Poster

Identification of Potential Area for Paddy Field to Increase Rice Production Using Model Builder and Its Publication on The Internet: Case of Lombok Island, West Nusa Tenggara, Indonesia

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ABSTRACT

The study was conducted to identify the suitable location for paddy field to increase rice production in Lombok Island. Since rice is the staple food of the majority of Asian countries including Indonesia, the study about rice production is becoming one of the main researches conducted in those areas. Model builder was used to create the model and to find the potential area for paddy field. The result showed that 3.19% (146 km2) of the total area (4564 km2) are best areas with maximum productivity, 2.73% (125 km2) as potential areas, and 1.24% (57 km2) considered as potential areas with specific treatment. These areas are mainly located in the west and south part of the Island. The result is then published on the Internet. The multiple benefits of using a Web based GIS are that we have centralized base-map data meaning that the data can be managed more easily and everyone has access to changes as soon as they are updated. The database management system used for this study is PostgreSQL coupled with PostGIS. We found that this software has high capacity of storing and managing data. Ka-map was used as web-mapping interface and it provided different GIS tools such as zoom, pan, full extent, scale, legend, query option that allow users to retrieve attribute data from related database tables by selecting any location on the map. The benefits of this work are that further research can be done by considering other parameters such as climate and soil, and to focus on the sustainability of paddy field based on economic and social factors.

Keywords-*paddy field; potential area; rice; model builder; Web-based GIS*

I. INTRODUCTION

Growth in rice production resulting from the modern technology flowing to farmers from developing national and international research programs has been matched year by year and country by country by population growth [1]. Since the rice is the main food in many areas especially in Asia, the study about rice production is becoming one of the main researches conducted in some areas. Apart from that, in order to understand the domain of rice itself, a lot of researches focused on the study of paddy field which is a flooded parcel of arable land used for growing rice and other semi aquatic crops and becoming the dominant form of growing rice since the twentieth century. Reference [1] showed that the growth in rice production that has kept pace with the demands for food in the past 20 years has come largely from success in research and in application of that research to grow rice in farmers' fields. Most of that research has been done in relatively young national research programs. The current challenge is for those programs to grow in size, in scope, and in ability to serve the pressing need for more rice.

Coupled with the new technologies, like Geographic Information System, the researchers' tasks become easier. Many definitions exist for explaining what is exactly GIS or Geographic Information System. Reference [2] defined GIS as a computer packages which integrates the storage, manipulation, analysis, modeling and mapping of digital spatial information; [3] defined GIS as a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth; while [4] defined it as an organized activity by which people measure and represent geographic phenomena then transform these representations into other forms while interacting with social structures.

Government of West Nusa Tenggara wants to increase self-sufficiency in rice in West Nusa Tenggara province. To Increase the existing paddy areas, local governments make the determination of a potential area for rice development. These areas will be published on the Internet.

II. OBJECTIVES

The objectives of this study are to identify the potential area for paddy field to increase rice production and to publish the result on the Internet.

III. LITERATURE REVIEWS

A. System Development Life Cycle (SDLC)

SDLC refers to the process of creating or altering systems, and the models and methodologies that people use to develop these systems. System Development Life Cycle (SDLC) is the traditional methodology used to develop, maintain, and replace information system [5]. The different phases of the SDLC are shown in Fig. 1.

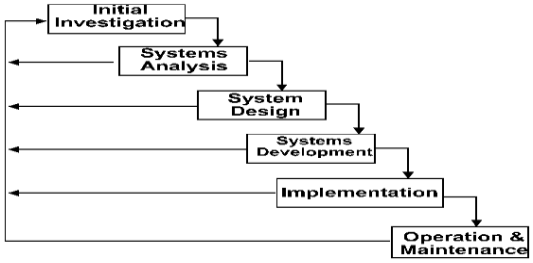

Figure 1. System Development Life Cycle (SDLC).

Initial Investigation: In this step, generate a high-level view of the intended project and determine the goals of the project. The feasibility study is sometimes used to present the project to upper management in an attempt to gain funding. Projects are typically evaluated in three areas of feasibility: economical, operational, and technical. Furthermore, it is also used as a reference to keep the project on track and to evaluate the progress of the Management Information System team [6].

Systems Analysis: The goal of systems analysis is to determine where the problem is in attempt to fix the system. This step involves breaking down the system in different pieces and drawing diagrams to analyze the situation. Analysts project goals, breaking down functions that need to be created, and attempt to engage users so that definite requirements can be defined.

System Design: In system design, functions and operations are described in detail, including screen layouts, business rules, process diagrams and other documentation. The output of this stage will describe the new system as a collection of modules or subsystems.

System development and Implementation: This step concerns about the conversion of the design into a complete Information System. It includes acquiring and installing systems environment, creating and testing database. Modular and subsystem programming code will be accomplished during this stage. Unit testing and module testing are done in this stage by the developers. This step also includes implementation preparation, implementation of the system into a production environment, and resolution of problems which can be found.

Operations and Maintenance: The deployment of the system includes changes and enhancements before the decommissioning or sunset of the system. Maintaining the system is an important aspect of SDLC. As key personnel change positions in the organization, new changes will be implemented, which will require system updates.

B. *Planning, Analysis, Design, Implementation (PADI)*

PADI consists of four general steps. The first one is planning. In this part, we ask the question why the GIS application should be built, will it provide business value. The second one is analysis and the question what the system will do, who will use the system (analyzing business need, business process) is asked. The third part is design. How the system will operate in term of hardware and software architecture to fulfill business need, business process. The last part is implementation which consists of both construction and installation.

IV. METHODOLOGY

A. *Scope of Study*

The study was conducted from March to June 2010. The area concerns Lombok Island, which is situated in West Nusa Tenggara. It is bounded between longitude 115^{o} 49' 14'' E and 116^{o} 45' 16'' E and latitude 8^{o} 12' 36'' S and 8^{o} 57' 23'' S with an area of approximately 4.564 km2. Fig. 2 shows the study area.

B. *Required Tools*

There are some tools required for this study. These are hardware and software. Table 1 shows the list of materials needed for this work.

C. *Data Source*

Apart from the hardware and software, different types of data will be used for this study. These data are listed below.

- Island or boundary (in shapefile format)
- Roads (in shapefile format)
- Rivers (in shapefile format)
- Slope (in shapefile format)
- Land use (in shapefile format)

D. *Methodology*

There are some important stages of working with our data: the first one is data preparation and entry in which data about the study area is collected and prepared to be entered and/or used into the system, data analysis and simulation in which collected data is reviewed, and the last part is data presentation in which the result of earlier analysis are presented in an appropriate way.

To build the model, different processes have been conducted. Below are the criteria to be fulfilled in order to reach the objective which is to identify the potential area for paddy field in Lombok Island. The criteria for rice development areas are:

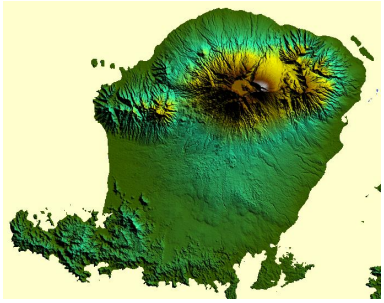

Figure 2. Lombok Island.

TABLE I. HARDWARE AND SOFTWARE

Hardware/Software	Details	
	Characteristics	***Function***
Notebook	Toshiba Intel Centrino inside 2.1 GHz, 2.0 GB of RAM	Data processing
ArcGIS	Version 9.3	Data Processing and Analysis
Map Server (MS4W)	Version 3.0	Web Server
Ka-Map	Version 1.0	Web-mapping interface
PostgreSQL	Version 8.3	Database Management
PostGIS	Version 1.3.5	Extension for PostgreSQL
Notepad ++	Version 5.7	Web Development

- Should be less than 3 km from river
- Have a maximum distance of 5 km from the road
- Have a minimum 10 m distance from coastline
- Have a maximum slope of 15%

To increase rice production, the government wants to increase the potential land other than paddy areas and existing settlements. For that, new areas will be defined to develop the paddy areas. The determination of the potential areas will be based on the following criteria:

- Slope <2%: Best area with max productivity
- Slope 2-8%: Potential areas
- Slope 8-15%: Potential area with specific treatment

To reach these objectives, different processes and tools provided by ArcCatalog in ArcGIS Software will be used. Some of these tools are extract, overlay, and proximity from analysis tools, and fields, general, and generalization from data management tools.

To summarize, the enhancement of the business process considered by the Government of West Nusa Tenggara are to increase rice production by identifying the potential area for paddy field and to provide the map through Internet to the concerned institutions which are located in different geographical areas not only in West Nusa Tenggara, but also in other areas in Indonesia.

For that, the production of maps will be considered as the business process automation. This will be done by processing the data and by extracting the potential areas for paddy field in Lombok Island. This step will be desktop based. New improvement will be done also because the resulting maps will be displayed on the web. Internet is important as being a global network of interconnected computers. The information can be shared anywhere and anytime. That will be considered as the business process improvement since the new process in displaying the maps on the web does not exist yet. In addition, it can be considered also as the business process reengineering because before, the maps have to be printed and to be brought to different institutions by a responsible engineer in the Government which is often a waste of time and money, but now, different institutions concerned can obtain and visualize the information from their own place. As a Web-based system, concerned institutions can access geographical information through Internet using Internet browser. Web Server communicates with Internet Map Server. Internet Map Server retrieves geographical information from Spatial Database and transform into an appropriate format before sending the data to a Web Server. The architecture of a Web-based GIS is shown in Fig. 3.

Based on the Web-based GIS architecture, the data can be accessed not only by the West Nusa Tenggara Government, but also by other Government Institutions which are interconnected with the West Nusa Tenggara Government.

V. RESULT AND DISCUSSION

The identification of potential area for paddy field to increase rice production and its publication on the Internet was the objective of this study. The determination of the potential area for paddy field was done using ArcGIS Software.

There are many ways to reach this objective. For this study, Model Builder which is one of the most powerful and yet most underused tools in ArcGIS is used to build the model. Model builder provides a graphical environment to create a diagram of multiple steps to complete a complex geo processing task. The diagram to be built represents a model. Tools can be dragged from ToolBoxes in the ArcCatalog tree or from the ArcToolbox window into the Model diagram to build the processes that make up the model, then filled in the necessary input data and parameters for each tool and connect the processes together. When the model is run, Model Builder processes the input data in the order specified and creates output data. The model can be saved, modified and rerun [7].

The model for identifying the potential area for paddy field created by using Model Builder, which is a powerful functionality offered by the ArcGIS Software is shown in the Fig. 4. The Model is easy to understand based on the name and color. Blue color means input, yellow color means processing, and green color means result or output.

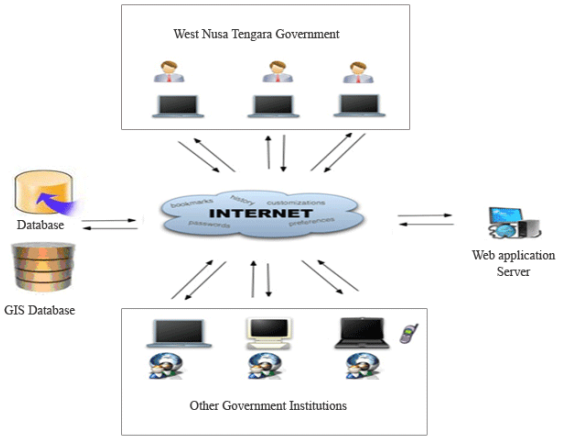

Figure 3. Web-based GIS Architecture.

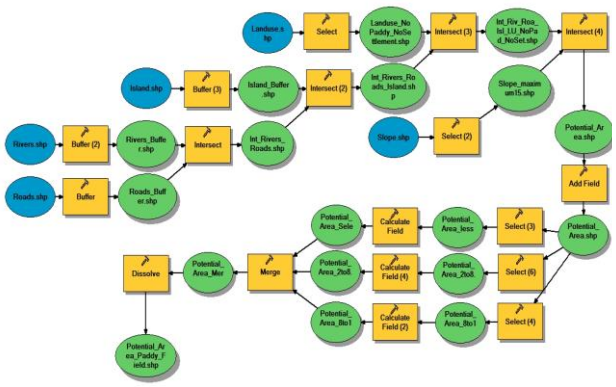

Figure 4. Model created by using Model Builder in ArcGIS Software.

It is important to know that Model Builder will create automatically all files (data) when executing the processes in the model. The resulting map based on the model is shown in the Fig. 5. In order to obtain a better visualization of the map, the layout was processed to GIS tools using the Layout functions offered by ArcGIS. Fig. 6 shows the potential area for paddy field layout.

The Database management software used for this study is PostgreSQL coupled with PostGIS. This software has high capacity of storing data based on the operating system. Ka-Map is used as web-mapping interface for this work. The advantages of using Ka-Map is that it provides different GIS tools such as zoom in, zoom out, pan, full extent, scale, legend, query option that allows the user to retrieve attribute data from related database tables by selecting a location on the image displayed on the web browser and so on. Fig. 7 shows the Web interface on a Web browser. The interface is mainly menu driven, making it very easy to use. All the menu options are given appropriately, so that a novice computer user can use the system.

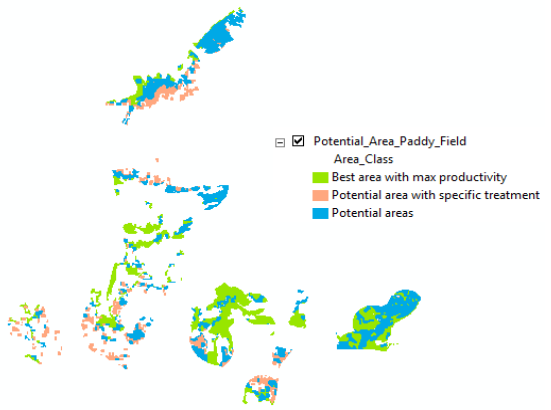

Figure 5. Potential area for paddy field.

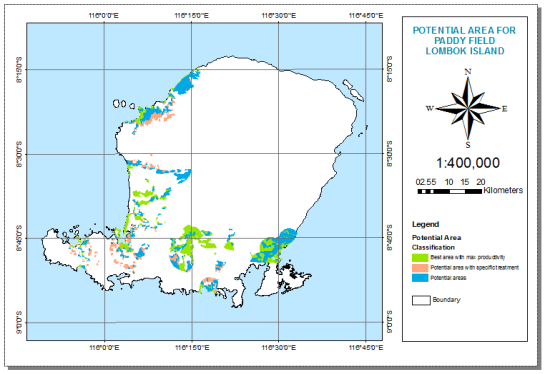

Figure 6. Potential area for paddy field layout.

The Web page is equipped with a map to indicate the location where the potential area for paddy field in Lombok is exactly located. Only two layers are shown here which are the boundary and the potential area which is classified in three classes, best area with max productivity, potential areas, and potential area with specific treatment. Other layers can be implemented to the system if needed.

VI. CONCLUSION

The potential area for paddy field is especially located in the west and south part of Lombok Island. The study showed that 3.19% (146 km2) of the total area (4564 km2) are best areas with maximum productivity, 2.73% (125 km2) as potential areas, and 1.24% (57 km2) considered as potential areas that need specific treatment. The use of Model Builder is very interesting and helpful. There is no need to execute one by one all of the processes. Once the model is built, just run the model and all processes are executed. The result can be shown by adding the proper layer to the table of content tools of ArcGIS. On the other hand, ArcToolBox offers different capabilities and tools when building the model not to mention Analysis Tools or Data Management Tools.

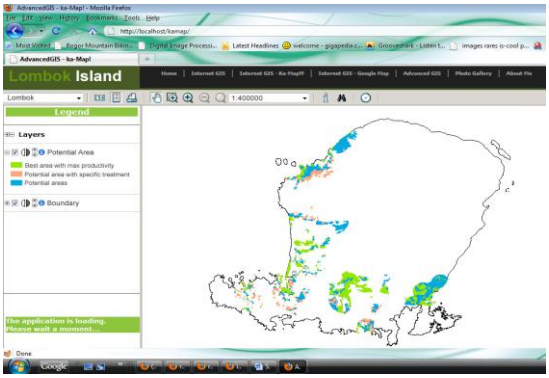

Figure 7. Home page of the Web-based GIS.

Nowadays, Internet becomes faster and faster, and the technology more and more developed. The use of Web based GIS do not put any problem as long as users have Web browsers up-to-date and Internet connection. The development and implementation of a web based GIS will be benefit not only for the Nusa Tenggara Government, but also for other Government institutions since the information can be accessed and obtained as long as there is Internet connection, web browser, and access to the system. The real time interaction given by the system is really important because it can reduce the time traveling and the time wasting. The use of PostgreSQL is also important because it makes easy when managing the data. In this study, only two layers are shown which are potential area and the boundary.

If needed, other layers can be implemented to the system such as the road, river, land use, slope, and so on for a specific purpose. Moreover, other parameters such as climate and soil can be considered for a future work, and the sustainability of paddy field based on economic and social factors can be focused.

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