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Webgis-Based Land Suitability Using Remote Sensing Technology in Merauke Regency of Papua

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ABSTRACT
The potential of an area for agricultural land development is basically determined by the physical nature of the environment which includes climate, soil, topography / shape of the region, hydrology, and some certain usage requirements. The suitability between the physical environment characteristics of an area with the certain requirements of use or the commodity to be developed provides an illustration or information that the land has a potential to be developed for such purpose. One of the problems that need attention is the suitability of the land to the type of use. Therefore, we need the right land suitability and in accordance with land use. In this study, the researcher developed Land Suitability Model in Merauke Regency of Papua and the study areas concerned in Merauke District, Semangga District, Tanah Miring District and Kurik District. The purpose of this study is to determine between the suitability land use and Merauke Regency Regional Spatial Plan. This study use a methodology based on Web-based Geographic Information Systems (WebGIS). The method developed is a combination of spatial data analysis and field data which is processed by using remote sensing system with OSMF (Open Street Map Foundation) image. This study produces seven land classification classes that are displayed visually by WebGIS-based land suitability model and they are such as classification of paddy land, developed land, low density forest land, medium density forest land, high density forest land, irrigation and airport

Keywords - WebGIS, Remote Sensing, Merauke, Papua.

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I. INTRODUCTION

Development in various sectors can be done if adequate land is available. The development of an area will be seen in changes of land use patterns which are a combination of the types of human businesses, the level of technology mastered, as well as the type and number of human businesses related to space. Population growth demands an increase in infrastructure which require space to accommodate all activities in the future.

There are various issues regarding land and its use often appears along with the development of an area. The bigger and more developed of a region and there will be more problems that arise. One of the problems that must be concerned is the suitability of land toward the type of use and potential land use after the land is increased [1].

Land is included as a physical or natural potential that will not increase in quantity, while population growth continues to experience rapid development over time. This case will cause an imbalance between the population's need for unlimited land and a limited amount of land. However, the more increase of population and increasing of development, the land needs also will increase more, especially the land for agriculture.

The land use which can survive and suitable with the time changes are land uses that are in accordance with land condition, soil and rock characteristics [2], location of land and related to other land use around it and land that is not productive [3]. Terms of land use can be suitable with the development of the era which contained in the criteria for the direction of the function area, such as both function of protected area, the buffer function area, and the area of the cultivation function. The research conducted by [4] - [10] is also used for the development of this research.

The development of world information system has been developing very rapidly, one of which is Geographic Information System (GIS) of Web based (*WebGIS*). With the existence of various *WebGIS* software, various spatial modeling analyzes can be carried out, including regarding the suitability of land use to the direction of area functions by using certain methods related to various factors that influence [11] - [14].

One of the methods that often used is *remote sensing* method. Remote sensing is defined as the process of obtaining information about an object without direct physical contact with the object. Information is obtained by detecting and measuring various changes in the land where the object is located. The process is carried out by touching or recording the energy reflected or emitted processes, analyzing and applying the information. Information is potentially captured at an altitude through energy that is built up from the surface of the earth, which is obtained in detail from variations in the spatial, spectral and temporal variations of the land.

The variations of spatial, spectral and temporal variations provide additional information that is complementary. The distribution of straight-line formation that forms pathways provides information on the existence of an activity of the study site. Regular formations that resemble as like houses can add an information that the location is also a place to live. Two of that information comes from the spectral variation of objects, such as the brownish red color clarifies the difference in the collection of house objects with the location of land which covered with green vegetation. This additional information comes from the spectral variations of objects which can increase the accuracy of object identification in detail. Changes in the number of objects of a location contained in two or more images will provide information about the growth of the phenomenon in the research location.

The ability of remote sensing technology in the acquisition of extensive information without direct contact with the object is widely used in various spatial matters. Recently, the remote sensing has been applied for the purposes of environmental management, ecology, land degradation, natural disasters, to climate change and still it is being used until now.

Remote sensing as a science and technique to obtain information about an object on the surface of the earth without direct contact with the object which is still being studied has developed rapidly in line with the increasing need for natural resource information. This thing was triggered by the enactment of Law number 32 of 2004 concerning Regional Autonomy which required the management of territories in the Regency and City levels, so that detailed information up to that level must be available. This development can be seen in the increasing importance of the use of remote sensing for the supply of natural resource information and the changes that occur in it as well as the environmental impacts caused by its management nowadays.

In line with technological developments, the use of satellite imagery is very helpful in recording resources for tapping information quickly on natural resources in an area for various purposes including the need for evaluating the suitability of land use in region of Merauke Regency, province of Papua.

II. RESEARCH OBJECT

This research was conducted from March to August 2019, by taking locations in 4 (four) districts in Merauke district, namely Merauke district, Semangga district, Tanah Miring district and Kurik district. The people in Merauke Regency who are involved as sample areas of this study in these 4 (four) districts are generally farmers. In clearing land for agricultural purposes, there are still many people do not pay attention and give concern to factors affecting the land such as topography, geology, soil conditions, water, and vegetation as land cover, but simply ignore as long as the land can be overgrown with plants. The impact of inappropriate use of agricultural land resulted in the destruction of forest land in Merauke Regency.

This case can be found in other cities of Indonesia as like Merauke Regency, it has the characteristics of physical environmental problems which are relatively similar to the environmental problems faced by other regions in Indonesia. Therefore, it needs efforts to provide information about land suitability, especially to support increased agricultural production and maintain the sustainability of land resources in rural areas, it is also necessary to apply practical research methods so that data collection and implementation of land suitability evaluation can be done quickly.

In this study, the researcher developed WebGIS-based land suitability model by using remote sensing methods in Merauke Regency of Papua. This model is able to help the government in Merauke Regency to develop a regional spatial plan for land suitability online. This way also can be used by policy makers in the management of agricultural land in Merauke Regency.

III. RESEARCH METHOD

This research was conducted with visual and digital interpretation of remote sensing imagery of the research location to obtain tentative maps which were then used for field survey. The data used in this study are primary data. The primary data for this research is conducting open interviews with the community in the research location and direct observation by researchers in the field and also by taking photos directly. Meanwhile, the remote sensing is using OSMF (*Open Street Map Foundation*) satellite imagery.

1. Composite Image

Composite image that is combining 3 bands namely Red, Green, and Blue which aims to facilitate the identification of colors from land use.

2. Geometric Correction

Geometric correction is a correction of the image position due to geometric errors. Geometric correction is done by using a reference control point known as the *Ground Control Point* (GCP). In this study, geometric corrections were made to both images by using Google Earth Maps as a reference for correction. Determination of the coordinate point is carried out at locations identified as paddy fields, vacant land, developed land and others. The next step is making a training Area by digitizing coordinates in the image based on the coordinates of the location of each sample. After creating the *training area*, we can calculate statistical data (*Calculated Statistics*). Classification of *training areas* can be done after the statistical calculation process is complete. The classification used is *Supervised Classification*.

3. Cropping Image Data

Cropping is a way that aims to cut the image in accordance with the administrative boundaries of the study area so that the research is focused only on the research area.

4. Creating Sample Area

Making the sample area or Training Area is done to determine the class identifier (Class Signature). Creating sample area is an activity to identify a prototype (cluster) of a number of pixels representing each class or expected category. This activity is carried out by determining the position of the sample in the field with the help of imagery as a reference for each land cover class.

5. Classification

Classification is a technique used to eliminate detailed information from input data to display important patterns or spatial distribution to facilitate image interpretation and analysis so that useful information is obtained from these images. This research uses Malingreau classification system as a reference in carrying out the classification. In the phase of mapping land cover, its result can be obtained from the multispectral classification process of satellite imagery. Multispectral classification itself is an algorithm designed to present thematic information by grouping phenomena based on one criterion which is called as spectral value. Multispectral classification begins by determining the pixel value of each object as a sample. Then, the pixel value of each sample is used as input in the classification process. The acquisition of land cover information is obtained based on color in the image, static analysis and graphical analysis.

6. Multisprectral Classification

Image classification is the most important part of digital image analysis in order to identify and then classify image characteristic patterns in one or a number of classes and categories of objects, for example classification in determining the mainstay economic areas using decision tree techniques [15] and classification of potential risk areas in the health sector using neural network modeling [16].

The basic understanding of multispectral classification is the concept of object spectral ladder as a function of wavelength spectrum and electromagnetic radiation. The spectral classification of remote sensing images aims to produce thematic maps, in which each color represents a particular object, for example forests, rice fields, etc. Classification can be interpreted as the activity of grouping symptoms into some categories where each category can be considered homogeneous on the basis of certain criteria. The results of this classification or classification are usually in the form of a map based on the distribution of different symptoms. Image classification is also a technique which is used to eliminate detailed information from input data to display important patterns or spatial distribution to facilitate interpretation and analysis of images, so that images can be obtained from useful or appropriate information. For mapping land cover or land use, the results are obtained from the multispectral classification process.

7. Supervised Classification Method

In this supervised method, the researcher first sets several sample areas (training areas) on the image as a specific land class. This determination is based on knowledge of the analysis of the area in the image of areas of land cover. The pixel values in the sample area are then used by the computer as a key to recognize other pixels. Areas that have similar pixel values will be included in the predetermined land class. Therefore, in this supervised method, the researcher identifies the information class first which is then used to determine the spectral class that represents the information class.

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IV. RESULT AND ANALYSIS

The previous data processed was OSMF Image (Open Street Map Foundation) coverage area of Merauke Regency with the research areas in four districts. This processing data phase includes image geometric correction and image cutting which aims to focus on the study area of research namely Merauke district, Semangga district, Tanah Miring district and Kurik district.

1. Identification

An object on the surface of the earth in satellite imagery can be visually recognized through

its composite color. In order to be able to display this composite color, it requires a combination of three bands on the Red, Green and Blue. In addition to composite colors and to distinguish more each object must also be recognized texture, shape and its association with other objects. The sensor can measure and record the time from the moment it emits electromagnetic waves to the sensor. Based on the travel time of the pulses, the distance of the object can be calculated and based on the intensity of the backscattering the object type can be estimated.

2. Image Correction

Geometric correction of image is done in order to get the position of the image in accordance with the actual position on the surface of the earth. This is very necessary because the initial image is still experiencing position errors. Errors can be seen from the plot of the data coordinate samples taken in the field and they are still far from the position they should be. Geometric corrections are carried out by using the image to map rectification method using GCP (*ground control point*) taken free of charge from Google Earth device. Data from Google Earth is used because it is not only easy to obtain, but also because the use of RBI maps in this geometric correction actually adds to the error and it is difficult to do. Another consideration for using data from *Google Earth* is that the display image is sourced from a digital globe image that has a higher resolution.

Geometric correction was carried out on a total of 80 points of OSMF (Open Street Map Foundation) imagery from four research districts. GCP retrieval on the reference data also considers the appearance of the image to be corrected OSMF (Open Street Map Foundation). It has been known that in general, the object or location chosen as the bonding point must have a clear appearance and be able to interpret well on the image and most likely not experience changes over the time span between the reference data and the image data to be corrected. Appearances that are widely used as a tie point include a crossroads, bridges, and one of the points located in the corner of an airplane runway.

3. Classification

Classification is aimed to divide or categorize parameters into classes as prepared at the beginning. This study is using supervised classification by making *Region of Interest* of each class in the software then directed or processed automatically by the software. In the classification available / supervised, the computer only recognizes objects based on spectral or pixel values and then statistical computation such as mean, variance, etc., so analytical skills are needed to translate things or objects which are specific to approach the computer's perception.

Classification is done by training samples as much as in the study area. The number of classes used is 7 land cover classes which is explained in the following table:

Table- I Land Use Classification

No	Category
1	Rice field Land
2	Developed Land
3	Low Density Forest Land
4	Medium Density Forest Land
5	High Density Forest Land
6	Airport
7	Irrigation

The seven (7) classes classification above is applied to the Image used in this study, OSMF Image (*Open Street Map Foundation*) to obtain classification results which are then used to calculate the area of each class and to determine the area of land changes. The data usage class from Table 1 can be described in visual form using WebGIS can be explained as follows.

The main page of *WebGIS* as shown in Figure 1 is the main view of the map that is composed of several layers and which is divided into basemaps and vector layers. The list of map layers interactively displays the map when it is clicked (a check mark appears) as shown in Figure 2 The polygon-type layer will cover both the line and point type layers when placing above order. For this reason, this *WebGIS* layer layout has considered this.

Fig. 1. Map of Land Use In 4 District of Merauke

Identify is one of the mandatory menus on every WebGIS application that is used to display detailed information of each object on the map. Merauke WebGIS Land Suitability provides identifying facilities by directly clicking on the map object so that detailed map information will appear as shown in Figure 3.

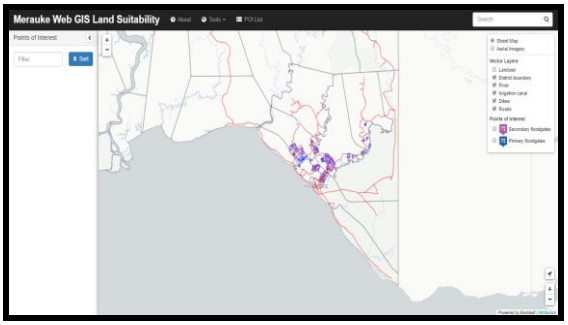

Fig. 2. Main Display of WebGIS

The search facility (filter) as shown in Figure 4 is used for searching by typing certain words as part of the selection criteria in the map layer attribute. If the list of search result attributes is clicked, the associated map will interactively *zoom in* on the selected map object.

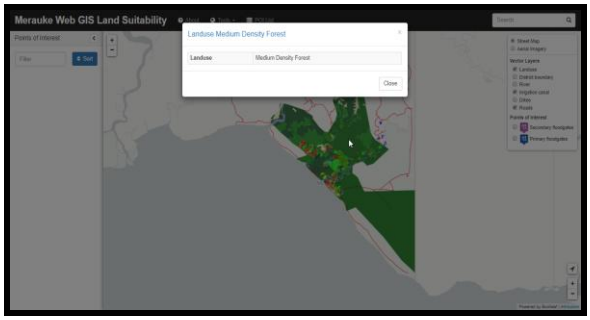

Fig. 3. Form Identify on WebGIS

Figure 5 displays a rice field map according to the first land use class, where the image chosen by the object is the rice field in the study area.

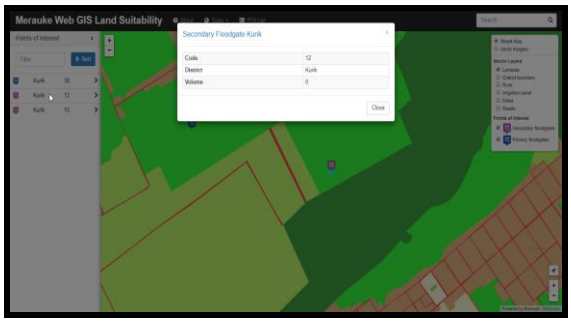

Fig. 4. Attribute Filte

Figure 6 displays a map of the built land in accordance with the second land use class, where the image chosen by the object is the one that has been built including housing, offices, stores, market business centers and places of worship in the study area.

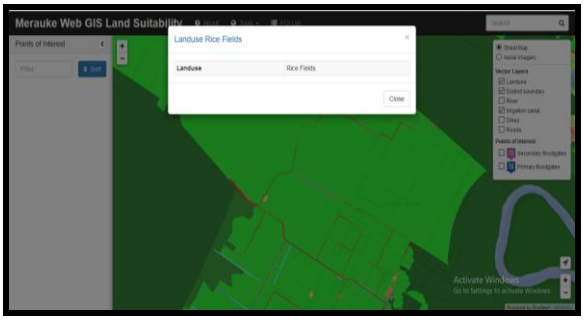

Fig. 5. Land of Rice Field

Figure 7 displays a map of low density forest land according to the third land use class, where the image selected by the object is land that is still included in a low density forest where the trees in the forest *look like the remnant of natural forest, but the condition is much uncontrolled and is in recovery. (Inside it, there are people's plants / mixed gardens*).

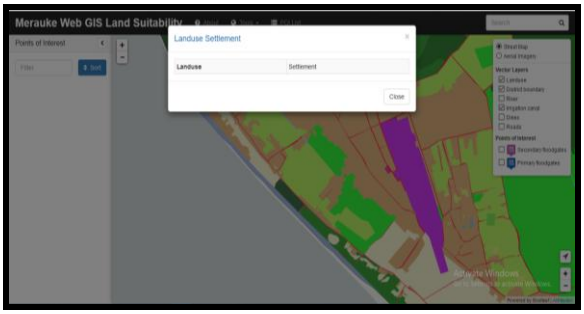

Fig. 6. Developed Land

Figure 8 shows a map of medium density forest land according to the fourth land use class, the image selected by the object is land that is still a forest with a medium density level where the trees in the forest look like the rest of natural forest, but the condition is worse than with high density forests.

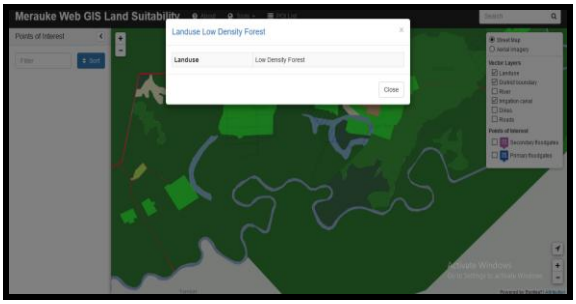

Fig. 7. Low Density Forest Map

Figure 9 displays a map of high density forest land according to the fifth land use class, the image selected by the object is land which is still in the form of high density forest where the trees in the forest look like the remnant of natural forest, secondary forest with near conditions primary forest.

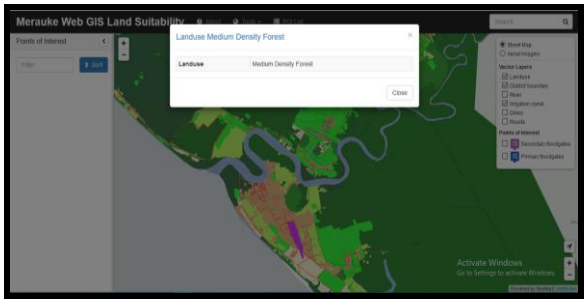

Fig. 8. Map of Medium Density Forest

Figure 10 shows the irrigation or irrigation according to the sixth land use class, the picture selected by the object is the land that was built irrigation for irrigating rice fields in the study area.

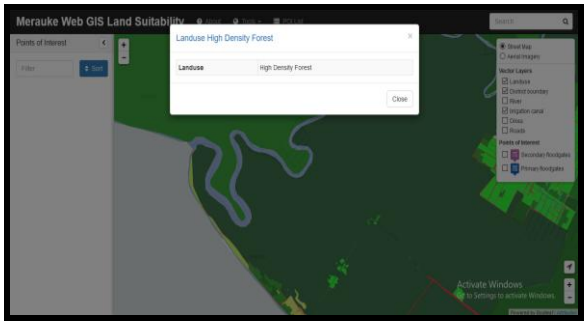

Fig. 9. High Density Forest Map

Figure 11 displays a map of the airport or airport according to the 7th land use class, the image selected by the object is the land that was built by the airport or airport for air transportation in Merauke Regency.

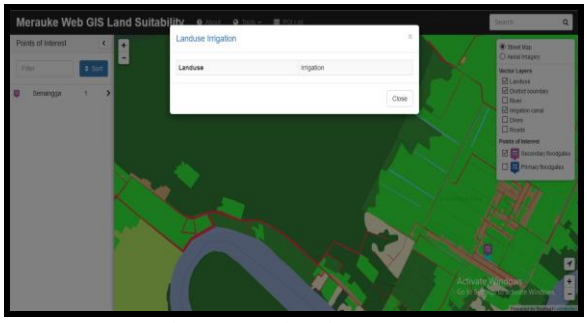

Fig. 10. Irrigation Map

This research also produces other classes in the classification, including regional administrative boundary classes, river classes, lake classes, road classes, housing classes, places of worship classes, business center classes all of which can be seen visually on the WebGIS-based land suitability model.

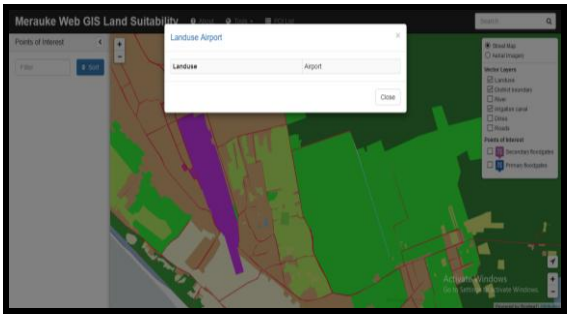

Fig. 11. Airport Map

V. CONCLUSION

ABased on the results and previous discussions, the researcher can conclude the following conclusions, such as:

1. The results of the classification of land cover shows that there are seven land classes, such as paddy/ rice field land, developed land, low density forest land, medium density forest land, high density forest land, irrigation and airport
2. All the result of land classes can be displayed visually on the WebGIS-based land suitability model in Merauke Regency of Papua.

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