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REPORT

HoB

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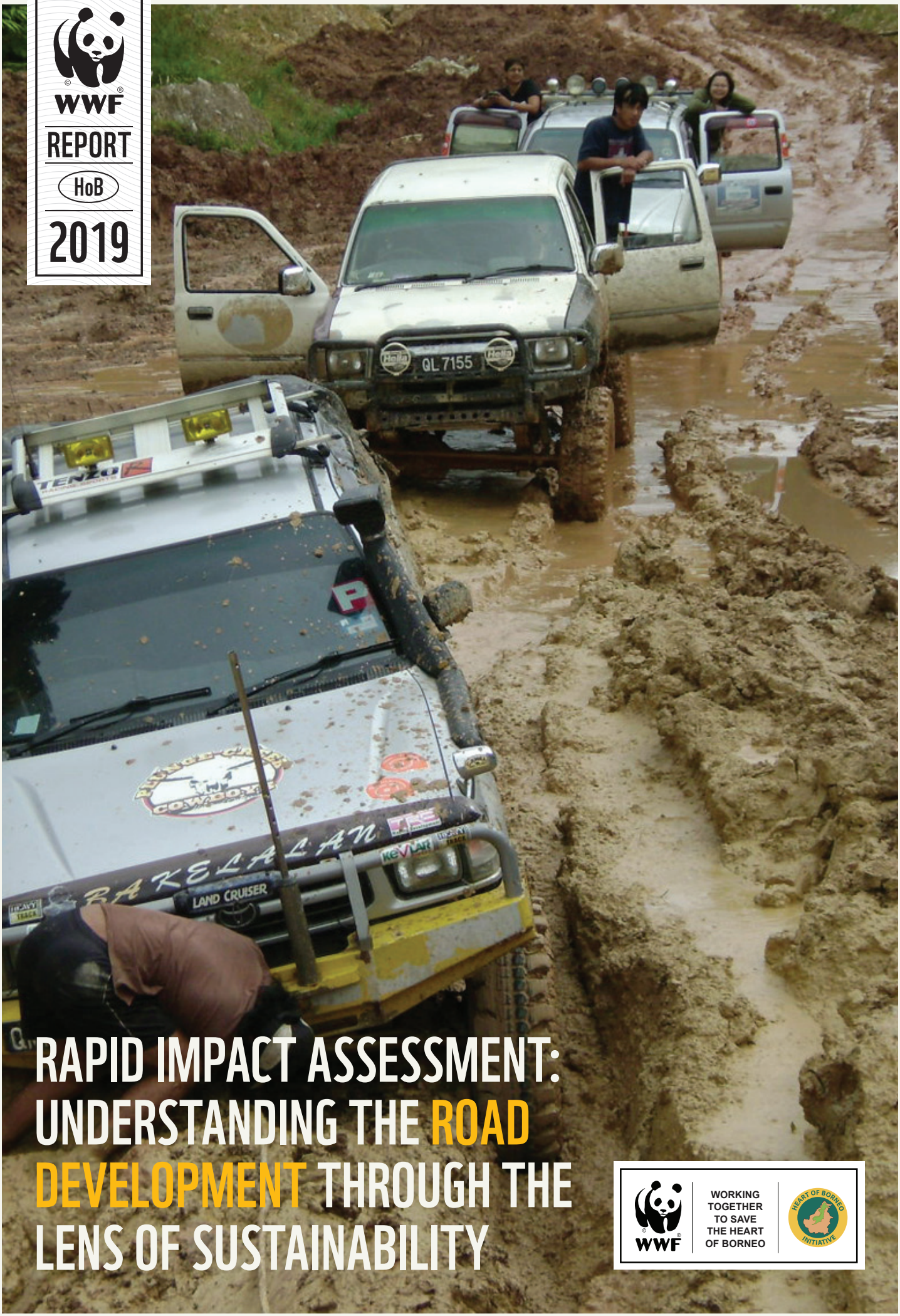

RAPID IMPACT ASSESSMENT: UNDERSTANDING THE ROAD DEVELOPMENT THROUGH THE LENS OF SUSTAINABILITY

WWF

WORKING TOGETHER TO SAVE THE HEART OF BORNEO

HEART OF BORNEO INITIATIVE

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WWF is one of the world's largest and most experienced independent conservation organisations, with more than five million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by: conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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FOREWORD
BY THE HEART OF BORNEO PROGRAM

The trilateral Heart of Borneo conservation and sustainable development initiative is not undertaken in isolation from the need of infrastructures. For the purpose of better access to market, goods and services such as health and education, infrastructures catalyze development. Communities owe much of their vitality to the ease where economic and social interactions take place. While roads are central to such interactions, the introduction of new roads or expansion of the old ones may as well cause disruptions to the existing interactions that outweigh the benefits. In the context of the Heart of Borneo that holds strategic environmental functions of the island, proper planning is a must to ensure benefits to the surrounding communities as much as it avoids environmental destruction. This is where the discourse on *sustainable infrastructure* comes as an alternative to the lacuna by examining the integration of the concept to the existing road project planning policy.

The term of *sustainable infrastructure* has been appearing more frequently, especially in the middle of discussions on avoiding a trade-off between landscape conservation and development in general. Despite various interpretation of the term, for the purpose of realizing sustainable development in the Heart of Borneo, sustainable road is understood as an interconnected network that conserve natural ecosystem values and functions that provides associated benefits to human populations. It differs from the conventional approach where land development does not consider in-depth conservation values that may be impacted both in short and long run.

To be able to draw such comprehensive strategy to better equip the infrastructure development within the Heart of Borneo with principles and practices of sustainability, there are threefold of prepared documents:

1. **Understanding the Road Development within the Heart of Borneo through the Lens of Sustainability**

   The aim of the study is to present a balanced reference on the social, economic and environmental interests behind the need to build linear infrastructure, in this case road development.

2. **Ecological Impact Assessment on Road Development and Spatial Planning in the Heart of Borneo Area**

   Specific to the ecosystem and landscape of the Heart of Borneo, this study further details scenarios of land allocation using spatial analysis tools.

3. **Advocacy Strategy to Ensure Sustainable Road Development in the Heart of Borneo**

   An internal WWF guiding document that maps stakeholders and identifies engagement strategy to maintain the integrity of the Heart of Borneo area.

As both the Government of Indonesia and the Government of Malaysia have substantially increased their focuses towards road infrastructure development over the past several years in the area of the Heart of Borneo, there needs to be an organized attempt to safeguard the intactness of the tropical rainforests. With a view to maintain the health of biodiversity hotspot in the Heart of Borneo, systematic alignment of sustainability principles with the existing road route and construction process is mandatory. The Heart of Borneo team believes that alignment strategy should cover the entire project cycle, that is planning, financing, design & construction and post-construction phases. These multifold documents prepared by the team as the first steps to set a common understanding on the threats of linear infrastructure development as well as possible mitigation actions.

1. SUMMARY OF THE REPORT

Road infrastructure development in the Heart of Borneo (HoB) region requires a sustainability approach to ensure the ecological value of HoB is not reduced and the benefits for the local community and national interests are well provided. By using Cost Benefit Analysis and Analytic Hierarchy Process (AHP), this study aims to assess the impacts of major road development in the HoB area. The methodology consists of road corridor selection, spatial analyses, economic valuation, and analytical-hierarchy process. Although only counted on the secondary data and several interviews, the results show that the road impacts can increase the environmental risks in the main corridor and growth centers area in direct manner. In Indonesia side, the diagonal road that consists of Long Pahangai – Long Nawang, Long Nawang-Malinau, and Malinau- Long Midang segments has BCR less than one and require several improvements for road design to reduce the costs. In Sabah, most of the roads are not economically feasible, except Ranau-Telupid. However, since the road is already existed, the land use control through zoning regulation should be proposed. Developing new segments and upgrading existing roads through eco-road design are perceived as the best alternative to achieve the sustainability.

2. INTRODUCTION

2.1 OPPORTUNITIES AND THREATS OF ROAD PROJECTS IN HEART OF BORNEO (HOB)

The Heart of Borneo (HoB) is rich in natural capital with over 22 million hectares of intact tropical forest. It contains the most terrestrial biodiversity that is still under explored. According to the 2010 WWF Report on "Borneo's New World: Newly Discovered Species in the Heart of Borneo', the HoB is the home of 10 primate species, more than 350 bird species, 150 reptiles and amphibian, and more than 10,000 world-endemic vegetation. Since 2007, many discoveries occurred. Every month, new three species discovered. And at the same time, it is the headwaters of the major rivers in the Borneo Island. More than 18 million people with different cultures and nations live in this island. Number of cities also grow fast that require high inter-connectivity and urban infrastructures to serve the growing economy sectors. Not only the uncontrolled rapid urbanization, but also the increasing demand of global food and energy market tends to create high pressures to the HoB landscape.

In 2007 the three Bornean Governments signed the HoB Declaration, committing to conserve and sustainably manage the biodiversity, ecosystems and natural resources. They aware to bridge conservation and sustainability in their development planning through five objectives: transboundary management, protected areas management, sustainable natural resource management, ecotourism development, and capacity building. The 2015 Paris Agreement on climate change should also be mainstreamed into those purposes. Therefore, the new direction of green economy will influence the agenda to balance conservation and socio-economic development of HoB.

The initial key factor in managing the balancing agenda is a road development. The road network will trigger the economic development through new public and/or private investments. Without intervening the road development, the potential losses

of ecological values and unexpected social and cultural changes of local community might be higher. Land clearing for road construction will alter the ecological landscape and the original habitat in the region will be disrupted. Several major ecological corridors lie on the 23 million ha of HoB tropical forests. Among of them is the elephant conservation habitat in the river upstream areas in Southern Sabah and Northern Kalimantan area. Another ecological corridor is the one that connects the Ingei river in the Brunei conservation forest and Ulu Temburong National Park, the Mulu and Buda Mountain and Pulong Pau National Park in Sarawak, Crocker Range National Park in Sabah, and Kayan Mentarang National Park in Kalimantan. Orang Utan conservation habitat that located from Batang National Park and Lanjak Entimau Wildlife Sanctuary in Sarawak to the Betung Kerihun and Danau Sentarum National Parks in West Kalimantan is easily spotted as a crucial corridor for the species.

In addition, Tropical Forest of HoB also plays a significant role as water catchment for at least 14 of 20 main rivers in Borneo Island. It also shows that the river should not only provide water for human consumption, but also the living space for many rare species. It is imperative to reduce the pressures on water catchment and rivers by limiting the land use conversion. Therefore, the road construction as an economic development trigger needs to be designed properly, especially to avoid the potential habitat segmentation. Choosing a route line with minimum biodiversity pressures and designing the road with ecological and green principles are the minimum prerequisites.

It is acknowledged that opening new roads and increasing the road capacity will expand the opportunity of extracting industries grows. If no strong zoning regulation applied, the hardest challenge is to anticipate the unplanned activities that aims to benefit the road presence. Land use changes e.g. from forests to plantations or mining industries will be very extensive following the road networks. Although to some extent, the road can also trigger eco-tourism industries--that is no mandatory to change the landscape-- to create economic opportunities. Therefore, the motives and purpose of road construction should be clearly stated at the beginning. It would become the basis for regulating the road usage and roadside activities.

In the social aspect, the forum of local custom has also been established with the name of FORMADAT (the forum of local communities). It serves various of customs in Kalimantan communities, but not in the Sabah and Sarawak sides. Based on the interviews with the Batang Kerihun and Danau Sentarum National Park Management Board, various Dayak community lives in the respective area, e.g. Bungan and Tanjung Lokal villages. The road development will certainly impact to the livelihood and culture of local people. Therefore, the road alignment route should be carefully developed because it will not only alter the landscape, but also the living way of local communities.

In addition, since the HoB covers three different countries, it is also imperative to increase the transboundary conservation management, including how to have a common perspective on the road development to serve the cross-border mobilities without disrupting the biodiversity value of HoB.

2.2 THE IMPORTANCE OF INCORPORATING SUSTAINABILITY IN HOB

Conceptually, the sustainability is an ultimate balancing value of economy, ecology, and social equity interests. It should produce a healthy environment, a socially progressive community, and a stable economic condition. Since the HoB is the conservation area, the regional development should put the environmental sector as the main priority, followed by the social and economic sectors. Soehartono et al., (2017) emphasize the importance of HoB in building biodiversity connectivity in Borneo Island. The HoB development can also support the achievement of Sustainable Development Goals (SDGs), particularly in the goal number 15 (life on land), 13 (climate action), 9 (Industry, Innovation, and infrastructures), and 6 (clean water and sanitation). For SDG 15, the HoB has very clear message and strong relation with the agenda 6, mainly to protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably management forests, and halt biodiversity loss. Since HoB has very thick forests, the potentiality to take urgent action to combat climate change and its impacts is also relevant to the HoB. In addition, the proper approach to build resilient (road) infrastructure and foster innovation are the agenda that has strong relationship to the road projects in HoB. Lastly, preserve the water catchment of HoB can also address the SDG 6, especially to provide healthier ecosystems.

Draw on the sustainability concept above, this paper attempts to apply the sustainable impact assessment (SIA) to analyze the road policies and planning in HoB area. It is an approach for exploring the combined economic, environmental, and social impacts of proposed policies, programs, strategies, or action plans. It can be a tailored design depends on the purpose and data availability. The result is expected to increase the understanding of the policy makers on the basic value of HoB eco-region before they decide the road projects or improve the construction process if the project has been undertaken.

Since the road network is a system, it is thus very important to assess the backbone that plays a major role in shaping the spatial structure. In Indonesia, the spatial planning establishes the road network to serve the connectivity between growth centers as the structure plan. It is defined in the spatial planning policy. To minimize the impacts, the first and strategic intervention should go to the backbone. Because if it is treated properly, managing the second line or below hierarchical road is easier. The development of economic activities either in the growth center areas that connected by the road or in the other service areas depends on the operation of the backbone. Therefore, this study offers the road impact valuation from the direct to the indirect ones. It would be an initial step to mainstream the sustainability concepts into the road policies and planning. In addition, assessing the backbone of the HoB would be an important exercise to identify the gaps in achieving sustainable HoB.

For Indonesia-Malaysia cooperation, discovering the impact value of road development in the ecosystem sensitive area, such as HoB is the best way to raise the awareness of multi-lateral stakeholders on sustainable development. The HoB ecological network among countries should be introduced as an integral part of the social and economic connectivity soon or later. In the regional context, the vision of ASEAN connectivity 2025 that encourages the country-to-country cooperation is also a conducive environment for HoB to take a part, especially in developing sustainable infrastructures. Therefore, preparing a sustainable solution for road development is a useful preventive solution.

For road policies and planning in Indonesia, this study will be a good exercise to identify the impacts of the planned road structure that shape the future spatial direction of HoB. According to Government Regulation No. 13 of 2017 on the national spatial planning, the HoB has been defined as a national strategic area. However, at this moment, the detailed spatial plan for HoB area is still under construction and hopefully will be established in this year.

2.3 PURPOSE AND STRUCTURE OF THE STUDY

The purpose of this paper is to deepen the understanding of the impact value of road development in HoB area. This study aims to assess the economic value of the impacted road development in HoB through cost-benefit analysis (CBA) and the analytical Hierarchy process (AHP) to confirm the findings. Although it is a rough value estimation, but it is expected to be an initial working platform for future study development, especially in adding more detailed and primary data, and improving the assumption that taken by this study. It is expected that this paper can provide an initial assessment framework for WWF field offices in Kalimantan and Sabah to identify the benefits and costs for every road development in HoB. The outline of this paper consists of the identification of HoB road policies and planning, impacted area identification, sustainable impact assessment, and recommendation.

3. IDENTIFICATION OF POTENTIAL NATIONAL ROAD DEVELOPMENT WITHIN HOB

3.1 INDONESIA

Based on the Government Regulation concerning the National Spatial Planning (PP 13/2017-RTRWN), the HoB area is defined by three-folded main functions, which are state-border security, nature conservation, and economic development. The state-border area lies on 1,038 km along from the west to east part, comprised of the area of Kabupaten Nunukan, Kabupaten Malinau, Kabupaten Kutai Barat dan Kabupaten Kapuas Hulu. The conservation management area consists of National Park of Betung Kerihun, Danau Sentarum, Bukit Baka-Bukit Raya, and Kayan Mentarang; Nature Conservation Tourism Park of Bukit Kelam Komplek and Sapat Hawung. The strategic economic development area consists of Watershed Kahayan-Kapuas-Barito and Kapuas Hulu region, including Putussibau as the regional growth center. Those national interests indicate the complexity to balance the economic, ecological, and national security development. It means that the infrastructure development would be allowed to serve those interests. In addition, the presence of custom society should also be considered as one of main target groups to be empowered through the road development.

In order to operationalize the PP 13/2017-RTRWN, the Ministry of Agrarian and Spatial Planning (MASP) prepared several detailed spatial policies. First, the Presidential Regulation (Perpres) No. 3/2012-RTR Kalimantan Island that emphasizes the presence of HoB as the core of the ecological corridor. The HoB protection is targeted as 45 percent of tropical rain forests protection in Kalimantan Island. Second, the Pepres 31/2015-RTR KSN Kalimantan that provides the spatial direction of the state-border area development in order to increase the level of security and prosperity of local people. Both planning creates the structure plan that defines the growth centers' location and a transportation system that serves those.

The growth centers consist of Pusat Kegiatan Wilayah (PKW) Sintang, PKW Malinau, PKW Putussibau, PKSN Nangga Badau, PKSN Long Midang, and PKSN Long Pahangai which are designated as industrial processing centers for oil palm and rubber plantations, forest product processing, ecotourism development and cultural tourism, and also various activities for a state border interest. For the transportation system, the primary collector road network from the west to the northeast Kalimantan that crosses the HoB area is defined to serve those centers, namely as diagonal road. The road serves as the national strategic infrastructure to improve accessibility of less developed area and the security services for the state-border area.

Following that, the Ministry of Public Works and Houses (MPWH) prepares an integrated infrastructure programming as drawn in the picture below. It stated that the connectivity among growth centers in the state-border area would be facilitated by several roads and other supported infrastructures development. The third, the draft of Pepres concerning the HoB area that has not been established to date. It is assumed that the road infrastructure development also followed the other spatial regulation (Pepres 31/2015 regarding National Strategic Area in Kalimantan).

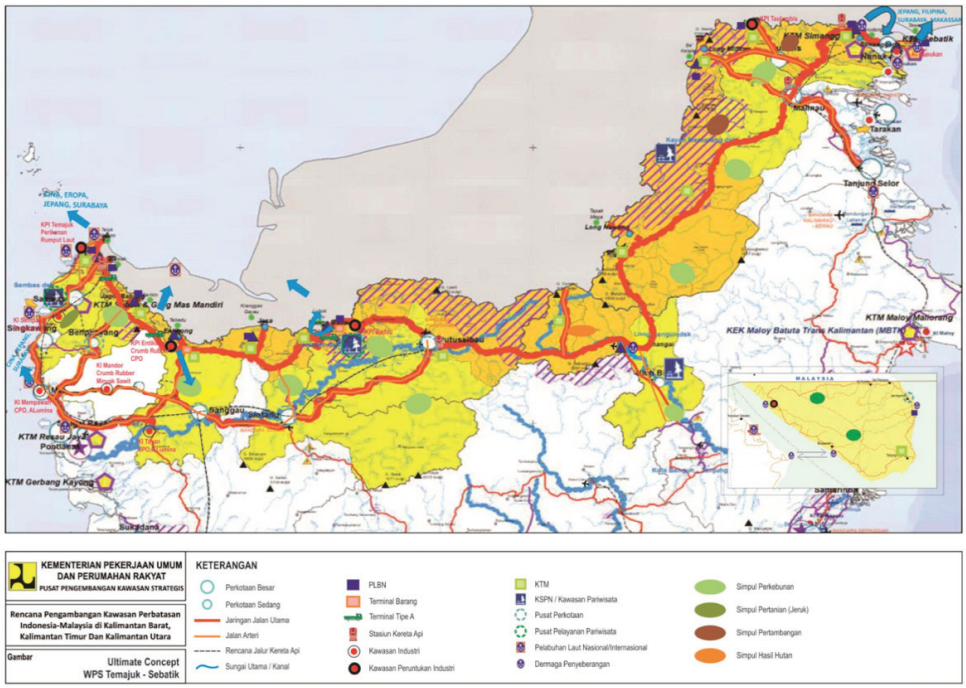


Figure 1 The infrastructure planning in HoB area

Source: Strategic Area Development Center, Ministry of Public Works and Public Housing

Based on the road policies above, it is clear that the diagonal road development will play significant role for future HoB development. As stated in the Table 1 below, only 2 (two) of 6 (six) main road segments have not been constructed yet are in the planning phase. One segment will have upgrading project.

Table 1 Road Status in HoB Kalimantan-Indonesia

ROAD SEGMENT	LENGTH (KM)	STATUS
Nangga Badau-Putussibau	160.52	Existing Primary Road
Sintang-Putussibau	270.78	Existing Primary Road
Putussibau-Long Pahangai	241.76	Half constructed, has FS, DED, and EIA documents
Long Pahangai-Long Nawang	189.40	Not yet, has FS, DED, and EIA documents
Long Nawang-Malinau	278.26	Not yet, has FS, DED, and EIA documents
Malinau-Long Midang	137.66	Existing local road, but planned to be upgraded, has FS, DED, and EIA documents
Grand Total	1,278.38	

Source: Analysis, 2019 GIS based on Ministry of Public Works and Public Housing, 2015

Based on the figure below, the road segments (red line) encounter the HoB area (purple polygon area). The planned road dominates the road networks. It is thus imperative to examine these major road segments that act as the backbone of state-border area development. The vision to connect border cities through road development will impact the HoB value. This road alignment will alter the landcover that crossed by the road, the side of the road, and the settlement or economic activities that connected by the road.

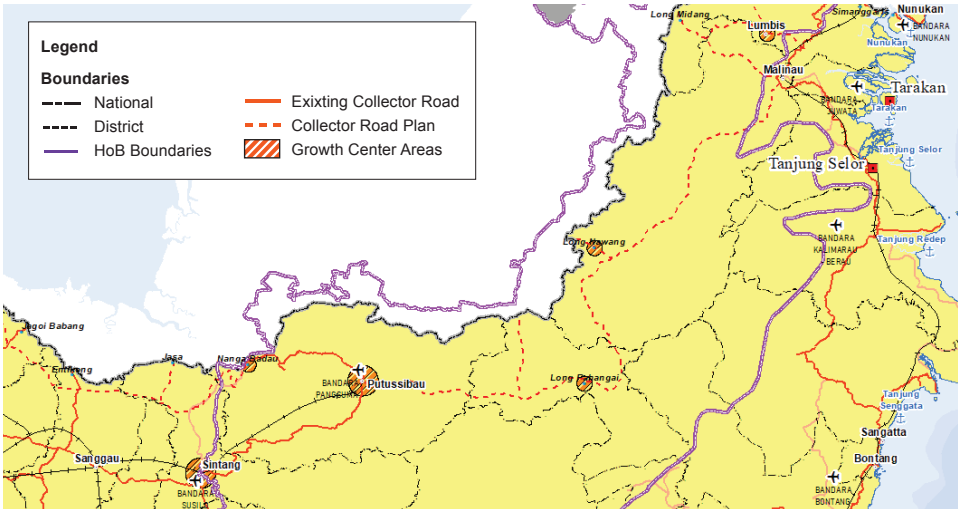


Figure 2 Infrastructure in HoB Kalimantan-Indonesia

Source: Analysis, 2019 GIS based on Ministry of Public Works and Public Housing, 2015

Although this study does not cover the road policies and planning at the province and district level, but it is important to put their spatial planning into the spotlight. Since the decentralization, the local regulation on spatial planning is also a key instrument that needs to ensure the HoB presence and its main function work properly. The massive local road projects are indicated to serve the economic development. In the West Kalimantan Province, the spatial plan tends to develop the resource-frontier regions for agriculture sectors. In the HoB area, the rehabilitation and protection of conservation area has been included, but still there are opportunities for limited timber industries and other agriculture activities. Given the critical land map from the Ministry of Forestry based on Technical Regulation No P. 4/V-SET/2013 regarding Spatial Data of critical land, the priority area in HoB is located in surrounding National Park Gunung Palung, Betung Kerihun, Danau Sentarum, and Gunung Niut Penrissen. For the state-border area that related to HoB area is the connectivity between Paloh-Jagoi Babang-Entikong-Sekayam-Badau-Putussibau. In the East, North, and Central Kalimantan Province, the conservation and ecosystem protection are the main policies for HoB area, including disaster risk mitigation, historical and cultural sites protection. But, it is still also opened for timber industries and agriculture land.

3.2 SABAH-MALAYSIA

The HoB area in Sabah covers almost all the central region of Sabah with an area of approximately 40,000 km2, which not only include the mainly Class II Forest Reserves and the protected areas, but also state lands and alienated lands. The Sabah Structure Plan 2033 [1] has mentioned the HoB area in the development strategy, which is to provide for a sustainable population growth to the north and interiors of Sabah. It states that strategic economic investment is needed to retain population growth and community vitality for both the northern and interior areas, such as developing the northern corridor's coastal tourism belt and the world-renowned forest reserve in the interior's Heart of Borneo.

1). The Sabah Structure Plan 2033 consists of development scenario and a combination of the existing and proposed development through six major components in the Proposal Map namely: (a) Major Land Uses; (b) Key Growth Centers; (c) Special Economic Zones; (d) Environmental Sensitive Areas; (e) Transportation/Connectivity; and (f) Infrastructures and Utilities.

The major land uses are forest, agriculture, rural/urban built up areas, wetlands and open water. By 2033, Forests in Sabah is planned as the largest land use with an area of 4,938,547.14 hectares or 66.71% of the State area. It is based on retaining all Permanent Forest Reserves, conservation of forest based on the Priority Conservation Areas (PCA) and coastal mangrove forest under the Shoreline Management Plan (SMP). The second largest one will be agriculture and rural covering 2,250,550.14 hectares (30.40%). The estimated area of major land uses as generated with supervised classification from Spot-5 satellite imagery of 10-meter resolution in the period of 2008-2012 is tabulated in table below.

Table 2 Current and projected land use coverage in Sabah

LAND USE	2010 AREA (ha)	%	PROJECTED 2033 AREA (ha)	%
Agriculture & Rural	2,038,035.01	27.53	2,250,550.14	30.40
Idle Land	267,507.70	3.61	173.1	0.00
Others	225,441.37	3.05		
Urban/ Built-up	171,928.05	2.32	181,021.17	2.44
Wetlands & open Water	56,299.82	0.76	32,378.51	0.44
Forest	4,643,458.12	62.73	4,938,547.14	66.71
	7,402,670.06*	**100.00**	**7,402,670.06**	**100.00**

Source: Sabah Structure Plan 2033

In contrast to Indonesia, the major roads in HoB are mostly developed, except several local roads Tongod-Semendapi, Tongod-Tambunan, Tulid-Tambunan, Sipitang-Long Pasir, and Merotai-Kunak. In this study, the examined road segments cover the Kalabakan-Nabawan (but only the segment that crossed the HoB area), Keningau-Tambunan, Nabawan-Keningau, Ranau-Telupid, Tambunan-Ranau, and Tenom-Kaningau (see table 3 below).

Table 3 Road Status in HoB Sabah-Malaysia

ROAD SEGMENT	LENGTH (KM)	STATUS
(Kalabakan)-Nabawan	171.51*	Existing Road
Keningau - Tambunan	51.18	Existing Road
Nabawan - Keningau	56.96	Existing Road
Ranau - Telupid	93.02	Existing Road to be Upgraded
Tambunan - Ranau	61.91	Existing Road
Tenom - Keningau	43.24	Existing Road
Grand Total	477,81	

Note: *) only that crosses HoB area, Source: Sabah Structure Plan 2033

Major road proposals that relate to HoB include upgrading the primary roads to highway status for the Sipitang-Kudat, Kota Kinabalu-Sandakan-Tawau and Papar-Keningau-Tawau routes. The construction of new primary roads proposed under the HNDP [2], covers Tongod-Sook, Tongod-Sapulut, Sapulut-Kemabong, Sukau

2). According to SSP 2033, there are the blueprint about road plans called Highway National Development Plan (HNDP) represents the highway network planning throughout Malaysia. Developed by the Highway Planning Division, Ministry of Works Malaysia in 1993, the objective is to formulate a Highway Network Master Plan to serve the economy as articulated in the national planning policies. HNDP has since then been reviewed in 2003 for Peninsular Malaysia and 2008 for Sabah and Sarawak (HNDP2).

Tambisan, Ranau-Paitan via Abuan Agropolitan and Kunak-Kalabakan. A major rebuilding of railway linkages is also proposed by introducing the implementation phase of a west-east coast railway service. It includes the construction of new railway tracks from Keningau-Tongod-Sandakan-Lahad Datu-Tawau, Kota Kinabalu-Kudat and Beaufort-Menumbok. Another possible linkage is the Nabawan-Tawau route.

Figure 3 Road network plan for Sabah under HNDP2

Source: Sabah Structure Plan 2033

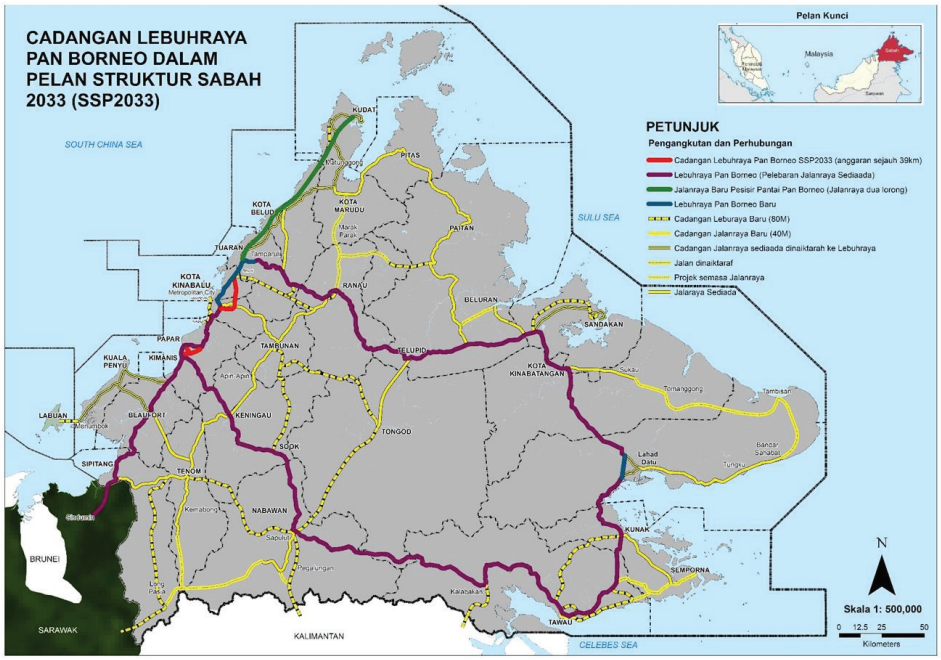


Figure 4 Proposed route for Pan Borneo Highway in SSP2033

Source: Sabah Structure Plan 2033

4. IDENTIFYING THE ROAD IMPACTED AREA

4.1 METHODOLOGY

Based on road segments identification above, we identified the main road that has a function as the backbone of interconnecting road centers within and outside of HoB. Following that, we divided the impacted area into three parts:

i. The total area of HoB as a future indirect impacted area since the road is the backbone;

ii. The development area of the growth centers that connected by the road network whose perimeter assumed for about 15 km radius as an indirect impacted area;

iii. The corridor area alongside the road that its width assumed 1-km distance as a direct impacted area.

> "It thus requires a zoning regulation to the area of the centers that connected by the road network.

Kriswardhana et al., (2017) found the increasing economic value of land due to toll road development, especially in the exit toll. It thus requires a zoning regulation to the area of the centers that connected by the road network. The delineation of 15-km radius of regional growth center area is assumed as a maximum distance of logistic services within the urban center. It would take approximately 15 minutes to serve the main various economic activities within the center area. However, for local center, the distance only serves a half of radius of the regional growth center because it has less variety than the regional ones. Using this delineation will also provide the focus area of advocacy because the level of road occupancy will be affected by the size of growth center. If we can control the expansion of growth center area to avoid the biodiversity spots, it would reduce the potential risks of road projects.

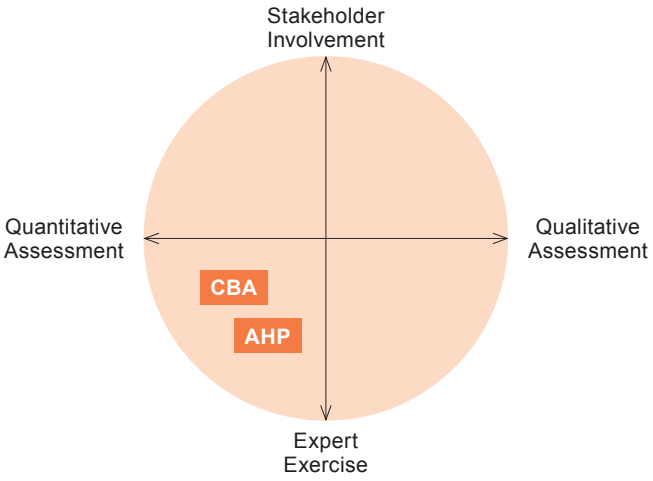
The 1-km road corridor area is assumed as the most probable area that is going to experience land use changes due to the road line. 500 meters for each is a maximum distance that an economic activity take the road as an entrance or exit of their land parcels. More than 500 meters, it is usually served by another supporting roads, not the main road. Therefore, if we can control the utilization of the 1-km road corridors we can minimize the potential risks, manage the proposed local roads to connect, and prevent the massive land use changes in the hotspot area.

Considering the limited available time and resources, the study only applied a quantitative approach and expert choices involvement to assess the impact value of road development in HoB area. Having had the identified road corridors and the growth centers, the first step is to conduct spatial analysis using GIS software. This step is to identify the characteristic of existing and planned road network that would be used for impact assessment. The delineation of the impacted area either direct or indirect impacts would be characterized by such as the land use, potential impacted habitats, economic concession, potential carbon stocks, and water catchment. The total area of impacted area will be used as the basis for the economic valuation.

According to Boardman (2015) there are a method to make better-informed, more consistent public policy decisions like Cost-Benefit Analysis (CBA). CBA is a method for assessing the economic efficiency of proposed policies or programs through the systematic prediction and valuation (i.e., monetization) of all costs and benefits to all members of society (see also Mishan and Quah, 2007). The concepts of 'willingness to pay' and 'opportunity cost' guide the valuation of social benefits and social costs. Future benefits and costs are discounted at the social discount rate. Kriström (2011)

applied the CBA to assess the economy of forestry. On this assessment, The Cost-Benefit Analysis (CBA) is used to compare the cost and benefits of road development. Each component for costs and benefits would be identified and monetized by the economic measures. Benchmarking studies are used to monetize both components, followed by standardization process for the economic value and time line. The road development is considered feasible if the benefits value is higher than the total costs.

Figure 5 The methods of impact value assessment



In addition, there is also a method which is a prominent and powerful tool for making decisions in situations involving multiple objectives, The Analytic Hierarchy Process (AHP). Saaty and Vargas (2012) applies the AHP in order to solve problems focused on the following three themes: economics, the social sciences, and the linking of measurement with human values. Yasin (2009) argue that the AHP is useful in identifying the significance of the impact of climate change to the ecohydrology. At the micro level, AHP can also be applied for conducting environmental impact assessment (Ramanathan, 2001). The stepwise to conduct AHP is following: (i) define the main purpose and its alternative strategies, (ii) establish the criteria that derived from the main purpose followed by the hierarchical indicators, (iii) add the weight for each criteria and indicators, (iv) compare and rank those alternative strategies, and (v) calculate the consistency through sensitivity analysis. See the questionnaires in the annex.

On this assessment, the AHP is carried out to define the priority of road development strategies to achieve the objectives based on agreed criteria from the expert choices. Since the distribution of questionnaires only for the Indonesian experts, this result will only be applied for Indonesian case. The experts are the practitioners that have experiences in implementing road construction, conservation management, and regional development. The result of AHP would be quantitatively assessed to obtain the consistent and valid conclusion.

4.2 INDONESIA

4.2.1 HoB Area in Kalimantan

Based on Ministry of Environment and Forestry (MOEF) (2017), the total HoB area within Indonesia jurisdiction is about 16.85 million ha. The large proportion is the protected and conservation forest for about 83 percent, followed by mixed-agriculture land for about 8.5 percent or 1.5 million ha. For the future land use, based on the draft of HoB spatial planning, by 2035 the total conservation area is still preserved is approximately 43.8 percent or 7.3 million ha through protected forest (3.08 million

> Based on Ministry of Environment and Forestry (MOEF) (2017), the total HoB area within Indonesia jurisdiction is about 16.85 million ha.

ha), ecosystem corridor (1.13 million ha), national and conservation park (2.57 million ha), and peatland (0.56 million ha). The second main function is the production forest for about 42.2 percent of 7.06 million ha. Also, allocation for other land use will be increased for about 1.6 million ha or 9.66 percent. Both increasing productive forests and other land use indicate the attempt to optimize the upcoming road development. Another interesting change through the spatial plan is the allocation for the settlement that reaches 71,8 thousand ha, including 166 ha within the ecosystem corridor. It thus requires detailed guideline for the human settlement development.

Although the conservation dominates the function (this covers only 43.8 percent), the draft of HoB spatial planning shows the extensive economy development. The production forests and agriculture land are apparently become the main growth engines. Based on the MoEF data (2014), the forest concession refers to Permenhut No. P.8/Menhut-II/2014 concerning limitation of area for forest utilization (IUPHHK) in Natural Forest, Industrial Forest, and Ecosystem Restoration. The total allocation for IUPHHK in natural forest is about 5.3 million ha, industrial forest for about 0.42 million ha, and Palm Oil for about 1.1 million ha. With that scale of development, it is predicted the timber industries will boost the regional economy. It is thus important to have ecosystem services balance to ensure the potential losses of ecological value is minimized.

Draw on the land use pattern, we can estimate the potential of carbon stock in the HoB area based on the mineral content and peatland, if applicable. The sum of both is an estimated above carbon stock. Total carbon stock in HoB area is estimated by 3.2 gigaton carbon equivalent. The preservation of HoB carbon stock certainly has significant ecological and economic value.

Beside of carbon stocks, the biodiversity is the most non-economic value that potentially impacted by the road development. Based on WWF Indonesia (2016), the dominant habitats are Orang Utan for about 25.11 percent or 2.1 million ha, Rhinos and Orang Utan (22.78 percent), and Rhinos (13.30 percent). For the vegetation, the flora fagaceae for about 0.69 million ha or 8.24 percent and Diptero for about 2.16 percent dominate the HoB area. Although, there are no information regarding the economic value of those habitats, they certainly pose intangible values.

4.2.2 Growth Centre Area

> 6 (six) urban areas that have potentiality to become the growth centers. Sintang and Putussibau are planned for the regional growth center.

Road network serves people and goods mobilities from one point to another. It is hence important to identify the potential or existing centers that connected by the backbone. It is assumed that the regional growth center will continuously grow and expand in the maximum 15-km radius. The 15 km is an average distance for internal urban logistic services coverage. While the development area for local center will require a half of the regional center area. Based on the spatial planning policies, we identified 6 (six) urban areas that have potentiality to become the growth centers as seen in the figure 3 below. Sintang and Putussibau are planned for the regional growth center. The area of growth center takes around 70.69 thousand ha, but since only in the east part of Sintang that included in HoB area, the growth center area of Sintang only takes 19.96 ha. The local centers cover Nanga Badau, Lumbis, Long Pahangai, and Long Nawang. Those centers will require maximum radius 7.5 km so the development area is estimated reach 17.67 thousand ha for each of them. Besides 4 (four) local centers, there is also Long Midang that has a main function to serve the villages and its surrounding settlements. However, since the location is in the National Park, it must require specific zoning regulation than the others.

> The local centers cover Nanga Badau, Lumbis, Long Pahangai, and Long Nawang. Long Midang that has a main function to serve the villages and its surrounding settlements.

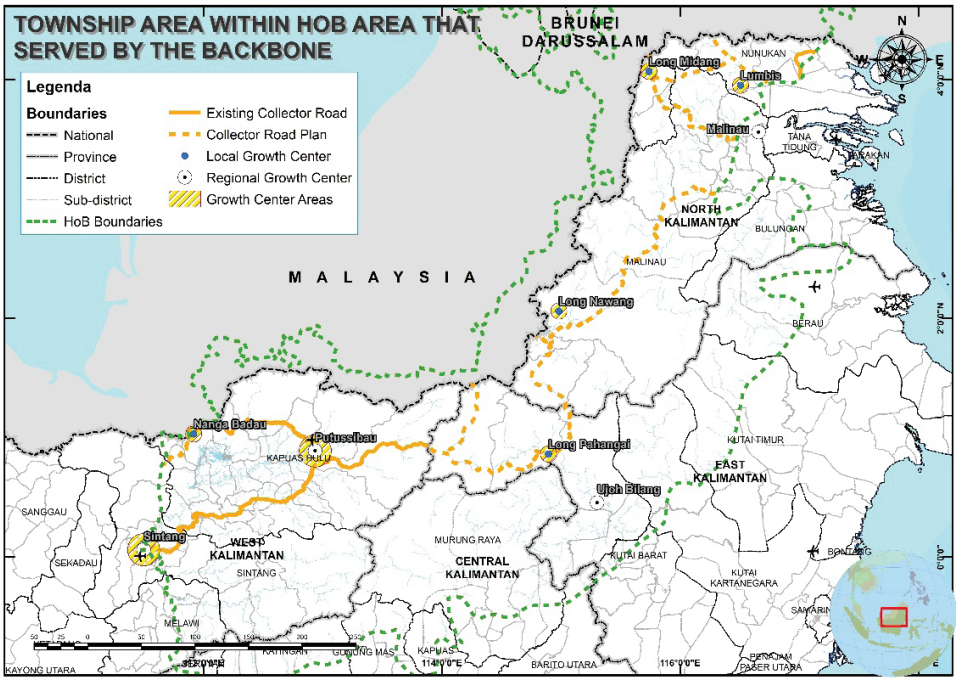


Figure 6 Township area within HoB area that served by the backbone

Source: Spatial analytical process, 2019

> Long Nawang, Long Pahangai, and Lumbis would be developed as Agropolitan area

Having had the delineated area, the existing composition of land use in the respective area is used to identify the activities that impacted by the road development. In general, the area of growth centers that is still dominated by Forest, i.e. Long Nawang, Long Pahangai, and Lumbis would be developed as Agropolitan area, referring to the draft of HoB Spatial Plan. In Nanga Badau and Sintang, the existing land use dominated Agriculture would also be developed as agriculture-based township. The interesting part is Putussibau. The future allocation of peatland reaches 59.39 percent of its area development. The dominance of peatland will raise the question on how the centers can utilize the peat resources as an engine of growth without converting or losing them.

Table 4 The existing and planned land use in HoB area

No	Growth centers	Existing land use	Area (ha)	%	Land Use plan	Area (ha)	%
1	Long Nawan	Water Bodies	21.14	0.12	National Park	2,862.72	16.22
		Bush	20.58	0.12	Productive Forest	6,540.03	37.05
		Primary Dryland Forest	17,617.92	99.69	Agriculture	8,247.26	46.73
		Built-up area	11,34	0.07			

No	Growth centers	Existing land use	Area (ha)	%	Land Use plan	Area (ha)	%
2	Long Pahangai	Water Bodies	92.18	0.52	Protected Forest	1,619.16	9.21
		Bush	215.41	1.22	Productive Forest	14,222.39	80.91
		Primary Dryland Forest	485.62	2.75	Agriculture	1,737.42	9.88
		Secondary Dryland Forest	16,871.29	95.74			
		Mixed Agriculture	6.65	0.04			
		Long Pahangai Total	17,671.15	100.00		17,578.97	100.00
3	Lumbis	Water Bodies	131.90	0.75	Protected Forest	2,542.37	14.57
		Primary Dryland Forest	6,843.66	36.69	Productive Forest	9,912.20	56.81
		Secondary Dryland Forest	9,942.24	56.26	Rural Settlement	193.12	1.11
		Built-up area	42,97	0.24	Agriculture	4,699.43	27.51
		Mixed Agriculture	1,070.38	6.06			
		Lumbis Total	17,671.15	100		17,447.12	100
4	Nanga Badau	Bush	11.16	0.08	Peatland	2,921.60	19.55
		Secondary Dryland Forest	766.64	5.18	Productive Forest	458.20	3.07
		Secondary Swamp Forest	525.14	3.55	Rural Settlement	173.68	1.16
		Built-up area	61.83	0.42	Agriculture	11,390.49	76.22
		Plantation	4,078.88	27.54			
		Mixed Agriculture	8,892.30	60.04			
		Open land	473.72	3.,20			
		Nanga Badau Total	14,809.68	100.00		14,943.98	100.00

> The dominance of peatland will raise the question on how the centers can utilize the peat resources as an engine of growth without converting or losing them.

No	Growth centers	Existing land use	Area (ha)	%	Land Use plan	Area (ha)	%
5	Putussibau	Water Bodies	1,674.00	2.37	Peatland	41,031.47	59.39
		Infrastructures	34.45	0.05	Productive Forest	6,017.76	8.71
		Bush	1,298.09	1.84	Rural Settlement	308.65	0.45
		Swamp bush	2,146.89	3.04	Urban Settlement	3,312.57	4.79
		Secondary dryland forest	3,761.47	5.32	Agriculture	18,422.18	26.66
		Primary swamp forest	3,954.24	5.59			
		Secondary swamp forest	21,385.74	30.25			
		Built-up area	1,023.01	1.45			
		Plantation	4,002.79	5.66			
		Mixed Agriculture	31,346.71	44.35			
		Open land	57.81	0.08			
		Putussibau Total	70,685	100.00		69,092.63	100.00
6	Sintang	Water Bodies	970.33	4.64	Peatland	3,339.36	16.73
		Bush	338.80	1.62	Natural Tourism Park	38.18	0.19
		Swamp bush	2,572.40	12.29	Agriculture	16,580.31	83.08
		Secondary dryland forest	46.24	0.22			
		Secondary swamp forest	1,149.70	5.49			
		Built-up area	724.39	3.46			
		Plantation	4,820.92	23.04			
		Mining	955.09	4.56			
		Mixed Agriculture	8,172.93	39.06			
		Open land	1,172.70	5.60			
		Sintang Total	20,923.49	100.00		20,923.49	100.00

Source: Analysis, 2019; modified from KLHK data 2017

In line with the future land use pattern, the concession for economic investments in forestry should also be recognized as the key factor that impacted or benefits from the road development. Most of the centers, except Long Nawang, have Palm Oil concession. In Sintang, it will take 79.24 percent of total growth center area that located in the HoB area. In Nanga Badau, it takes 55.06 percent. The utilization of forest trees in natural forests is allocated in 53.13 percent of growth center area of Long Pahangai and 64.53 percent in Lumbis. Those concessions indicate the economic development vision for the growth centers in HoB area.

> “The largest habitats take a place in Long Pahangai for Orang Utan for about 15,25 thousand ha and for Fagaceae in Long Nawang for about 14,5 thousand ha. In Putussibau, the habitat for Orang Utan take a large portion for about 11,70 thousand ha. Also, 884 ha in Nanga Badau for Orang Utan. In addition, the smaller portion of habitat for Proboscis that only takes 294.5 ha in Sintang and 78.9 ha in Putussibau.

Table 5 Productive Forest concession in HoB Indonesia

Growth Centers	Type of forest concession	Area (Ha)	% of growth center area
Long Pahangai	Natural Forest	9,339.48	53.13
	Palm Oil	1,813.60	10.31
Lumbis	Natural Forest	11,258.04	64.53
	Palm Oil	3,868.82	22.17
Nanga Badau	Palm Oil	8,227.66	55.06
Putussibau	Natural Forest	7.524,32	10.89
	Industrial Forest	7.746,72	11.21
	Palm Oil	7.271,24	10.52
Sintang	Palm Oil	15.814,88	79.24

Source: Analysis, 2019 GIS based on MoEF data, 2017

However, the growth center areas are also the places for several habitats of key species. The largest habitats take a place in Long Pahangai for Orang Utan for about 15,25 thousand ha and for Fagaceae in Long Nawang for about 14,5 thousand ha. In Putussibau, the habitat for Orang Utan take a large portion for about 11,70 thousand ha. Also, 884 ha in Nanga Badau for Orang Utan. In addition, the smaller portion of habitat for Proboscis that only takes 294.5 ha in Sintang and 78.9 ha in Putussibau. The presence of those habitats in the growth center area obviously requires highly sensitive biodiversity intervention. In addition, the largest potential carbon stock based on existing land use is located in Putussibau for about 14 million tons Carbon and the smallest is in Sintang for about 1.7 million tons Carbon. The other centers mostly have the same value around 3 (three) million tons carbon equivalent. Therefore, the valuation of ecosystem services is an initial key reference for preparing detailed spatial planning of these growth center area. The plan should develop the centers with the design principle of urban nature.

4.2.3 Road Corridors

Although there are numerous national roads that planned for HoB, we focus on the 6 (six) major roads as the backbone for the region with the total length is around 1,278 km. The following road segments are Nanga Badau- Putussibau 160.52 km, Sintang-Putussibau 270.78 km, Putussibau-Long Pahangai 241.76 km, Long Pahangai-Long Nawang 189.4 km, Long Nawang-Malinau 278.26 km, and Malinau-Long Midang 137.66 km. The road status is different for each segment. Most of the segments had the Feasibility Studies (FS), Detailed Engineering Design (DED), and Environmental Impact Assessment (EIA), except Nanga Badau-Putussibau and Sintang Putussibau because the road is operated already. Only 165-km Long Nawang-Malinau corridor is still under construction, and it remains for 113 km more. The other road segments are not completed yet. Assuming the width of road corridor is not exceeded for 1 km for each side of the road, we can identify the existing and planned land use within the corridor and figure out what kind of concessions, habitats, and potential carbons that will receive the road impacts.

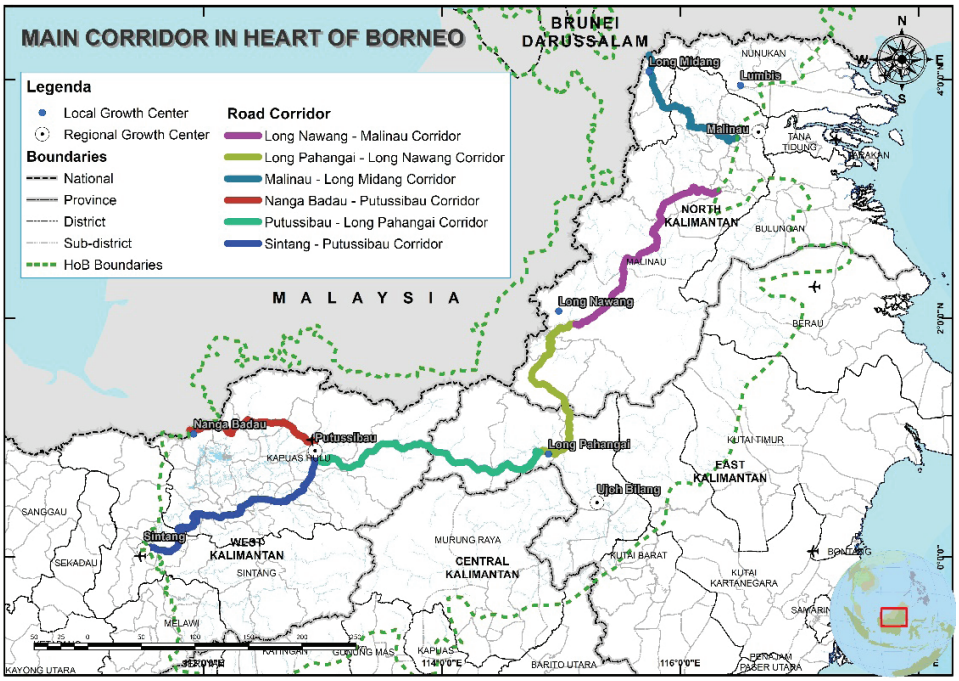


Figure 7 Main Corridor in HoB

Source: Analysis, 2019

A. Nanga Badau-Putussibau Corridor

In Nanga Badau-Putussibau corridor, the road has been operated for years although in some parts are still bad condition. The existing land use pattern is more variative, but dominant for agriculture purpose for about 73 percent. The future land use plan is also dominated by agriculture for about 50 percent.

Table 6 The existing and planned land use in Nangga Badau-Putussibau Corridors

Road Corridor	Existing Land Use	Area (Ha)	%	Planned Land Use	Area (Ha)	%
Nanga Badau-Putussibau	Water bodies	15.93	0.10	Peatland	3,154.51	19.87
	Bush	861.46	5.42	Protected Forest	1,088.95	6.86
	Swamp Bush	309.85	1.95	Protected Forest-Ecosystem Corridor	361.28	2.28
	Secondary dryland Forest	936.68	5.90	Productive Forest	1,619.24	10.20
	Primary Swamp forest	211.86	1.33	Productive Forest-Ecosystem Corridor	123.65	0.78
	Secondary Swamp Forest	1,560.80	9.82	Rural Settlement	284.89	1.79
	Built up area	69.82	0.44	Rural Settlement -Ecosystem Corridor	128.66	0.81

Road Corridor	Existing Land Use	Area (Ha)	%	Planned Land Use	Area (Ha)	%
	Plantation	25.69	0.16	Urban Settlement	2.11	0.01
	Mixed Agriculture	11,630.24	73.20	Agriculture	7,844.23	49.42
	Swamp	6.12	0.04	Agriculture-Ecosystem Corridor	1,264.90	7.97
	Open land	259.89	1.64			
Total Nanga Badau-Putussibau		**15,888.35**	**100**		**15,872.42**	**100.00**

Source: Analysis, 2019 based on MoEF data 2017

In the correlation with economic concession, the land for productive purposes are estimated for about 3,239 ha, while concessions for Palm Oil for about 2,715 ha. The habitats in this corridor consist of Orang Utan for about 2,063.49 ha. The carbon stock in this corridor is estimated around 1.4 million tons that consists of mineral carbon for about 746,942.17 tons and peatland for about 663,039.81 tons.

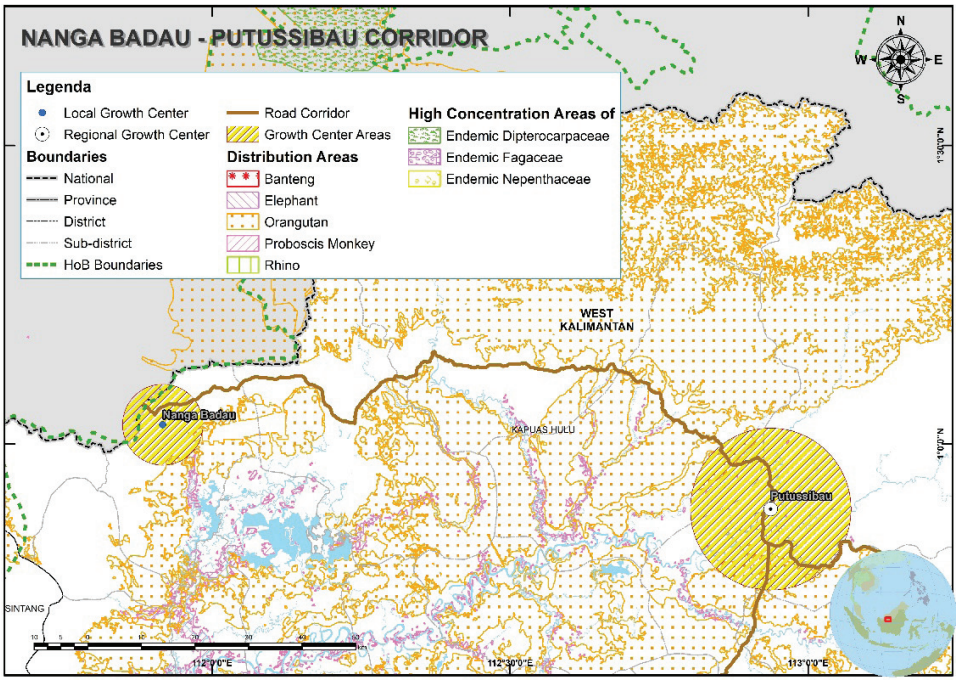


Figure 8 Habitats in Nanga Badau-Putussibau Corridor

Source: Analysis, 2019

B. Sintang-Putussibau Corridor

The same with previous corridor, this road has also served the mobilities of economic and people flow for many years. Therefore, the land use pattern in this corridor is also variative, but dominant for agriculture for about 83 percent. The future land use plan is also allocated for agriculture for about 69 percent. The proportion is lowered since the allocation for settlement and productive forests is increased. It is also interesting in this corridor, the urban settlement is also allocated, although in small portion.

Table 7 The existing and planned land use in Sintang-Putussibau Corridors

Road Corridor	Existing Land Use	Area (Ha)	%	Planned Land Use	Area (Ha)	%
Sintang-Putussibau	Water bodies	350,66	0.30	Peatland	2,134.23	8.00
	Infrastructures	35,10	0.02	Protected Forest	1,237.43	4.64
	Bush	1043,29	1.30	Natural Tourism Park	79.75	0.30
	Swamp Bush	1321,58	2.85	Productive Forest	3,045.97	11.42
	Secondary dryland Forest	996,59	1.47	Rural Settlement	901.70	3.38
	Secondary Swamp Forest	1311,99	1.48	Urban Settlement	781.20	2.93
	Built up area	1721,57	4.07	Agriculture	18,845.70	69.32
	Plantation	2276,18	3.68			
	Mining	803,89	1.77			
	Mixed Agriculture	42769,09	82.90			
	Open Land	224,05	0.15			
Total Sintang-Putussibau		**26,745.41**	**100.00**		**26,665.98**	**100.00**

Source: Analysis, 2019 based on MoEF data 2017

In the correlation with economic concession, this corridor is dominated by the concessions of Palm Oil for about 7,533 ha. The other concession is the land for productive purposes are estimated for about 826 ha. The habitats in this corridor consist of Orang Utan for about 336.59 ha. The carbon stock in this corridor is estimated at 1.18 million tons, consisting of carbon stocks in the mineral field for about 603,244.23 tons and 577,220.80 tons on peatlands.

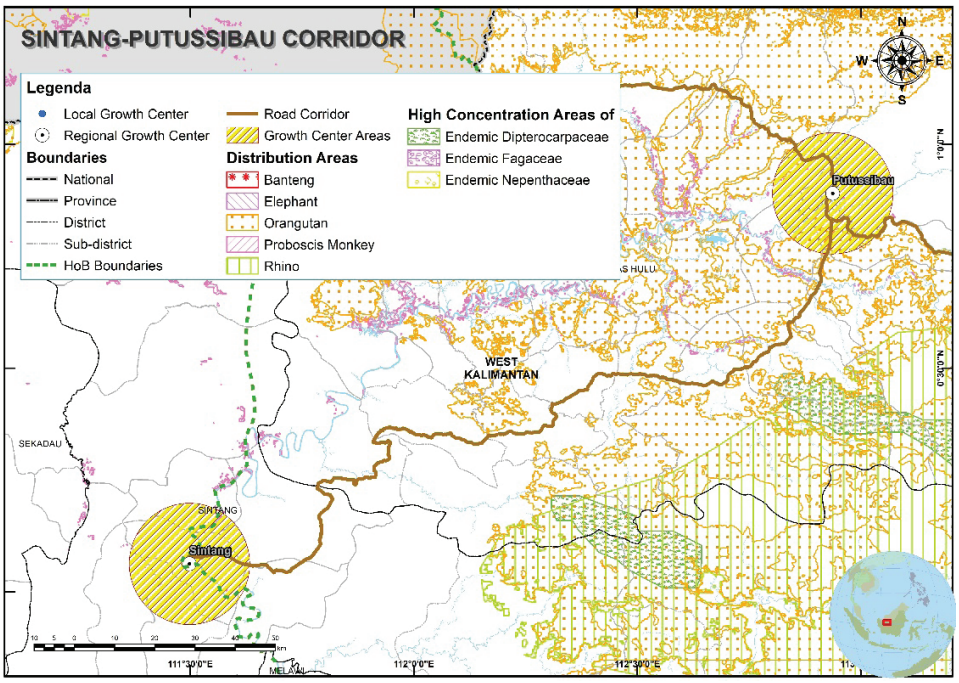


Figure 9 Habitats in Putussibau-Long Pahangai Corridor

Source: Analysis, 2019

C. Putussibau-Long Pahangai Corridor

The road network in this corridor is still progressing, only half of the total length of the road that has been constructed. The land use pattern is still dominated by primary and secondary dry land forest for about 79 percent. But, the future land use plan is designed for agriculture for about 36 percent, and protected forest for about 34 percent. It is also interesting in this corridor, the urban settlement is also allocated, although in small portion. However, in general, the agriculture-based and timber industries are estimated to occupy the road corridors.

Table 8 The existing and planned land use in Putussibau-Long Pahangai Corridors

Road Corridor	Existing Land Use	Area (Ha)	%	Planned Land Use	Area (Ha)	%
Putussibau-Long Pahangai	Water bodies	346.88	1.44	Peatland	683.62	2.87
	Bush	1,823.68	7.55	Protected Forest	8,079.45	33.92
	Swamp Bush	0.07	0.00	Protected Forest-Ecosystem Corridor	584.35	2.45
	Primary dryland Forest	9,9962.37	41.24	National Park	2,964.35	12.45
	Secondary dryland Forest	9,359.24	38.74	Productive Forest	2,776.59	11.66
	Primary Swamp forest	170.25	0.70	Rural Settlement	82.72	0.35
	Secondary Swamp Forest	529.14	2.19	Urban Settlement	20.22	0.08
	Mixed Agriculture	1,936.17	8.01	Agriculture	8,625.48	36.22
	Open land	31.66	0.13			
Total Putussibau-Long Pahangai		**24,159.47**	**100.00**		**23,816.78**	**100.00**

Source: Analysis, 2019 based on MoEF data 2017

In the correlation with economic concession, the land for productive purposes are estimated for about 1,905 ha, while concessions for Palm Oil in this corridor for about 5,232 ha. In addition, the land allocation for Industrial forestry is also available in Putussibau-Long Pahangai for 1,480 ha. The habitats in this corridor consist of Orang Utan for about 11.358,83 ha, bull about 3.014,02 ha, and also small portion of Proboscis for about 7 ha. The carbon stock in this corridor is estimated for about 4.37 million tons consisting of carbon stocks in the mineral field for about 4.1 million tons and peatlands for about 0.27 million tons.

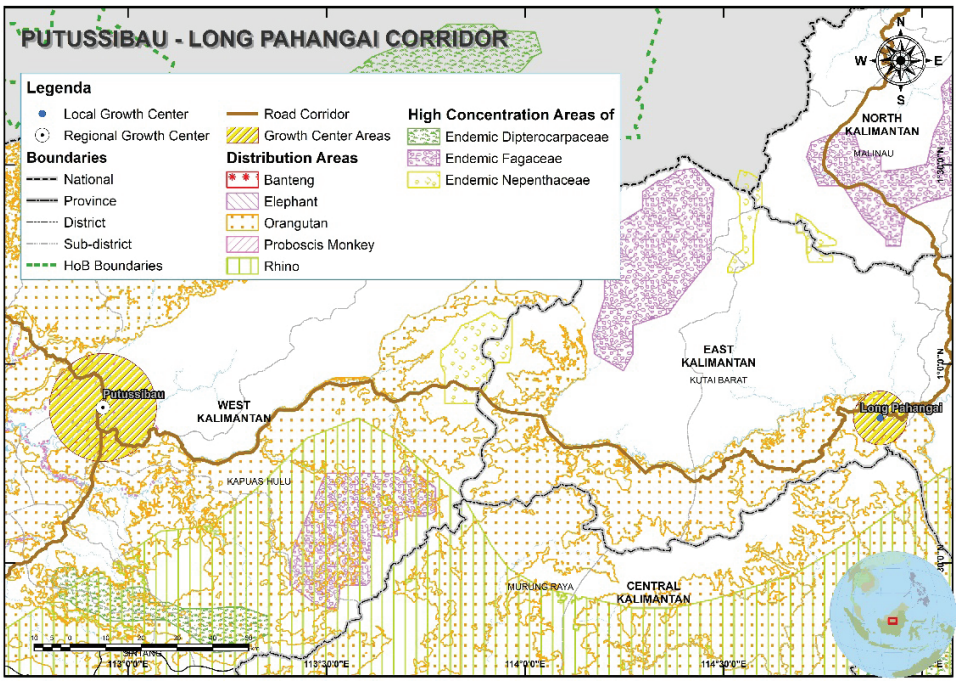


Figure 10 Habitats in Putussibau-Long Pahangai Corridor

Source: Analysis, 2019

D. Long Pahangai-Long Nawang Corridor

In this corridor, the land use pattern is dominated by the primary and secondary dryland forest area for about 88 percent in total. It means that no massive economic activities have been occurred for a while. However, the future spatial plan provides a direction to increase the productive forest area around 58.30 percent, followed by agriculture for about 20 percent. In term of economic activities, the land for productive purposes are estimated for about 9,292 ha and the concessions for Palm Oil plantation is around 1,360 ha in this corridor.

Table 9 The existing and planned land use in Long Pahangai-Long Nawang Corridors

Road Corridor	Existing Land Use	Area (Ha)	%	Planned Land Use	Area (Ha)	%
Long Pahangai-Long Nawang	Water bodies	68.53	0.36	Protected Forest	2,318.00	12.34
	Bush	886.77	4.70	Protected Forest-Ecosystem Corridor	937.53	4.99
	Primary dryland Forest	8,289.11	43.97	Productive Forest	10,953.57	58.30
	Secondary dryland forest	8,478.32	44.97	Productive Forest-Ecosystem Corridor	817.80	4.35
	Built up area	47.96	0.25	Rural Settlement	123.92	0.66
	Dryland Agriculture	489.71	2.60	Agriculture	3,639.79	19.36
	Mixed Agriculture	484.76	2.57	Agriculture-Ecosystem Corridor	0.11	0.00
	Open Land	106.25	0.56			
Total Long Pahangai-Long Nawang		**18,851.42**	**100.00**		**18,787.73**	**100.00**

Source: Analysis, 2019 based on MoEF data 2017

However, this corridor also poses the habitats of flora and fauna. The Fagaceae habitat is for about 1,142.47 ha, while habitats for the Orang Utan for about 1,018.58 ha. If we see the figure below, the potential of segmented habitat of Fagaceae is very high. In addition, the carbon stock in this corridor is estimated around 3.4 million tons and mostly from mineral carbon. It is only 36,515.30 tons carbon from the peatlands.

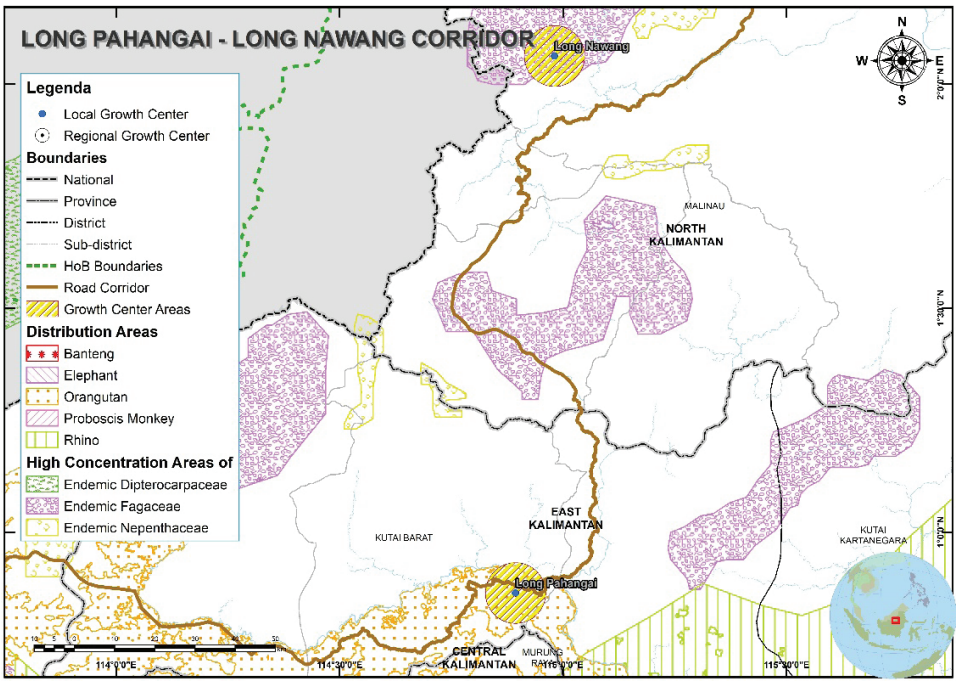


Figure 11 Habitats in Long Pahangai-Long Nawang Corridor
Source: Analysis, 2019

E. Long Nawang-Malinau Corridor

This corridor is currently dominated by the primary forest for almost 80 percent, while in the future, 50 percent of this corridor would be developed to be productive forests and for 13 percent for conservation area. In addition, there are 11.80 percent in the ecosystem corridor that is allocated to be productive forest.

Table 10 The existing and planned land use in Long Nawang-Malinau Corridors

Road Corridor	Existing Land Use	Area (Ha)	%	Planned Land Use	Area (Ha)	%
Long Nawang-Malinau	Water bodies	50.83	0.23	Protected Forest	235.85	1.18
	Bush	225.74	1.04	National Park	2,615.86	12.12
	Primary dryland Forest	17,288.02	79.92	Productive Forest	10,836.56	50.21
	Secondary dryland forest	2,110.96	9.76	Productive Forest-Ecosystem Corridor	2,546.23	11.80
	Built up area	17.41	0.08	Rural Settlement	12.59	0.06
	Dryland Agriculture	632.20	2.88	Agriculture	4,457.12	20.65

Road Corridor	Existing Land Use	Area (Ha)	%	Planned Land Use	Area (Ha)	%
	Mixed Agriculture	1,302.38	6.02	Agriculture-Ecosystem Corridor	859.42	3.98
	Open land	13.93	0.06			
Total Long Nawang-Malinau		**21,623.48**	**100.00**		**21,851.62**	**100.00**

Source: Analysis, 2019 based on MoEF data 2017

It has a strong correlation with the economy concession. Based on MOEF data (2017), the utilization of forest trees and other components in natural resources are quite high. In Long Nawang-Malinau corridor, the land for productive purposes are estimated for about 5,995 ha. On the other hand, those corridors also pose the habitats for flora and fauna. Diptero habitat is in Long Nawang-Malinau corridor for about 752 ha. In addition, the carbon stocks are about 4.37 million tons consisting of mineral carbon for about 4.3 million tons and only 33.7 thousand tons on peatlands.

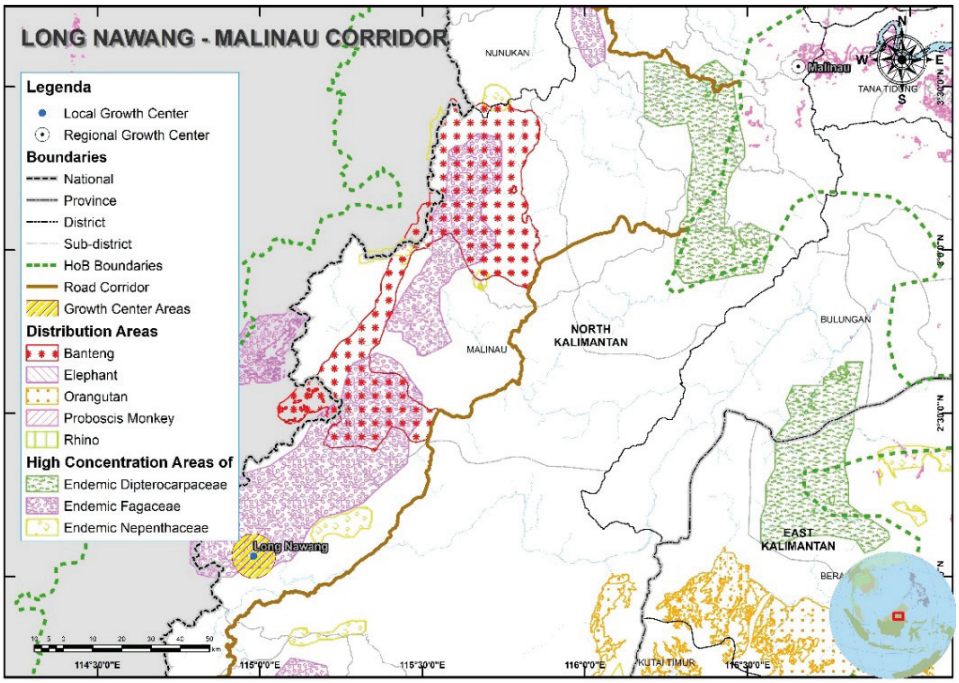


Figure 12 Habitats in Long Nawang-Malinau Corridor

Source: Analysis, 2019

F. Malinau-Long Midang Corridor

In this corridor, the primary dryland forest dominates the corridor area for about 83 percent. The future plan allocates the productive forest for about 34.08 percent, the largest portion is still for conservation and protected forests for about 56.7 percent. It means that the conservation still becomes the primary activities for the corridor area. Although, there are still forests that allocated for productive areas for about 4,000 ha.

Table 11 The existing and planned land use in Malinau-Long Midang Corridors

Road Corridor	Existing Land Use	Area (ha)	%	Planned Land Use	Area (ha)	%
Long Nawang-Malinau	Water bodies	50.83	0.23	Protected Forest	235.85	1.18
	Bush	225.74	1.04	National Park	2,615.86	12.12
	Primary dryland Forest	17,288.02	79.92	Productive Forest	10,836.56	50.21
	Secondary dryland forest	2,110.96	9.76	Productive Forest-Ecosystem Corridor	2,546.23	11.80
	Built up area	17.41	0.08	Rural Settlement	12.59	0.06
	Dryland Agriculture	632.20	2.88	Agriculture	4,457.12	20.65
	Mixed Agriculture	1,302.38	6.02	Agriculture-Ecosystem Corridor	859.42	3.98
	Open land	13.93	0.06			
Total Long Nawang-Malinau		**21,623.48**	**100.00**		**21,851.62**	**100.00**

Source: Analysis, 2019 based on MoEF data 2017

However, this corridor also poses the habitats of flora and fauna. Fagaceae habitat is for about 1,297.93 ha, while habitats for the orang utan for about 1.018,58 ha. Based on the figure below, the potential of segmented habitat is very high. Meanwhile, this corridor is also potential for carbon stock. It is estimated for about 2.6 million tons, mostly from mineral carbon, and only 3,415.51 tons from the peatlands.

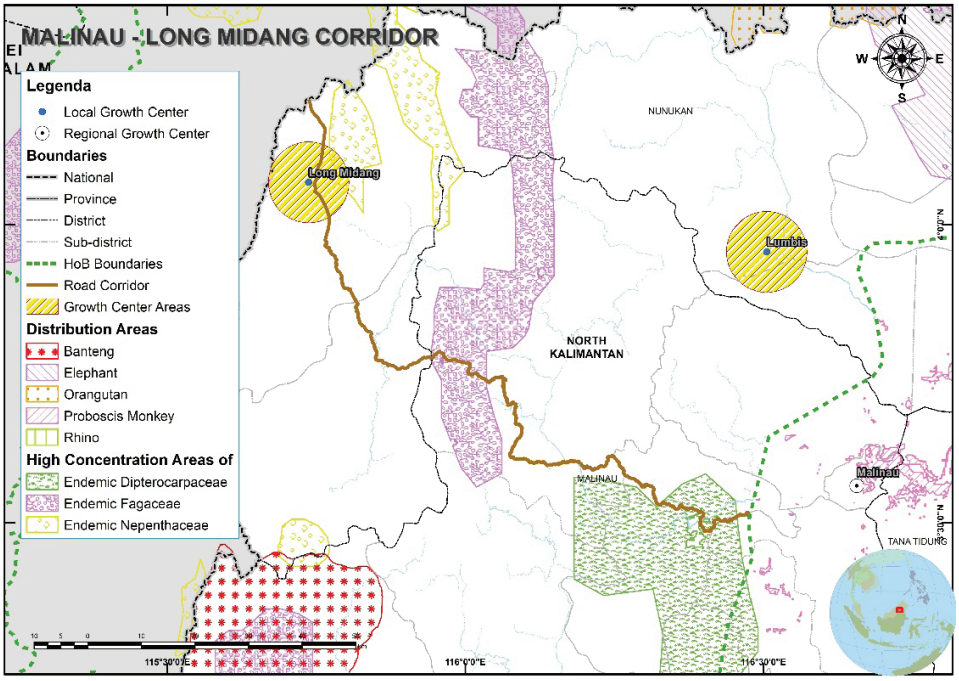


Figure 13 Habitats in Malinau-Long Midang Corridor

Source: Analysis, 2019

4.3 MALAYSIA (SABAH)

In the same vehicle with Indonesian case, identifying the impacted area in HoB Sabah also divided into three parts: the total area of HoB, the development area of the growth centers, and the road corridor.

4.3.1 HoB Area in Sabah

The land use pattern of HoB area in Sabah is dominated by forest for about 71.92 percent or 2.8 million ha, followed by logged forest 13.53 percent, and plantation for about 10.75 percent of total 3.96 million ha. While, the built-up area only covers 2.78 percent. Sabah Forest has a significant role as a water catchment for 15 watersheds, especially Kinabatangan (31.59%), Padas (23.16%), Sapulut (15.16%), and Labuk (12.07%). The Sabah forest also a home for various rare species, mainly Orang Utan for about 43.47 percent or 0.9 million ha and elephant+bull+orang utan for about 25.34 percent. In smaller proportion, the habitat for Bull, Proboscis, Diptero, Nephentes, and Fagaceae is also included in the HoB Sabah. Those means that the economic value of Sabah forest can be inferred at least as industrial and pharmacies resources, water container, and biodiversity spot.

Table 12 Land Use Pattern of HoB Sabah, Malaysia

LAND COVER	AREA (ha)	%
Built Up Area	109.841,89	2.78
Cleared Land	307,10	0.01
Cultivated Land	38.476,51	0.97
Forest	2.844.961,08	71.92
Logged Forest	535.183,13	13.53
Mangrove	1.619,11	0.04
Plantation	425.072,61	10.75
Total (Ha)	**3.955.461,43**	**100.00**

Source: WWF, 2017

4.3.2 Growth Center Area

Using the same assumption with the Indonesian growth center, it is identified 6 (six) major settlement area sthat connected by the major road network that examined in this study. They are Keningau, Nabawan, Ranau, Tambunan, Telupid, and Tenom. The largest town is Keningau. Therefore, we estimate the development area of Keningau is larger than the other five towns. The development area of Keningau is predicted to be 70.6 thousand ha, while the others are predicted to reach 17.6 thousand ha for each. As shown in the figure and table below, the area of each center would be delineated to estimate the maximum allocation for economic activities due to road impacts.

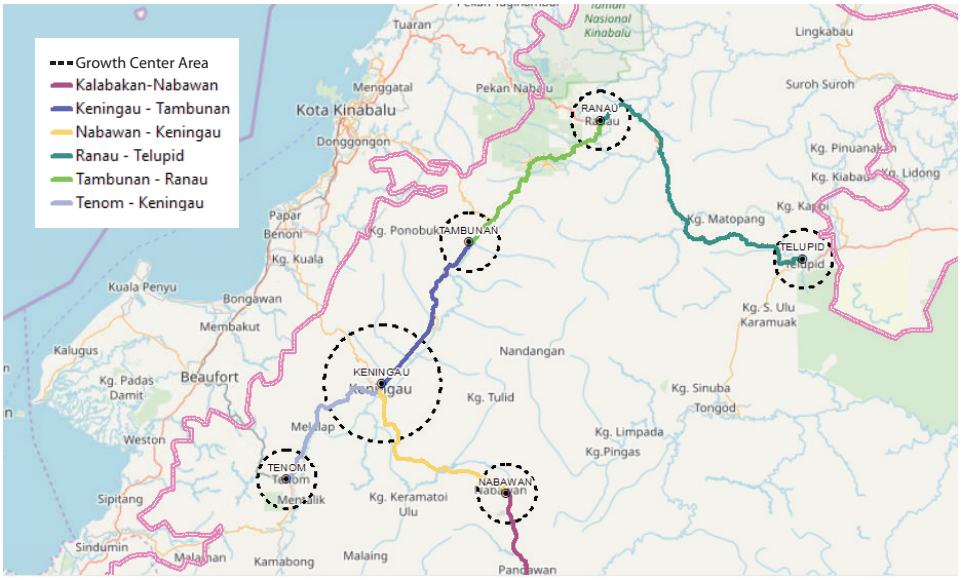


Figure 14 Sabah Growth centers in HoB

Source: Analysis, 2019

Based on the table below, the forest is still the dominant land use that potentially converted due to the road impacts. At the same time, for most of the towns, the forest is the habitat for fauna and flora, except for Ranau. It means that the area of urban economic growth that caused by the road should be anticipated to minimize the potential ecological losses.

Table 13 Land uses in HoB Sabah, Malaysia

Growth center	Land Cover	Area (ha)	%	Habitat	Area (ha)
Keningau	Built Up Area	26,881.32	38.07	Fauna:Orang Utan	15.331,86
	Cultivated Land	4,585.95	6.49	Flora:Fagaceae; Fauna:Orang Utan	50,44
	Forest	**33,339.32**	**47.21**		
	Logged Forest	2,641.92	3.74		
	Plantation	3,164.91	4.48		
	Total Keningau	70,613.41	100.00		
Nabawan	Built Up Area	2,328.06	13.19	Fauna:Orang Utan	4,138.23
	Forest	**7,871.98**	**44.59**		
	Logged Forest	4,642.94	26.30		
	Plantation	2,812.88	15.93		
	Total Polar	17,655.86	100.00		
Ranau	**Built Up Area**	**11,912.38**	**67.47**	-	-
	Forest	4,919.87	27.87		
	Plantation	822.57	4.66		
	Total Ranau	17,654.82	100.00		

Growth center	Land Cover	Area (ha)	%	Habitat	Area (ha)
Tambunan	Built Up Area	6.941,76	21.18	Fauna:Orang Utan	1,519.27
	Forest	**60.410,25**	**78.05**	Flora:Fagaceae	130.55
	Plantation	1.650,71	0.77	Flora:Fagaceae;	
	Fauna:Orang Utan	37.01			
				Flora:Nephentes	2.44
				Flora:Nephentes+Fagaceae	148.24
	Total Tambunan	17,656.41	100.00		
Telupid	**Forest**	**9,942.15**	**56.34**	Fauna:Banteng	111.20
	Logged Forest	114.92	0.65	Fauna:Banteng+Orang Utan	6,465.58
	Plantation	7,591.13	43.01	Fauna:Orang Utan	2,117.78
	Total Telupid	17,648.21	100.00		
Tenom	Built Up Area	549.05	3.11	Fauna:Orang Utan	2,490.34
	Cultivated Land	3,802.94	21.53		
	Forest	**8,160.40**	**46.21**		
	Plantation	5,147.91	29.15		
	Total Tenom	17,660.30	100.00		

Source: Analysis, 2019 based on WWF data 2017

4.3.3 Road Corridor

We selected 6 (six) major roads as the backbone for HoB area in Sabah region with the total road length ± 477 km. The road segmentation consists of Kalabakan-Nabawan for about 171.51 Km, Keningau-Tambunan for about 51.18 km, Nabawan-Keningau for about 56.96 km, Ranau-Telupid for about 93.02 km, Tambunan-Ranau for about 61.91 km, and Tenom-Keningau for about 43.24 km. Using the same assumption for buffering 1 (one) km as the corridor area, the area of those road segments reaches 47,467.69 ha. It means that the potential area that directly impacted by the road and is the most probably changed is approximately 30 thousand ha. The area of each road segment can be seen in the table below:

> “It means that the potential area that directly impacted by the road and is the most probably changed is approximately 30 thousand ha

Table 14 Road Segmentation of HoB

ROAD SEGMENT	LENGTH (km)	CORRIDOR AREA (ha)
(Kalabakan)-Nabawan	171.51	17,081.24
Keningau - Tambunan	51.18	5,056.76
Nabawan - Keningau	56.96	5,674.52
Ranau - Telupid	93.02	9,204.92
Tambunan - Ranau	61.91	6,042.79
Tenom - Keningau	43.24	4,407.45
Grand Total	477.81	47,467.69

Source: Analysis, 2019

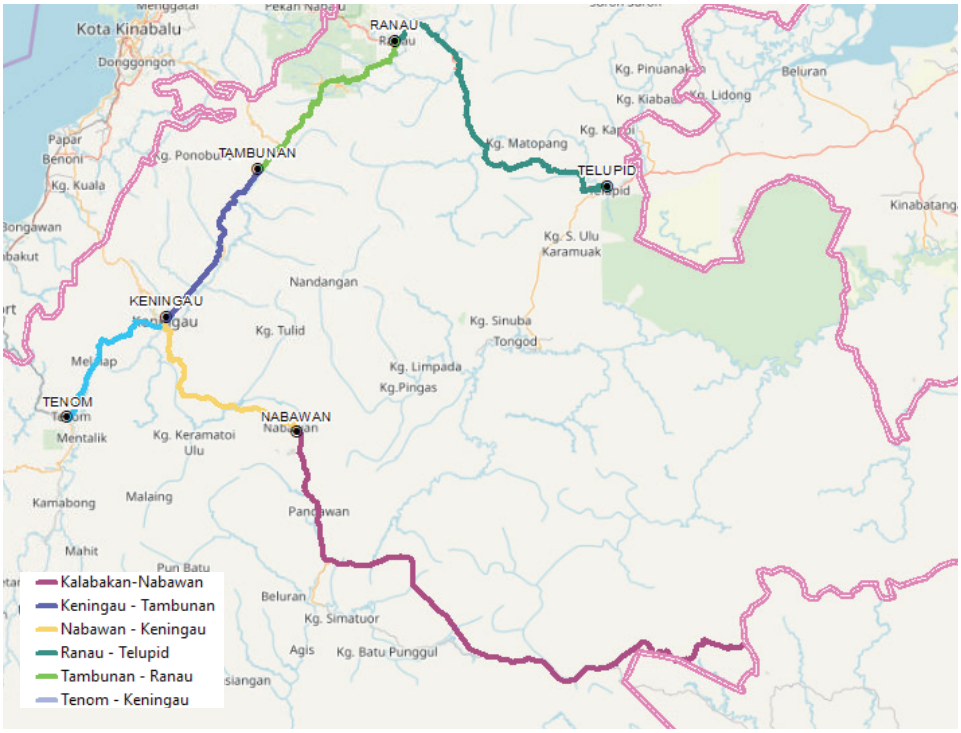


Figure 15 Main Corridor in HoB Sabah-Malaysia

Source: Analysis, 2019

In the Kalabakan-Nabawan segment, the forest dominates the corridor area. There are so many habitats like orangutan, bull, and elephant lived in that area. In the Keningau-Tambunan segment, the built-up area and forest dominates the corridor area. In the forest area, the habitat of Orang Utan is also detected for about 481.45 ha. However, in Nabawan-Keningau corridor, the non-forest, such as built-up area and cultivated land dominates the corridor are. This segment has the lowest risks of ecological losses. Although in Ranau-Telupid corridor is dominated by built-up area, but the forest is also a habitat of Orang Utan for about 989.41 ha. The same case also occurs to Tambunan-Ranau corridor, but for habitat of Fagaceae for about 56.33 ha. In Tenom-Kelingau corridor, forest dominates the area and also habitat of Orang Utan.

Table 15 Profile of Road Corridors

No	Road Corridors	Land Cover	Area (ha)	%	Habitat	Area (ha)
1	(Kalabakan)-Nabawan	Built Up Area	1.446,21	8,48%	Fauna:Bull	103,97
		Cultivated Land	298,77	1,75%	Fauna: Bull +Orang Utan	3.447,08
		Forest	11.940,58	70,00%	Fauna:Elephant+ Bull	1,72
		Logged Forest	1.983,39	11,63%	Fauna: Elephant + Bull +Orang Utan	4.630,64
		Plantation	1.388,94	8,14%	Fauna:Orang Utan	4.900,95
Kalabakan-Nabawan Total			**17.057,89**	**100,00%**		**13.084,36**

No	Road Corridors	Land Cover	Area (ha)	%	Habitat	Area (ha)
2	Keningau - Tambunan	Built Up Area	2.937,66	58,09%		
		Forest	2.067,30	40,88%		
		Plantation	51,81	1,02%		
Keningau - Tambunan Total			**5.056,76**	**100,00%**	**Fauna:Orang Utan**	**481,46**
3	Nabawan - Keningau	Built Up Area	2.116,17	37,29%		
		Cultivated Land	1.872,22	32,99%		
		Forest	465,77	8,21%		
		Logged Forest	22,66	0,40%		
		Plantation	1.197,70	21,11%		
Nabawan - Keningau Total			**5.674,52**	**100,00%**		
4	Ranau - Telupid	Built Up Area	4.230,48	45,96%		
		Forest	2.283,47	24,81%		
		Plantation	2.690,97	29,23%		
Ranau - Telupid Total			**9.204,92**	**100,00%**	**Fauna: Orang Utan**	**989,41**
5	Tambunan - Ranau	Built Up Area	3.441,12	56,95%		
		Forest	2.133,90	35,31%		
		Plantation	467,78	7,74%		
Tambunan - Ranau Total			**6.042,79**	**100,00%**	**Flora: Fagaceae**	**56,33**
6	Tenom - Keningau	Built Up Area	1.245,91	28,27%		
		Cultivated Land	945,10	21,44%		
		Forest	1.900,94	43,13%		
		Plantation	315,50	7,16%		
Tenom - Keningau Total			**4.407,45**	**100,00%**	**Fauna: Orang Utan**	**53,09**

Source: Analysis, 2019; modified from WWF Data 2016

5. ANALYZING ROAD IMPACTS ON HOB

The infrastructure development within the HoB should minimize the development impacts to the ecosystem or reduce the potential future risks. The need to build the roads should recognize communities' traditions and relations with the forests, while respecting the rights to also be served by public facilities. Increasing the connectivity through road development is unavoidable due to social economic prosperity and homeland security reasons. Thus, it is our task to communicate the impact values of the road development and how we can optimize the road development targeting the right beneficiaries.

5.1 POTENTIAL IMPACTS

5.1.1 Economic Aspect

Measuring the economic impacts of road development can be divided into two major aspects. First, the negative impact that mainly related to a high construction cost. Based on the interview with the staffs of Ministry of Public Work and Housing (MPWH), the average cost to open the forest for road construction in Kalimantan Island is IDR 2.5 billion per km. The construction cost for national road specification is about IDR 25 billion. In addition, the cost of road preservation and maintenance is about IDR 0.5 billion per km. Therefore, it is estimated by the forest opening and construction for about IDR 27.5 billion per km.

> "The construction cost for national road specification is about IDR 25 billion. In addition, the cost of road preservation and maintenance is about IDR 0.5 billion per km. Therefore, it is estimated by the forest opening and construction for about IDR 27.5 billion per km.

Beside of construction costs, the other potential **negative impacts** are an increased risk of road accident if the road line segmented the habitat and becomes the cross road for certain species. In many cases, the crossing animals can trigger the car accidents. The potential costs are the medical cost if any injured and the repairing costs for broken cars. Furthermore, another economic risk is the potential extra costs to relocate the habitat if the road segments has no alternative routes. Since there is no literature on how much costs, but it will take costly.

While, the **positive impacts** cover:

i. Emerging and growing extractive economic activities, such as timber production, palm oil, and other plantations. In this case, the study only limits the potential economic uses based on the spatial planning direction. For timber production, based on Sumarga et al. (2005) that study the forestry industries in Central Kalimantan Provinces, it is known that the value of timber production reach Euro 30.10 per ha per year. Refers to palm oil, it depends on the life time. For newly planted palm oil (0-4 years), the value is –3,326.40 Euro per ha per year; FFB production of young oil palm (5-9 years), the value is 7,736.80 Euro per ha per year; FFB production of mature oil palm (10-20 years), the value is 37,704 Euro per ha per year.

ii. Emerging tourism sectors, especially for natural and cultural tourism destination. Based on global studies that conducted by CBD (2001), the value for recreation reaches USD 770.00 per ha per year. The value of tourism sectors especially depends on the site specifics of destination area, number of visitors, and the length of stay. Those will sharpen the economic value of the tourism sectors.

iii. Reduced the logistic costs. It is the main reason to develop road through HoB area. In this case, based on the air cargo costs Jakarta-Pontianak, the logistic cost is IDR 19,365 per ton per km, compared to land cargo that costs IDR 3,175, the reduced logistic cost reaches IDR 16,190 per ton per km.

iv. Reduced the passenger costs. Based on air ticket price Jakarta-Pontianak (806 km), the average cost is about IDR 1,320 per km, while if using Bus from Pontianak-Sintang (386 km), the average cost is about IDR 648 per km. Therefore, the reduced cost is about IDR 672 per km.

v. Job employment and business opportunity is also categorized as the positive impacts, but it is a part of economic sectors, although it is recognized there are other sectors that have not been included in the major sectors above. At this moment, no available studies to confirm the average value.

5.1.2 Social Aspect

Measuring the social impacts of road development depends on the availability of empirical data on the perception of local people on what kind of social or cultural value that affected by the road development. The **positive impact** that identified is an increased social cohesion since the frequency to have a customary event or social gather will be higher. In addition, the social motives to make a trip is also increased. However, since no available studies on those, it is categorized as an intangible value.

The identified **negative impacts** are:

i. The potential losses of cultural assets and heritages, such as sacral or worship forests. In term of efficiency, sometime road alignment has potentiality to pass those respective areas. It is not necessary included in the village settlement. It can be far from the settlement. However, no available studies

ii. Mal-adaptation of local people in benefiting the road connectivity. Most of the communities live in the forests have their own livelihood and to certain extent have limited capacity on financial literacy that needed to expand the business.

Nonetheless, at this moment, there are no empirical works to explore the perceived value on both aspects. It thus makes these components cannot be included in the monetary valuation.

5.1.3 Environmental Aspect

Measuring the environmental impacts of road development consists of positive and negative impacts. The positive one is a reduced surveillance cost for protected and conservation area due to road services. It saves time and personalities. However, the economic value of this components has no proper benchmarking studies. It is thus not included in the calculation.

The negative impacts of road development in HoB consists of at least:

i. Losses stock carbon, especially the peatland or peat forest that has significant amount of sequestrated carbon. In this case, the value is estimated IDR 1.146 billion per ha per year, based on Muratni et al. (2016). It is also better calculation if any empirical of carbon stock assessment.

ii. Biodiversity losses or damages. Segregated habitats when crossed by the road alignment. It is actually intangible values, but the study by Verma (2000) in India indicates that the habitat services can be valued as USD 435.00 per ha per year. It would be a better valuation if the specific habitat studies are available. Other approaches to calculate the value of biodiversity aspects are the risks of human animals' conflicts, e.g. the cost of car accidents because of animals cross walking or attacking on the road when it is operated yet; the relocation cost of habitat because it has been segmented by road.

iii. Degraded forest as water catchment. Van Beukering et al. (2003) studied the fresh water supply in Indonesia in 2000. They estimate the value is about USD 118.81 per ha per year. In the other study regarding water regulation, Perrot-Maître and Davis (2010) through Mexico case study in 2008 calculate the cost is about USD 27.30 per ha per year. In this case, we use the accumulation of both studies, it thus will cost USD 146.21 per ha per year.

iv. Increased the critical land due to forest conversion. It links to the flood and erosion prevention, pollination of crops, micro-climate regulation, genetic resources, biochemical and bioprospecting process. Based on Van Beukering et al. (2003), the cost for erosion prevention is USD 900.00 per ha per year. According to Rosales et al. (2005) using the case study of Laos country, the cost for flood prevention reaches USD 92.30 per ha per year. Refer to genetic resources, the global studies conducted by CBD (2001), the value is about USD 1,500 per ha per year. Biochemical and bioprospecting process would take USD 133.38 per ha per year based on Rosales (2005) and Costello and Ward (2006).

5.2 ECONOMICS VALUATION

5.2.1 Indonesia

Using those assumptions, the valuation of benefit and costs for each road corridor and connected towns is calculated in the time period of 25 years and on discounted rate of 6 (six) percent using Bank Indonesia Repo Rate. The summary of benefits and costs can be seen in the table below:

Table 16 Economic Valuation in Indonesia

Road segmentation	Length (km)	Benefits (IDR)	Costs (IDR)	BCR
Nanga Badau-Putussibau, including direct impact to both towns	160.52	68.242.975.074.645,60	15,887,654,531,980.50	**4.30**
Sintang-Putussibau including direct impact to both towns	270.78	114.563.457.861.936,00	21,635,920,559,540.90	**5.30**
Putussibau-Long Pahangai, including direct impact to both towns	241.76	53.752.885.283.826,90	36,785,596,279,015.30	**1.46**
Long Pahangai-Long Nawang, including direct impact to both towns	189.40	12.084.474.745.368,50	34,720,160,486,629.40	0.35
Long Nawang-Malinau, including direct impact to Long Nawang only	278.26	150,932,905,349.36	29,384,817,389,599.30	0.01
Malinau – Long Midang, without indirect impacts to both towns	137.66	14,657,321,164,393.00	20,079,361,094,315.6	0.73

Source: Analysis, 2019

Table 16 above shows that not all road corridors have positive impacts for the next 25 years. Based on BCR value, the road corridor that has good investment in sustainability is only Nanga Badau-Putussibau, Sintang-Putussibau, and Putussibau – Long Pahangai. The length of the road has no correlation with the positive impacts, but the centers that connected by the road. Putussibau is a key point for these networks. But

if we go thorough on what kind of economic producers from these corridors is the palm oil. The absence of palm oil is one of the factors that explain the low return of the remain three corridors

Road corridors within HoB area are high-cost project because they alter ecosystem services of the natural forest which possess multi-functionality in addressing conservation and protection purposes. Low population in many local centers also the causal factor of the underutilized road if it has been operated. It brings to the consequence that the local stakeholders need to find out what kind of economic activities that can generate revenue without hampering the forest. On the other hand, the re-design of road construction is also recommended to reduce the construction costs. It can reduce the physical dimension, or changing material, or improving the design.

5.2.2 Sabah

Using the same formula with Indonesian case, the benefits and costs for Sabah can be estimated in the table below. The result shows that most of the road corridors are not feasible in sustainable investment manner, except Ranau-Telupid corridor. The costs are higher than benefits that indicated in BCR value. Since the road has been already operated, minimizing the costs only can be occurred if we improve the road segments to serve the habitats and control the forests use within corridor to avoid potential losses of carbon.

Table 17 Economic Valuation in Sabah

Road segmentation	Length (km)	Benefits (IDR)	Costs (IDR)	BCR
(Kalabakan)-Nabawan, including impacts to Nabawan	171.51	8,060,142,079,577.65	25,693,114,170,249.7	0.31
Keningau – Tambunan, including impacts to both centers	51.18	6,573,735,169,608.48	33,782,229,036,466.4	0.19
Nabawan – Keningau, including impacts to both centers	56.96	13,700,399,564,366.6	32,669,260,394,048,7	0.42
Ranau – Telupid, including impacts to both centers	93.02	2,0911,246,273,226.10	15,453,714,330,998.9	1.35
Tambunan – Ranau, including impacts to both centers	61.91	2,854,121,809,949.50	15,198,828,120,070.4	0.19
Tenom – Keningau, including impacts to both centers	43.24	16,401,162,180,635.90	30,242,831,681,414.7	0.54

Source: Analysis, 2019

5.3 EXPERTS CHOICE ON ROAD PROJECTS IN HOB

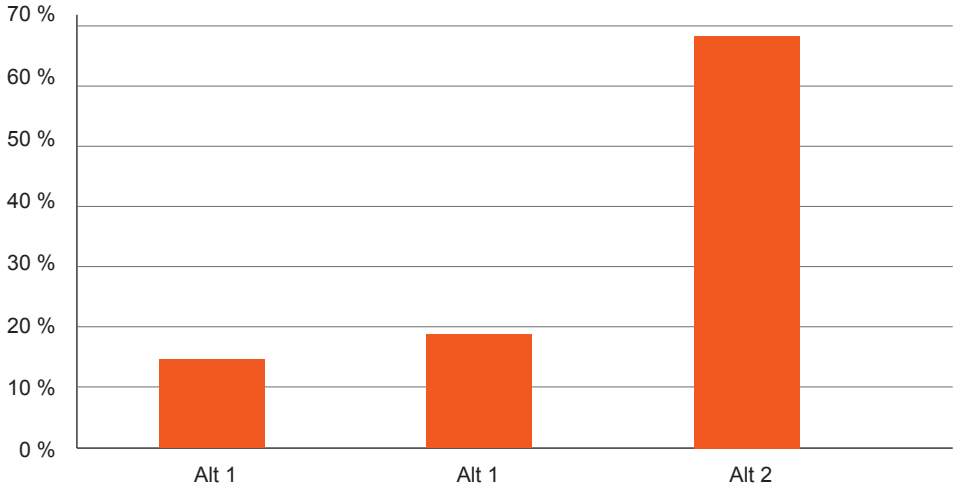
To confirm the importance of ecological value in HoB area for the Kalimantan side, we conducted the AHP method to several experts. The AHP results show that:

1. In terms of criteria selection, the result shows that of economy and social, the environment is the most importance with the normalized principal eigenvector 52.61 percent. The consistency ratio is 1.70 percent.

2. The reason why environment is selected because the HoB forest is perceived as a place that has a rich biodiversity that can enrich the future generation (18.18%), contain ground water resources (16.55%), prevent the natural disasters, such as drought and flood (12.43%). The consistency ratio is good, reach 2.5 percent.

3. In selecting the prioritized strategies, the experts prefer to choose Alternative 3, which is to develop eco-road infrastructures with the normalize principal eigen-vector is 62.73%. The other alternatives are no road development (Alt 1) and conventional road development (Alt 2). The consistency ratio is also < 10 percent, which 7.10 percent.

Those results confirm that the presence of road is also accepted by the experts but should meet environment criteria, which are HoB forest as the habitats and water resources. It is imperative to have road development without hampering the forestry but within tolerable margin of reduced environmental values.



Alternative	Alternative Value per criteria			Final Alternative Value	Rank
	Criteria 1	Criteria 2	Criteria 3		
	(16.43%)	*(52.61%)*	*(30.97%)*		
Alt 1	5,59%	21,71%	6,48%	14,34%	3
Alt 2	31,68%	10,45%	26,20%	18,81%	2
Alt 3	62,73%	67,85%	67,32%	66,84%	1

Figure 16 AHP Results
Source: Analysis, 2019

5.4 LIMITATION OF STUDY

Using CBA and AHP that counts on the benchmarking studies has demonstrated the importance of quantitative indicators to support the HoB policies in the near future. It is recognized that without field empirical data, it will not provide accurate information. But at least at macro level, the HoB has a general framework and initial results on the impact of road backbone in HoB. However, the author also realizes the significance of regional and local roads alter the HoB landscape. It is expected that using this method, the WWF Regional Office can dig more data deeper and study further on this impacted value.

The area of impact valuation is delineated within HoB area which probably narrowing down the economy externalities of road development. It should also be studied the externalities to other surrounding places, e.g. Malinau and other growth centers outside HoB that can take benefits from the development of road crosses the HoB area. Furthermore, this study did not count the intangible value, especially non-economy sectors that probably impacted by the road development. It is suggested to have deep study to use the empirical eco-anthropological studies in identifying the non-economic losses or benefits from the road construction.

6. CONCLUSION AND RECOMMENDATION

In general, the road construction may increase threats to the ecological value of HoB region, but at the same time can create social and economic opportunities for local communities and improve regional connectivity. In preparing road projects in HoB area, the development should have a strong mission to minimize the ecological and social impacts. This study demonstrates that of 6 (six) road corridors in Indonesia, only 3 (three) corridors that meet sustainable investment criteria. Yet, there are still many intangible cost factors that were not included in the calculation due to limited data and benchmarking. Therefore, the first key message is to have a proper preparation of road project.

The monetary valuation is the finest way to inform the stakeholders about the balancing social, economic, and environmental values. Although this study has certain limitation in empirical data, but at least the benchmarking method reveals the same value that will make decision-making process easier. In developing valuation method, it is imperative to define the impacted area of road project that needs to be managed by the stakeholder in common understanding. Although the road corridor takes a little portion of space, but it is the strategic key factor that can cause massive changes, if it is not controlled.

The potential threat for conservation value in HoB is not only for the habitat but also for the water resources. The 7 million-ha allocation for production forest should be fully monitored and controlled by the stakeholders, not only in utilizing the forest trees, but in opening the forest for the road construction. It is also estimated that the productive forests will use the corridor network for increasing the accessibility of timber industries. It is thus highly recommended to stop the usage of heavy trucks in the backbone road network. The option to optimize the river transportation for those industries should be offered. In a smaller scale, the allocation for human settlement in the ecosystem corridor obviously need to conform the eco-design guideline and eco-zoning regulation. It is highly recommended to support the central and local governments in providing basis for both regulations.

In regards to road project within growth centers area in HoB, the study recommends for the government to enact urban threshold in the radius 15 km area for regional growth center and 7.5-km area for local centers with the allocation 30 percent for green open space. It means that the development rights in the respective areas would not be given without full control. By managing the growth centers, we can also provide property direction of economic flows that are applicable to the road corridors. To activate the threshold, the detailed spatial planning for growth center should also consider the compact cities development and low carbon cities design to reduce the potential losses of the biodiversity. For the central government, refers to the 7 (seven) potential Indonesian towns and 6 (six) Sabah towns in the HoB, it is also useful to endorse the regulation on hotspot cities to avoid mislead land use plan. It should also be considered the development of tourism sectors that utilize the nature conservation through eco-tourism development. It will also lower the risks of losing biodiversity values.

In regards to the road corridors, the opportunity to revise the road segment is closed, but for certain segment is still possible. The main assignment now is to intervene the DED process for Nanga Badau-Putussibau and Sintang-Putussibau,

especially in applying the eco-road design, including material selection. For the other segments, the opportunity to urge the forbidden truck regulation and development control within the road corridor is still quite opened. It is important to provide zoning regulation and eco-design guidelines for each corridor. It is also highly recommended to have an integrated monitoring system for road corridor utilization in the post-construction phase.

Table 18 Key Recommendation for HoB Indonesia

ROAD CORRIDOR	LENGTH (km)	RECOMMENDATION
Nanga Badau-Putussibau	160.52	• Minimize the number of local roads that connect to the existing road, especially in the segment where peatland and Orang Utan habitat located, followed by strong control on land use changes in the 1km-corridor area • Keep away the direction of urban expansion to the protected forest, peatland, and habitat area in both corridors and growth center of Putussibau and Nanga Badau area • Strengthen the surveillance system in the road segment that relates to the habitat of Orang Utan
Sintang-Putussibau	270.78	• The changes for settlement and agriculture should be guided by green or low carbon development strategies • Conduct the detailed spatial planning of Putussibau and Sintang that apply the bio-climate resilience principles
Putussibau-Long Pahangai	241.76	• Improve the road design for half segment that has not been constructed, especially in reducing the ecological costs and increasing preservation economy • Strengthen preservation and Control for habitat Orang Utan and Badak • Avoid land use changes in the peatland area
Long Pahangai-Long Nawang	189.40	• Revisit the road design for the segment that cross the habitat of Pagaceae • Conduct the eco-design for urban and rural settlement in both local centers, followed by strong zoning regulation • Consider to change road segments avoiding the habitats and potential natural forests
Long Nawang-Malinau	278.26	• Evaluate the proportion of productive forests since this corridor is not economically feasible • Increase the monitoring system for habitats due to increased productive forests pressures • Consider to change road segments avoiding the habitats and potential natural forests
Malinau-Long Midang	137.66	• Revisit the road design for the segment that cross the habitat of Pagaceae • Provide better guidance for preserve carbon stock and protected forests • Consider to change road segments avoiding the habitats and potential natural forests
Grand Total	**1,278.38**	

Source: Analysis, 2019

> “ eco-design guideline into the road corridors that crossed the habitat, although only covers for about 5 (five) percent of the total road corridors

Changing road segments for those three corridors should consider the balance of costs and benefits in developing the road. It also depends on what centers that need to be linked by the road. Re-assign the route should follow the criteria of minimum costs and maximum benefits. The detailed assessment is needed to identify the best route for the road networks.

In the context of Sabah region, since there is no detailed information regarding the road maintenance or upgrading status, the main concern is to examine the potential habitat segmentation for the road segments that has passed the habitat area. The result shows only the road segment Polar Nabawan-Keningau that has no cut. Applying the eco-road design is a must, but the other key solution is to prepare the strict zoning regulation and eco-design guideline into the road corridors that crossed the habitat, although only covers for about 5 (five) percent of the total road corridors.

In designing eco-road design, there should be a preparation that needs to be conducted. First, developing baseline study on biodiversity value in the corridor. It would be applicable, if the biodiversity assets can be defined before taking spatial intervention through design. The empirical study is highly recommended. Second, conducting building a projection model through spatial dynamic in developing several scenarios with design. Third, conducting stakeholder workshop to identify actors and actants that receiving impacts due to road development both positive and negative impacts.

Therefore, the direction to **apply green economy** are the best alternative solution for HoB development, especially to the corridor that has BCR value <1. The green economy is expected to be able to conserve green areas along with their biodiversity and improve the quality of the surrounding communities and the inter-cities connectivity. Developing road network in HoB should avoid the environmental damage, increase the ecosystem adaptive capacity, and reduce the potential disaster risks. The further detailed study to implement those principles in one or two road corridors is highly recommended.

In preparing green economy intervention, there are several studies need to be conducted. First, the baseline of carbon balance in the corridor, especially for potential carbon stocks. Adding the other ecological value are recommended, such as water containment, wildlife habitat and its connectivity, and protected vegetation. It is expected to have an economic value at the present day. Second, the opening land for settlement and the human livelihood should be measured by trade off mechanism. The allowing activities should has higher value that the existing state. Therefore, the scale and type of economic activities are the significant factors. The small scale is recommended because it would take limited conversion and allow local communities to be the primary actors. The economic activities such as eco-tourism, forest education, etc. that are not categorized as extractive industries would have low risk values. Third, preparing the regulatory framework to allow the green economy applied. Starting from defining zoning regulation on the corridor, providing incentive and disincentive, establishing the institutions for decision making and controlling, and offering sanction for those who break the law.

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PAPER FROM RESPONSIBLE SOURCES

3rd LARGEST

Borneo is the third largest island on the planet.

FORESTS LOSS

About half of Borneo's natural forests have been lost and losses continue at a rapid pace.

850,000

Between 1985 and 2005 Borneo lost an average of 850,000 hectares of forest every year. If this trend continues, forest cover will drop to less than a third by 2020.

75.5 MILLION

East Kalimantan alone is believed to lose over €75.5 million a year in business tax revenue due to illegal logging and illegal timber processing.

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