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The Influence of Land Cover Change towards Connectivity Networks of Forest Ecosystem in Tesso Nilo National Park

Aulia Fajrin Ramadhani Nasution [1], Kurnia Yunitasari [1], Muhammad Reza Fauzan [1] and Rizki Atthoriq Hidayat [1]

[1] Departmen of Geography, Faculty of Social, Universitas Negeri Padang, Indonesia
* Coresponding email: arinnasution55@gmail.com .

ABSTRACT: Tesso Nilo National Park is one of the protected areas designated as KPA by the Decree of the Minister of Forestry No.225/Menhut-II/2004 dated July 19, 2004 covering an area of 38,576 ha, then expanded again through the Decree of the Minister of Forestry No.663/Menhut/2009 dated 19 October 2009 with an area of ± 83,068 ha. The Tesso Nilo National Park area is experiencing the dynamics of land cover changes, namely the conversion of forest land which causes the forest area to become increasingly narrow in this area. With the reduction in forest area in this area, it causes a decrease in ecosystem network connectivity due to forest fragmentation that occurs, so that forests are separated and further apart. This study aims to analyze changes in land cover in the Tesso Nilo National Park area to find out information on changes in habitat ecosystems in the last 20 years. the observations were made using satellite images in 1999, 2010 and 2019. so that it can be seen the effect of forest fragmentation on ecosystems in the Tesso Nilo National Park area. From the results of the analysis, it was found that the area of forest cover in the Tesso Nilo National Park decreased from 1999 to 2019 and caused changes in the connectivity network of forest ecosystems, which was found in the study, the weakest connectivity separated forest fragments as far as 17394.47 meters due to forest cover fragmentation.

Keywords: ecosystem network connectivity; fragmentation; land cover change; Tesso Nilo National Park; forest

1. Introduction

National Parks are the last bastion of Flora and Fauna from the threat of habitat destruction. This habitat destruction includes damage due to natural disasters and damage caused by human actions such as illegal logging, land conversion, and others, this has an extraordinary impact on natural damage to forest ecosystems, then the national park is made so that ecosystems and habitats can be maintained, but can a national park really become a home for living creatures' habitat, while it is shrinking every year. According to the IUCN Institute, a National Park is a large nature conservation area, both on land and sea where there are one or more intact and undisturbed ecosystems; in it, there are types of plants and animals and so their habitats, as well as places that are geomorphologically suitable for the benefit of education, recreation, and tourism, prominent natural panoramas; where the community is allowed to enter for that purpose, this could be mean that the national park can only be accessed on a limited basis for research and tourism purposes, not for cultivation, especially production (Totok, 2010) this is also related to nature conservation, in the realm of conservation we can see the existence of human efforts to make ecosystems saver to avoid the extinction. Conservation is a form of processing efforts on natural resources (Totok, 2010).

Meanwhile, according to Law no. 5 of 1990, conservation of living natural resources is the management of living natural resources which their utilization is carried out wisely to ensure the continuity of their supply while maintaining and improving the quality of diversity and its value. This is different from national parks which are now easily accessible by various levels of society, especially resource extraction and land-use changes due to inadequate security. So, this is the case in Tesso Nilo National Park. The Tesso Nilo National Park area was designated as a KPA by the Decree

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of the Minister of Forestry No.225/Menhut-II/2004 dated July 19th 2004 covering an area of 38,576 ha, then expanded again through the Decree of the Minister of Forestry Regulation No.663/Menhut/2009 dated October 19th 2009 with an area of ± 83,068 ha and is designated as a Tesso nilo area. Tesso Nillo is a low-lying area that is have a role as a habitat for rare animals such as the Sumatran tiger (Panther Tigris Sumatra) and the Sumatran Elephant (Elephas maximus sumatrasnus). This area is also not spared from human activities, encroachment on forest function areas, and the destruction of various flora and fauna. Of course this can cause disasters and losses for the environment and humans (Andi Kusumo et al, 2016). Human survival depends on good nature conditions, if nature being damaged then human life will not be good.

The ecosystem is an ecological system which by the reciprocal relationship between living things and their environment (Rahayu Effendi et al, 2018). It can be said that every living thing and the environment are mutually formed with each other. The Tesso Nilo Ecosystem has quite a lot of biodiversity, of course, with the existence of a habitat conservation area for living things, this can be saved, it is known that the ecosystem in Riau Province has changed its function into oil palm plantations and other habitat changes. The Tesso Nello National Park area has lowland forest formations on the island of Sumatra with an attractive landscape, with biodiversity of approximately 360 plant species belonging to 65 genera. The recording method used is that there is no other area in the world that has such diversity of plants as in Tesso Nilo. In general, habitat conditions in this area are quite good with vegetation cover of more than 90%, generally overgrown with types of kempas (Kompassia malaccensis), karanji (Dialium platysepalum), durian burung (Durio lanceolatus), medang (Litsea resinosa), rengas (Gluta rengas, meranti (Shorea sp.), bintangur (Calophyllum macrocarpum), and several other species (Gillison, 2001), 50 species of fish, 12 species of amphibians, 8 species of reptiles, 107 species of aves and 37 species of mammals (Lipi, 2003), and also as a habitat for Sumatran elephant (Elephas maximus sumatranus) and Sumatran tiger (Phantera tigris sumatrae) (TNTN Seminar, 2021).

Forman Gordon said that the landscape is a heterogeneous area formed from various types of ecosystems that interact with the bottom view taken from an airplane is an illustration of a good definition of the landscape from the horizontal dimension. The spread of various land cover/uses in different shapes and sizes can provide an overview of landscape heterogeneity. Changes in the landscape are changes caused by disturbances/allocations in the structure or function of the landscape, either in the form of natural events or human disturbances. Disturbance to function does not always change the structure, but disturbance to the structure will definitely change the structure of the landscape. The ecosystem connectivity of the Tesso Nilo area is decreasing, the cause is deforestation. Deforestation is the activity of changing the function of forest land for agricultural use, and illegal logging. In the last 25 years, Riau has lost more than 4 million ha of forest or 65% of forest cover has been lost, one of which is the Tesso Nilo National Park which makes this situation the cause of human and elephant conflict, causing the Sumatran elephant population to decreased. Forests and land by the Industrial Plantation Forest company as well as the entry of people from other provinces into the Tesso Nilo area by controlling and owning 60% of the land in the Tesso Nilo National Park (TNTN) area and converting it to oil palm plantations (Romes Irawan Putra, 2016). The habitat of flora and fauna in Tesso Nilo National Park is increasingly threatened. The biggest threat to Indonesia's forests is the opening of plantations, and the rate of plantation expansion, including converting forest areas, community gardens, and agricultural land (Hidayah et al, 2016). The Tesso Nilo ecosystem area covers 3 regencies, namely Kampar, Pelalawan, and Kuantan Singingi, including the Tesso Nilo National Park (TNTN) area and the surrounding production forest area with an area of around 916,343 ha. Currently, the Tesso Nilo National Park area of 81,793 ha has encroached on an area of 44,544 ha (54%) (Romes, 2016).

One of the threats to habitat preservation is the forest destruction, which is dangerous for various types of animal species. Forest fragmentation is to breaking up of a large forest area into smaller ones, forest fragmentation affects species richness, the process of formation of naturally occurring fragments, fragments due to disturbance, and original fragments. In this discussion, referring to fragments that occur due to disturbance, these changes change a new original habitat

which triggers the process of moving species, plants, and animals. Species that cannot adapt to new habitats will of course moving or die, which leaves population dynamics and biodiversity. The decreased of the forest connectivity is due to forest fragmentation, namely the encroachment of forest ecosystems and the conversion of forest functions that occur in Tesso Nilo National Park such as forests, shrubs, plantations, and vacant land. It can be seen that the change in forest area fragmentation every year is getting narrower, where the forest area has become less in the last period. Scrub, bush, and reeds cover types are a form of degradation of a forest area due to disturbances that cause the distance between forest fragments to occur causing animal movement and hindering the mating process. The change in fragmentation is a disclimax form of primary forest and land forest (Sugeng and Chandradewana, 2009). Deforestation and forest degradation pose problems for biodiversity conservation, namely habitat loss. Fragmentation and isolation of species in and protected areas between biodiversity centers, result in interior species in narrow habitats that can trigger extinction, especially large-bodied species (Prasetyo, 2017). An example of a large-bodied species in the Tesso Nilo forest area is the Sumatran elephant, which is a species with a wide-roaming range, which has difficulty moving from one area to another. This results in conflicts with the community because these animals enter plantations or villages. In addition, the value of the species is also a target for hunting because it has an economy. National parks in Indonesia are in-site ecosystem areas for both local and local flora and fauna species. The area of Tesso Nilo National Park is designated for the conservation of Sumatran elephants. Sumatran elephants need a habitat that is able to support their needs for food, protection, and movement. The uncontrolled presence of invasive species can result in habitat destruction and the proximity of the development and growth of native plant species which are the source of food for Sumatran elephants. The changing composition of the ecosystem and habitat destruction by land clearing and the presence of dangerous species, of course, endanger the existence of the Sumatran elephant in Tesso Nilo National Park (Andi K et al, 2016).

The problem encountered is the function of the forest in the Tesso Nilo National Park area over time it can be seen that the forest area that can be maintained is decreasing. The use of Geographic Information Systems in making changes to land cover is very necessary for preventing exploitation and conversion of forest land that causes environmental degradation and using data obtained from Geographic Information Systems can predict the extent of land changes that occur in the future. Arie Yurikho Ginting et al, 2019).

The purpose of this study was to analyze changes in land cover in the Tesso Nilo National Park area to find out information on changes in ecosystems in the last 20 years. Then observations were made using satellite images in 1999, 2010, and 2019. So that it can be seen the effect of forest fragmentation on the ecosystem in the Tesso Nilo National Park area. As a result of deforestation and encroachment in the forest area of Tesso Nilo National Park.

2. Methods

The approach used in this research is the quantitative method. According to V. Wiratna Sujarweni (2014:39), quantitative research is a type of research that produces findings that can be achieved (obtained) using statistical procedures or other means of quantification (measurement). This study uses a quantitative method that analyzes the effect of land change on ecosystem network connectivity in the Tesso Nilo National Park area, Pelelawan Regency, Riau Province.

The location of this research was carried out in the Tesso Nilo National Park, having the address at Jalan Raya Langgam KM 4, Pangkalan Kerinci, Pelelawan Regency, Riau Province. This is based on obtaining information about the effect of land cover changes on ecosystem network connectivity in the Tesso Nilo National Park Area, Pelelawan Regency, Riau Province.

The data used in this research is satellite image data. The images used in this are Landsat 5 TM images with time in 1999 and Landsat 8 OLI images with research times in 2010 and 2019. Landsat 5 images have a resolution of 30x30 m. Landsat 8 OLI imagery has a spatial resolution of 30x30 m and a radiometric resolution of 16 bits. The data can be obtained from the United States Geological Survey (USGS) which is obtained free of charge at http://earthxplorer.usgs.gov.

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Radiometric Correction

In this study, we perform image correction using radiometric correction. Radiometric correction is a basic image correction carried out to remove noise contained in the image as a result of distortion by the position of sunlight and one example of satellite imagery that requires this process is Landsat satellite imagery (Rahayu & Candra, 2014). In this study, radiometric correction is carried out to correct the pixel values disturbed by atmospheric disturbances so that the pixel values will be corrected according to the object's actual reflected value. This correction process is carried out in Envi software by reducing the minimum value of each band in the image with the default minimum value that already exists in the image. The method used in this correction is a fairly simple method, where the formula used is as follows.

$$\text{Corrected DN} = \text{Band} - \text{Bias (minimum value)}$$

Information :

Band = Band to be corrected

Bias (minimum value) = Default minimum value on band

Image Cropping

Image cropping is done to take the area that is the object of research by using images based on the administrative area of the National Park Area, thus providing a more focused area boundary. The purpose of cutting the image is so that the processing process becomes lighter.

Digitation on Screen

In land cover classification, we use satellite image interpretation to get the results of the land cover changes. Interpretation is done by digitizing one by one according to land cover class manually using ArcGIS software to convert land cover data digitally and more specifically. Digitation is the process of converting geographical features on analog maps (raster format) into digital format (vector format) using a computer digitizer table (ESRI, 2004). The digitization process is carried out by delineating the boundaries on objects that are useful for limiting an object so that it is easy to observe and can distinguish it from other objects. The digitization was carried out on the third image, namely the Landsat 5 TM image in 1999, and the Landsat 8 OLI image in 2010 and 2019. The digitization results represent the land cover that has been determined, then fill in the attribute data according to the name of the land cover class and the code number for the class used.

Graphab Analysis

In this study, we performed an ecological analysis using software called Graphab which is a theoretical tool for modeling ecological networks from a graph framework. Graph theory is useful in conservation efforts where a vertex can represent where a certain area is located and an edge represents a migration path. The formal mathematical definition for a graph can be denoted as follows:

$$G = (V, E)$$

G = Graph

V = The non-empty vertex set contains vertices/vertex/node $\{V_1, V_2, V_3, \ldots V_n\}$

E = The set of edges/lines/edges denoted by vertices $\{e_1, e_2, e_3, \ldots e_n\}$

Graphic analysis was carried out to design a habitat connectivity model to make it easier to describe how landscapes can have an impact on living species and to support land use-related designs where biodiversity is an important consideration (Foltête, et al 2021). In this study, graphic analysis was carried out to analyze the connectivity network of forest ecosystems in Tesso Nilo National Park.

In processing graphab files used in the form of raster data. In the graphab, a raster file contains information about the stored value and the core habitat required as input. The habitat patch is then limited by selecting the minimum area including (4 connections) as part of the habitat patch, with a minimum patch area of zero. In the calculation process related to the matrix, a barrier effect index is applied where for a corridor-type class the effectivity coefficient value is 1 meter, neutral class is 1000 meters, agricultural class is 750 meters, natural class is 500 meters, and barrier class is 250 meters (Marulli and Mallarach, 2004). This function is performed to extend the corridor path that stretches

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above the specified permeability matrix limit so as to provide relevant results. A minimum distance model that displays the shortest path can avoid disturbance and ensure that species complete migration smoothly so that they can know all the biodiversity that exists. The formula is as follows.

$$MCR = f\ min \sum_{j=n}^{i=1} (\text{Dij x Ri})$$

MCR = Basic Basic Values
f = Unknown positive function
D_{ij} = Species distance from ecological source patch to landscape unit i
R_i = Landscape unit resistance coefficient I to the movement of several species

3. Results and Discussion

Types of land cover that are correlated with forests, shrubs, and plantations can become a habitat that has the potential to be inhabited by various types of wildlife due to the density and diversity of plant species in it so that on this character there can be a form of movement of animals from one location to another properly without any obstacles. In the form of the existence of bareland or built land that can cut off the existence of the space for their movement. The land cover of the Tesso Nilo area is divided into four classes, including forest, shrubs, plantations, and bareland obtained based on the process of interpreting Landsat 5 and Landsat 8 images with a spatial resolution of 30 meters with a sample year of image collection being 1999, 2010, and 2019.

The satellite image sample used was previously preprocessed in the form of radiometric correction, which is the process of improving the pixel value in satellite images due to radiometric errors in the form of atmospheric disturbances in order to improve the visualization of the image so that it is easier to identify land cover fragments in it. This correction is the correction process that is mostly carried out before the image processing process to eliminate radiometric errors in the image as a result of distortion by differences in sunlight, cloud cover or light fog so that it can shift the pixel value in the image used. This improvement process is carried out on the Envi software by reducing the minimum value of each band in the image with the default minimum value that already exists in the image so as to produce an equivalent minimum value between each band, namely 0. This process is continued by manually digitizing the ArcGIS software to use digitally and more specifically convert the land cover data. The resulting object is in the form of vector data using the digitized method on the screen with an image that has been pre-processed previously as a spatially referenced base layer. The digitized results on this screen represent the land cover that has been previously determined and attribute data is filled in according to the name of the land cover category along with the identification of the numeric code for the class used. The results of this process show the dynamics of land cover in Tesso Nilo National Park in the last 20 years and can be seen in Figure 1 below.

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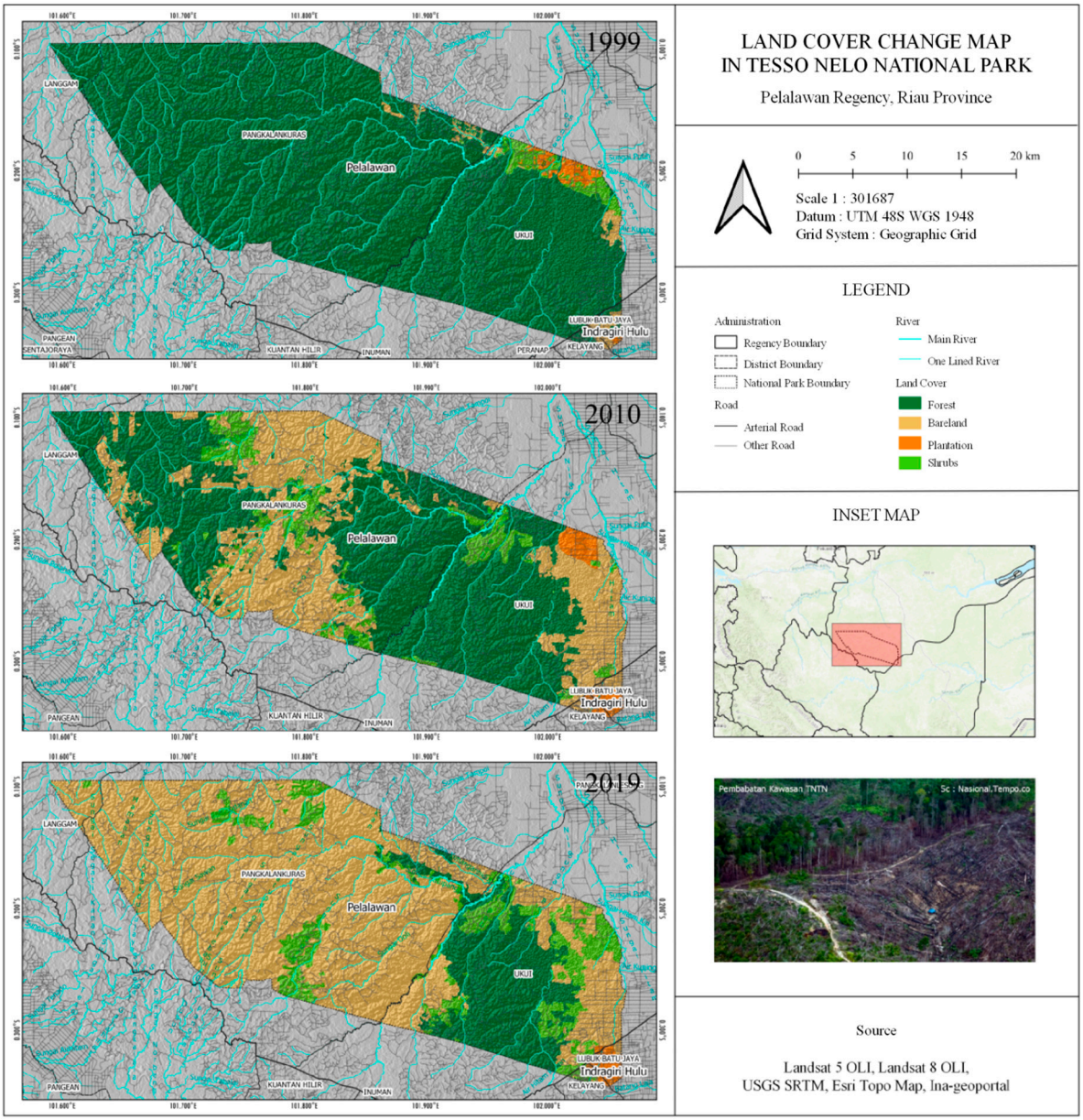

Figure 1. Tesso Nilo National Park Land Cover Change Map.

A map showing the land cover dynamics of Tesso Nilo National Park is needed to see how much change has occurred above this priority. Judging from the results of image interpretation using the digitizing method on the screen in Figure 1, 1999 was a year with very good land cover conditions compared to the following years, although there was little bareland and plantations on the northeastern side of the National Park. Very critical land cover was shown in 2019 when almost all of the forest in the area began to be cleared with bareland and was marked by a fairly large forest fragmentation process in 2010. The results of the land cover analysis of the landscape of Tesso Nilo National Park sequentially from 1999, 2010, and 2019 showed significant degradation of forest areas by 82.28%, an increase in shrubs by 84.64%, and an increase in bareland areas by 97.65%. In terms of convenience in observing the results of changes in land cover dynamics of Tesso Nilo National Park in the last twenty years, it can be seen from the presentation of the following Table 2.

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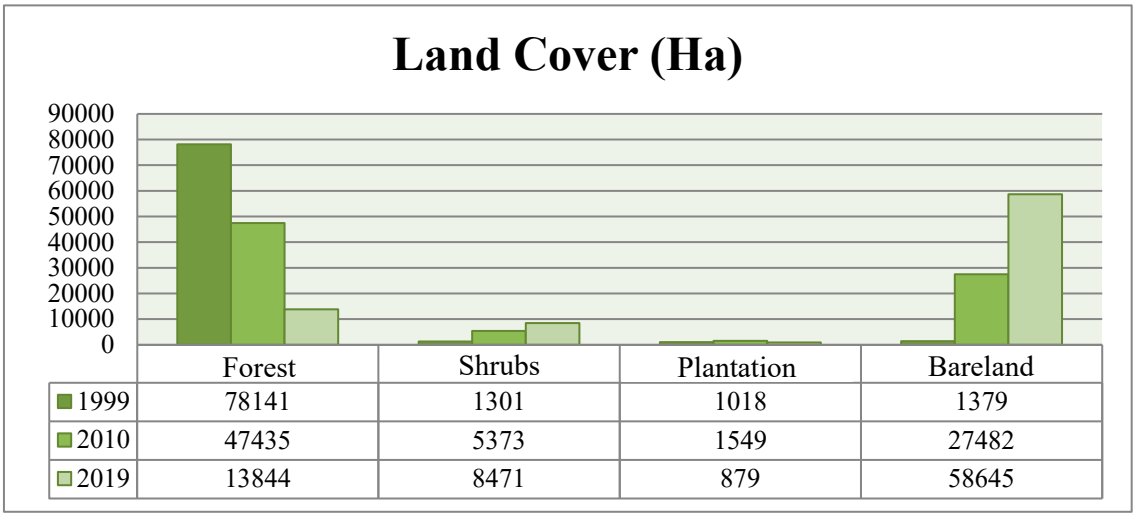
Table 2. Land Cover Area of Tesso Nilo National Park (Ha).



	Forest	Shrubs	Plantation	Bareland
1999	78141	1301	1018	1379
2010	47435	5373	1549	27482
2019	13844	8471	879	58645

Table 2 above shows that there are indications of a decrease to an increase in area in each variable of land cover types that can be observed visually. The forest area reached an area of 78141 Ha in 1999, decreased in 2010 by 30706 Ha, and in 2019 as much as 64297 Ha from the initial area. On the other hand, the results of the bareland have increased from year to year respectively as much as 26103 Ha and 57266 Ha from the initial area. Changes in the land cover area certainly have a big influence on the connectivity of the Tesso Nilo National Park ecosystem area which appears in the form of changes to forest fragments.

After getting the results of data collection on the distribution of land cover, then the processing is carried out using the Graphab method. The analysis process uses an approach from related methods to design a habitat connectivity model to make it easier to describe how landscapes can have an impact on living things and support the design of regulations with land use where biodiversity content is an important consideration to pay attention to (Foltête, et al 2021). The Graphab approach used is an ecosystem habitat network connectivity approach with a set-probability level of connectivity between habitat fragments. The function settings of the graph are presented to reconstruct the landscape network and calculate the matrix from land cover classification data in ASCII raster format to facilitate the code related to the character encoding of the data to be used. In the calculation process related to the matrix, a barrier effect index is applied where for a corridor type class, the affective coefficient value is 1 meter, neutral class is 1000 meters, agriculture class is 750 meters, natural class is 500 meters, and barrier class is 250 meters (Marulli and Mallarach, 2004). This function expands the spatial path of the corridor where the expanse of the stretch is determined by the terms of the permeability matrix distance which gives relevant results to the processed data. Each line from the processing of this graph represents a potential corridor which is an area where the movement of individual animals can occur in it. For the Tesso Nilo National Park area, the results of graphic processing visually show the occurrence of habitat fragmentation which is really significant in the last 20 years so it provides a very significant change in connectivity between potential habitat fragments in this area as shown on the map in Figure 2.

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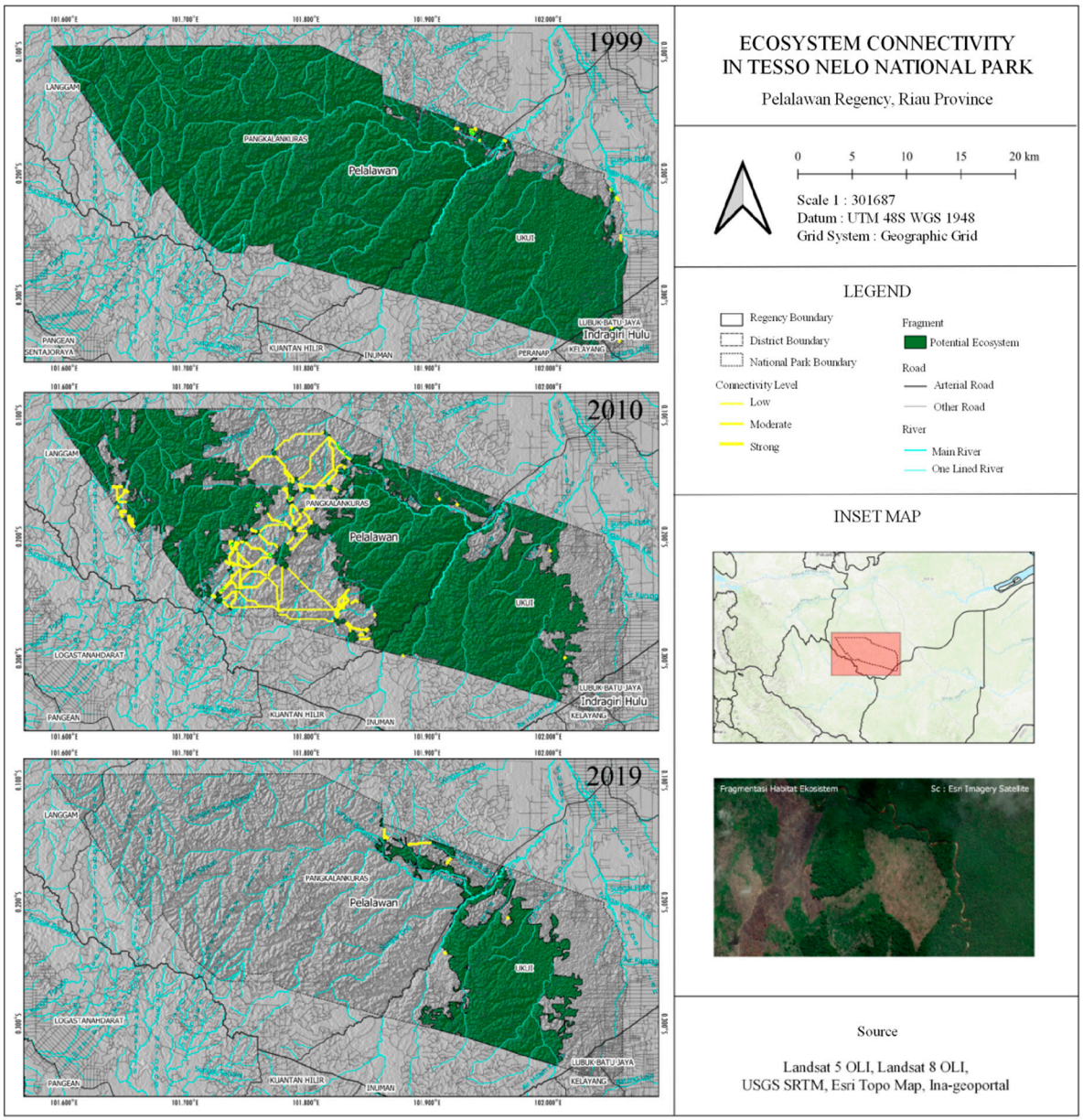

Figure 2. Tesso Nilo National Park Land Cover Connectivity Map.

Referring to the results of Graphab processing, the minimum value of connectivity distance which is a class with an average strong connectivity effectiveness level in each span of the research year was found to be 42.42 meters while the maximum distance value which indicates a low level of connectivity effectiveness was found in 2019 as far as 17394.47 meters. The results of finding the minimum to maximum distance values for each year of research are presented in the following table

Table 2. Minimum and Maximum Distance Connectivity Finding.

Minimum Distance and Maximum Connectivity (m)			
Strength Level	**1999**	**2010**	**2019**
Strong	42.42	42.42	42.42
Low	390	5783.31	17394.47

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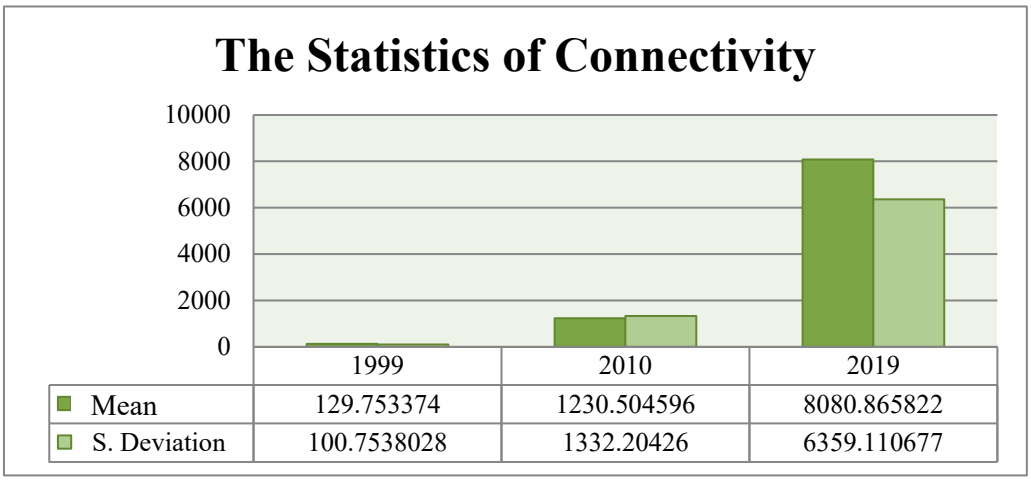
The analysis of the analyzed ecosystem network is based on the dynamics of the strength of the surrounding environment, the possible distribution of species habitats, as well as random opportunities obtained from processing the variables used. The replicated data set with additional data and information can increase the power of the results in describing, explaining, and predicting the structure of the network of variables used (Poisot et al. 2016). The length of the network processed by the data provides information on potential disturbances that can arise by providing a measurement of how dense the network is in a landscape area (Delmas, 2018). If the connectivity network is considered to be still dense and congested, it is certain that the potential for interference will tend to be lower than the connectivity network which is rarely spread out and far apart. The results of the analysis of the distribution of ecosystem network connectivity to the variable distribution of forest fragments found as many as 17 segments in 1999 with strong connectivity in the 0-500 m class with a maximum distance value of 390 meters. This result is considered related to the overall condition of the forest which is still good and not too disturbed by land clearing activities or activities. In 2010 the distribution of the connectivity network was divided into 121 segments and served each class of strong, moderate, to low connectivity strengths. As for 2019, where forest fragments are decreasing than before, there are 10 segments of which 3 are in the moderate connectivity strength class and 7 segments are in the strong connectivity strength class. Details of the connectivity segment findings of each fragment based on its class can be seen in detail in the following table where the findings are compared with the reduction and addition of forest fragments every year.

From Table 3 we can see in what year the number of connections increases and decreases to the distribution of forest fragments in each year. It can be determined that the results are also related to the average and graded distribution deviations from the class of strength provisions that have been determined and can be observed visually from Table 4.

Table 3. Connectivity Room Class.

Connectivity Level				
Strength Class	**Distance Range (m)**	**Number of Connections**		
		1999	**2010**	**2019**
Strong	0 – 500	17	49	7
Moderate	500 – 3000	0	61	3
Low	> 3000	0	11	0

Table 4. Tesso Nilo National Park Connectivity Statistics Calculation (Ha).



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Tesso Nilo National Park has a small amount of connectivity but in such a strong level in 1999 can also be determined from the average distance which is within a distance of 129.75 meters with a distribution deviation of 100.76 meters. In 2010, along with the distribution of the largest forest fragments, the average strength of ecosystem connectivity was in the medium class as far as 1230.51 meters with a deviation of 1332.21 meters. The year 2019 was the year with the lowest connectivity strength with an average in the weak class of 8080.86 meters, and the standard deviation of the distribution deviation was 6359.12 meters. The lower the graph, the stronger the level of connectivity strength will be.

The results of this study provide evidence that in the last twenty years there has been a very large reduction in forest area in the west and east of Tesso Nilo National Park. Encroachment of forest areas is usually followed by a process of land occupation which is also synchronized with land clearing in the form of forest logging, clearing of plantation areas, and forest fires. The problems that arise in the Tesson Nilo National Park area are relevant to the fact that there is an overlap in the perspectives of stakeholder interests in this area. The existence of these interests at the same time often makes claims over the land area in the National Park (Handoyono, 2015), the area of the Tesso Nilo National Park is 81793 Ha and the status as a permanent forest area or national park area is only 13844 Ha in 2019 and in this case, clearing is also found. There are also facts based on Weatlands International's findings that almost all forest fires in Indonesia arise as a result of human activities intentionally or there is no evidence of fires occurring naturally yet (Wibisono et al, 2005 in Totok Dwi Diantoro, 2011).

The obvious damage to land cover conditions in the landscape of Tesso Nilo National Park affects ecosystem connectivity in terms of its distribution. We agree with the explanation that the results of the connectivity network analysis show that there is a good correlation between the distribution of forest fragments with other variables that become a point of attention, such as the increase in the area of shrubs, plantations, and bareland. The reduced area in forest cover can lead to no space for animals to move, resulting in isolated habitat problems as well as the possibility of decreasing opportunities for both animals and plants to reproduce. The combination of habitat isolation problems, limited habitat distribution space, as well as low reproductive ability due to lack of space to develop can increase the possibility of certain types of organisms (Kadmin and Allouche, 2007). The presence of forest fragments may be a symptom that can be revealed that ecosystem connectivity in the Tesso Nilo National Park is in a very bad condition, especially for one of the key animals in this area, the Sumatran Elephant. This very strong influence in the protected zone can only be expected to recover with the presence of several connections connecting fragments to other fragments, and of course with not so far distances. The spatial pattern that emerges from the results of the Graph analysis can be a serious consideration for the restoration of the Tesso Nilo National Park area. In terms of connectivity, the natural land cover index shows a simple ecosystem linkage model based on distance and cover that allows for pockets of habitat for species within the ecosystem coverage of Tesso Nilo National Park. The use of the Graphab method as a model for the landscape area can be the main step in analyzing the natural area of the Tesso Nilo National Park and then between the dynamics of activities related to biology and habitat fragmentation in the area.

The impact of problems related to connectivity causes ecological damage which is quite ironic. This land that has been converted must be returned to an area that should function as a National Park for the interests of large or small investors because the conflicts that occur in this area related to humans and animals are of course high. Not only related to animals and humans but even between indigenous people and migrants, cultivators and owners of capital, to the government (Tanda Pinem, 2016). Another problem is the occurrence of land clearing either because forest fires can increase the level of cultivation of plantation lands such as oil palm and others so that land with monoculture plants will expand in this area so that the environmental quality of endemic animal habitats will decrease as well, changes in the dynamics of the hydrological function of the local area, breaking a certain chain system, some populations in the ecosystem area move territorially and cause animal conflicts at the same time.

Restoration of the land functions must be optimized by considering that this priority area only leaves 13844 Ha of forest area whereas in the other hand should be an area to provide good air absorption, the existence of a maintained water source, the availability of tree canopy cover that can become an area of flora and fauna and the development of ecosystem protection within it. This area is considered very important in being a concern to maintaining balance and becoming the surrounding ecosystem, and it would be better if it continued to be developed throughout its scope. There is connectivity that tends to be at a strong to a moderate level in 2019 although with an increasing area it is a separate form of support in improving functional recovery because the closer the connectivity is, the greater the level of distribution of organisms can occur around the area, of course, by looking at the critical conditions of Tesso Nilo National Park, the area needs help by human hands directly. It should be noted that although the level of land quality in the Tesso Nilo National Park area is good for agricultural potential, it is necessary to pay attention so that the expansion rate of the area does not increase in the future so that the area of this protected place only remains as an imaginary area, with the habitat and conservation function that should be exist becoming lost. It is actually can be followed up by utilizing spatial modeling as a basis for preventive measures in this problem. The results of spatial modeling are used as a link between variables that provide a significant role in modeling, especially habitat modeling or ecosystem threats (Hidayat and Hanif, 2020). From the results represented in the variable data processing, there is an interrelated relationship in influencing the effect of land use change on the connectivity of the Tesso Nilo National Park ecosystem network which has been successfully proven on the effectiveness of the use of geospatial technology in displaying information, both quantitatively and visually on the interaction of variables within the scope of the area under study.

4. Conclusion

The results of the classification of landscape land cover in the research area, we can conclude that Tesso Nilo National Park is experiencing forest degradation as a medium for storing key ecosystems at a very significant level, and in this case, the biggest obstacle that arises is the increase in the area of shrubs, and bareland area, although there is also a slight influence from the presence of plantation land on the east side of TNTN. Conditions with reduction in the area of habitable ecosystems for local organisms in the Tesso Nilo National Park also have an influence on the range of connectivity between each fragment so that in the final result the value of the lowest connectivity strength is 17394.47 meters. The connectivity network in the Tesso Nilo National Park area has a wide range of segments based on the length of the line connecting each existing ecosystem fragment, where a good network has few obstacles and a short distance that can connect every surrounding area and vice versa. Land clearing activities by humans, whether for agricultural purposes or for other things, greatly affect the availability of adequate ecosystem follicle in this area and of course can lead to the isolation of species development and habitats of natural organisms, the urgency of territorial changes, and also animal conflicts. Bareland, plantations, and shrubs cannot be relied upon to maintain local ecosystems, especially in relation to large animals, due to their limitations in providing a place for growth and development as well as forested areas with a canopy and dense vegetation on the floor. This research can be useful as a basis for reference with methods that can be implied in the application of other ecosystem evaluations and even related to living natural habitats in various areas. It can be hoped that by looking at the example of evaluation in the Tesso Nilo National Park ecosystem, the critical land which was actually recorded by the data could be carried out rehabilitation steps to restore the original function of the area as it should be in the future.

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