Vegetation cover analysis and ecotourism business model for sustainable forest management in Gunung Leuser National Park, Indonesia

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Abstract. Gunung Leuser National Park (GLNP) is part of the Tropical Rainforest Heritage program of Sumatra that was designated by UNESCO. GLNP is very vulnerable to vegetation land cover decrease due to illegal logging, encroachment, oil palm expansion, and inappropriate management of ecotourism. GLNP authority has the responsibility to handle forest threats by estimating vegetation cover and manage the ecotourism sector. This study aims to estimate vegetation cover and investigate strategy in developing ecotourism business model for sustainable forest management in GLNP. The methods used Normalized Vegetation Index (NDVI) analysis in estimating vegetation cover, and Social Enterprise - Business Model Canvas (SE-BMC) in developing a strategic business ecotourism model. NDVI was classified into 5 classes from class 1 to 5 (non-vegetation or very low dense vegetation to very high dense vegetation) based on unsupervised classification (natural breaks in ArcGIS). The results showed the largest vegetation area in GLNP belongs to class 4 (443876 ha or 32.68%) and class 5 (355018 ha or 26.02%). This indicates that the majority of GLNP by area is still densely vegetated. Based on SE-BMC analysis, GLNP management needs to collaborate with the local community and other stakeholders. We recommend improving ecotourism management and enhancing community development.

1. Introduction

Indonesian forest cover accounts for 120.6 Mha or 63% of the Indonesian land area [1]. Indonesia holds the third-largest acreage of the tropical forest of any nation globally, with those forests characterized as a mega-biodiversity country [2]. However, this is a demotion from their prior rank at 2 globally. Deforestation and excessive forest degradation, due to forest fires, illegal logging, and forest conversion to non-forest areas in recent decades are to blame [3]. In 2000-2012, Indonesia’s lost approximately 6.02 Mha of primary forest. This loss was estimated to be greater than that experienced by Brazil in 2012 [4]. Indonesia’s forest loss affects biodiversity and economic loss, as well as greenhouse gas emissions that contribute to climate change.

Approximately 2 Mha of 24.3 Mha degraded land in Indonesia is located in conservation areas. Area of conservation aims to protect life systems, and preserve flora as well as fauna diversity, for example, National Park. Gunung Leuser National Park (GLNP) is one of the UN World Heritage Sites, specifically...
as Tropical Rainforest Heritage of Sumatra in 2004 that plays a vital role in conserving biodiversity due to having the natural habitat for in-situ conservation (including endangered species). GLNP is embedded in the Ecosystem of Leuser, a major habitat for critically endangered species for example Sumatran Orangutan, Sumatran Tiger, Sumatran Rhinoceros, and endangered species such as Sumatran Elephant [5]. However, GLNP is very vulnerable to decreasing land cover due to many factors such as illegal logging [6], over-extraction for wood and non-timber forest products (NTFP) and inappropriate tourism management [7], oil palm expansion [8], and oil palm industry [9], crops cultivation, as well as industrial expansion in monoculture.

The local communities who live in and around the forest play important roles in maintaining the forest and its biodiversity. About 25,800 villages (34.1%) of total villages in Indonesia are located around the forest and they live to depend on forest resources. Before the 1990s, the government did not give attention to the local communities. In 1990-1998, there was an acceptance and the local community started to be involved in forest management. Then in 2007-2013, some regulations were issued in supporting the roles of local community in forest management. In 2007-2014, legal access was officially issued for the local community and recently the President of Indonesia announced social forestry as a booster for the local communities’ access to the forest resources (Hutan adat or Adat forest) [1].

Monitoring Indonesia’s forest cover, especially in GLNP is highly needed. Forest monitoring by involving the local community is necessary, however, for some matters, quick and accurate methods are more recommended. The use of remote sensing and satellite imagery to produce forest cover and forest loss is important. These technologies are effective and accurate to obtain the information of surface cover [10]. Many vegetation indexes are used as indicators in measuring the vegetation’s greenness by using satellite data. The widest vegetation index used is the Normalized Difference Vegetation Index (NDVI) [11,12]. NDVI has been used for many purposes such as in identifying land cover changes by human activities, land-use changes in Klang-Langat Valley for green space and urban sprawl [13], mapping the plantation of rubber in Xishuangbanna Region of Southwest China [14], mapping genus *Coccocypselum* (Rubiaceae) in Brazil for conservation planning [15] and as an indicator of vegetation health [16]. NDVI contributes to mapping the species distribution processes by showing the canopy closure, water content, and phenological status. NDVI has great potential to implement in larger-scale models for plant species distribution [15].

GLNP also has potential in the ecotourism sector due to the stunning landscapes and unique biodiversities, such as Alas valley, Tangkahan, orangutan habitat in Tripa, Singkil, Kluet, and other tourist destinations. This potential has not been developed optimally due to a lack of understanding and corporation in developing a business model. Business Model Canvas (BMC) is usually used for business creation and consists of nine main elements, namely: key activities, value propositions, key partnerships, channels, key resources, cost structure, revenue streams, customer relationships, and customer segments [19]. For social and environmental purposes, BMC is modified to become Social Enterprise - Business Model Canvas (SE-BMC) by adding 3 additional elements, namely: missions, impacts, and measurements.

GLNP authority has the responsibility to handle forest threats by estimating vegetation cover and manage the ecotourism sector as a safeguard in achieving sustainable forest management by involving the local communities and other stakeholders. Therefore, this study aims to estimate vegetation cover using NDVI and investigate the strategy in developing an ecotourism business model for sustainable forest management in GLNP.

2. Method
2.1. Study sites
This study site was located in Gunung Leuser National Park (GLNP) (figure 1). GLNP was originally established based on the decision ZB No. 317/35 as Indonesia Nature Reserve in 1934 with a total area of 142,800 ha, then based on the decision 811/Kpts/Um/II/1980 it formally established as a National park in 1980 with a total area is 862,975 ha and located in two provinces, namely Aceh and North Sumatera Province. The Decrease of Minister of Forestry no. 276 / KPTS-VI / 1997 declared that the total area in GLNP increased become 1,094,692 ha [5].
2.2. Methods

2.2.1. Vegetation index analysis. This research used Landsat 8 satellite imagery that has been collected from USGS (U.S. Geological Survey) at https://earthexplorer.usgs.gov. The data were acquired on 22 March 2020 (path row 129/57), 2 January 2020 (path row 129/58), and 13 March 2020 (path rows 130/57 and 130/58). Those different dates due to looking for the best imageries with cloud cover less than 20%. All the data were re-projected to a Universal Transverse Mercator (UTM) coordinate system, data WGS84, and 47 N. NDVI can be calculated this below formula [17]:

\[
NDVI = \frac{(NIR - RED)}{(NIR + RED)}
\]  

(1)

Where NIR is near-infrared and measured by band 5, while RED is the red light and measured by band 4 in Landsat 8. Landsat 8 uses combination bands of 5, 4, 3 (NIR, Red, and Green) for constructing RGB color (Red, Green, and Blue). NDVI was also calculated by using these bands [18]:

\[
NDVI = \frac{(Band \ 5 - Band \ 4)}{(Band \ 5 + Band \ 4)}
\]  

(2)

Processing all imageries data in ArcGIS 10.3 with main steps: (1) satellite data collections, (2) image pre-processing such as layer stacking, (3) geo-referencing data, (4) derivation of NDVI values from unsupervised classification with natural breaks (jenks) in ArcGIS, (3) classification of vegetation’s density. We classified the NDVI value into 5 classes, class 1 (non-vegetation or very low dense vegetation), class 2 (low dense vegetation), class 3 (moderate dense vegetation), class 4 (high dense vegetation), and class 5 (very high dense vegetation).

2.2.2. Qualitative analysis. Analysis of flora diversity, forest management, and strategy in developing ecotourism business model for sustainable forest management in GLNP was collected by literature review. Secondary data collection focus on holistic literatures such as books with a reputable publisher, scientific journals, and other trusted information. The steps for qualitative analysis were data collection, data verification, interpretation, and conclusion. We want to investigate the questions:

1) How is the status of vegetation diversity in GLNP?  
2) What kind of forest threats and their management in GLNP?  
3) What is the strategy in developing an ecotourism business model for sustainable forest management in GLNP?
2.2.3. Business model development. Business Model Canvas was created by Osterwalder and Pigneur [19] which is called the Social Enterprise - Business Model Canvas (SE-BMC) [20]. There are nine main elements of BMC, namely: key activities, value propositions, key partnerships, channels, key resources, cost structure, revenue streams, customer relationships, and customer segments. Then, there are 3 additional elements, namely: missions, impacts, and measurements in the modified SE-BMC. SE-BMC not only focused on profit-oriented but also on the social and environmental aspects of the business. SE BMC is an alternative guide to develop comprehensive and innovative business models of sustainable forest management in GLNP.

3. Result and discussion
3.1. Vegetation cover in Gunung Leuser National Park (GLNP)
The Decree of Minister of Forestry no. 276 / KPTS-VI / 1997 declared that the total area in GLNP increased become 1,094,692 ha. This area consists of Gunung Leuser Wildlife Reserve (416,500 ha), Kluet Wildlife Reserve (20,000 ha), Lawah Selatan Wildlife Sanctuary (882,985 ha), Langkat Barat Wildlife Reserve (51,000 ha), Kappi Wildlife Reserve (142,800 ha), Limited Production Forest and Protected Forest (292,707 ha), also Lawe Gurah Tourist Park (9,200 ha). The peak of GLNP reaches 3,404 m.

![Map of GNLP based on NDVI analysis](image)

**Figure 2.** Map of GNLP based on NDVI analysis.

The Development of remote sensing technologies can assist the information of vegetation dynamics easily, quickly, and cheaply obtained based on satellite analysis. This research used Normalized Difference Vegetation Index (NDVI) to quantify the greenness of vegetation by using satellite data. NDVI values are ranging from -1 to 1. The negative value shows the land has no vegetation and the positive value shows vegetated land. We classified the NDVI value into 5 classes, class 1 (non-vegetation or very low dense vegetation), class 2 (low dense vegetation), class 3 (moderate dense vegetation), class 4 (high dense vegetation), and class 5 (very high dense vegetation) (figure 2). For zoom in the map, NDVI classes in each imagery can be found in figure 3.
Based on the vegetation index analysis, the largest up to the smallest vegetation area belong to class 4 (445,876 ha or 32.68%), class 5 (355,018 ha or 26.02%), class 3 (297,132 ha or 21.78%), class 2 (142,152 ha or 10.42%), and class 1 (124,231 ha or 9.11%) (Figure 4). It indicates that the dominant area in GLNP is still in the vegetated area. However, in the border area, there are many red and orange colors (classes 1 and 2).

### Figure 4. Percentage of vegetation cover in GLNP based on vegetation index analysis.

3.2. Vegetation diversity in Gunung Leuser National Park (GLNP)

Western Indonesia’s forests are dominantly found by the dipterocarps family [21] that has high economic value and most of the infrastructure there has been well-established. Otherwise, Eastern Indonesia’s forest has only a few dipterocarps families with the area very remote and difficult to access [21]. Indonesia has 552 conservation areas in all provinces (27.4 Mha). Amount 25 endangered species in Indonesia (listed on IUCN as threatened species). Dipterocarpus cinereus has high economic value and good quality timber. It is one of the extinct species in the wild due to that was declared by IUCN in 1998.
Sumatra Island is one of the largest islands in the world with 476,000 km² of wide [22]. Sumatra has 9,000 – 10,000 plant species were around 3,000 – 4,000 species are existing in Gunung Leuser National Park (GLNP). There are several families that exist in the GLNP forest ecosystem, namely Dipterocarpaceae, Myristicaceae, Euphorbiaceae, Sapotaceae, Meliaceae, Moraceae, and Oleaceae [22].

Gunung Leuser National Park and Leuser Ecosystem have 8,500 flora species that grow in different ecosystems, for example, alpine, mountain, lowland, swamp, and beach. Some of them (4,000 flora) can be found in GLNP. In the beach and swamp forest can be found mangrove trees, pandan, nibung palms, camphor, wild nutmeg, and casuarina trees, while Pometia pinnata grow along the river. The dipterocarp trees such as meranti, keruing, and wild fruit like durian, mango, and jackfruit can be found in the lowland ecosystem. Some species of moss and wildflowers: strawberries, gentians primulas, herbs, and wild orchids can be found in the alpine and mountain ecosystems.

The Research Station of Ketambe, GLNP, Aceh Province, they noted that forest composition in the primary forest was consisting of 138 species of trees and lianas, which belonging to 49 families, where 17 species of them had not identified yet [22]. Another hand, in secondary forest (ex-logged forest), they found 120 species of trees and lianas which included 37 families, where 21 species had not been identified yet. Table 1 shows a list of dominant species between primary forest and secondary forest in the Research Station of Katambe, based on the comparison of Important Value (IV).

| Local name* | Species* | Family | Local name* | Species* | Family |
|-------------|----------|--------|-------------|----------|--------|
| Entap       | Parashorea lucida | Dipterocarpaceae | Entap       | Parashorea lucida | Dipterocarpaceae |
| Meranti merah | Shore sp. | Dipterocarpaceae | Kayu karet | Elateriospermum tapos | Euphorbiaceae |
| Perlak      | Elateriospermum sp. | Euphorbiaceae | Meranti merah | Shorea sp. | Dipterocarpaceae |
| Kerakah pagar anak | Castanopsis sp. | Fagaceae | Medang papula | Phoebes sp. | Lauraceae |
| Setur gajah | Aglaia racemosa | Meliaceae | Tampu biasa | Macaranga tanarius | Euphorbiaceae |
| Dukut dasih | Planchonia valida | Lecythidaceae | Rambutan biawak | Nephelium rambunake | Sapindaceae |
| Kayu lasun  | Scorodocarpus borneensis | Olacaceae | Rambutan hutan | Nephelium lappaceum | Sapindaceae |
| Geseng tanduk | Quercus sp. | Fagaceae | Kayu arang | Diospyros sumatrana | Ebenaceae |
| GMS         | Dysoxylum sp. | Meliaceae | Tampu tapak gajah | Macaranga tribola | Euphorbiaceae |
| Kayu arang  | Diospyros sumatrana | Ebenaceae | Medang sawa | Phoebes elliptica | Lauraceae |

Source: [22].

Logging in 1990 – 2003 affected the loss of indigenous tree species in GLNP [22]. So that secondary forest is dominated by pioneer species. On the other hand, liana is also found in this study. Table 2 shows a list of dominant lianas species between primary forest and secondary forest in the Research Station of Katambe, based on the comparison of the Important Value Index (IVI). Based on this research, it’s known that the species of trees were found in the primary forest ecosystem are Dipterocarpaceae, Euphorbiaceae, Fagaceae, Meliaceae, Lecythidaceae, Olacaceae, and Ebenaceae. On the other hand, in the secondary forest, the species that were found are Dipterocarpaceae, Euphorbiaceae, Lauraceae,
Sapindaceae, and Ebenaceae. This research shows that the primary forest ecosystem in Ketambe, GLNP has a higher number of the family than secondary forests.

Table 2. List of top ten dominant lianas species in primary and secondary forest in Ketambe, GLNP

| Local name* | Species* | Family       | Local name* | Species* | Family       |
|-------------|----------|--------------|-------------|----------|--------------|
| RTPB        | Ficus altissima | Moraceae    | Akar lengen | Trichosanthes sp. | Cucurbitaceae |
|             | Acacia pennata | Leguminosae  | Akar susu kambing | Tinomiscium phytocrenoides | Menispermaceae |
|             | Loides cirrosa | -            | Akar kekait | Uncaria sp. | Rubiaceae |
|             | Garcinea sp. | Clusiaceae   | Akar tombing | Scindapsus hederaceus | Araceae |
|             | -              |              | Akar susu | Alyxia stellata | Apocynaceae |
|             | Kibessia sp. | Melastimataceae | Akar tanduk | Kibessia sp. | Melastimataceae |
|             | Ficus sp. | Moraceae    | Akar palorawan | Gnetum latifolium | Gnetaceae |
|             | Rambung kusin |              | Akar susu kambing besar | Tinomiscium sp. | Menispermaceae |
|             | Ficus sundaica | Moraceae  |              |              |              |
|             | Akar lengen | Trichosanthes sp. | Akar susu | Fibraurea sp. | Menispermaceae |
|             | Akar susu | Alyxia stellata | Akar kuning |              |              |

Source: [22].

The Dipterocarpaceae family grows up in Ketambe Research Station [23]. This family is known as a food source and nest for Orang Utan. Species of Dipterocarpaceae that were found in this station were Shorea johorensis, Parashorea lucida, and Hopea dryobalanoides. Based on the ecological characteristic, the Dipterocarpaceae family has some limiting factors for the growth-up, specifically adaptability and distribution. Principally, two environmental factors can be the limiting factors of Dipterocarpaceae’s growth and distribution, namely edaphic and climatic factors [24].

Table 2 shows that the primary forest is composed of native liana, while in secondary forest consists of pioneer liana, namely Tinomiscium phytocrenoides and Scindapsus hederaceus. On the other hand, native species (Kibessia sp.) are found in the secondary forest, but in lower species number [22]. Generally, both ecosystems are showing the similarity of tree and liana species, because those ecosystems are contiguous to each other [22,25]. The forest vegetation of the riverbank in Alas River, Ketambe, GLNP is approximately different from the forest ecosystem which far from the river [26]. Table 3 presents a species list of ten dominant trees and saplings in Alas River Bank Forest, Ketambe, GLNP.

Based on table 3 at least that there are two the most dominated species at Alas River Bank, namely Dendrocnide stimulans and Paraneophelium nitidium. Generally, the forest vegetation of the riverbank is relatively different from the forest vegetation of forest ecosystems where is far from the river. This phenomenon may be caused by the growth restraint factors in the riverbank ecosystem is higher than the forest ecosystem where is far from the river.
Table 3. List of ten dominant trees and saplings species in Alas River Bank Forest, Ketambe, GLNP.

| Category* | Local name | Species* | Family |
|-----------|------------|----------|--------|
| Tree      | Jelatang gajah, pulus | Dendrocnide stimulans | Urticaceae |
|           | Matoa      | Pometia pinnata | Sapindaceae |
|           | Randu alas, randu hutan | Bombax ceiba | Malvaceae |
|           | Nyampuh semut | Aglaia odoratissima | Meliaceae |
|           | Kayu kacang | Strombosia javanica | Ocaceae |
|           | Pingku, kasip hutan | Dysoxylum pachyrache | Meliaceae |
|           | Kajoe ira, kayu ira | Dysoxylum excelsum | Meliaceae |
|           | Jambu jelutong, kelat jambu, kelat putih | Mallotus sphaerocarpus | Euphorbiaceae |
| Sapling   | Jambu jelutong, kelat jambu, kelat putih | Paranephelium nitidum | Sapindaceae |
|           | Tongtolok, melembu | Eugenia zollingeriana | Myrtaceae |
|           | - | Pterocymbium javanicum | Malvaceae |
|           | Jelatang gajah, pulus | Siphonodon celastrinus | Celastraceae |
|           | Beringin sulawesi | Aglaia cauliflora | Meliaceae |
|           | - | Trevesia sundica | Araliaceae |

Source: [26].

Usually, we can find small trees (diameter < 30 cm) in this area. Forest disturbances such as flooding, water puddle, as well as soil erosion are the several growth inhibitor factors [26]. Another hand, the forest ecosystem in GLNP also has a potential plant of medicinal [27] in their study recorded 158 species in GLNP which are potential medicinal plants.

Table 4. List of ten families which are potential medicinal plant in the forest ecosystem of GLNP.

| Family       | Species             | Local Name | Note |
|--------------|---------------------|------------|------|
| Acanthaceae  | Graptophyllum sp.   | Puding hitam | Leaves are said to cure trachoma |
|              | Justica gendarusa   | Bebetu, bebesi | Leaves are said to remedy bloody diarrhea and remedies for fever |
| Amaranthaceae| Amaranthus spinosus | Bayam duri | Leaves are used as a salve of boils |
| Anacardiaceae| Mangifera indica    | Mangga | The bark is used for medicines, e.g abdominal pain, the remedy of malaria, and diarrhea. |
| Annonaceae   | Cananga odorata     | Kenanga, bunga selanga, ylang-ylang | The flower is used for skin irritation, the remedy of fevers. Even Heyne (1927) [28] explained that the dried flower is used for anti-malaria in Indonesia. |
| Apocynaceae  | Alstonia scholaris  | Pulai, gceeh, ruttu | The latex or bark is effective against malaria |
|              | Alyxia sp.          | Kayu pelasari | The Wood and bark can be drunk to remedy headaches |
| Compositae   | Blumea pubigera     | Serungkas sebekas | The leaves are used in complex remedies taken orally / applied externally for paralysis (stroke), leprosy, and remedy of mental disorders. |
| Dipterocarpaceae| Dipterocarpus sp. | Kayu patimah | Leaves are used for leprosy. |
|              | Parashorea lucida   | Entap, kayu intap, damar pepening | The solidified resin of the trunk for urinary tract infection |
| Lauraceae    | Cinnamomum burmanii | Kayu manis, kutil manis | For oral remedies such as cough associated with leprosy, vomiting, tuberculosis, chest infections, epigastric pain, and headaches. |
| Meliaceae    | Aglaia argantea     | Baliang angin, balik sempa | For treat fevers, diarrhea, remedies for non-specific abdominal pain, and colic |
| Moraceae     | Ficus variegata     | Gele | Young leaves are used for remedying the diarrhea |

Source: [27].
Biodiversity can contribute to human life, due to we can obtain various productive materials from biodiversity, such as food, medicine, raw materials, etc. On another hand biodiversity also provide us with its functions through ecosystem service. Ecosystem services are the processes and conditions of the ecological system that support human life [29]. Biodiversity plays a major role in mitigating climate change, especially through the long-term sequestration of carbon in the biomass [30].

3.3. Threats of forest cover and its management in Gunung Leuser National Park (GLNP)
Currently, tropical forests are facing a serious threat which resulted in forest biodiversity loss. There are many factors that able to degrading and disturbing forest biodiversity and its functions, and mostly dominated by human activities such as: illegal logging, forest encroachment, and shifting cultivation. Generally, those all are causing forest conversion into a non-forested area. [31] stated that forest disturbance by forest encroachment and shifting cultivation may influence the forest structure.

In 2003, approximately 73-88% total of timber in Indonesia was logged illegally and GLNP is one of the most areas affected by this activity [6]. Over extraction logged and non-timber forest products (NTFP) are found in the lowland ecosystem, as well as inappropriate management of ecotourism management becomes the threat of flora diversity [7]. GLNP is very vulnerable to decreasing land cover because of many factors. Oil palm has expanded in Sumatera in 1911. Many Indonesian rainforests have been converted into oil palm and this condition affects Indonesia as the largest palm oil producer [32]. In 1985-2001, Aceh forest converted 265995 ha into oil palm [8] and oil palm industry [9]. Additionally, crops like soybean and sugar cane in large-scale cultivation, as well as industrial expansion in monoculture plantation are becoming a great threaten for deforestation in GLNP [5]. Those activities pose greenhouse gasses emission, biodiversity, and environmental pollutions (water and air pollutions).

According to [33], from 1996 until 2014, GLNP land cover classes and its buffer zone consisted of forests, grass, shrubs, and cropland. Then in 2014, there were mismatches between land cover classification, in terms of proposed forest zoning and provincial master plan in Southeast Aceh Regency. In 2015, forests are the most dominant land cover in GLNP (89.29%), especially in Gayo Lues, Langkat, and Southeast Aceh. 5.37% of land cover were grass and shrubs, then cropland (3.75%). An increase of cropland in 1996 and 2005 and plantation in 2005 and 2014 caused a decrease in forest cover.

Additionally in 1999, the Indonesian government and Free Aceh Movement (Gerakan Aceh Merdeka), which affected many people moved to inside GLNP, and also tsunami disaster in 2004. Recently, an increase in the human population with diverse cultures and more widespread. They have high demands for settlements, cropland, plantation, and other purposes. According to Leuser Management Unit (2005) [34], local farmers around GLNP need 0.75 ha for building a settlement. Forests in Gayo Lues, Langkat and Southeast Aceh are the greatest forest exploitation by a human [33]. Additionally, land cover changes increase due to the conflicts between wildlife and humans in GLNP [33].

Forest management with persuasive and repressive approaches have been conducted by GLNP for many years ago such as a zoning system, conservation village model development, and ecosystem recovery implementation. GLNP consists of some zone systems, are core (857,175.64 ha), wilderness (66,921.08 ha), utilization (12,431.78 ha), rehabilitation (143,734.87 ha), traditional use (10,495.03 ha), religion (7,327 ha), and other zones (1,326.28 ha). GLNP is used for science, education, research, cultivation area, recreation, and ecotourism destination [33]. However, it did not work well. Recently, resort-based management (RBM) is one of the strategies in a conservation area (including in National Parks) to overcome the various problems, understand the diversity (e.g. cultures, history), and collaborate with the local communities in conducting National Park activities. There will be a mutualism symbiosis between National Park and the local communities [1]. Additionally, forest management by involving the local community is important. It would be more impactful when the management can collaborate with all stakeholders, and considering socio-economic, as well as ecological aspects.

3.4. Ecotourism business model using SE-BMC for sustainable forest management in GLNP
According to [1], there are 13 National Parks in Indonesia that succeed on ecosystem restoration with a collaborative approach. One of those National Parks is Gunung Leuser National Park with a total ecosystem restored 870 ha. GLNP has a high potency on ecotourism sector. For example, Tangkahan in Langkat Regency, North Sumatera (17,000 hectares) is a habitat of wild elephants, Bukit Lawang as a
orangutan Sumatran observation center, Kedah as a main gate to go to the top of GLNP, and other tourist destinations.

This potential has not to be developed optimally due to a lack of understanding and corporation in developing a business model. Business Model Canvas (BMC) is used for business creation and consists of nine main elements, namely: key activities, value propositions, key partnerships, channels, key resources, cost structure, revenue streams, customer relationships, and customer segments [19]. BMC is modified to become Social Enterprise - Business Model Canvas (SE-BMC) by adding 3 additional elements, namely: missions, impacts, and measurements for social and environmental purposes.

Based on the analysis of the social enterprise business model canvas (SE-BMC) resulted in the twelve main elements for the business ecotourism model in achieving SFM in GLNP. The recommendation for ecotourism business model strategy using SE-BMC in GLNP for sustainable forest management (SFM) is showed in figure 5.

Each element in SE-BMC has a relation and implication with other elements. The mission of business ecotourism using the SE-BMC model in GLNP is achieving sustainable forest management (SFM). While, in terms of Sustainable Development Goals (SDGs), the mission is to achieve SDGs 15 (life on land) and 17 (partnership for the goals), and increasing the income & livelihoods of the community. The expected impact of the business ecotourism model in GLNP is achieved SFM, achieved SDGs No.15 and No.17, and increased community income & livelihood. The measurement of the impact and mission of the social enterprise business model was based on the level of SFM and SDGs implementation, community participation, and level of community income.

Value proposition shows the value of products and services for customers by giving problem solutions. Based on the analysis of SE-BMC, the value proposition business model was attractive ecotourism with sustainable forest management & SDGs as well as local community participatory orientation. Additionally, the recommendations for GLNP management and the analysis of SE-BMC showed that customer segments of this business ecotourism consist of domestic tourists (especially with upper middle income), international tourists, and travelers with high sustainable ecotourism awareness. To keep and increase consumer loyalty, SE-BMC recommends the analysis of customer relationship programs were used, namely community partnership, virtual education of ecotourism, and memberships. This social

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**Figure 5.** Recommendation for ecotourism business model strategy using SE-BMC in GLNP for sustainable forest management (SFM).
enterprise business model using several channels through word of mouth, digital platforms, social media, and website utilization. The key activities of this business model consisted of 1) research development, 2) partnership, 3) website and social media development. Business ecotourism GLNP needs natural resources, human resources, capital, and finance in implementing the key activities. This business model needs to involve travel agents, digital platforms, airlines, communities, NGOs, government, media in achieving business sustainability.

4. Conclusion
Gunung Leuser National Park (GLNP) is a World Heritage Sites, specifically as Tropical Rainforest Heritage of Sumatra in 2004 that plays a vital role in conserving biodiversity due to having the natural habitat for in-situ conservation (including endangered species). GLNP is very vulnerable to decreasing land cover due to illegal logging, encroachment, oil palm expansion, and inappropriate management of ecotourism.

Based on the analysis of Normalized Difference Vegetation Index (NDVI) value, GLNP was classified into 5 classes, class 1 (non-vegetation or very low dense vegetation), class 2 (low dense vegetation), class 3 (moderate dense vegetation), class 4 (high dense vegetation), and class 5 (very high dense vegetation). The largest up to the smallest vegetation area belong to class 4 (445,876 ha or 32.68%), class 5 (355,018 ha or 26.02%), class 3 (297,132 ha or 21.78%), class 2 (142,152 ha or 10.42%), and class 1 (124,231 ha or 9.11%). It indicates that the dominant area in GLNP is still in the vegetated area.

GLNP management needs to collaborate with the local community and other stakeholders (government, NGO, media, and scientists) to achieve SFM. Based on the SE-BMC analysis, improving ecotourism management (community-based organization, inventory of ecotourism attraction, re-branding, online and offline marketing, and promotion, and public-private partnership) and enhancing community development (institutional strengthening, community agroforestry enhancement, community-based sustainable agriculture and livestock, local product training, and access to the market) was recommended.

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