Analytic hierarchy process for zonation review of Sembilang National Park, Banyuasin Regency, South Sumatera Province, Indonesia

by Dedik Budianta

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Abstract. Sembilang National Park is one of the largest wetland conservation areas in Indonesia. As a conservation area with the main ecosystem in the form of approximately 91.679 hectares mangrove ecosystem in 2003. Sembilang National Park is managed based on a zoning system that is utilized for research, science, education, supporting cultivation and tourism. At present, the zoning of Sembilang National Park consists of core zones, jungle zones, utilization zones, traditional zones, rehabilitation zones and special zones. The predetermined zones need to be evaluated because the damage to the national park is continuing, so that the primary mangrove forest area in Sembilang National Park has shrunk from 83.447 hectares in 2009 to be 70.263 hectares in 2017. The Purpose of this study is to determine the zoning of Sembilang National Park by using the analytical Hierarchy process (AHP) method. The results showed that the main criteria in determining national park zones based on ecological aspects were the presence of peat domes, typical of soil and land cover conditions. While the right social indicators are access to conservation areas and the existence of settlements.

1. Introduction

Sembilang National Park (TNS) is a nature conservation area located in a wetland area dominated by mangrove forests, freshwater swamp forests and peat swamp forests covering an area of 202,896.31 ha (a merger of SM deep canal, deep canal limited production forest, S. Sembilang Nature Reserve Forest and surrounding waters). Located on the east coast of South Sumatra Province, included in the region of Banyuasin Regency, Banyuasin II Sub - District. In 2003, Mangrove forests dominate the Sembilang National Park stretching up to 35 km to the south west (upstream) covering an area of 91,679 ha or 45.18 percent of the area of Sembilang National Park thus making this region one of the largest mangrove ecosystems in Western Indonesia. The number of mangrove forests in Sembilang National Park has shrunk to 83,447 ha in 2009 which means that in the period of 6 years 2003-2009 there was a decrease in the area of mangrove forests by 8,232 ha [1].

One of the causes of mangrove damage in Sembilang National Park is illegal logging and aquaculture or manufacturing of ponds, plantations and settlements resulting in mangrove degradation in Sembilang National Park [2]. Forest fires in 2015 also added to the wide spread of mangrove damage in the Sembilang National Park area. The encroachment of the area into a rice field cultivation area occurs in an area directly adjacent to the transmigration area, for example in Purwodadi Village, Prumpung Raya Village and Karang Sari Village [3].

The presence of humans in the periphery of conservation areas, for example for poaching and nature tourism can cause changes in ecosystems and biodiversity, especially on the peculiarities of wildlife and the presence of exotic species [4]. The main cause of forest destruction is an increase in population and expansion of agricultural land by poor communities around the forest area [5]. The rapid increase in land use by communities around protected or conservation areas will gradually reduce the capacity of this area to maintain the preservation of species and ecological processes [6]. Among these threats, human activities such as expansion of settlements, activities related to agriculture and road construction can cause further serious threats in the form of reducing the effective extent of conservation areas, damaging ecosystem services, and increasing disturbance around conservation areas [7].

2. Research methods

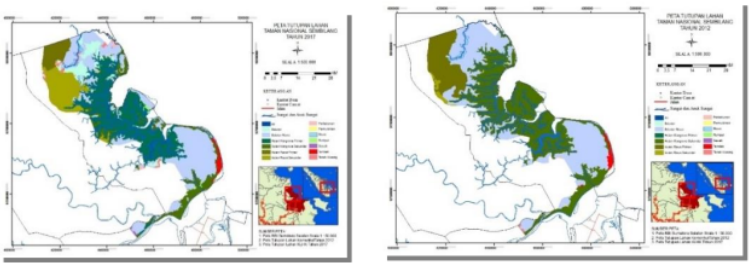
This study used case study research design with a qualitative approach. This research focuses intensively on zoning of the Sembilang National Park crossing and use deviations in each zonation that has been determined. The author uses the survey and interviews method to obtain facts that occur in the research area, namely in Sembilang National Park, Banyuasin District, South Sumatra Province, Indonesia. The data analysis method used in determining TNS sensitivity is Spatial Multi Criteria Analysis (SMCA) by using a limited rational model to produce output in the form of area sensitivity according to its function. The study conducted on January-Juni 2020. Data obtained in the field were then processed and analyzed using QGIS. While the method used to determine the most appropriate criteria is analytical hierarchy process (AHP).

3. Results and discussion

3.1. Sembilang National Park

Sembilang National Park is located on the east coast of South Sumatra Province (104014'-104054' East Longitude and 1053'-2027' South Latitude). This administrative area is mostly included in the Banyuasin II Sub-district area-Banyuasin Regency, and a small portion belongs to the Lalan District Musi Banyuasin Regency, South Sumatra Province. Sembilang National Park has high biodiversity potential with a complete combination of wetland ecosystems that includes 44% mangrove ecosystems, 42% back swamp, 9% swamp forest (freshwater and peat), mud plains 2.5%, pond 1, 5% and sand beach 1% [8]. Mangroves are the largest habitat in Sembilang National Park (±83,447.23 Ha in 2009), densely covered/thick mangrove cover of 44,206.53 Ha (53%), moderate mangrove cover 28,545.16 (34.20%), and rare mangrove cover of 10,695.10 Ha (12, 80%), with 17 true mangrove species and 6 associated mangrove species [9].

In its development, the Sembilang National Park and JICA-RECA identified 4 (four) new species of true mangroves (but not yet published), so that the total number of true mangroves in Sembilang National Park was 21 species, namely *Avicennia marina, Avicennia alba, Avicennia ofificinalis, Aegiceras corniculatum, Aegiceras floridum, Bruguierra gymnorrhiza, Bruguierra parviflora, Bruguierra sexangula, Bruguierra cylindrica, Ceriops decandra, Ceriops tagal, Excoecaria agallocha, Kandelia candel, Nypa fruticans, Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, Sonneratia caseolaris, Sonneratia Ovata, dan Xylocarpus granatum, xylocarpus molucensis* [8]. The area of mangrove forests continues to decline along with the increase in human activities in the Sembilang National Park and surrounding areas, especially for ponds, rice fields and illegal use of wood [2]. Degradation of Sembilang National Park mangrove forests in 2012 - 2017 is presented in Figure 1.



2012 2017

Figure 1. Change in land cover of Sembilang National Park.

3.2. Zoning Sembilang National Park

Zoning of Sembilang National Park consists of core zones, jungle zones, utilization zones, traditional zones, rehabilitation zones and special zones [10-12]. The core zone is a unit within a national park that characterizes a conservation area and functions as a regulator that determines the totality of national park characteristics [13]. Zoning of national park zones is dynamic, zones that have been determined are still possible to be reviewed based on evaluation results. The evaluation of the National Park zone is carried out as a proposal for changes in the management zone needed for management purposes, carried out periodically for a maximum period of 10 (ten) years in accordance with the results of an inventory of the area's potential [14].

The zoning review was carried out based on consideration. First, there was an increase in the area of Sembilang National Park, one of which was the determination of the Marine National Park area so that the area of the Sembilang National Park became ±267,592.42 Ha. Second The use of the Lalan River, Sungai Bungin Kiri and Sembilang River channels for public transportation and the transport routes of HTI companies, oil palm plantations and mining. Third, restoration of ecosystems in the rehabilitation zones located in Solok Buntu and Barong through land rehabilitation, mangrove restoration and natural succession that went very well so that the zone was changed from a rehabilitation zone to a jungle zone (±328.25 Ha). Fourth, to create a balance between the ecological, social and economic interests of the communities around Sembilang National Park. The five dynamics of development around the Sembilang National Park area include the development of the Tanjung Api-api Special Economic Zone (KEK) and the development of a marine tourism area [15]. While the determination of social sensitivity is done by using criteria for distance of settlements and accessibility in the form of rivers/canals and roads (social sensitivity) [16].

3.3. Ecological sensitivity

The TNS sensitivity map based on land cover criteria, shows that most of the TNS area is an area with a low sensitivity level (131,376.98 ha), with the dominance of land cover in the form of mangrove forests and primary peat swamp/swamp forests. The TNS area with medium sensitivity covers an area of 75,620.93 ha with a cover of swamp forest and secondary mangrove. TNS area with a very high sensitivity covers an area of 6,155.31 ha with the dominance of land cover in the form of vacant land, ponds, plantations, rice fields and settlements. The rest (9,965.68 ha), the TNS area is an insensitive category with land cover in the form of rivers, swamps/lakes. Sensitivity maps based on land cover are presented in Figure 2.

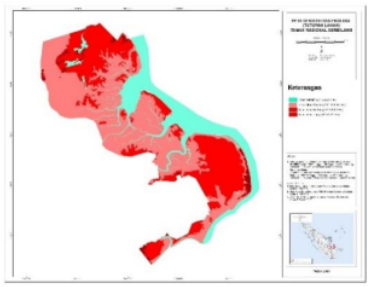


Figure 2. Sensitivity of Sembilang National Park based on land cover.

TNS sensitivity based on soil types in general are grouped into two main categories, namely peat and non-peat soils. As it is known that peat ecosystems have high biodiversity, but on the other hand, peat ecosystems are also ecosystems that are very vulnerable/easily damaged when there is management/disturbance that results in permanent damage, for example due to forest and land fires. A TNS sensitivity map based on soil type, is presented in Figure 3. The next ecological aspect which is an indicator of TNS sensitivity is the depth of the peat. As it is known that in TNS there are at least three (3) peat hydrological units (KHG Air Hitam-Kecil Buntu River), KHG Ngirawan River - Sembilang River and KHG Sungai Sembilang-Lalan River.

The level of sensitivity of TNS is strongly influenced by the presence of KHG and the presence or absence of peat dome is also a factor that determines the level of sensitivity of TNS. The presence of peat dome is an indicator like topography/slope level in bumpy or mountainous areas. The deeper the peat dome, the more sensitive the area will be. Based on the presence of peat dome (peat depth), the TNS sensitivity level is presented in Figure 4. Based on Figure 4, it can be seen that the TNS area with low sensitivity is 183,064.2 ha and the TNS area with medium sensitivity is 9,606.31 ha. While the TNS area which has a high sensitivity is 23,279.2 ha. Based on the three indicators as presented above, the ecological sensitivity of TNS based on land cover, soil type and peat depth is presented in Figure 5.

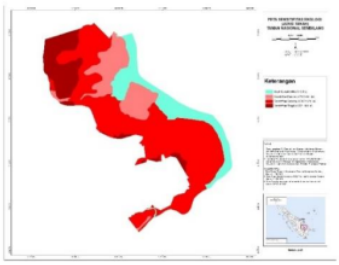


Figure 3. Sensitivity of Sembilang National Park based on soil type.

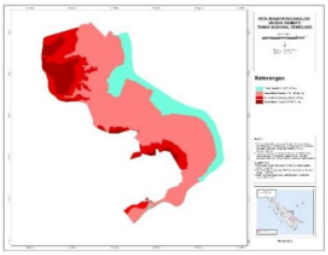


Figure 4. Sembilang National Park sensitivity based on peat dome.

3.4. Social sensitivity

The next step is to conduct an analysis of the social sensitivity of the TNS by using indicators of the ease of community access to the TNS either by road or through the river / river channel. Based on existing settlements, the TNS sensitivity based on existing settlements is presented in Figure 6.

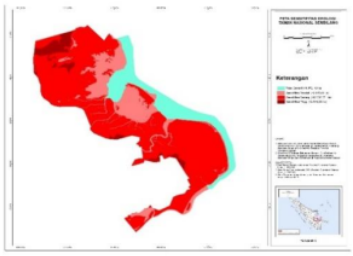


Figure 5. Ecological sensitivity of Sembilang National Park.

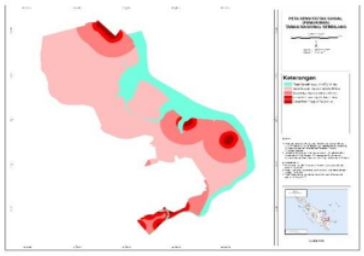


Figure 6. Sensitivity of Sembilang National Park based on the existence of settlements.

Figure 6 shows that the TNS area which has a low sensitivity based on settlement covers an area of 54,377.99 ha and the non-sensitive TNS area covers an area of 197,078.96 ha. While TNS areas that have medium and high sensitivity levels cover an area of 11,335.51 ha and 4,799, 49 ha. The second indicator of social sensitivity is the existence of roads or rivers / canals which are the transportation routes of the community to access TNS resources to meet needs both for food needs (fishery products) and to meet the needs of boards (dwellings) in the form of natural resources in the form of palm leaves, nibung wood, firewood and other wood forest products. Based on observations and information from the community, it is known that there are at least five main rivers that have access to the community, namely the Benu River, Sembilang River, Bungin River, Lalan River and Calik River. TNS sensitivity based on the presence of roads and rivers or canals is presented in Figure 7.

The next step is to conduct an analysis using the AHP to determine which criteria are most important in determining the zoning of the Sembilang National Park. The analysis showed that the most important criteria in determining zoning are presented in Table 1. shows that based on the order of the most important criteria that must be considered in determining the zoning of Sembilang National Park in a row is the existence of peat domes, soil types, accessibility, land cover and the existence of settlements. The presence of peat domes is the most important criteria because the presence of peat domes has high biodiversity potential and is also the most vulnerable area to forest fires. The TNS peatland forest area is divided into three peat hydrological units (KHG) namely KHG Air Hitam - Little Buntu River, KHG Sungai Ngirawan - Sembilang River and KHG Sungai Sembilang - Lalan River.

Table 1. Ranking of Sembilang National Park zoning criteria.

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	Accessibility	0.0899	0.1798	0.4211	3
	Type of soil	0.0964	0.1929	0.4518	2
	Peat dome	0.2135	0.4270	1.0000	1
	Settlement	0.0388	0.0777	0.1820	5
	Land Cover	0.0613	0.1226	0.2872	4

The presence of peat ecosystems in TNS in addition to increasing the diversity of the TNS ecosystem also has an impact on increasing the susceptibility of TNS to fire hazards. The TNS peat ecosystem is located to the west of the TNS and is directly adjacent to the concession area for HTI timber forest product utilization permits. Lowland forests and peat swamp forest areas are very suitable for the development of natural tourism in the form of forest tracking, river conquest, bird watching, and fishing, etc. Communities can benefit from ecotourism services including: transportation services (local boats, speed boats), forest guard equipment rental services, service guides, homestays, restaurants, souvenirs and other services. In some areas the proposed Berbak-Sembilang Biosphere Reserve has developed prospect areas for aquaculture (fisheries) and animal husbandry. Based on the sensitivity of the region

and the results of the selection of indicator criteria that are appropriate to the National Park zoning review, the recommended zoning is presented in Figure 7.

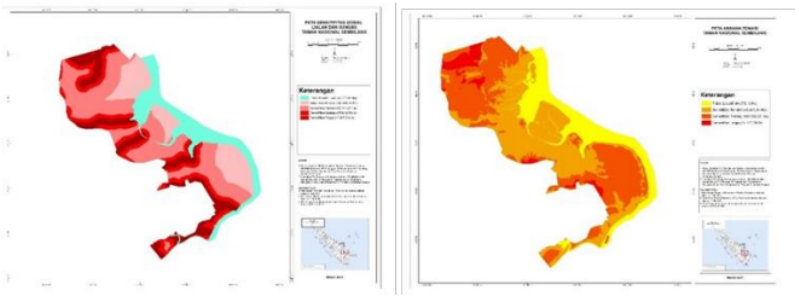


Figure 7. Sensitivity of Sembilang National Park based on the existence of road/river as access.

4. Conclusion

Based on its sensitivity, almost 50% of the TNS area has a moderate to high level of sensitivity to environmental changes as a result of human intervention. Based on the order of the most important criteria that must be considered in determining the zoning of the Sembilang National Park in a row are the presence of peat domes, soil types, accessibility, land cover and the existence of settlements. Increasing the number of population in and around TNS has a direct impact on the increasing pressure on TNS and the use of natural resources, thereby reducing the quality of the TNS ecologically. Some ecosystem service functions that are very important with the sustainability of TNS include the spawning of various types of fish and other fishery products so that they can meet the needs of fishing communities around the TNS, including water conservation, soil and water conservation, windbreaks and sand fixation, and conservation biodiversity.

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