areas would increase. This trend may result from increasing pressure on forest resources caused by threats to rural livelihoods. In contrast, under the optimistic scenario, current forest areas were projected to increase if forestry laws were strictly enforced and conservation measures were effectively implemented in protected forest areas (Kamusoko *et al.* 2011) ^[13].

Regarding secondary forests, which include areas with potential for forest recovery, the proportion of these areas decreased in almost all parts of Laos. In the northern region, the decrease was approximately 0.83% according to a report by the Department of Forestry (DAFO, 2015) ^[5]. One possible explanation is that the Land Use Planning and Allocation (LUP/LA) program did not have a strong influence on local livelihoods. The implementation of land-use regulations was not always strict; for example, some plots located near roads were registered, whereas more remote plots were not registered. As a result, some local people continued to practice shifting cultivation (Bouahom *et al.* 2011) ^[2]. Similarly, rural people did not always comply with the rules established by the government for village forests. Some households continued to practice shifting cultivation outside the boundaries of designated village forests for their livelihoods, which contributed to the continued expansion of these areas (Hansen, 1997) ^[9]. Although government development policies resulted in a considerable reduction in the number of people practicing shifting cultivation and producing opium poppies, challenges remained in the implementation of land allocation programs and the relocation of remote villages to new resettlement areas (Douangsila and Pongchompu, 2012). Changes in livelihoods partly contributed to the deterioration of working conditions and had mixed impacts on the environment (Lestrelin and Giordano, 2007) ^[17]. Similarly, Boundeth *et al.* (2012) ^[3] found that land use and land cover changed over different periods as a result of socioeconomic factors, with almost 70% of forest cover experiencing significant decline.

More broadly, human activities are considered major drivers of deforestation and forest degradation. Approximately 80% of global deforestation and 70% of deforestation in Latin America and the tropical forests of Asia have been associated with timber extraction and logging activities (Kissinger, Herold, and Sy 2012) ^[15]. Other important drivers include fuelwood collection, charcoal production, uncontrolled fires, and livestock husbandry (Hosonuma *et al.* 2012) ^[10]. Inappropriate land-use practices and inadequate land management can also result in negative impacts on ecosystem services (SOUPHIALATH *et al.* 2017) ^[24].

4. Conclusion and Recommendations

The analysis of forest-cover changes in Luang Prabang Province during the period 2002–2010 showed a significant recovery of forest cover. Forest cover increased by approximately 3.11% per year, indicating a strong potential for natural forest regeneration. The results suggest that approximately 31.10% of the forest area had the potential to recover naturally, while the remaining areas may have depended on forest restoration and plantation-development activities. During the period 2010–2015, the proportion of primary forest cover increased by approximately 22.34%, representing an average annual increase of 4.47%. In contrast, the proportion of secondary forest cover decreased by approximately 18.95%, representing an average annual decrease of 3.79%. The increase in primary forest cover may indicate forest regeneration and the effectiveness of forest conservation and restoration efforts. However, the decline in secondary forest cover suggests that some areas of secondary forest may have been converted to other land uses or developed into more established forest cover. For the

period 2015–2019, the analysis of tree cover loss showed a negative change in tree cover across Luang Prabang Province. In particular, substantial tree cover loss occurred in 2016, 2017, and 2019, with annual losses exceeding 50,000 ha. These results indicate that, despite the increase in forest cover observed during earlier periods, forest resources continued to face considerable pressure during 2015–2019. Overall, the findings demonstrate that forest-cover change in Luang Prabang Province has been influenced by both forest recovery and forest loss. Forest regeneration, plantation development, conservation policies, and local forest-management activities have contributed to forest recovery, while agricultural expansion, shifting cultivation, logging, infrastructure development, fire, and other human and natural disturbances may have contributed to tree cover loss. This study was based primarily on secondary data and the synthesis and analysis of information from existing reports and datasets. Therefore, some information was incomplete, particularly regarding the precise changes in forest area and the proportions of forest-cover increase and decrease during 2015–2019. In addition, comprehensive information on tree cover gain was not available for all study periods.

Based on these limitations, the following recommendations are proposed:

Promote sustainable local livelihoods: Alternative livelihood activities should be promoted to reduce local communities' dependence on shifting cultivation and other activities that place pressure on forest resources.

Conduct further research: Future studies should combine remote-sensing data, field surveys, and socioeconomic information to better identify the causes and spatial patterns of forest-cover change in Luang Prabang Province. In particular, further research should examine the relationship between tree cover gain and tree cover loss and determine whether tree cover loss represents temporary disturbance, forest regeneration, plantation harvesting, or permanent deforestation.

5. Compliance with ethical standards

Disclosure of conflict of interest.

No conflict of interest to be disclosed.

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