Indonesian Journal of Electrical Engineering and Computer Science
Vol. 4, No. 3, December 2016, pp. 670 ~ 677
DOI: 10.11591/ijeecs.v4.i3.pp670-677

Mapping of Flooded Areas in the Kudus District

Rina Fiati*, Anastasya Latubessy
Muria Kudus University, Kudus, Indonesia
*Corresponding author, e-mail: rina.fiati@umk.ac.id

Abstract

Flood is still an annual problem in the Kudus District. Based on the survey and interview with Regional Disaster Management Agency (BPBD – Badan Penanggulangan Bencana Daerah) data showed that in the Kudus District there are still many flood-prone areas. They also said that, there are six parameter that can be used to identify potential flood area such as: extensive inundation (km2, ha), depth or height of flood waters (meters), the flow velocity (m/s, km/h), the material washed away by flood flow (rocks, boulders, trees, and other solid objects), concentrations of water or silt thickness (meters, centimeters), and duration of inundation (hours, days, months). Therefor this research use six parameters are then analyzed and used as a benchmark model to identify flood-prone areas by using the production rule method, and as the material in constructing and designing flood-prone area identification systems based on expert system. Thus this research resulted a system to assist the identification of flood prone areas in the Kudus District by using expert system and geographic information system (GIS).

Keywords*: mapping, systems, information, floods*

1. Introduction

AADF Science and technology are among the best things human beings have ever had. They can be helpful for human live if they are well managed. Processes such as information identification, evaluation, and management are examples of those that can be better carried out using technology. Even bigger problems such those faced by a nation can also be solved by using technology. One of technology that can be use to help human live is Expert System. Yudistira B, uses Expert System to making sketch for crime investigation purposes. This research adding sketcher knowledge and the result of the system can made sketching reach 85% of accuracy level [1]. Arif SN, also uses rule based expert system to detecting damage a computer network system [2]. Meanwhile Santoso LW, in their research uses fuzzy expert system to analysis of disease in humans [3]. There are so many advantages of expert system.

One of the problems that our nation has to deal with is the annual flood potentially occurs in some areas. At the beginning of 2012 Kudus District was terribly flooded; with the high rainfall at that time, only few parts of the city were free from flood. Accordingly, this study discusses an application to map areas of potential flooding in Kudus. The area is mapped based on six parameters including extensive inundation (km2, ha), depth or height of flood waters (meters), the flow velocity (m/s, km/h), the materials washed away by flood flow (rocks, boulders, trees and solid objects etc.), concentrations of water or silt thickness (meters, centimeters), and duration of inundation (hours, days, months). The parameters were obtained based on a survey and interviews with the Regional Disaster Management Agency (BPBD) of Kudus District [4]. These six parameters were modeled using production rule, and resulted in a flood-prone area identification system based on expert system [5].

In the other side, GIS technology is widely used in many researches. Minan T, uses GIS technology to modeling and simulation of mecanical parking system. It provides references for the intelligent transportation system[6]. Shukla V, Sarup J in their research stating that Web GIS is an advance technology to manage and display all geographical locations on the earth surface [7]. Bunch MJ, uses this technology in mapping and managing environment in India. The results from the research can be used in decision making [8]. Another research using GIS technology was carried out in 2015 by Hassaan MA, on Suitability Analysis for Siting a Solid Waste Incineration Power Plant in an Urban Area in Alexandria [9]. The other research have published in 2012 by Setiawan CB, also using GIS Technology to mapping the flood risk based

Received September 9, 2016; Revised October 25, 2016; Accepted November 10, 2016

on Land Physical Character at Kudus Regency. The results shows that more than 50% of total areas in Kudus Regency is vulnarable againts flood due to its slope, soil and landuse condition [10].

Targeted innovation in this research is the construction of identification model for flood-prone areas using the combination between GIS and expert system. This focus research is to combine Expert System and GIS. The results from this identification is used to locate the flood-prone spots. This research give a concept of developing a model called E-GISIFA (Expert-Geographical Information System for Identificatian Flood Area) that can be used as alternative in flood responding system.

2. Case Study

Kudus are the smallest city in Central Java, covering 42.516 Ha which divided into 9 sub-districts. It is both industrial and trading city. These two sectors significantly contribute to PDRB (Gross Regional Domestic Product). Kudus is one of District (regency) in Central Java, surrounded by other four Districs: Jepara Distric (some part on the north and west), Demak District (some part on the west), Grobogan District (some part on the south), and Pati District [5] (some part on the south and east).

The geographical coordinat is 6.51' – 7.16' longitude and 110 36' - 110 50' latitude. The longest distance from west to east is 16 kms and from north to south is 22 kms. Topographical speaking, the lowest part Kudus District has is Undaan Subdistrict, only 5 meter above sea level, while the highest one is Dawe Subdistrict with 1600 above sea level. Figure 1 shows the map of Kudus District.

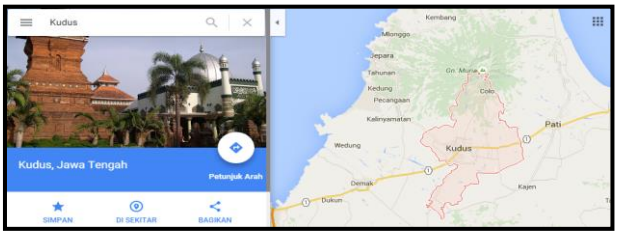

Figure 1. Map of Kudus District

The soil in Kudus District is mostly brown alluvial, covering 32.12 percent of the region, with slope of 0-2 degree and 90 cm effective depth. Details are in the following Table 1.

Table 1. Land Data According to the Slope in KudusDistrict

sub-disctrict	(0-2) Degree	(3-15) Degree	(16-40)Degree	>40 Degree
Kaliwungu	3,267.35	-	-	-
Kota	1,047.32	-	-	-
Jati	2,629.80	-	-	-
Undaan	7,081.03	8.50	87.50	-
Mejobo	3,676.57	-	-	-
Jekulo	6,139.51	1,115.10	176.35	860.72
Bae	2,273.91	58.36	-	-
Gebog	2,198.91	1,183.33	439.75	1,687.92
Dawe	549.50	4,299.98	2,343.38	1,390.88
Total	28,863.90	6,665.27	3,046.98	3,939.51

3. Methodology

This research collaborates expert system and GIS technology by using action research method. This method is selected because at the first phase there will be a research on development criteria previously done, and from the result of this research it continues to the analysis and design formulation, and then the implementation of expert system to identify flood-prone areas in Kudus District. In the second year, there will be improvement by the

implementation of additional GIS module in the mapping of flood-prone areas in Kudus District. The research method of Geographic Information System for mapping the flood-prone areas is shown in Figure 2.

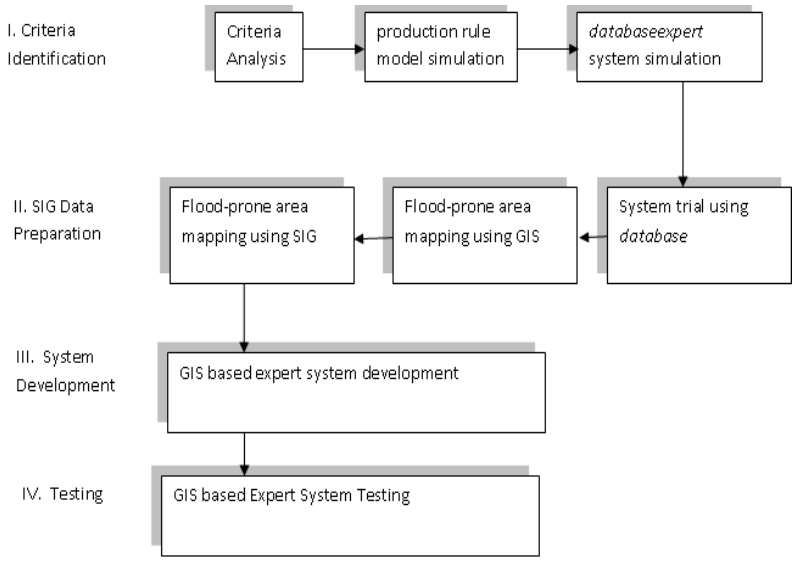

Figure 2.Research Method of GIS to Identify Flood-prone Areas based on Expert System

4. Results and Discussion

This research using six parameter including extensive inundation (km2, ha), depth or height of flood waters (meters), the flow velocity (m/s, km/h), the materials washed away by flood flow (rocks, boulders, trees and solid objects etc.), concentrations of water or silt thickness (meters, centimeters), and duration of inundation (hours, days, months). These six parameters were modeled before using production rule method. Production rule is a method that can be used to identify the flood prone area as shown in Table 2.

Table 2. Pseudocode of Production Rule using Six Parameters

No	Line of Pseudocode
1	IF extensive inundation > 200 m AND
2	depth or height of flood waters > 15 cm AND
3	the flow velocity > 2 m/s AND
4	the material washed away by flood flow == rocks OR boulders OR trees OR other solid objects AND
5	concentrations of water or silt thickness > 1 m
6	duration of inundation == 1 day
7	THEN
8	FLOOD PRONE AREA

Based on the results from the research and data from Regional Disaster Management Agency, there are thirty flood-prone villages in Kudus District, spread over five subdistricts as shown in Table 3.

Based on data in Table 3, this research resulted in a system that can map areas based on their vulnerability level to flood. This research uses GIS technology (Geographic Information System) for the process of mapping the area. Figure 3 is the opening display of flood-prone area identification system. On the middle left there is a menu for user login, and a link to login as the administrator is located on the footer.

Table 3. Table of Flood-prone Villages in Kudus

No	Subdistrict	Village
1.	Kaliwungu	Setrokalangan
		Banget
2.	Jekulo	Pladen
		Sidomulyo
		Bulungcangkring
		BulungKulon
		Sadang
3.	Undaan	Lambangan
		Kalirejo
		Medini
		Sambung
		Glagahwaru
		Kutuk
		UndaanKidul
		Undaan Tengah
		UndaanLor
		Karangrowo
		Larikrejo
		Wates
		Ngemplak
		Terangmas
		Berugenjang
4.	Mejobo	Gulang
		Kirig
		Temulus
		Kesambi
		Jojo
		Payaman
		Hadiwarno
		Mejobo
5.	Jati	Jetiskapuan
		Tanjung karang
		Jati Kulon
		Jati Wetan
		Pasuruan Lor
		Loram Wetan
		Loram Kulon
		Ngembal Kulon

Figure 3. The Opening Display of Flood-Prone Area Identification System

A user refers a village that has been registered by the admin as a system user. Figure 4 is a view of the opening page of the registered user. On this page, the user can change the profile of the village, the identification of the region, as well as the history of completed identification of regions per period. Period will be annually activated.

Figure 4. Opening Page of a Registered User

Data about the village which has identified can be seen through the identification history menu as shown in Figure 5. There are two options on the table history data, the option to delete the data and the option to view detailed historical data identification area. Detailed view of history is shown in Figure 6.

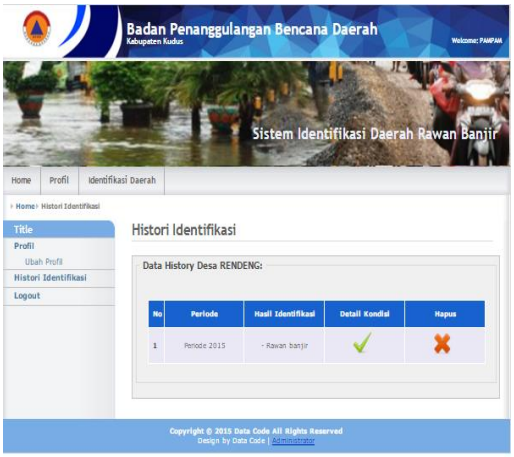

Figure 5. A Display of Village Identification History

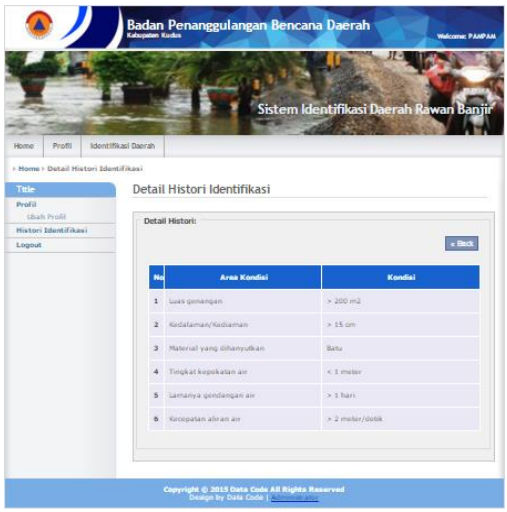

Figure 6. A Display of Detailed Identification History

On the other hand, the administrator page is a page where the data is managed. The data management includes master data management, area data management, user data management, and data reporting management. Other menu on the admin page is period setting menu, and map identification result menu. A display of admin page is shown in Figure 7.

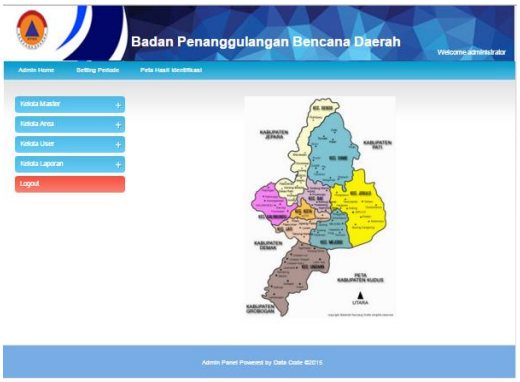

Figure 7. A Display of Admin Page

Master data management process includes a criteria data management where six criteria parameters are used, criteria values used for inputting the value of each criterion, as well as data resulted from the identification. A display criteria data management is shown in Figure 8.

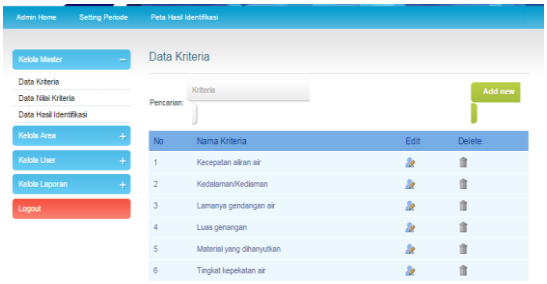

Figure 8. A Display of Criteria Data Management

Data of villages in every Subdistrict of Kudus District have already inputted on admin page as shown in Figure 9. These data is editable through edit menu available on the page.

Figure 9. A Display of Village data

Admin can see details of village data previously inputted, as shown in Figure 10. Village data includes the subdistrict where the village is located, village name, area size, village coordinate, village potentials, and a map.

Figure 10. An Example Display of Details of a Village

The final result of this research is to show the mapping of flood-prone areas in n Kudus District. Figure 11 shows the display of area mapping in Kudus District. Areas printed in red indicate the flood-prone ones, while those printed in blue in the map are non-flood-prone areas.

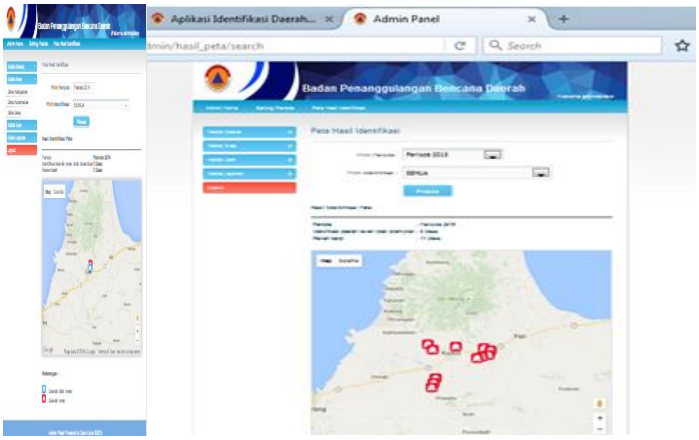

Figure 11. A Display of Area Identification Mapping

5. Conclusion

Based on the result of the study, it is concluded that:

1. There are thirty eight villages detected as flood-prone areas in Kudus District, spread over five subdistricts including Kaliwungu, Jekulo, Undaan, Mejobo, and Pati.
2. A system that capable of combining expert system and GIS technology to map areas in Kudus District is finally constructed.
3. This system is then called E-GISIFA (*Expert-Geographical Information System for Identificatian Flood Area)* which can be used as an alternative for flood responding system.

References

[1] Yudistira B, Putra IKGD, Sudana AAKO. Sketching Expert System for Crime Investigation Purposes. *Indonesian Journal of Electrical Engineering and Computer Science.* 2014; 12(7): 5655-5660.

[2] Arif SN. Implementasi Rule-Based Expert System Dalam Mendeteksi Kerusakan Sistem Jaringan Komputer Dengan Metode Backward Chaining. *Jurnal SAINTIKOM.* 2011; 10(2): 81-93.
[3] Santoso LW, Intan E, Sugianto F. *Implementasi Fuzzy Expert System Untuk Analisa Penyakit Dalam Pada Manusia.* Seminar Nasional Aplikasi Teknologi Informasi. 2008: 1-6.
[4] Fiati R, Latubessy A. Ruled Based Modelling Untuk Identifikasi Daerah Potensi Banjir*. Jurnal Simetris.* 2015; 6(1): 57-68.
[5] Fiati R, Latubessy A. *Identifikasi Daerah Potensi Banjir Berbasis Expert System*. Seminar Nasional Teknlogi dan Informatika. Kudus. 2015; 181-190.
[6] Minan T, Xiaoming W, Shuang Y. Site Selection of Mechanical Parking System Based on GIS with AFRARBMI. *Indonesian Journal of Electrical Engineering and Computer Science.* 2013; 11(7): 3935-3944.
[7] Shukla V, Sarup J. Applied Open -Web GIS Server based solution to develop the Web-Based Mapping Application using Open-Source Software Server (OSS). *International Journal of Informatics and Communication Technology (IJ-ICT)*. 2012: 1(1): 33-42.
[8] Bunch M J, Kumaran TV, Joseph R. Using Geographic Information Systems (GIS) For Spatial Planning and Environmental Management in India Critical Considerations. *International Journal of Applied Science and Technology.* 2012; 2(2): 40-54.
[9] Hassaan MA. A GIS-Based Suitability Analysis for Siting a Solid Waste Incineration Power Plant in an Urban Area Case Study: Alexandria Governorate, Egypt. *Journal of Geographic Information System*. 2015; 7: 643-657.
[10] Setyawan, CB, Murakami, K. 2012, *Flood Risk Mapping Based on Land Physical Characters Case Study at Kudus Regency, Central Java, Indonesia*. library.jsce.or.jp/jsce/open/00074/2012/56-02-0046.pdf