IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 10, October 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2016) – 5.264
www.ijiset.com

Webgis Model of Agricultural Land Management Using a Remote Sensing Technique in Merauke Regency of Papua

Abner Doloksaribu[1], Heru Ismanto[2] Susanto[3] And Diana Sri Susanti[4]

[1] Civil Enginnering, Universitas Musamus, Merauke, Indonesia.

[2,3] Informatics Enginnering, Universitas Musamus, Merauke, Indonesia.

[4] Agroteknologi, Universitas Musamus, Merauke, Indonesia.

Abstract

Land use is an object of study that is considered important to be studied because it is related to global and local problems (Hartono 2012). The extent area farmland of Merauke Regency according to data from Bappeda of Merauke Regency is 4.6 Million Hectares and within the next 5 Years will be working on as many as 1.2 Hectares spread in 22 districts.

The method that is used in model of farmland management in Merauke Regency is done by using *remote sensing* technology. This technology helps the management of agricultural land use by utilizing a system that displays the condition of the earth's surface without direct contact / direct survey to the field. The condition of the earth surface is displayed in the form of image. The displayed imagery can be used to identify land use which is called interpretation activity. Remote sensing imagery is obtained from *SASPlanet* software. Interpretation of agricultural land is done by using an image that comes from *Bing Maps-Satellite* because it is able to display the condition of the earth's surface and it is according to the original appearance. Imagery from *SASPlanet* was obtained by downloading data. This farm management model is made within the farmland *WebGIS* of Merauke Regency.

The result of this WebGIS model of agricultural land can interpret agricultural land in Merauke regency by taking sample 4 districts such as Semangga, Tanah Miring, Kurik, and Merauke.

Keywords: *agricultural land, remote sensing, WebGIS, Merauke Papua*

1. Introduction

Agriculture is an important factor of the inhabitant's life in Indonesia because most of Indonesian people relies their lives on agriculture. Agriculture is the main job of most Indonesian people, especially in rural areas. An overview of the current situation of farmers in Indonesia can be explained that 83% of agriculture / farm-based districts and 82% of the population are rural agricultural laborers, small and micro medium enterprises (Soeromihardjo, 2007).

The total extent area of farmland in Merauke Regency according to data from Bappeda of Merauke Regency is 4.6 Million Hectares and within the next 5 Years will be in work as much as 1,2 Hectares.

Until 2011, Merauke Regency still becomes the largest rice producer in Papua Province. The rice planting area reaching 27,887.20 ha is able to produce paddy as much as 115,289.43 ton of rice. The number is decreased by 6.24 percent compared to the previous year. The largest rice producing area is Tanah Miring (33.10 percent) .The cassava is the second largest food crop after rice. In 2011, the planting area of 59.45 ha is able to produce cassava as much as 945.98 tons. Mostly produced in Kurik District, which is 220.50 tons (23.31 percent), the source is cited in Merauke In Figure 2014.

Based on the social function of the land, the use of agricultural land must be managed properly. Land use is closely related to the type of soil, the type and amount of resources, the cost of maintenance and production. Therefore, the use of agricultural land should be managed as well as possible so that the land is not damaged and can provide benefits for the welfare of the people. Land use management should be oriented towards improving the welfare that can be measured through farmer income (Vink, 1975).

The activity in recognition the use of agricultural land in an area can be done by using remote sensing technology. This technology helps to recognize the agricultural land use by utilizing a system that displays the condition of the earth's surface without direct contact / direct survey to the field. The condition of earth surface is displayed in the form of image. The displayed imagery can be used to identify land use which is called as interpretation activities.

Remote sensing imagery is obtained from SASPlanet software. The imagery which is contained in SASPlanet comes from a variety of satellite sources with various usage purposes and makes it looks in different displays. Interpretation of agricultural land is done by using an image that comes from *Bing Maps-Satellite* because it is able to display the condition of the earth surface according

to the original appearance. Imagery from SASPlanet was obtained by downloading data.

Remote sensing as a science, technique and art to obtain information about objects without direct contact with the object under study, has grown rapidly along with the increasing need for information. This development will be proven by the growing importance of remote sensing use for the provision of natural resource information and changes occurring within it and the environmental impacts of current land management. This is because the benefits of remote sensing systems in presenting data / information both in terms of time required shorter, the coverage area is large enough, the accuracy of good information and the cost of the use is relatively lower when those are compared with the terrestrial system.

This research will develop WebGIS Model of Agricultural Land Management in Merauke Regency by using *Remote Sensing* Technology.

2. Basic Concept Of Webgis

Geographic Information System (GIS) is a system designed to work with spatially-referenced data or geographic coordinates. GIS has the ability to perform data processing and perform certain operations by displaying and analyzing data. The current GIS application grows not only in the number of applications but also from the diversity of apps. GIS application development in the future will lead to Web-based application which is well-known as *WebGIS*, Denny Charter (2004).

WebGIS is an application of Geographic Information System (GIS) that can be accessed online via internet / web. In the *WebGIS* configuration, there is a server that has function as a MapServer in charge of processing the request map from the client and then sends it back to the client. In this case, the user / client does not need to have GIS software, but it is only use internet browser like Internet Explorer, Mozilla Fire Fox, or Google Chrome to access the existing GIS information on the server.

GIS has ability to perform data processing and perform certain operations by displaying and analyzing data. The current GIS application grows not only in the number of applications but also from the diversity of apps. The development of GIS application in the future will lead to Web-based application that is known as *WebGIS*. This is because the application development in the network environment has shown great potential that is related to geo information.

2.1. *WebGIS* Service *WebGIS* Service

GIS-based web services have added a whole new dimension to where the GIS industry works. GIS web has made it very easy to share spatial data through the World Wide Web and is accessible to every user in every corner of the world without having special GIS software loaded on the machine. *WebGIS* has the potential to revolutionize the way in which GIS is developed, accessed and used worldwide.

WebGIS generally uses 3-tier of architecture, it allows to access attribute data along with spatial data over the internet. This data can be integrated with other upcoming technologies such as GIS integration with Mobile Phone, GIS integration with CCTV.

WebGIS has helped to create an independent distribution channel platform for GIS data. The application can share data from different data sources and formats which have been bundled together in one application and it has been clear that data has come from different sources or locations.

GIS desktop has certain limitations. Therefore, the users need to have specific software which must be installed on the computer, and it is difficult to download data from multiple sources and view it over multiple platforms together. These difficulties have been solved and replaced by *WebGIS*, data can be shared around the world without having specific software. Local governments may publish data for the use of the community that requires such data Ismanto et al (2016). *WebGIS* plays a key role in making GIS technology affordable and useful for thousands of users in the true sense.

2.2. SDLC (*Systems Development Life Cycle*)/*Water Fall*

Systems Development Life Cycle, or generally called as *Water Fall Method* in systems engineering and software engineering, is the process of creating and changing systems and the models and methodologies used to develop those systems. This concept generally refers to computer systems or information. SDLC is also a pattern taken to develop a software system, which consists of stages: planning, analysis, design, implementation, testing and maintenance. In software engineering, the concept of SDLC underlies various types of software development methodologies. These methodologies form a framework for planning and controlling the manufacture of information systems, namely the process of software development. There are 3 types of system life cycle method most used, namely: traditional system life cycle, life cycle using prototyping, and object-oriented system life cycle, , Blanchard, BS, & Fabrycky, WJ (2006).

3. Basic Concept Of Remote Control

Remote sensing is the science and art of obtaining information about objects, regions or natural phenomena through analysis of data obtained by a device without

direct contact with the object, area, or phenomenon under study (Lillesand, et al., 2004). The objects, regions, or phenomena studied in the definition may be on the earth surface, in the atmosphere, or planets outside the sky. Remote sensing is very closely related to the measurement of electromagnetic radiation emitted from the earth surface. There are various kinds of earthly objects that have different characteristics in reflecting back electromagnetic radiation. Based on the difference in the spectral reflectance value on the interaction of electromagnetic waves with each object present in the earth, it makes the object can be identified.

Based on the recognition of the objectswhich is depicted in the image, there are three series of activities required, such as detection, identification, and analysis. Detection is the observation of an object. Identification is an attempt to characterize objects that have been detected by using sufficient information. Further information was collected on the analysis stage, Lintz Jr. and Simonett (1976, in Sutanto, 1994).

Visual image interpretation can be defined as a visual activity to examine an image that shows the image of the earth surface and which is depicted in the image for the purpose of identifying objects and assessing their meaning (Howard 1991). According to Sutanto (1994), remote sensing image interpretation technique is done by using component interpretation which includes reference data as well as key image interpretation or image diagnostic element.

According to Lillesand et al., (2004), remote sensing data formed in digital data is equipped with spectral, spatial, and temporal resolution. The third resolutions which belong to remote sensing data are its own advantages indeed. Remote sensing data generated in the form of satellite images and aerial photographs is used to interpret, identify and classify objects on the earth surface. The principle of object recognition in the image visually depends on the characteristics or attributes which are depicted in the image. Characteristics of objects on the image is used as an element of recognition of objects that is called as elements of interpretation of the form, hue, size, texture, patterns, shadows, sites.

The acquisition of remote sensing data can be done through manual and digital analysis (Buiten, 1993, Jensen, 1996). By analyzing this collected data, it can be obtained some information about the object, area or phenomenon which is studied. Remote sensing results will be used by data users for specific purposes. The success of remote sensing applications depends on the acceptability of remote sensing results by users of data (Sutanto, 1986).

3.1. Satellite Imagery of SASPlanet.

SASPlanet is used to display and simultaneously can be used to download high resolution images from Google Maps, Here from Nokia, Kosmosnimki, Yandex.Maps, Yahoo! Maps, Bing Maps, Gurtam, OpenStreetMap, eAtlas, Genshtab maps, iPhone maps, Navitel maps.

The use of SASPlanet can overlay between two different mapping services in one view. For example, doing a comparison of road layers (following street names) from OpenStreetMap with satellite imagery that is contained in Google Maps.

This study uses SASPlanet to download high resolution satellite imagery from Google Earth.

3.2. Interpretation of Imagery Satellite

The technique of satellite image interpretation is included in remote sensing systems. Remote sensing is the science and art of obtaining information about objects, regions or symptoms by analyzing data obtained by using tools without direct contact with the objects, areas, or symptoms studied (Lillesand and Kiefer, 1997).

The process of interpretation is done by observing the object with several steps, such as detection, identification and analysis. Interpreting the information through the image can be simplified done by using the interpretation key. The elements of interpretation include: hue / color, texture, shape, size, pattern, site, association, and convergence of evidence (Sutanto, 1997).

Hue (*tone*) refers to the brightness of the object in the image. Hue is usually expressed in gray scale, for example black / very dark, rather dark, bright, very bright / white. If the image used is colored, then the interpretation element used is color, although in the mention is still combined with hue; for example red, green, blue, yellowish brown, darkish-greenish blue.

The *shape* as an interpretation element refers to the general form, configuration, or outline of the object being individually. The shape of some objects is sometimes too different from the others, so that the object can be recognized only from its form elements only.

The *size* of the object in the photo should be considered in the context of the existing scale. The mention of size is also not always possible for all types of objects.

Pattern is associated with the spatial arrangement of objects. Patterns are usually associated also with the repetition of the general form of a group of objects in space. The terms which are used to express the pattern are regular, irregular, less orderly. However, it is sometimes necessary to use a more exhaustive term such as circular, elongated, concentrically elongated.

Shadows are very important for the interpreter, because they can give two opposite effects. First, the shadow can confirms the object in the image because the

outline of the object becomes sharper / clearer, and it also happens in the impression of its height. Second, the shadow precisely lacks in the reflection of the object to the sensor, so that the observed object becomes unclear.

Texture is a measure of the frequency of changes in the color of the image object. Textures can be generated by aggregations or groupings of apparel units that are too small to be individually differentiated, such as leaves on trees and shadows, wildlife gangs, or rocks scattered above the ground. Texture impression is also relative, depending on scale and image resolution used.

Site or location is an explanation of relative object to objects or other features that are easier to recognize, and it is considered to be the basis for the identification of the object under study. Objects with bright and cylindrical have shadows, and it is arranged in a regular pattern thar can be recognized as an oil refinery when located near the coastal waters.

Association is element that concerns to the interrelationship between an object or a phenomenon with another object or phenomenon, which is used as a basis for recognizing the object under study. For example, in large-scale aerial photographs, the building is larger than the house, has an open courtyard, lies on the edge of a large road, and there is an appearance like a flagpole (visible with a pole shadow) on the page. This building can be interpreted as an office building, based on flagpole associations with offices (especially government offices).

The most dominant element and directly affect to the interpretation is called as the key of interpretation. The most dominant interpretation key is the color / hue. Interpretation can be done visually with *digitasion screen* technique in mapping software.

4. Agricultural Land

Land has some understanding which is provided by FAO as well as experts. According to (Purwowidodo, 1983) land has the meaning: "A physical environment that includes climate, soil relief, hydrology, and plants that to some extent will affect the ability of land use".

Land is also defined as "Surface of land with solid, liquid, and even gas" (Rafi'i, 1985). Another definition is also expressed by arsyad that said: land is defined as a physical environment consisting of climate, soil relief, water, and vegetation and objects that exist on it as long as there is influence on the use of land, including the results of human activities in the past and now results of marine reclamation, vegetation cleansing and also adverse outcomes such as those that are chlorinated (Arsyad, 198

Forms of land use in the framework of regional development planning should be done in order to achieve optimization of existing land resources and it is also aim to achieve a better order without leaving the sustainability of the environment. The embodiment of good planning is inseparable from the physical aspect which is the basis of the determinants of activities that can be planned in it apart from non-physical aspects such as social, economic, law, and lan so on. The physical condition of the land determines the function of land use whether the land can be cultivated or protected and buffer land.

The division of land use function is the basis of the activity determination plan with the *existing* land use that can show how much land use mismatch. One of these activities is agriculture that requires accurate data and land resource information in managing agricultural land system.

The occurrence of the conversion of agricultural land into non-agricultural land or built-up caused a reduction in agricultural land as a source of food production. Therefore, it is needed a system of agricultural development planning as one way to overcome the problem.

One of the agricultural development planning is considering the physical condition of nature which is useful in the preparation of land suitability, so it can be useful as an increase of agricultural potential. (Rakasiwi, 2013).

5. RESEARCH METHOD

The method in this research was conducted with several stages including: stage preparation, implementation phase, processing stage and yield analysis.

5.1. Preparation stage

The activities that is done at the preparatory stage are data collection and literature studies which is related to the research to be done, image preparation and other assistive data, for the preparation of spaciousness for data collection.

5.2. Implementation stage

a. Image Correction

Before processing an image, it is done the image correction process which involves correction of radiometric and geometric correction. It is because the image is a conditioning operation for the image which is used and actually provides information that is geometrically and radiometrically accurate.

b. *Cropping* Image of Research Location

After the radiometric and geometric correction process in the whole image *scene* is done, and then the image-cutting process will be done according to the previous use limit. The orientation of this activity aims to focus the location of the study to facilitate the process of visual interpretation activities (landform and soil infiltration) as well as digital interpretation (cover / land use) according to the intended research objectives.

c. Arragement of Composite Image

SASPlanet imagery allows for a combination of channels (composites) which is set similar to the purpose of analysis. The purpose of composite image composition is to obtain visual images as well as viewing infrared colored aerial photos, so that object observation, sample selection, and aesthetic aspects of the image can be improved (Danoedoro, 1996).

d. Image Interpretation

Interpretation of land use is done by recognizing the color difference in the composite image. The difference in color is due to each spectral on each other object which is different. Land use classification refers to the classification of Malingreau land use (1981) with various additions adjusted to the circumstances of the study area.

e. Land Unit Mapping

Unit of land isthe smallest unit of land as the interpretation and mapping of selected landscape features associated with hydrological processes (Meijerink, 1987)

5.3. Processing Stage and Result Aanlysis

The input data in this study consists of graphical data or spatial data and attribute data or tabular data. Spatial data consists of data in vector and raster formats. Data processing is used in Geographic Information System using ArcGIS software ver. 9.3. Data in vector formats include: Land map, Geological Map, and Digital RBI Map. Data in raster format include SASPlanet image data in Geotif format, Digital ElevationModel data (DEM). Attribute data is physical land characteristic data. The graphic data or spatial data above must be converted into digital form.

a. Digtization

Digitization is the process of converting analog data into digital data stored in magnetic media with vector data format (Danoedoro, 1996). Vector data is data organized in segments stored through mathematical equations. Before the digitization process, it is firstly done the registration process or determination of map projection system with reference to *Universal Transver Mercator* (UTM) coordinate system.

b. Land Use Mapping

Preparation of the actual land use map of the research area by using an analysis of the relationship between land cover and landform are embodied in a two dimensional matrix. The ecological relationship between the land cover and the landform is seen from the field check of result and is raised as a matrix of land unit and land use relations. The land use classification which is used in this study is the classification of Malingreau land use (1981).

6. Discussion And Explanation

The study of land use in Merauke Regency is done by utilizing remote sensing technology and Web-based Geographic Information System (*WebGIS*). Remote sensing technology and *WebGIS* is used for data tapping, data processing, calculation, and data analysis.

a. Map of Land Use

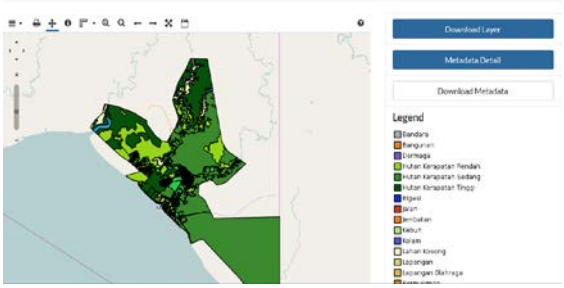


Figure 1 Map of Land Use

Figure 1 shows a land use map, where the map describes the land use according to the color of the map legend.

b. Map of Rice Field

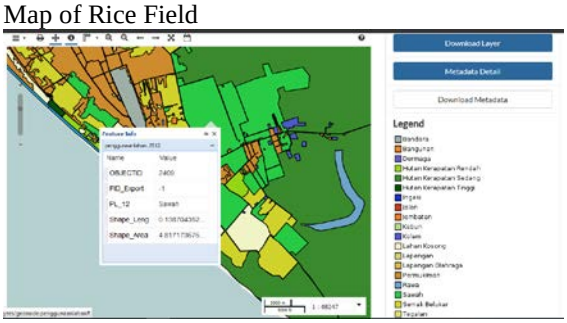


Figure 2 Map Of Rice Field

Figure 2 shows rice field maps in spatial form and vector data attributes, which are dynamic in nature which can be updated at any time.

c. Map Of Irrigation Flow

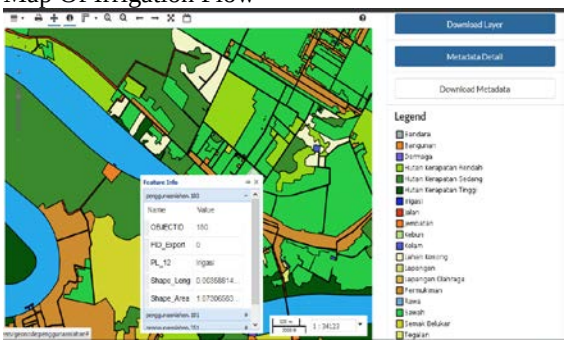


Figure 3 Map of Irrigation Flow

Figure 3 shows irrigation flow maps in spatial form and dynamic attributes which can be updated at any time.

d. Map of Garden Estate

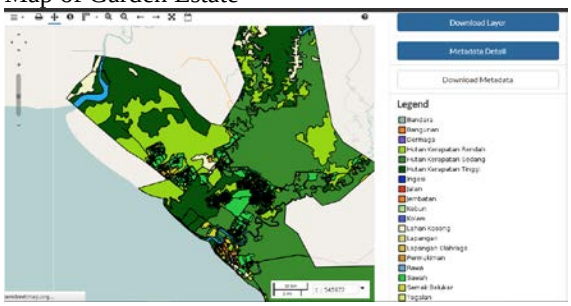


Figure 4 Map of Garden Estate

Figure 4 shows a map of spatial garden land and attribute data contained in the Research Area.

e. Empty Land Map

Figure 5 Map of Empty Land

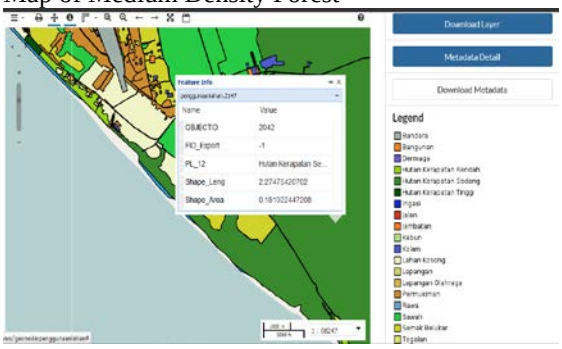
Figure 5 shows an empty field map in spatial form and attributes, dynamic dynamic that can be updated at any time.

f. Map of Low Density Forest

Figure 6 Map of Low Density Forest

Figure 6 shows a low density forest map in spatial form and attributes, dynamic dynamic that can be updated at any time.

g. Map of Medium Density Forest



Gambar 7 Map of Medium Density Forest

Figure 7 shows a medium density forest map in spatial form and attributes, dynamic dynamic that can be updated at any time.

h. Map Of High Density Forest

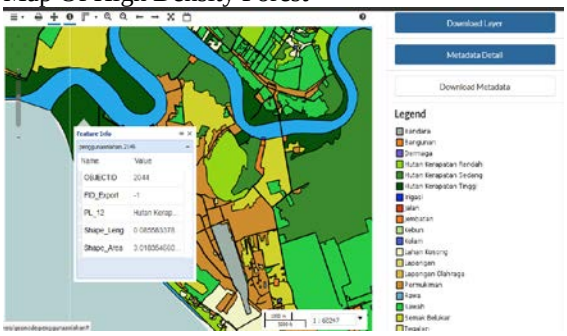


Figure 8 Map of High Density Forest

Figure 8 shows a high-density forest map in spatial form and attributes, the data is dynamic that can be updated at any time.

7. CONCLUSSION

After the authors did research then the authors can draw some conclusions, they are such as:

a. Agricultural land-based management model based on *WebGIS* is made to show complete farmland management in 4 (four) District of Merauke Regency. The sample can display map of administration area, paddy field map, garden land map, empty field map, irrigation map, swamp map, low density forest maps, medium density forest maps, and high density forests.

b. Reports generated by the model through attribute data for each map in accordance with existing data in the field and which are dynamic can be changed according to map data update

c. Data update permissions on this system are owned by the administrator.

Acknowledgments

Thanks to the Ministry of Research Technology And Higher Education of Indonesian Government has support researchers in Agricultural Land Management model.

REFERENSI

Arsyad, S., "Konservasi Tanah dan Air" Bogor, IPB, 1989

Bappeda Kab. Merauke, 2012, "Merauke Dalam Angka", BPS Kab. Merauke, CV. Sekar Wangi, Merauke.

Buiten, H.J., " Image Interpretation : Visual or Digital" Dalam : Buiten, H.J. dan J.G.P.W. Clevers (Eds), Land Observation by Remote Sensing : Theory and Applications. Gordon and Breach Science Publ. Amterdam, 1993.

Charter, Denny. Agtrisari, Irma." *Desain dan Aplikasi GIS Geographics Information System"*, PT. Elex Media Komputindo, Jakarta, 2002.

Danoedoro, P., " Pengolahan Citra Digital Teori dan Aplikasinya dalam Bidang Penginderaan Jauh" Fakultas Geografi Universitas Gadjah Mada, Yogyakarta, 1996.

http//id.wikipedia.org/wiki/sistem-informasi-geografis, 2014

Ismanto, H., Doloksaribu, A., and Syafrianto, A., "Webgis-based Irrigation basic Map Model of Merauke Regency Papua", *International Journal of Computer Applications* (0975 – 8887), 2016, Volume 152 – No.3

Jensen, J.R., "*Urban/Suburban Land Use Analysis"* Dalam Colwell, R.N., Manual of Remote Sensing. Vol II, American Society of Photogrammetry,Virginia, 1983.

Lillesand, T.M. dan R.W. Kiefer, "Remote Sensing and Image Interpretation" Terjemahan : Dulbahri, P. Suharsono, Hartono dan Suharyadi, 1990, Gadjah Mada University Press, Yogyakarta.

Malingreau, J.P., *"A Land Cover / Land Use Clasification for Indonesia"*, PUSPICS Universitas Gadjah Mada, Yogyakarta, 1982.

Prahasta, E, "Konsep-Konsep Dasar Sistem Informasi Geografis", Informatika, Bandung, 2001.

Prahasta, E., "Sistem Informasi Geografis: Membangun Aplikasi WebBased GIS dengan MapServer", Informatika, Bandung, 2007.

Purwowidodo, *"Teknologi Mulsa"*, Dewaruci Press, Jakarta, 1983.

Rachmawati, A., 2007,"Aplikasi SIG (Sistem Informasi Geografis) untuk Evaluasi Sistem Jaringan Prasarana pengairan di Sub DAS Lowokwaru Kota Malang", Jurnal Rekayasa Sipil, Jurusan Teknik Sipil, Fakultas Teknik, Universitas Islam Malang, 2007.

Radjabidfard, Abbas, " SDI Hierarchy, from Local to Global SDI Initiatives", Melbourne, Victoria: Spatial Data Research Group, Departement of Geomatics. The University of Melbourne, 2001.

Rafi'i, S., "Ilmu Tanah. Bandung", Angkasa Bandung, 1985

Rauf, S., "Pemetaan Jaringan Prasarana pengairan Berbasis Quantum GIS Open Source di Kota Makasar", Prosiding Hasil Penelitian Fakultas Teknik Unhas, Makassar, 2012.

Setiawati D., Haryanto T., "Penggunaan system informasi geografis berbasis web untuk pembentukan proptotipe peta dasar pengairan", Tesis Program Studi Teknik Geomatika FTSP-ITS. Surabaya, 2010.

Sidharta, " Irigasi dan Bangunan Air " Gunadarma, Jakarta, 2007.

Sutanto, "Penginderaan Jauh" Jilid 2, Gadjah Mada University Press, Yogyakarta, 1987.

BIOGRAPHIES OF AUTHORS

First Author, Abner Doloksaribu received his bachelor's of Civil Engineering, and Master of Civil Engineering from Bandung State University and Hasanuddin University in 1982 and 2009 respectively. He was interesting in flooded System. He can be contacted by email: abner_doloksaribu@yahoo.com

Second Author, Heru Ismanto received his bachelor's of Informatics, and Master of Computer Science from Universitas Padjadjaran and Universitas Gadjah Mada in 1996 and 2009 respectively. Currently he is a lecturer at Department of Informatics Engineering, Musamus University, Merauke, Papua and his a doctoral student at Department of Computer Science and Electronics, Universitas Gadjah Mada since 2014. He was interesting in Decision Support System, GIS, e-Government System. He can be contacted by email: heru@umus.ac.id

Third Author, Diana Sri Susanti received bachelor's of holticulture from Universitas Of Papua Indonesia in 2008, received Master of holticulture from Hasanuddin University, Makassar, Indonesia in 2014**.** Currently, he is a lecturer at Department of Agroteknologi in Universitas Musamus, Merauke, Papua,

Four Author, Susanto received bachelor's of Informatics from Amikom, Yogyakarta, Indonesia in 1996, received Master of Informatics Engineering from Hasanuddin University, Makassar, Indonesia in 2011, Currently, he is a lecturer at Department of Informatics Engineering in Universitas Musamus, Merauke, Papua.