Detection of Flood-Prone Areas Using Geospatial Data with Deep Learning Method Approach

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Abstract. The flood problem that happens in Palembang City occurs due to seasonal tidal floods and flooding as a result of inundation caused by rainwater which results in the overflow of the Musi River. The Musi River that flows through the City of Palembang canon accommodates the increasing flow of water and high rainfall which can cause problems to many flood-prone areas along The Musi River. The flood that happens in Palembang City can reach 30cm and this motorbike riders can cause interfere with their travel. Flooding that occurs on the streets can cause damage, especially to vehicles, both two-wheeled and four-wheeled. In addition, flooding can also cause traffic congestion because vehicles have to slow down and this can cause long queues of vehicles on top of that flooding can affect roads and other infrastructure in Palembang City. To determine the volume of water flow we can use a CCTV camera at a strategic location and use Computer Vision alongside Deep Learning to Determine Water Level, and we can plot the data Into Geospatial Data that can be used to model Flood Hazard Areas.

Keywords: Flood Detection · Deep Learning · Computer Vision · GIS Application

1 Introduction

Flooding is a problem that occurs in almost all cities in Indonesia, including Palembang City. The problem of flooding in the city of Palembang has become a serious problem for the Palembang City government, especially for the Public Works Office and the Palembang City Spatial Planning Office. Flooding in the city of Palembang occurs due to seasonal tidal floods and inundation floods due to rain that often occurs on the streets of Palembang. Flooding due to rain in Palembang in some locations can reach 30cm for adults so that for motorists can interfere with the trip. Flooding that occurs on the streets, can cause damage, especially to vehicles, both two-wheeled and four-wheeled. In addition, flooding can also cause traffic jams because vehicles have to slow down their vehicles so as not to damage vehicles and not disturb other passing motorists. In order not to happen and motorists usually avoid flooded roads by looking for alternative lanes or roads that are not flooded to pass.

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On December 24, 2021, it rained in Palembang and peaked on December 25, the level of rainfall began to be high, starting from dawn to 09.00 am causing all activities and mobility to be disrupted due to flooding that happen everywhere on many streets on Palembang City. Other streets. Almost all roads in the city of Palembang were flooded, Common factors for flooding can be seen from illegal logging, high infrastructure development, regional conditions in some areas, and public awareness of the importance of not littering in river basins resulting in very high sedimentation, as well as narrowed by the density of the building makes the problem more complex. Some of these problems can eventually trigger flooding in Palembang City. Based on these problems, there is a need for research on flood detection that can provide information on flood areas using Deep Learning Model.

Geospatial is a geographic information system that manages spatial and non-spatial data. With the development of geospatial technology and Artificial Intelligent, the two sciences are united in renewable science, namely Geospatial Artificial Intelligent or GeoAI. GeoAI is a combination of spatial data and artificial intelligence that provides solutions for solving mapping information systems using artificial intelligence.

Geospatial technology using Artificial Intelligent has been carried out by previous researchers in different fields of scientific aspects both in government [3, 8], in the field of land vegetation [5], in the field of infrastructure [9–11], agriculture [4], and the field of food [13].

Geographic Information System (GIS) can be a means of analyzing community preparedness mapping in the face of various phases of flooding. The disaster phase of flooding can be divided into three phase levels, namely the warning phase, the disaster climax phase, and the healing or repair phase. The aspects that include research are the identification of preparedness levels, data collection, descriptive statistical analysis, and GIS-based spatial analysis [1].

Computer vision is one of the fields of artificial intelligence that allows computers to extract useful information from a digital image, video or another visual device and then determine the action or provide recommendations based on this information [6]. Computer vision requires a lot of data for the training process before it can perform image classification whereas the algorithms used in the training process are deep learning and convolutional neural networks (CNN) [2, 7, 14, 15]. CNN and machine learning allow computers to learn data by representing images in the form of labelled pixels.

This method uses labels to perform convolutions which are mathematical operations on two functions to generate a third function and make predictions about what is learned from an image. CNN was originally implemented on a single image but in its development with the development of the CNN model, this method can be implemented in video applications [12].

The Information can be gathered through Video of the flow of water on the river in the strategic area this video then can be processed through Computer Vision to get ROI (Region of Interest) and then this ROI will process by a Deep Learning Model the get Data about level of water which is we can use to make detection system of floods.

By using geospatial data as a flood-prone detector, it is hoped that it can provide solutions to handling floods in Palembang city.

2 Research Methods

In the Research Flow diagram in Fig. 1, the step taken is to review the problems that are then carried out by taking data both primary and respectively. Primary data collection consists of 2 stages, namely by using existing map data and making a flood detection prototype placed in a watershed that has been determined as a sample and taking test data from the prototype results. The test results are processed with a deep learning method approach. The output produced is in the form of spatial and non-spatial data which is expected to be a solution to minimize flood areas in Palembang.

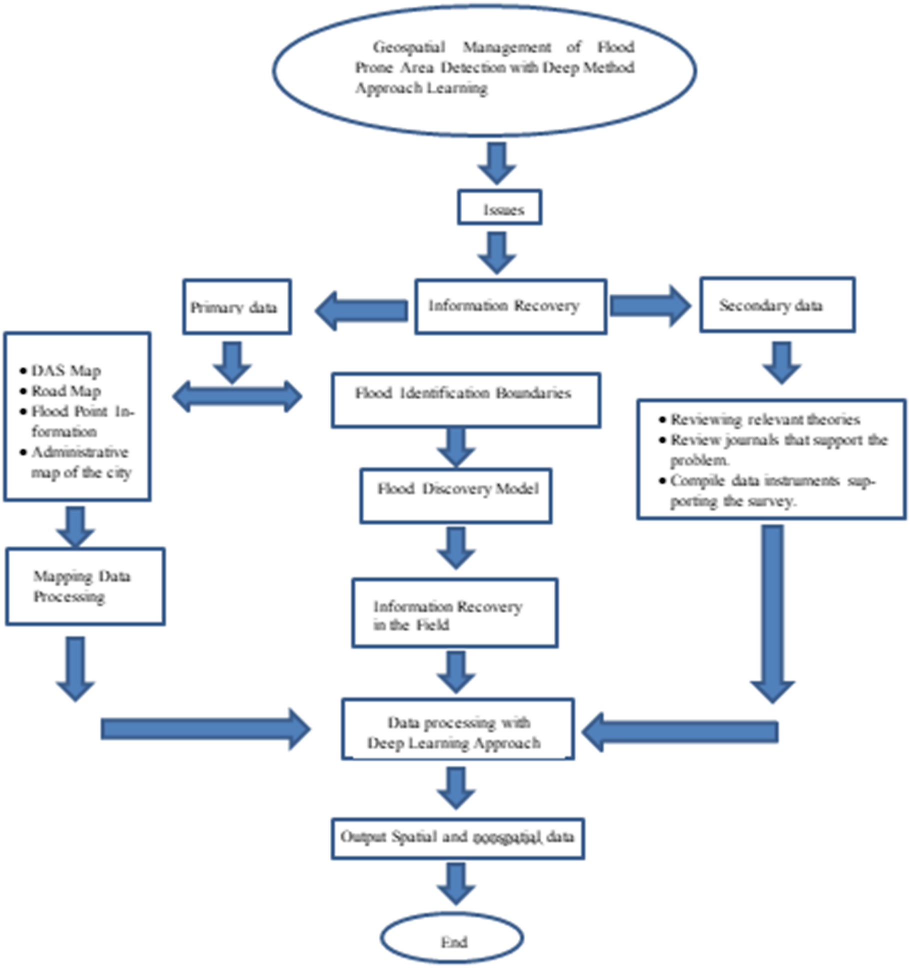

Fig. 1. Research Method

3 Discussion

3.1 Design Phase

For the initial design phase, the steps that must be done are to determine the product design, namely the Region of Interest (ROI) Segmentation design, model design for deep learning, login page design, Android App application design, and spatial design (Map) (Fig. 2).

Figure 3 describes the layers contained in the deep learning process. In the deep learning process, it is known that the total value of params has the same value as the trainable params value, which is 932,897 (Fig. 4 and Fig. 5).

3.2 Development Phase

In the implementation of the design stage, program testing and development stages must adjust to the implementation stage, design and testing of the program (Table 1). In the testing phase, the program is very important in the user eligibility process (Table 2).

The final test of suitability is carried out at the time of dissemination to the end user, namely the user in the hope of knowing the shortcomings and difficulties of the system (Table 3).

The dissemination phase is the last phase of the program testing phase. Because in the dissemination phase, it provides information to the public as information and performance of the flood detection system (Fig. 6).

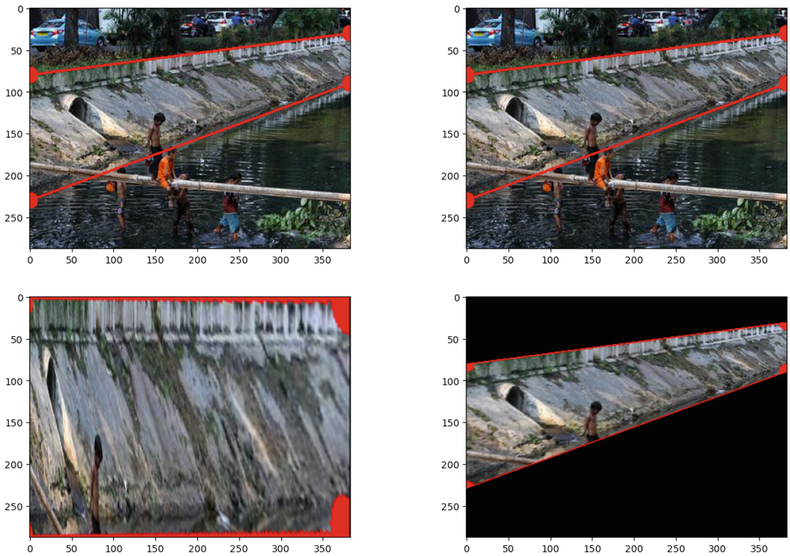

Fig. 2. Region of Interest Segmentation

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_6 (Conv2D)           (None, 254, 254, 32)      896

 max_pooling2d_6 (MaxPooling  (None, 127, 127, 32)     0
 2D)

 conv2d_7 (Conv2D)           (None, 125, 125, 16)      4624

 max_pooling2d_7 (MaxPooling  (None, 62, 62, 16)       0
 2D)

 conv2d_8 (Conv2D)           (None, 60, 60, 32)        4640

 max_pooling2d_8 (MaxPooling  (None, 30, 30, 32)       0
 2D)

 flatten_2 (Flatten)         (None, 28800)             0

 dense_8 (Dense)             (None, 32)                921632

 dense_9 (Dense)             (None, 16)                528

 dense_10 (Dense)            (None, 32)                544

 dense_11 (Dense)            (None, 1)                 33

=================================================================
Total params: 932,897
Trainable params: 932,897
Non-trainable params: 0
_________________________________________________________________
```

Fig. 3. Deep Learning Model

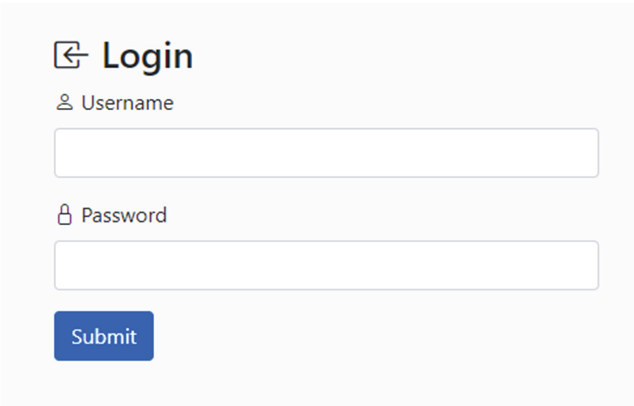

Fig. 4. Login Page

Fig. 5. GIS Map

Table 1. Tests Web Application

No	Menu	Tools	Output	Result
1	Login Menu	Admin Tools	The User Home Page	Succeed
2	View GIS Map	Observe Map that showed on the screen	User view GIS Map	Succeed
3	Logout	Select Logout	The system Log Out	Succeed

Table 2. Deep Learning System Testing

No	Utility	Method	Output	Resultant
1	classification	ModelProcess Test Image	A Model can determine class based on Test Image	Succeed

Table 3. Region of Interest Segmentation System Testing

No	Utility	Method	Output	Resultant
1	Segmentation/Filter	FilterProcess Test Image	A Filter can Segment correct ROI from image	Succeed

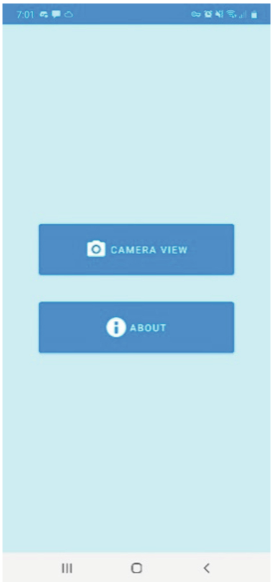

Fig. 6. Display of Main Activity

4 Conclusion

Based on the implementation of the Detection of Flood-Prone areas Using Geospatial Data with Deep Learning Method, 5 clusters are obtained, namely 0, 1, 2, 3 and 4, where cluster 0 has a water level of 120–130 cm, cluster 1 has water of 130–140 cm, cluster 2 has a water level of 140–150, cluster 3 has a water level of 150–160 cm, cluster 4 has a water level of 160–170 cm and cluster 5 has a water level above $\geq$ 170 cm. The integration of the system makes it easier for operators to find out the water level based on geospatial data.

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