Original Article

Smart Land Use Model using WebGIS to Support Smart Village in Merauke Regency of Papua

Heru Ismanto[1], Abner Doloksaribu[2], Diana Sri Susanti[3], Lilik Sumaryanti[4]

[1,4] *Informatics Engineering, Universitas Musamus, Merauke, Indonesia.*
[2] *Civil Engineering, Universitas Musamus, Merauke, Indonesia.*
[3] *Agrotechnology, Universitas Musamus, Merauke, Indonesia.*

[1]*Corresponding Author : heru@unmus.ac.id*

Abstract - Population growth in Indonesia continues to increase every year. It is recorded that Indonesia's population reached around 275.77 million in mid-2022. This case is, of course, causing an increasing demand for land. Therefore, land use mapping is needed so that land use can be more appropriate in use. Merauke Regency is one of the regencies, the capital of South Papua Province, Indonesia. The district capital is located in the Merauke district. This district is the largest and the easternmost district in Indonesia. This condition certainly encourages the Merauke Regency government to conduct land use mapping so that land use in Merauke Regency becomes more appropriate in use. This study aims to develop a Web-based Geographic Information System (WebGIS) for land use in Merauke so that land use can be more appropriate in use. The development of GIS in Merauke regency uses QGis and JS leaflets. There are five phases carried out in the development of GIS, and they are such as data collection, analysis, design, implementation, testing, and preparation of reports and scientific articles. Tests were carried out by using blackbox testing and Mean Opinion Score (MOS) based on the User Acceptance Test (UAT). The results of GIS testing on 5 respondents showed that 90 percent of respondents stated that GIS is easy to operate. Overall, it can be concluded that GIS smart land use in Merauke can be used to simplify the land management process in Merauke Regency. GIS can display land use mapping in Merauke Regency. The mapping includes territorial boundaries, settlements, irrigation, roads, rice fields, drinking water sources, district roads, irrigation areas, and plantation areas.

Keywords - Smart land use, WebGIS, QGis, JS leaflets Merauke, Papua.

1. Introduction

Indonesia is one of the countries with the largest population. Based on BPS data for mid-2022, the total population in Indonesia is around 275.77 million people. This amount is, of course, very important. Of course, Indonesia's population growth has also led to an increase in demand for land. Land use is a human activity that aims to utilize the wealth of elements of natural land resources to meet the needs of daily life. The demand for community land use is increasing. It is necessary to manage land properly to avoid bad effects or not cause damage and environmental pollution.

For the management and planning of land use in an area, the government establishes a technical reference/reference document so that in the development of the area, it can be managed and oriented towards the use, use, and use of land. Technical reference in the form of laws and regulations regarding the use of space in an area, which develop in accordance with the characteristics and needs of the relevant government. The rules for the use of space are then presented in the form of maps, especially the Regional Planning Map. With this map, the government can control, monitor and plan the management and use of the area's land appropriately. The process of monitoring, planning, and land use The exact area

in the form of a map can be digitized using a computerized system, namely Geographic Information System (GIS).

GIS is an information system used to enter, store, retrieve, process, analyze and produce geographically referenced data or geospatial data to support decision-making in the planning and management of land use, natural resources, environment, transportation, city facilities, and services.

Research on GIS has been carried out by several researchers [1]–[14]. Research [10] conducted a Land Use Study Based on Satellite Imagery Data Using Geographic Information System (GIS) Methods. From these studies, it is concluded that the growth of settlements has a major impact on the surrounding environment, such as an increase in city temperature, which causes a decrease in the comfort level of residents, especially in Takalar Regency. Likewise, research [2] conducted research on the impact of land use using GIS in post-flood conditions.

The studies on GIS that were carried out have encouraged researchers to develop GIS land use in Merauke Regency. Merauke Regency is one of the largest and

easternmost regencies in Indonesia. Taking into account the land boundaries in the Merauke Regency area and the increasing demand for land, especially for developing plantations, rice fields, settlements, and others, land use management in this area is very important. This study aims to build GIS to provide an overview of the designation and transformation of land use functions in Merauke Regency.

2. Research Method

This research was conducted in Merauke Regency. Merauke Regency is one of the regencies, the capital of South Papua Province, Indonesia. The district capital is located in the Merauke district. Merauke Regency is the largest and the easternmost district in Indonesia. The area of Merauke Regency is 46,791.63 km², with a population of approximately 230,932 inhabitants.

For this research to be more focused and reach the point, it is necessary to carry out research stages. Broadly speaking, the stages of the research carried out consisted of five stages; these stages can be seen in Figure 1.

The data needed to develop GIS land use in the Merauke district was collected at the data collection stage. Data collection was carried out based on a literature study. Questions and observations were used during the data collection stage. Stakeholder interviews were conducted to obtain an overview of the needs and processes of land management in Merauke Regency. One of the questions asked in the interview process was what processes were involved in the stages of land management in Merauke Regency.

Observations were made by observing the data used for land registration, planning and land management in Merauke Regency. The analysis stage is the stage to analyze the elements needed to build a land use GIS in Merauke Regency. This analysis describes the results of ongoing research on the system.

The process design stage is proposed based on the results of the current system analysis. An overview of the proposed GIS for land use in Merauke Regency is explained through the following design stages: input, output, database table structure and interface design. At the GIS design stage, it is carried out by using the *Waterfall* method. The *Waterfall* method is a sequential software development method and consists of five interrelated and influencing stages. This method has several stages: analysis, design, implementation/coding, testing/verification, and maintenance. The stages of the *Waterfall* method are shown in Figure 2.
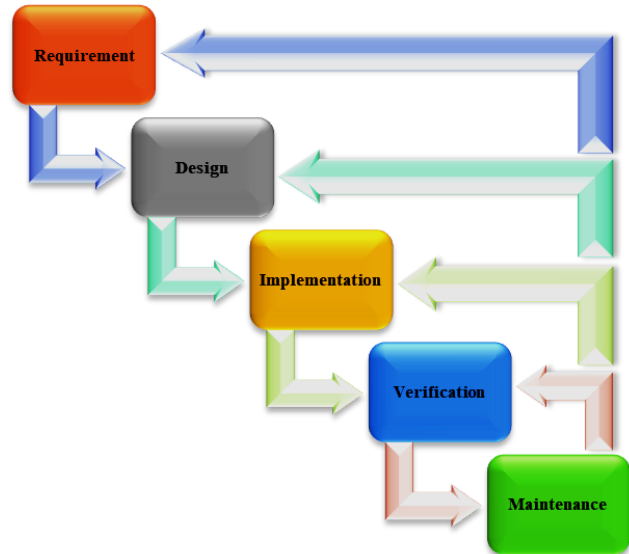

Fig. 2 Waterfall Method

After the design is done, it is implemented using QGis and LeafletJS. The next stage is GIS performance testing. The next step in this research is testing the information system and testing using the black box test method. This test is carried out to determine the system's deficiencies and bugs. The system is tested by users who perform real-life experiments.

The tests carried out are *black box* tests and *mean opinion scores*. Black box testing is a process that independently checks whether the implemented functionality meets the requirements. The average rating test asks several respondents to try the system and rate it on a scale of 1 to 4. A score of 1 represents the lowest score, and a value of 4 represents the highest score. Then, the average rating of all respondents is calculated, and the average opinion rating is obtained from the system. The final stage of this research is preparing reports and writing scientific publication articles.

Fig. 1 The Stages of Research

3. Result and Discussion

The result of this research is a smart land use model based on *WebGIS*. WebGIS can be used to simplify land management in Merauke Regency. WebGIS was developed by using QGis and Leaflet JS.

Based on the research steps that have been carried out, data on land use in Merauke Regency is obtained. Data on land use in Merauke Regency can be seen in Table 1.

Table 1 shows the land use distribution in Merauke Regency by taking 7 districts as samples. From the results of data collection that has been carried out, an analysis of what land uses will be included in GIS is carried out.

The analysis results then obtained several layers that will be displayed on GIS, such as regional boundaries, settlements, irrigation, roads, rice fields, drinking water sources, district roads, irrigation areas, and plantation areas.

Table 1. Data of Land Use in Merauke Regency

| No	Penggunaan	Naukenjerai	Ngguti	Okaba	Semangga	Sota	Tabonji	Tanah Miring
1.	Hutan Darat	11.224	111.363	6.575	4.018	59.045	224.129	60.007
2.	Perkebunan	0	16.869	0	0	367	0	345
3.	Semak/Belukar	123.189	27.273	139	8.744	181.572	13.663	23.984
4.	Lahan Budidaya	5.985	16.642	8.140	2.269	3.624	3.102	1.680
5.	Sawah	0	0	0	6.205	0	0	10.175
6.	Lahan Terbuka	267	58	16.279	0	0	85.081	0
7.	Permukiman Lanan Berair	1.303	652	680	2.048	436	62	2.512
8.	(Rawa/Gambut)	18.047	79.344	139.424	7.886	44.407	36.528	39.572
9.	Mangrove/Sagu/Pandan	8.131	934	5.088	524	0	15.623	0
10.	Tubuh Air	78	11.337	2.455	979	774	15.143	848
11.	Savana/Padang rumput	15.108	51.606	48.348	0	283	1.841	11.958
	Total	**183.333**	**316.078**	**227.128**	**32.673**	**290.509**	**395.171**	**151.080**
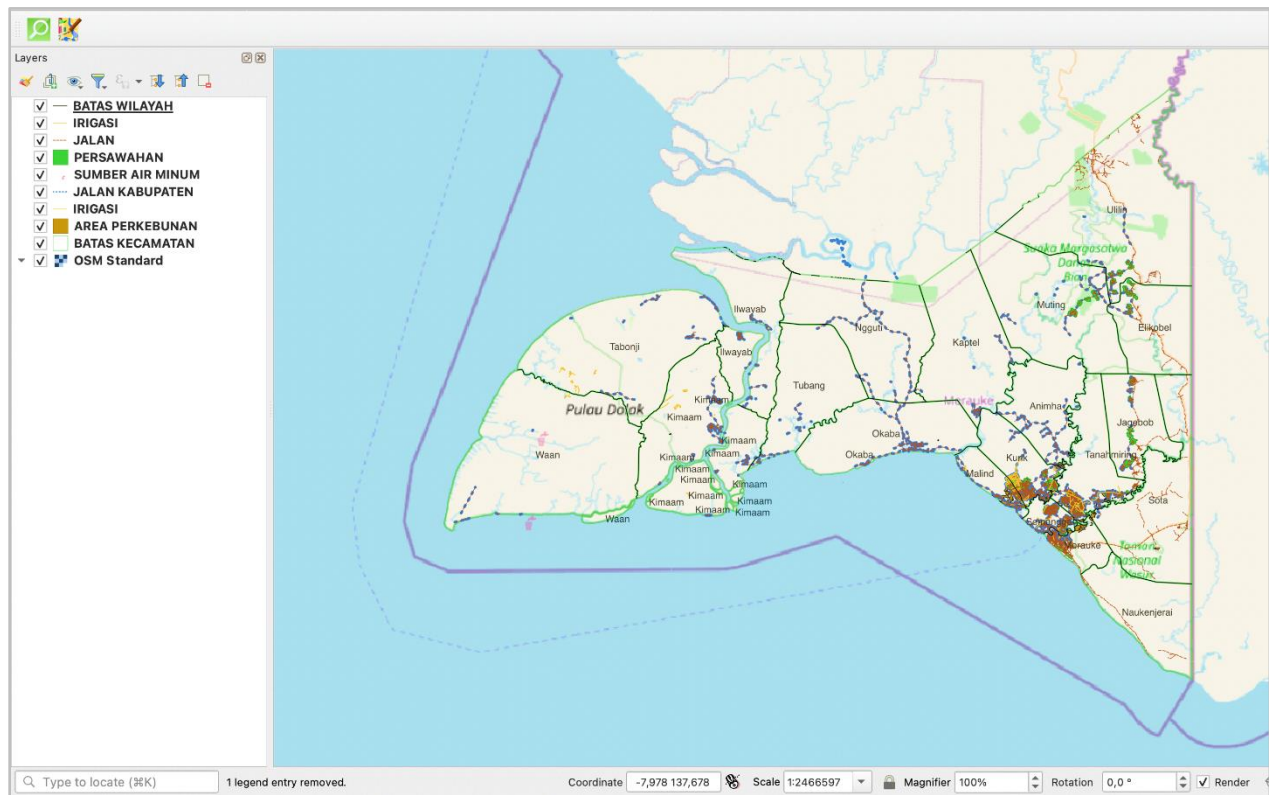
Fig. 3 Layer QGis SIG Land Use

Figure 3 is the result of a GIS design using QGis. In Figure 3, it can be seen there are ten *layers* used, they are such:

1. Territory boundary *layer*, this *layer* is to display the territorial boundaries in Merauke Regency
2. Settlement *layer*, this *layer* serves to display residential land
3. The irrigation *layer* has the function of displaying irrigation flow
4. Road *layer*, showing the road

5. The Rice field *layer* serves to display the rice fields in Merauke Regency
6. Drinking water source *layer*
7. District road *layer*
8. Plantation *layer*
9. District boundary *layer*
10. Merauke Regency *layer*

The implementation is carried out from the layers in the design stage. The implementation stage of GIS land use in Merauke Regency using QGis and LeafletJS can be seen in Figure 4.
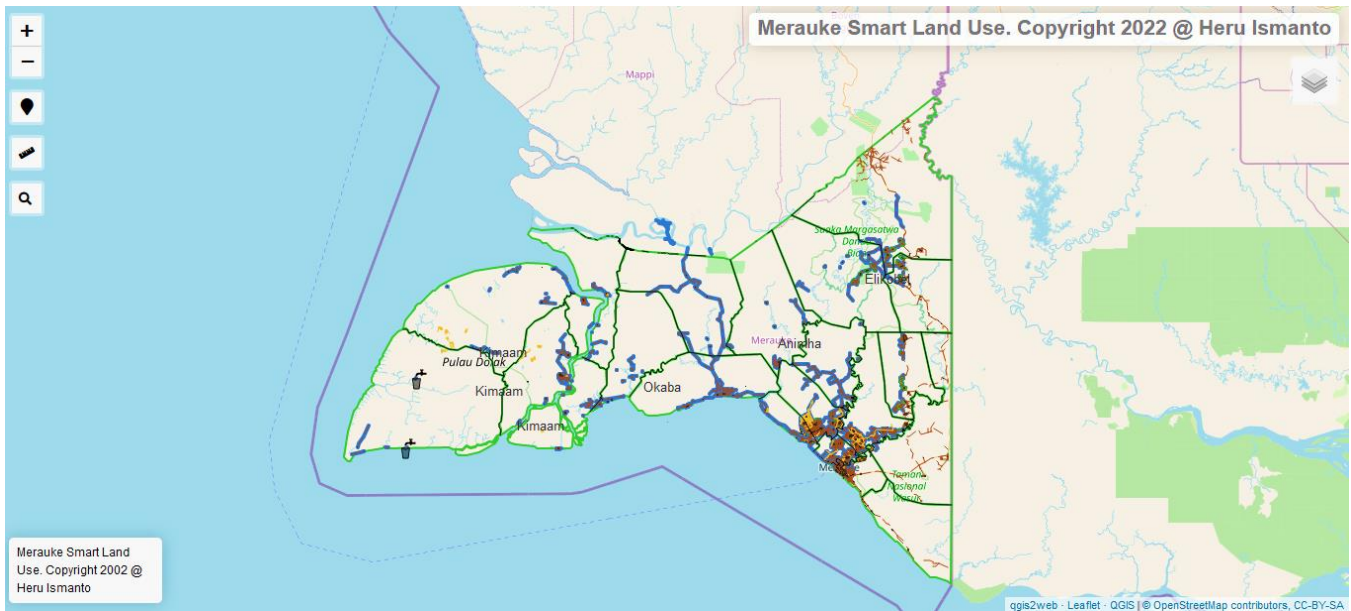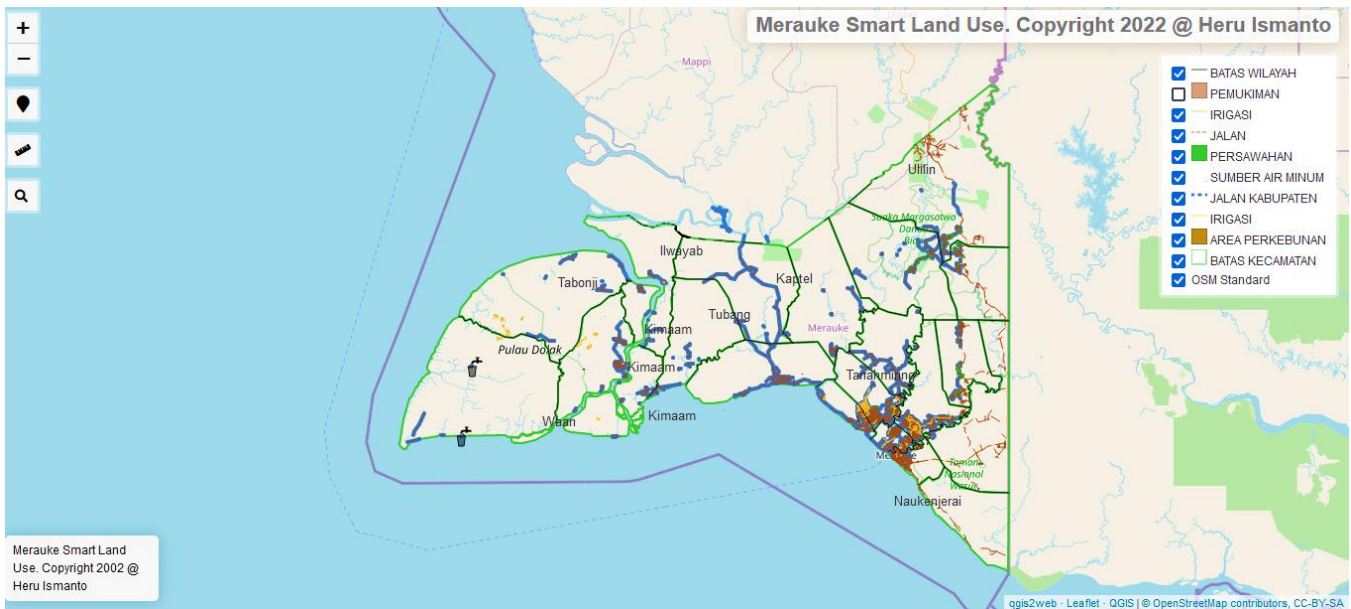

Fig. 4 Display of GIS Smart Land use in Merauke

Fig. 5 Layer Smart Land Use Merauke

Table 2. The Result of Mean Opinion Score Method

NO	Questions	SS	S	KS	TS
1	Is GIS operated?	3	2	0	0
2	Does GIS have a *user interface* that is easy to understand?	5	0	0	0
3	Does GIS have an attractive *user interface*?	1	4	0	0
4	Is GIS design (related to the *login, logout, print,* etc. buttons) efficient?	3	2	0	0
5	Is the *feedback* system highly interactive?	2	3	0	0
6	Are the features in GIS complete and as needed?	1	4	0	0
7	Does GIS display the appropriate data?	4	1	0	0
8	Does GIS display the appropriate information?	5	0	0	0
9	Is the layout of the information displayed by the system very clear?	2	3	0	0
10	Is the response time to access the features of each system fast and stable?	4	1	0	0

Figure 5 is an image of a WebGIS-based smart land use application in Merauke Regency. At the top right of WebGIS is a menu displaying the required layers. While on the left side of the WebGIS application, there is a zoom-in and zoom-out feature. In addition, a feature is also provided to perform a location search in WebGIS.

The system testing stage or *testing* is the stage which is carried out to match and observe the results of the implementation that has been carried out. System testing or testing conducted in this study using the blackbox method and *Mean Opinion Score* (MOS). The testing process with the *blackbox* method is carried out by testing one by one the functions that have been made, whether they are in accordance with user requirements, and whether the output of these functions is under what is expected. In contrast, MOS testing is carried out by subjective assessment of the quality associated with the system.

The results of the tests carried out on SIPENDAR using the MOS testing method based on *User Acceptance Test* (UAT) can be seen in Table 2.

The next test step is the analysis of Table 1. From the results of GIS test analysis based on user acceptance testing, the percentage value of MO is obtained as follows:

a. Respondents stated that 90% of WebGIS is easy to operate
b. Respondents stated that 100% WebGIS has an easy-to-understand *user interface*
c. Respondents stated that 90% of WebGIS has an attractive *User Interface*
d. Respondents stated that 90% of WebGIS designs (related to the *login, logout, print,* etc.) buttons are efficient

e. Respondents stated that 85% Feedback system is very interactive
f. Respondents stated that 90% of the features in WebGIS are complete and as needed
g. Respondents stated that 95% of WebGIS displays appropriate data
h. Respondents stated that 100% of WebGIS displays appropriate information
i. Respondents stated that 85% of the information layout displayed by the system was very clear
j. Respondents stated that 95% of the response time to access the features of each system was fast and stable.

4. Conclusion

This research has developed *Smart land use* by using WebGIS in Merauke Regency. QGis and LeafleatJS can produce WebGIS to display territorial boundaries, settlements, irrigation, roads, rice fields, drinking water sources, district roads, irrigation areas, and plantation areas.

Based on the results of the WebGIS testing that has been carried out, 90 percent of respondents stated that the Smart Land use WebGIS in Merauke Regency can already be used. In the future, it is expected that this WebGIS can be used as a reference for land use in Merauke Regency; this WebGIS is also expected to be the basis for the future toward the *smart village* and *smart city.*

Acknowledgments

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