

Potential Assessment and Ecotourism Carrying Capacity in Suwi Wetlands on Essential Ecological Areas East Kutai, Indonesia

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Abstract

The conservation and protected areas within the Essential Ecological Areas of the Mesangat-Suwi Wetlands are ecologically significant due to their high biodiversity, local community fishing resources, and habitat for endangered species. The distinctiveness of the Suwi Wetlands as a habitat for proboscis monkeys (*Nasalis larvatus*) and *Crocodylus siamensis* enhances the prospects for sustainable ecotourism through natural attractions. This study references evaluating natural tourism attractions' potential and the carrying capacity of both biotic and abiotic environments. Nine of the fourteen prospective variables evaluated exhibit significant potential: natural attractions, market potential, surrounding circumstances, climate, accommodation, supporting infrastructure, security, area carrying capacity, and market share. The Physical Carrying Capacity (PCC) for the maximum number of visitors is 80 individuals per day, whereas the Real Carrying Capacity (RCC) is three individuals per day. The quantity of visitors is consistent with the condition of biophysical characteristics. Wetlands of significant conservation significance must be safeguarded via sustainable ecotourism approaches. Conservation initiatives beyond forested regions should focus on cultivating ecotourism potential to guarantee long-term environmental sustainability.

Keywords: Wetlands, Conservation, Ecotourism, Potential, Masangat-Suwi

Introduction

Ecotourism has become a global issue and has recently been much discussed in Indonesia. Carrying capacity of ecotourism has several aspects, such as ecological capacity, physical capacity, social capacity, and economic capacity (Butarbutar, & Soemarno, 2013). The development of ecotourism in Indonesia is still relatively slow, so it requires identification, classification, and documentation to establish the identity of a species for ecotourism attraction (Chairiyah, 2013). The Problems of rural areas in Indonesia can be broken out through the ecotourism development in rural areas (Nugroho et al., 2016). Indonesia is very rich in biodiversity. Indonesia is known as one of the mega-biodiversity countries (Sutarno, & Setyawan, 2015).

Indonesia has experienced the most severe deforestation in recent decades (Firdaus et al., 2022). Ecotourism is seen as a solution to reduce environment and socio-economic problems in the Heart of Borneo (Chrismansyah, 2022). East Kalimantan has a comparative advantage in nature tourism with the development of ecotourism destinations that must be in line with sustainable development goals (Basyir et al., 2024).

The Masangat and Suwi Wetland landscapes include rivers, swamps, and lakes, and are important ecosystems for the habitat of protected, threatened, and endangered endemic species. The two adjacent areas are hereinafter referred to as the Masangat-Suwi Wetlands (KEP LBMS = *Kawasan Ekosistem Penting Lahan Basah Masangat Suwi*), located in the Long Mesangat and Muara Ancalong District, East Kutai Regency on East Kalimantan Province (Suryanto et al., 2019). Research results on Suwi Wetlands have found as many as 12 species of mammals, 63 species of birds, 9 species of reptiles, and 38 species of fishes. Based on Indonesia's regulations and international law Number P.106/MenLHK/Setjen/Kum.1/12/2018 concerning the Second Amendment to the Regulation of the Minister of Environment and Forestry Number P.20/MenLHK/Setjen/Kum.1/6/2018 concerning Protected Plant and Animal Species, there is a Bekantan which is an endemic animal and one of the priority species for conservation, and Siamese crocodile is one of the most endangered in the world (Wahyudi et al., 2017). Masangat-Suwi Wetlands are integrated in the form of management of Essential Ecological Areas (EEA). The area that has high ecological value is outside the conservation area, and most of the area is included in the concession of oil palm plantation companies (Mukhlisi et al., 2018).

Siamese crocodiles (*Crocodylus siamensis*) and Tomistoma (*Tomistoma schlegelii*) in Mesangat Wetland live co-exist. This location has also been subjected to recent disturbance from illegal logging and oil palm development, so that this unique ecosystem requires integrated conservation efforts (Staniewicz et al., 2018). Floating vegetation is one of the unique biotic components in the Mesangat Wetland ecosystem, which plays an essential role for Siamese crocodiles (Muslim, & Suba, 2021). The EEA, specifically in Suwi River on East Kutai Regency has been found in 63 species of birds. There it has been known 15 bird species have a protected status. Then six species are in Appendix Two, one is included in Appendix One of the Convention on International Trade in Endangered (CITES), and four were found to be vulnerable according to the International Union for Conservation of Nature (IUCN) (Isa et al., 2018). Suwi River, which is a part of Kenohan-Suwi Wetland of endangered animal habitats such as Bekantan. The Suwi Wetland with over 60 plant species still provides a potential source of food. Furthermore, a minimum of 12 monkey groups were distributed in this area. Efforts to protect the Bekantan habitats have been made by Yasiwa-Ulin Konsorsium. The institutions other that is committed to protecting this area include Federal and local government, NGOs, local colleges, local communities, and palm oil (Tri, & Mukhlisi, 2021). Through collaboration multi stakeholders and local communities it will good to participate in the conservation of *C. siamensis* habitats (Sudrajat, & Saleh, 2019). Based on the extraordinary potential of the wetland and conservation efforts, it is necessary to evaluate the

potential and carrying capacity of sustainable ecotourism. Sustainable ecotourism development is expected not to damage the wetland ecosystem and to be a supporter of conservation efforts.

Indonesia needs a strategy for the development of ecotourism. Ecotourism must be able to give incentive to local communities to be involved in conservation (Dalem, 2002). Sustainable ecotourism development in protected areas is a valuable source of employment and can be a significant tool for the socio-economic development of communities (Seifi, & Ghobadi, 2017). One strategy to reduce the impact of recreation and nature tourism activities is by conducting a carrying capacity (CC) analysis (Laksapriyanti et al., 2020). Carrying Capacity can be defined as the level of human activity that can be supported by an area without causing damage to its physical characteristics and environment. (De Sousa et al., 2014). Ecotourism, natural resource conservation, and local livelihoods are the most talked about issues in the world. Ecotourism is seen as nature-based tourism with the main attribute of biodiversity conservation (Samal, & Dash, 2023). The development of ecotourism in the Suwi Wetland needs to be based on the function and carrying capacity of the environment, so it is necessary to conduct a study of the potential for natural tourism attractions according to the characteristics of the area. This study will assess the potential and measure the carrying capacity based on biotic factors (diversity of fauna and flora) and abiotic (soil susceptibility to erosion, rainfall, and slope) of the Suwi Wetland.

Methods

Study area

In this study, we focus on Suwi Wetlands on Essential Ecological Areas of Masangat-Suwi Wetlands (EEA_MSUW). Suwi Wetlands is located in the Muara Ancalong District, East Kutai Regency, East Kalimantan Province (**Figure 1**). Muara Ancalong is one of the 18 sub-districts in East Kutai Regency. The area is mostly lowlands in the interior of the upper Mahakam River. The distance to the area from the district capital (Sangatta city) is about 150 km or 4-5 hour drive south of the capital.

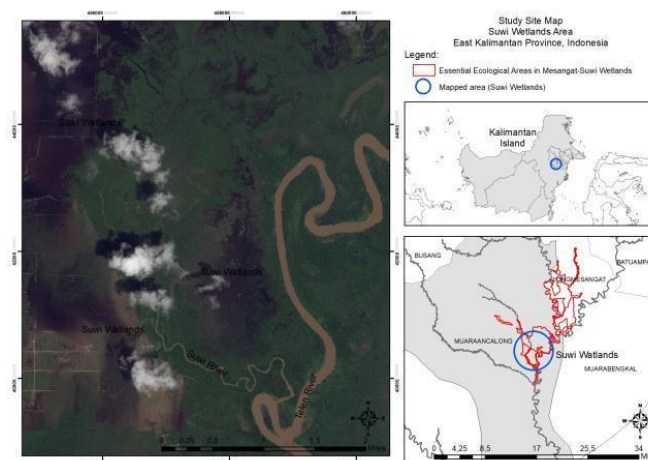


Figure 1. The case study area's geographical location
(Source: Khatuliswa Foundation and satellite image in 2018)

Data Used and Sources

Data collection in this study was carried out in two ways, namely primary and secondary data. Primary data is data collected directly at the research location, such as vegetation conditions, soil, topography and other data needed in this study. Secondary data is supporting data sourced from previous research results, activity reports, and other relevant documents. One source of secondary data is the results of research reports from the Khatulistiwa Conservation Foundation (Yasiwa), the Ulin Foundation, and reports from the EEA_MSW Forum that have been published.

The assessment of ecotourism potential in the Suwi Wetlands is conducted by assessing natural tourist attractions using a scoring or weight system for fourteen indicators (**Table 1**). The assessment system and indicator used are referred to as the Guidelines for Analysis of Operations and Natural Tourism Attraction established by the Indonesian government through the Directorate General of Forest Protection and Nature Conservation in 2003 (PHKA, 2019). In the fourteen indicators assessed, there are fifty-six sub-indicators according (PHKA, 2019) to the guidelines used. The weighting method for each criterion to better reflect its relative importance to the tourist attraction. This method is done by giving a score to each sub-criteria, then multiplying it by the weight of the criteria, then adding up all the scores to get the final value. The assessment of natural tourist attractions with various indicators is adjusted to the concept of ecotourism.

Table 1. Elements and source data for the assessment of natural tourism attractions

Assessment indicator	Weight	Source data
Natural attractions	6	Field observation
Market potential	5	Secondary data
Accessibility	5	Field observation
Conditions around the area	5	Field observation
Management and service	4	Field observation & Secondary data
Climate	4	Secondary data
Accommodation	3	Field observation
Supporting infrastructure	3	Field Observation
Security	5	Field observation
Area carrying capacity	3	Field observationa
Visitor settings	3	Field observation
Marketing	4	Field observation
Market share	3	Secondary data
Relationship with surrounding attractions	1	secondary data

Data analysis

Data analysis of natural tourist attractions in the Suwi Wetlands refers to the Guidelines for Analysis of Operational Areas and Natural Tourism Attractions by the Directorate General of Forest Protection and Nature Conservation. This potential analysis has become a standard and is widely used in research in Indonesia because it is very representative of the criteria for the development of natural tourism. Assessment is done by multiplying the weight by the value of

each element in each of the fourteen indicators. The suitable index is calculated by comparing the value for each element with the maximum value of an element in percent. Based on this index, the feasibility of an ecotourism area is determined as follows (Karsudi et al., 2010):

- 66.6% (high), area worth development
- 33.3% - 66.6% (medium), the area is quite decent for development
- < 33.3% (low), the area is not suitable for development

The environmental Carrying Capacity (CC) of Suwi Wetlands was calculated using the formula developed by Cifuentes (1992). This approach calculates the maximum number of visits in an area based on physical, biological, and management conditions at the three levels: Physical Carrying Capacity (PCC), Real Carrying Capacity (RCC), and Effective Carrying Capacity (ECC). Natural attractions in the study area are in an open space so it is influenced by several natural limitation factors (correction factors) in calculating the RCC. Commonly used correction factors in research such as are rainfall, soil erodibility, slope, landscape potential, and disturbance to wildlife.

Result and Discussion

Based on spatial analysis, the Masangat-Suwi Wetland Essential Ecological Area (KEE_MSW) has an area of 13,570.08 hectares occupying two administrative sub-districts in East Kutai Regency. KEE in Muara Ancalong District called "Lahan Basah Suwi" which is the focus of this study has an area of 6,192.59 hectares. The Suwi Wetland is a non-forestry cultivation area or other use area. In this area there are four oil palm plantation concession permits, namely Prima Cipta Selaras, Cipta Davia Mandiri, Sawit Sukses Sejahtera, and Gemilang Sejahtera Abadi. The Wetland is not planted with oil palm because it is an important ecosystem and is used as a conservation area. The area has extraordinary natural potential such as rivers, lakes, which are sources of fisheries, wetland vegetation (Figure 2), important animals such as the *Crocodylus siamensis*, *Tomistoma schlegelii*, *Proboscis Monkey*, *Bangau Tong-Tong*, and others.



Figure 2. (a) *Gluta renghas*; (b) Vegetaion survey; (c) River in the Suwi Wetland

Based on previous research, EEA_MSW has important ecological value, and habitat for endangered species, and is not suitable for oil palm plantations, so it is designated as an HCV (High Conservation Value) area. Currently, EEA is managed by NGOs supported by other

stakeholders such as central and local governments, plantation companies, universities, and local communities to maintain the integrity and sustainability of the ecosystem there. In the EEA_MSW protection and conservation action plan document for 2019-2023, one of the objectives is to use the KEE area for ecotourism that is environmentally sound and responsible (Suryanto et al., 2019). Ecotourism can be one of the strategies for the protection and conservation of the area with the involvement of local communities which ultimately to the welfare of the community.

Potential of Nature Tourist Attractions in Suwi Wetlands Area

The Suwi wetlands have high potential (**Table 2**) and important ecological functions. The area is very feasible to be developed as an ecotourism destination in rural areas.

Table 2. Assessment results of natural tourism attractions in the Suwi Wetlands

Assessment indicator	Weight	Total score					Category
		P	Pmax	S	Smax	index	
Natural attractions	6	200	204	1200	1440	83.33	High
Market potential	5	626	880	3130	4400	71.14	High
Accessibility	5	151	370	755	1850	40.81	Medium
Conditions around the area	5	210	240	1050	1200	87.50	High
Management and service	4	55	90	220	360	61.11	Medium
Climate	4	110	120	440	480	91.67	High
Accommodation	3	25	30	75	90	83.33	High
Supporting infrastructure	3	115	150	690	900	76.67	High
Security	5	95	120	475	600	79.17	High
Area carrying capacity	3	145	150	435	450	96.67	High
Visitor settings	3	10	30	30	90	33.33	Low
Marketing	4	5	30	20	120	16.67	Low
Market share	3	65	90	195	270	72.22	High
Relationship with surrounding attractions	1	220	400	220	400	55.00	Medium
Total/Suitable		2082	3000	9085	12830	70.81	Worth development

Note: P: Potential score; Pmax: Maximum potential score; S: Total score; Smax: Maximum score; Index: Suitable percentage

Based on fourteen indicators of natural tourist attractions assessed, ten elements have an index above 60%. The safety criteria have a high index because the area meets sub-criteria such as being free from disturbing odors, not noisy, the air is naturally cool, and there is no public traffic. The variety of activities also meets many criteria suitable for ecotourism activities such as educational tourism, research tourism, enjoying the beauty of nature, canoeing, animal attractions in nature, camping, and photography

In the assessment, there are still indicators whose feasibility is still relatively low, such as accessibility, visitor management, marketing, and relationships with surrounding objects. These

indicators can be improved with efforts to develop the region and manage sustainable ecotourism, for example, accessibility indicators will increase along with the increase in regional infrastructure development, especially because East Kalimantan Province will soon become the capital city of Indonesia. From the provincial capital or the airport to the location (Suwi Wetland), it is relatively far with the road conditions partly some of which are still dirt roads or non-permanent roads. Management and service indicators there are still weak because there is no special institution that manages ecotourism so the service to visitors there is not optimal. This is also the same as the visitor settings indicator which is still low because there is no special officer to serve visitors or tourists. Furthermore, for marketing indicators, strong support from the local government is needed to encourage the promotion and immediately establish a Suwi Wetland ecotourism management agency with the involvement of local communities and accompanied by competent stakeholders.

Biodiversity, deforestation, and oil palm plantation denote the focus and characterize the ecosystem services research in Indonesia currently. It can be a strategy for raising awareness about the critical importance of ecosystem services in the future (Firdaus et al., 2022). The ecosystem services of the tropical forests of East Kalimantan TEEB (Economic Ecosystems and Biodiversity) show a total economic value of 90,806,238,765 USD/year (Rahma et al., 2020). East Kalimantan has become the new capital city of Indonesia, so it is an opportunity to improve and increase the quality of tourist attractions in sustainable tourism development (Situmorang et al., 2023). In the tourism sector, wetlands provide a wealth of biodiversity and diverse landscapes including flora and fauna conservation tourism (Naparini et al., 2024).

Environmental problems of wetlands in Indonesia, especially in Kalimantan, are not only in the form of land fires, haze, floods, but can also be the use of river channels with various uses for community life, transportation facilities, and river channels as part of tourist destinations (Astuty et al., 2023). In order to promote environmental conservation in rural areas, the involvement of all stakeholders is needed. This can be done through the following efforts, (i) developing products with an emphasis on education, (ii) developing entrepreneurship in managing ecotourism services, (iii) strengthening leadership to direct the conservation vision, (iv) developing infrastructure related to environmental carrying capacity, (v) develop homestays as a place to develop learning products and services, and (vi) promote rural tourism and environmental values elsewhere (Nugroho et al., 2016). Ecotourism must be able to provide economic benefits to the surrounding community. From the social side, it can increase the knowledge and abilities of local communities about ecotourism, preserve local culture, and transfer information between local communities and tourists. Meanwhile, in terms of ecology, the community plays an active role in conservation efforts to protect ecotourism areas (Kia, 2021).

Carrying Capacity Area

Physical Carrying Capacity (PCC) is calculated to determine the maximum number of tourists who can physically visit the Suwi Wetland area each day while still getting satisfaction. Based on the

total area of the Suwi Wetland is 6,192.59 hectares and the assumption that the area opened for tourists to explore the river and swamp is around 100 hectares, and in one day it is opened for 9 hours, and the average tourist spends time at the location for 7 hours, then in one day there is only one rotation of visits. Based on the area of Suwi and the normal assumption, the PCC of the Suwi Wetland is 79.6 or a maximum of 78 people per day.

Real Carrying Capacity (RCC) is calculated to determine the maximum number of tourists who can visit the Suwi Wetland natural tourism object by considering environmental biophysical factors. The biophysical aspects that are considered as limiting factors (correction factors) of environmental carrying capacity used in the calculation of the RCC include vegetation diversity, animal diversity, rainfall, soil sensitivity to erosion, and slope. Sustainable ecotourism is highly dependent on the ecological conditions of an area such as the biophysical characteristics in Table 3 so it important was to consider in this study. This factor was selected because of its potential to limit tourism activities, the availability of reliable data, and its relevance for evaluating to the sustainability potential of a tourism destination.

Table 3. Correction factors to five element of biophysical characteristic

Variable biophysical	Biophysical characteristics	Lm	Tm	Cf
Biotic	Vegetation diversity (Cf1)	2.01	4	0.50
	Animal diversity (Cf2)	3.56	4	0.11
Abiotic	Rainfall (Cf3)	0.88	7	0.87
	Soil sensitivity to erosion (Cf4)	15	75	0.80
	Slope (Cf5)	3.50	100	0.97
RCC = PCC x Cf1 x Cf2 x Cf3 x Cf4 x Cf5		2.94		

Note: Lm: Limited magnitude of variable; Tm: Total magnitude of variable; Cf: Correction factors

The vegetation diversity in the Suwi Wetlands is based on the 2021 EEA_MSW vegetation survey document. The vegetation diversity index is 2.01 which is obtained from the growth rate index of seedlings, saplings, and trees. Number of tree-level species there are 31 species, saplings 16 species, and seedlings 17 species (Hendra et al., 2021). Animal diversity is represented by a bird diversity index of 3.56 with 93 bird species identified. The total magnitude of variable value for the two biotic factors is determined based on the Shannon-Wiener diversity index (Isa et al., 2018).

The limited magnitude of variable rainfall is based on data for dry and wet months. During the last five years, the number of dry months is known to be 28 months and the wet months are 32 months. The total magnitude of the variable is based on the highest index value in the Schmidt-Ferguson classification. The soil type there is Entisol, which is soil that is not sensitive to erosion and has a limited magnitude of the variable of 15, while for soils that are very sensitive to erosion, such as Renzina and Regosol, the highest score is 75. Furthermore, the study area is a wetland in the form of lowlands with a flat slope class of 0-8% so the limited magnitude of the slope variable is set at 3.5%. The two abiotic factors, namely soil, and slope refer to the Decree of the Minister of Agriculture Number 837/Kpts/Um/11/1980.

The equation of the calculation of the RCC number of people who can visit is 2.94 (**Table 3**) or 3 people per day. This number is in accordance with the diversity of natural animals there such as birds, mammals, reptiles, and protected animals so that they are not disturbed by the presence of too many humans. The maximum number of tourists who can visit based on the RCC is three people per day to explore 100 hectares, as explained above. The total area in Suwi cannot be explored as a tourist area, but the total area is a reference for calculating PCC and RCC. If the Suwi wetlands that can be accessed or designated as a tourist destination are 600 hectares, then the number of tourists who can visit is 18 people per day for every three people separately in an area of 100 hectares. This certainly also impacts the management of the available tour guides. The low PCC value of only three people per day is because there are several vulnerable animals and natural vegetation conditions with low correction factor (Cf) values. Apart from biotic factors, abiotic factors are also very important to pay attention to, such as the condition of the river or lake waters, which are the livelihoods of fishermen and whose naturalness must be maintained. Setting the number of people in a separate area is of course to avoid crowds of people that can disturb the animal life there. This can be done, of course, with the establishment of an ecotourism management agency and the availability of officers in the field.

Based on the consideration of the list of protected animal species According to the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia P.106/2018 and its status according to the IUCN RedList of Threatened Species, 6 species are designated as key animals (**Figure 3**) in the effort to protect and conserve EEA_MSW. The six animals are the Siamese Crocodile, also known as the Black Badas Crocodile (*Crocodylus siamensis*), the Flat-headed Tandang Cat (*Prionailurus planiceps*), the Proboscis Monkey (*Nasalis larvatus*), Tong-tong Stork (*Leptotilos javanicus*), Supit / False Crocodile (*Tomistoma schlegelii*), and Belida Fish (*Chilata* sp.) (Suryanto et al., 2019) Key animals and their habitats will be the main attraction in the program to develop natural tourism destinations in the Suwi Wetlands. The carrying capacity of the environment is very much considered in determining the type of limited tourism. The types of tourism that are possible include research tours, education, limited nature cruising/canoeing (river and swamp exploration), and other limited activities such as fishing, photography, and camping. In order to improve the EEA_MSW protection and conservation campaign, ecotourism can be an alternative that can also increase economic value added for the welfare of the surrounding community. The involvement of local communities is not only limited to conservation but also includes assistance in terms of preserving cultural arts with the values of local wisdom that they have.

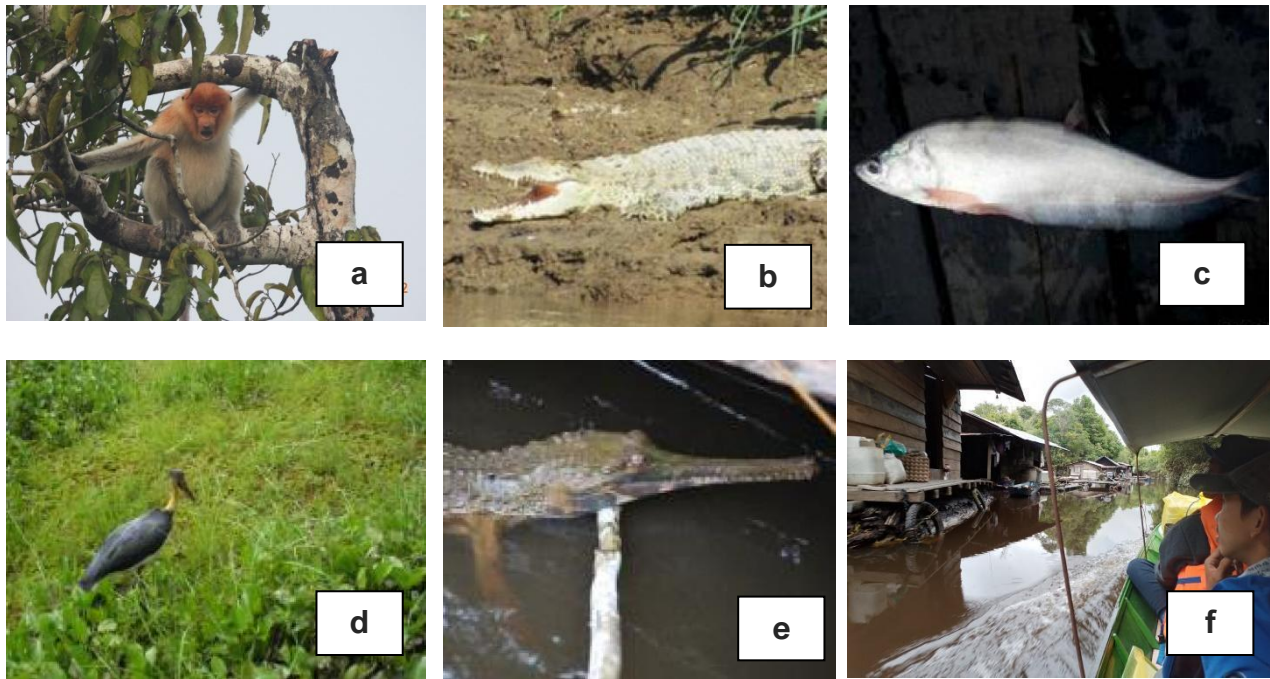


Figure 2. (a) *Proboscis monkeys*; (b) *Crocodylus siamensis*; (c) *Belida fish (Chilata sp)*; (d) *Leptotilos javanicus*; (e) *Tomistoma schlegelii*; (f) *Fisherman's house on the river bank*

The development of sustainable and environmentally friendly ecotourism can be the main solution in efforts to preserve the Suwi wetlands. The potential of natural tourism attractions there must be studied comprehensively because it is an important conservation area for protected and endangered animals. Abiotic factors are also very important because it is a swamp area, a regulator of water management, and a source of fisheries for the local community. The natural swamp forest there presents extraordinary views, but it remains a limiting factor in the development of ecotourism. So in this research it has been concluded that limited tourism or special interest tourism must be implemented there, with the number of one-day tourist visits limited to three to four people. The possibility of developing mass tourism can be done in nearby villages or areas on the outskirts of the Suwi wetlands.

Conclusion

Suwi Wetland is quite unique compared to other conservation areas in Indonesia because it is located outside the forest area or other use areas as determined by the Indonesian government. The area is under a palm oil plantation concession permit and is a high-value conservation area. This condition is a challenge in its management. Ecotourism is one of the objectives in the collaborative management action plan there, so it is very important to assess natural tourist attractions and environmental carrying capacity. The potential for high natural tourism attractions in the wetlands has various limiting factors such as fauna vulnerability, flora conditions, and water conditions that must be maintained because they are a source of fisheries for local communities.

The biophysical characteristics of the Suwi Wetlands area are unique so that it becomes a special consideration in the development of ecotourism. One of them is to limit the number of visits or tourists according to the carrying capacity in the results of this study. Sustainable ecotourism will also develop well with the preservation of the values of local wisdom of the local community.

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Conflict of Interest Statement

There is no conflict of interest in the writing process of the article entitled “**Potential Assessment and Ecotourism Carrying Capacity in Suwi Wetlands on Essential Ecological Areas of East Kutai, Indonesia**”. The author declares that this manuscript is free from any form of conflict of interest and is processed in accordance with applicable journal provisions and policies to avoid deviations from publication ethics in various forms.

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