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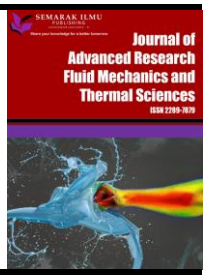

Early Warning System for Fire Catcher in Rain Forest of Sumatera Using Thermal Spots

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ABSTRACT

This research's goals were clear agricultural land in large tropical forests, it is usually very difficult to control because it requires no small amount of money for farmers. The burning method of tropical forest land is a cheap way for farmers to start farming and saves energy. Unfortunately, this method can increase the impact on health and environmental damage. There are several research on burning forest land for agriculture but there are still many weaknesses and shortcomings in the application of the applied method. Therefore, a model was designed to detect and reduce the weaknesses and shortcomings of each method applied in optimizing the detection and reduction of error rates in forest burning that can cause forest fires using the 4.0 technology method. In designing of the Early Warning System Model for Fire Catcher in the rain forest of Jambi, Sumatra, the methods used are literature study, analysis method with hotspots information system (hotspots) and Earth data, NASA. The analytical method in the form of action research is intended to examine the problems faced by the Forestry Service of the Province of Sumatra and the tropical forests of Sumatra. Forestry Service Unit in Sumatra Province as a sample. The design method is used to design a new application system based on data taken from interviews with the forestry service in the form of Intellectual Property Rights that can provide solutions to problem identification. In designing the Early Warning System Model for Fire Catcher in the rain forest of Jambi, Sumatra as the outcome of the first-year research that the methods used are literature study, analysis method with hotspot information system and Earth data, NASA. The design of the Intellectual Property Rights Model uses PHP, MySQL. The result to be achieved is the success of the early warning system model to detect forest fires also the widespread publication in Indonesia in the first year of this research.

1. Introduction

The use of forest land as the fulfillment of the people's economic needs mostly occurs due to the impact of changes in population characteristics and weak institutional control factors in monitoring forest land tenure activities for agriculture [1]. Uncontrolled forest clearing activities

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using land burning methods can lead to forest fires in addition to climate factors that usually occur in the dry season and extremes where the dry season is prolonged and longer, causing severe droughts such as during the El Nino season. El Nino can occur in most parts of Indonesia which are under normal conditions, namely the advance or retreat of the rainy season. Controlling the occurrence of forest fires due to weaknesses and shortcomings of hotspot detection methods is an important matter that must receive emphasis, especially in terms of preparation time and funding allocation [1]. Based on the BNPB Task Force, there were 135.7 thousand hectares (ha) of forest and land burned throughout 2019, where the most hotspots due to forest fires were in Sumatra and Kalimantan. Meanwhile in South Sumatra, the total area of land and forest burned reached 11,826 hectares and 11,022 hectares of land in Jambi. A total of 695 hotspots in Jambi, 532 hotspots in South Sumatra and 187 hotspots in Riau [2].

Data obtained from Si Pongi, the Ministry of Environment and Forestry, noted that there were 467 hotspots in Sumatra. Losses due to failure of forecasting and early detection due to forest fires are estimated to endanger 36 thousand lives per year between 2020-2029 if fire disasters due to forest expansion continue to occur [3].

Forest fires including peat forests in Indonesia, especially in South Sumatra are very detrimental to humans and the environment [4]. The occurrence of peat fires in 2015 caused a haze disaster in most areas of Sumatra. As a result of these fires, a smog disaster that is very dangerous for human health was recorded as a haze disaster in 1997, 2006, and 2015 which caused human deaths and respiratory diseases throughout Indonesia [3]. On the other hand, globally, peat fires can release carbon emissions into the atmosphere, causing global warming and extreme climate change.

Controlling due to forest fires is deemed necessary to utilize satellite technology prior to the occurrence of fires, but the technology is still at the monitoring level and has not yet entered the prediction level which allows it for a longer preparation time lag [1].

Based on PP No. 22 of 2008 concerning Funding and Management of Disaster Aid, Article 12 states that disaster management funds at the pre-disaster stage are allocated for activities in the following situations:

i. no disaster
ii. there is a potential for disaster.

Then Article 14 Paragraph 1 states that the use of disaster management funds in situations where there is a potential for a disaster to occur as referred to in Article 12 letter b may include:

i. preparedness activities
ii. early warning system development; and
iii. disaster mitigation activities.

With these laws and government regulations, the government needs to consider policies in increasing funding allocations for aspects of prevention and early warning (warning) of potential forest fires and not only during the suppression phase of the crisis due to forest fires.

2. Methodology

2.1 Research Roadmap

This study uses the early warning system model method which is formed from geographic and hotspots data obtained from the Jambi Province Forestry Service, Riau to observe an increase in the

incidence of peat forest fires between 2015-2019. This study processes data obtained through the FIRMS (Fire Information for Resource Management System) website to observe hotspots during peat forest fires to determine and detect the direction of movement of hotspots. Testing and data processing are carried out simultaneously and individually on each existing function. The research was conducted using a geographic information system model, which is an information system based on spatial and non-spatial data based on space and can be used in the decision-making process. In this geographic information system, the information retrieval process starts from storing and manipulating and analyzing geographic information based on location [5]. This information system can perform analysis in the form of statistics based on spatial information in a map, therefore it is used by industry and government circles to be implemented on various devices and operating systems such as the android system and windows operating system to be able to explain the diversity of response variables in this study, namely the breadth of forest fires and predictor variables studied in this study, namely FFMC, day, temperature, DMC, relative humidity, month, y-axis coordinates of spatial locations on the map, DC, and spatial x-axis coordinates of locations on the map [6]. This research is in line with Purnomo who is expected in the first year to obtain information about forest fire predictions as previous research using Neural data mining methods.

Network with Support Vector Machine. This research is expected to be able to predict the pattern of forest fires during extreme climates.

Management of geographic information system is currently placed with the provincial government and must be constantly updated. According to [7] the definition of a geographic information system is as follows: "a set of computer-based tools that allow to process spatial and non-spatial data into related information about the earth's surface and are used for collecting, storing, manipulating, analyzing and displaying data. which is then used as material for making decisions/policies. In designing the system model according to [8], there are stages that must be taken, namely system requirements investigation, analysis, design, testing and implementation. System investigation of geographic information systems by looking at the settings of the subsystem which will later provide information to process vector variables and predictor variables from climate data obtained from the FIRMS website [9]. The system analysis stage requires more information about ground surface data. While the system design stage [8] involves 2 types of class diagrams, namely overview diagrams and detailed diagrams. To design using class diagrams, you must place the required transaction tables and master tables on the UML class diagram and then define the required relationships and attributes between variables. Web-based offline Early warning system model where information on hot spots with extreme climate patterns takes data from the GIS communication flow model Figure 1.

The Geographic Information System (GIS) communication flow model was known in Indonesia in 1972 as data banks for development [10]. The GIS system in communicating has a GIS communication flow model, namely (1) geographic model selection; (2) database concept design; (3) the conception of GIS analysis; and (4) user conception [10].

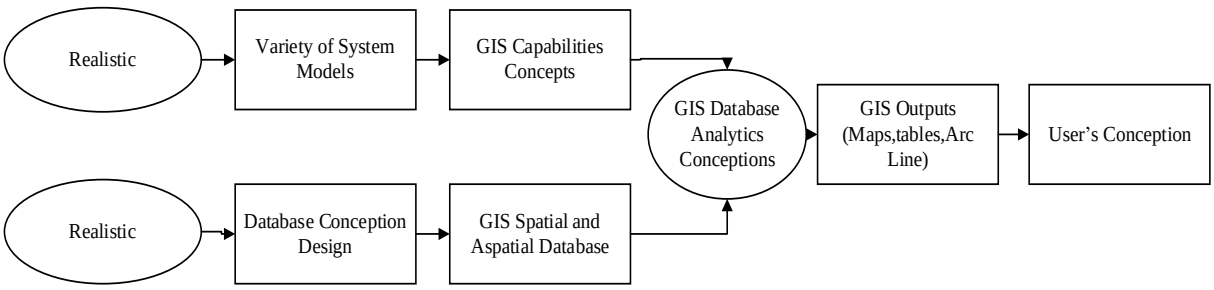

Fig. 1. GIS Flow Communication Model

2.2 The Use of GIS

GIS is an information system created based on the purpose of developing GIS itself. GIS is categorized into Transaction Processing Systems (TPS) level along with Office Automation Systems (OAS) and Knowledge Work Systems (KWS). The output from the GIS is used to process information into Management Information System (MIS) level input material which is included in the Decision Support Systems (DSS) category which then makes it easier for the Executive Expert System (EES) level to use and interpret information as decision making material as described in the triangle Model Information System levels in Figure 2. In the field of monitoring climate information, hotspots anticipate the occurrence of forest fires, the use of GIS is used in the process of monitoring government programs in Indonesia. GIS is used to view spatial and non-spatial data from the area of rain forest, the amount of rainfall and the area of logging by the community in an area.

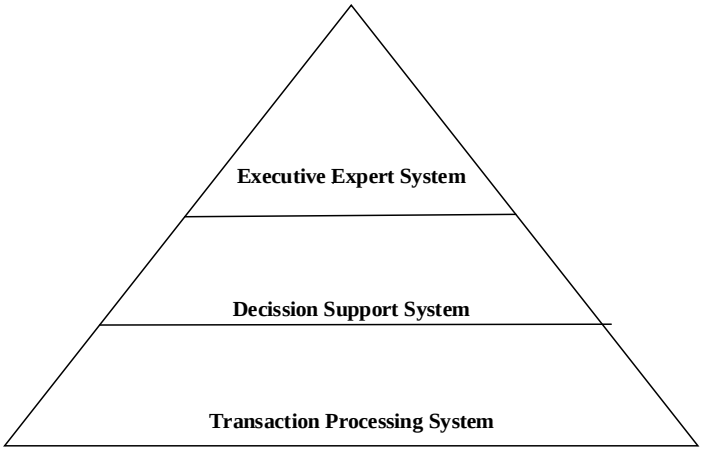

Fig. 2. Information System Level Model

2.3 GIS Infrastructure

In developing the selection of GIS as a method of assisting the process of distributing information on monitoring hotspots, this can be done in several ways, including using Google Maps and earth data obtained from the NASA website. Google Maps provides an infrastructure in the form of maps that can be accessed through the Google Maps API based on java script and provides data in the form of digital imaging using satellites so that users can view and access map data on the planet's surface [11]. The types of maps on Google Maps consist of [12]

i. G_NORMAL_MAP, which is a roadmap.
ii. G_SATELLITE_MAP, which is a map from satellite imagery.
iii. G_HYBRID_MAP, which is a more detailed normal map combination map.
iv. G_DEFAULT_MAP_TYPES, which is a map in an array of types and interactive.
v. G_PHYSICAL_MAP, which is a physical map based on terrain information.

Meanwhile, NASA's earth data provides data on the daily rainfall and climate of Jambi Province which was downloaded from NASA using the TRMM (Tropical Rainfall Measuring Mission) satellite in 2017-2019 [13]. Accessing data TRMM from the Meteorology, Climatology, and Geophysics (*BMKG*) and Jambi province map Figure 3 [19].

Fig. 3. Jambi Province Map

When viewed from the map, geographically, Jambi Province is bordered by other provinces in the vicinity. Jambi's western boundary is bordered by the provinces of Bengkulu, Riau, West Sumatera and South Sumatera. The border with the east of Jambi is bordered by the Strait. Jambi's northern boundary is bordered by Riau Province. Then the border to the south of Jambi is bordered by the province of Sumatra. South. With the geographical support of the database mentioned above, a large-scale GIS can be made according to the needs of the users of this research. The GIS model in this study will also be able to do various things, including previewing the map display before it is published, publishing the map results and or deploying it in the form of a modus file. The GIS model has two versions, namely a desktop version (offline) and a web version (online). The desktop version of the GIS model was first developed and can only run on a local environment, while the web version is a development of the desktop version of GIS and has more interactive features and can be accessed via a web browser. The early warning system model can also be combined with Google Maps in GIS development, namely in the process of making maps with the xml file stages from Google Maps (Earth) converted to a PHP's files so that they can be processed using Arc Map GIS 10.3 [13] to find values rainfall in pixels covering Jambi. Then Jambi's rainfall data is recapitulated monthly and annually to obtain information about the climate.

In the field of natural disasters, research related to the use of GIS on climate is carried out in Haiti. In this study, the kriging method was used to determine or estimate the damage to a building when a natural disaster occurred [14].

2.4 Review of Previous Research

Several studies have discussed the use of various sensors to detect the occurrence of fire hotspots, ranging from mountain top cameras, cameras with drones to the use of satellites covering areas throughout the observation area [15].

Previous research [15] states that cameras located on forest land in some systems experience weaknesses because they cannot detect hotspots in the camera sensor coverage, especially the area where the camera sensor is installed.

In addition, several studies were carried out in the form of implementation of mobile GIS technology using the Java programming language so that the results of the damage estimate could be described based on field or spatial conditions. Other related research is research in the field of mapping the risk of soil erosion due to the weakness of the existing system that occurred in Turkey [5]. The focus of this research is to map the area around rivers and dams using GIS data as a tool [5]. Determination of erosion risk areas based on four main factors, namely vegetation, topography, soil, and climate. The study resulted in 33.82% low risk areas, 35.44% medium risk areas, and 30.74% high risk areas [16].

Jambi is one of the provinces in Indonesia located on the island of Sumatra with a population in 2015 of around 3.4 million people. The area of Jambi is approximately 5 million hectares of which is 2.1 million hectares are forest and 0.6 million hectares are peatlands [17].

Thermal spots detected in several areas, namely in Tebo Jambi regencies are categorized as highly flammable due to lack of rainfall and rising ground surface temperatures [18]. The people in hot areas can tolerate higher indoor temperatures of environment as naturally thermal comfort [20].

Meanwhile, for 2019 the distribution of hotspots with the highest distribution includes West Kalimantan and Riau and Jambi [17]. The location of the fires occurred on community-owned plantations and in concession areas, both in the forestry and plantation sectors. The sample taken is the population regarding the area of forest and peatland fires, which are one of the frequent disasters in Indonesia, especially in Jambi Province, recorded from early January 2019 to September 2019 with a coverage of 101,418 and throughout 2019, 30,947 thermal hotspots were detected [17].

The research steps of the Early Warning System Model for Fire Cather in The Rain Forest of Sumatra were carried out based on the software development model Figure 1. Planning the research stage is a stage that must be carried out when conducting research Figure 2. The steps that must be taken when conducting research are as follows.

The steps were observing and looking for problems that will be used as research objects in the form of hotspots so that they can be run into the early warning system model application according to offline-based research methods. In this study, hotspot data was obtained which was downloaded from Apollo Mapping, MODIS with NOAA- AVHRR. Normalized Burn Ratio (NBR) is used to map the burned area in Apollo Mapping imagery. The upper part of the atmospheric reflectance values of the two WorldView1/2/3/4 GeoEye-1 bands (which are used to map the hotspots of the earth's surface in Jambi Province. The image Figure 4 was downloaded from the FIRMS institute.

By using the FIRMS Institute’s Data steps that are building a model application for the geographic information system of the Forestry Service by applying PHP and MySQL programming methods as followed.

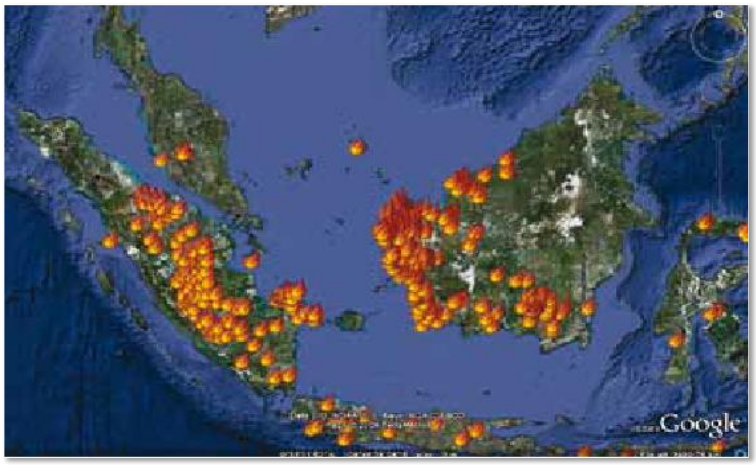

Fig. 4. Thermal Spots in parts of Sumatra and Kalimantan in the period 7-17 July 2009 (NASA/GSFC MODIS Rapid Response image)

2.4.1 Database clustering

The step is carried out with the intention of grouping data originating from the earth data site, the BMKG site and the Jambi Province administration site.

2.4.2 Clustering analysis

The step is carried out to find out the problems and needs needed in building an early warning system model using the offline method. The modeling language used in building this GIS is an object-oriented modeling language / UML by modeling the relationships between objects to be integrated. Clustering data is done by grouping on hotspot data set. Data Set and Study Area was conducted using South Sumatra Hotspots data obtained from Terra and Aqua Satellite through FIRMS MODIS Fires with data coverage up to 2015.

2.4.3 Clustering evaluation

The step is done by making a prototype model using the PHP and MySQL programming languages.

2.4.3 Visualization

The step is done by designing a system model. The outputs obtained from the visualization results will be made into several relationships with the application dashboard so that they can easily understand and make it easier to build the system. System design is directed to a system designer in designing the early warning system model software. System design is a technique for solving complementary problems by reassembling the component parts into an integrated system. In building a geographic information system model at the Jambi Provincial Forestry Service using the SQL-based Web-offline method with the following procedure sequence [11]

i. Designing the System Architecture by making the initial system architecture
ii. Building a User Interface Display by designing an interface so that the system can operate according to user's needs.
iii. Database Design by making the database built so that the data can be organized in a good and safe repository.
iv. Building a program with a program code design using PHP coding logic.
v. Implementing the system by testing and ensuring the operation of the system into a model as desired.

3. Results

Based on the research conducted at the Jambi Provincial Forestry Service, the results and detailed discussions are as follows

i. The frequent occurrence of forest fires during 2015 – 2019 in the rain forests of Jambi Province and the surrounding border areas due to the undetected hotspots as an early indication of information on forest fire disasters and there has never been a complete visual information media about mapping using GIS data, so the author provides solutions to overcome these problems include utilizing an information system model, namely the geographically based early warning system for fire catcher model using website access and offline data processing using NASA's earth data database.
ii. By utilizing the offline website, users can be helped to get complete information about hotspots and early indications of forest fires spreading in the rainforests of Jambi Province.

4. Conclusions

After conducting the research process on designing an early warning system model using a geographic information system, the research results can be explained as follows

i. The structure of the early warning system for fire catcher model is an illustration of how a GIS application is formed and what feature menus it has Figure 5. To form the structure of the GIS model, what you need to know first is the GIS communication architecture model, because with this model it will be seen who the structural needs of each user are. GIS communication flow architecture as shown in Figure 6.
ii. In accordance with the communication architecture, it can be seen how the communication pattern in the GIS model early warning system in data processing. The data processed in the GIS model consists of spatial and non-spatial data. The spatial data used is the location data of the rain forest coordinates, while the non-spatial data (attributes) used are data on climate change and weather in Jambi Province.

By utilizing the website model early warning system, users can be helped to get complete information about hotspots in the Jambi rainforest as a solution to the problem of detecting hotspots for forest fires for the Jambi provincial government**.**

Fig. 5. Login Menu Interface

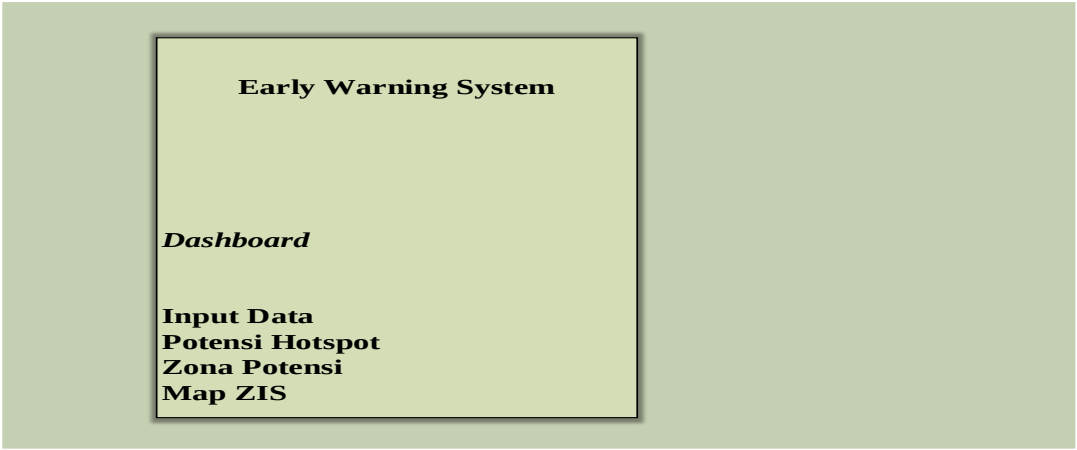

Fig. 6. Model Early Warning System for Fire Catcher Interface

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