Journal of Technomaterial Physics
Journal homepage: https://talenta.usu.ac.id/JoTP

Mapping Flood-Prone Areas Using GIS Through as Geo-Artificial Intelligence (Geo-Ai) Approach in Bengkulu City

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ARTICLE INFO

Article history:
Received 5 February 2024
Revised 12 February 2024
Accepted 19 February 2024
Available online 29 February 2024

E-ISSN: 2656-0755
P-ISSN: 2656-0747

How to cite:
A. Apriana, A. R. A. Ansory, T. Agustina, I. Amalia, and Refrizon, " Mapping Flood-Prone Areas Using GIS Through as Geo-Artificial Intelligence (Geo-Ai) Approach in Bengkulu City," Journal of Technomaterial Physics, vol. 06, no. 01, pp. 56-61, Feb. 2024, doi: 10.32734/jotp.v5i1.16006.

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http://doi.org/10.32734/jotp.v5i1.16006

ABSTRACT

Bengkulu City is an area prone to flooding due to its proximity to the river estuary. Flooding in Bengkulu City usually occurs during the rainy season, when high rainfall and overflowing rivers can cause inundation in several areas around the city. This research aims to identify flood-prone areas in Bengkulu City through a Geographic Artificial Intelligence (Geo-AI) approach. Geo-AI is an artificial intelligent machine with geospatial data, including satellite images and weather data, whose data analysis is more accurate and efficient in identifying flood-prone areas. Geographic Information System (GIS) can present objects of flood-prone areas from the real world in digital form. Through Google Earth Engine (GEE), satellite imagery data and other geospatial data are processed and analyzed using artificial intelligence algorithms to identify flood patterns and frequently flooded areas. The final result of this research is a map of flood-prone areas in Bengkulu City. On the map, it can be concluded that the red-colored areas including Rawa Makmur, Tanjung Agung, Bentiring, Kebun Tebeng, Penurunan, Sukarami, Pekan Sabtu, and Air Sebakul are areas that are often flooded so that these areas can be confirmed as flood-prone.

Keywords: Bengkulu City, Flooding, Geo-Artificial Intelligence, Geographic Information System, Google Earth Engine

ABSTRAK

Kota Bengkulu merupakan daerah yang rawan mengalami bencana banjir karena letaknya yang dekat dengan muara sungai. Banjir di Kota Bengkulu biasanya terjadi selama musim hujan, ketika curah hujan tinggi dan aliran sungai yang meluap dapat menyebabkan genangan air di beberapa daerah di sekitar kota. Riset ini bertujuan untuk mengidentifikasi daerah rawan banjir di Kota Bengkulu melalui pendekatan Geographic Artificial Intelligence (Geo-AI). Geo-AI adalah mesin cerdas buatan dengan data geospasial, termasuk citra satelit dan data cuaca, yang analisis datanya lebih akurat dan efisien dalam mengidentifikasi daerah rawan banjir. Geographic Information System (GIS) dapat mempresentasikan objek daerah rentan banjir dari dunia nyata ke dalam bentuk digital. Melalui Google Earth Engine (GEE), data citra satelit dan data geospasial lainnya diolah dan dianalisis menggunakan algoritma kecerdasan buatan untuk mengidentifikasi pola banjir dan daerah yang sering tergenang air. Hasil akhir dari riset ini adalah peta daerah rawan banjir di Kota Bengkulu. Pada peta tersebut dapat disimpulkan bahwa yang berwarna merah meliputi Rawa Makmur, Tanjung Agung, Bentiring, Kebun Tebeng, Penerunan, Sukarami, Pekan Sabtu, dan Air Sebakul merupakan daerah yang sering tergenang air, sehingga daerah tersebut dapat dipastikan rawan banjir.

Kata kunci: Banjir, Geo-Artificial Intellegence, Geographic Information System, Google Earth Engine, Kota Bengkulu

1. Introduction

A flood is an inundation of water, from the smallest to the largest. caused by both human and natural factors or high water flow, and not accommodated by the river flow so that the water overflows to more land

[1]. A Flood is defined as a mass of water that is produced from relatively high and uncontainable ground-level runoff that overflows naturally and that overflows naturally and causes inundation [2]. Flooding is a natural phenomenon that is closely related to the hydrological cycle. River water that flows beyond the capacity of the river will pass through the river and cliffs flooding the area [3]. The occurrence of floods is also caused by poor soil permeability so that it is no longer able to absorb water [4]. Floods occur as a result of the influence of heavy rains and natural waterways that cannot hold water [5]. Areas with low-lying conditions and near rivers tend to have higher flood vulnerability [6].

Flooding has become a frequent natural disaster. This is because climate change has become a concern all over the world in recent years causing flooding [7]. Flooding cannot be avoided, but it can be controlled and the impact of flood losses can be reduced [8]. It is therefore important to have access to reliable and up-to-date information to prevent or at least mitigate the effects of flooding. Potential flood maps are one type of important information [9]. Floods can have negative socio-economic impacts, loss of people and property, health-related problems, and ecosystem functions [10]. Public awareness about the importance of protecting the environment and behavior in disposing of waste properly are also important factors in preventing flooding [11]. Lack of awareness and environmentally unfriendly behaviors can cause drainage channels to clog and exacerbate flooding [12]. The ability to handle disasters, including floods, is a crucial issue [13].

This research is based on the phenomenon or disaster of flooding that occurs every year in Bengkulu city. Lately, there have been frequent storms or strong winds suddenly accompanied by heavy rain, which causes flooding. The disaster occurred after heavy rains caused the Bengkulu River to overflow. The challenges of dealing with climate change and rapid urban growth demand greater and more integrated efforts in managing flooding in Bengkulu City.

In general, studies on floods have been carried out by researchers Previously, it showed that areas in Bengkulu City had the potential to experience floods. However, previous research still managed flood disaster data which is still done manually so the data results are less accurate. The parameters used are very few, so mapping research is necessary for flood-prone areas in Bengkulu City.

Therefore, it is necessary effective efforts in identifying flood-prone areas to plan appropriate mitigation measures to reduce its impact. One of the innovative solutions is to utilize Artificial Intelligence methods and Geographic Information Systems (GIS) based on the measured parameters to obtain flood-prone maps. As time goes by, human abilities will be replaced by smart or intelligent machines in various fields. This smart machine is commonly called artificial intelligence or Artificial Intelligence, which is a part of computer science [14].

Geo-AI is a combination of artificial intelligence (AI) and geospatial technology, which aims to use geospatial data and perform intelligent analysis to make decisions or determine the identification of certain patterns related to geographic locations [15]. In Geo-AI, artificial intelligence technologies are used to process, analyze, and understand large-scale geospatial data with greater efficiency and accuracy [16].

Geospatial data includes information that information related to a particular location or area, such as maps, satellite data, drone data, sensor data, and others related to the geography and topography of an area [17]. Utilization of this AI technology can help process hydrological, topographical, and rainfall data to identify areas with high flood risk and plan effective mitigation strategies [18]. With AI technology, spatial data can be processed quickly and accurately to facilitate decision-making in flood mitigation planning in Bengkulu City. A geographic information system is a computer-based system that can handle geo-referenced data [19]. The hardware used for GIS is a computer (PC), mouse, digitizer, printer, plotter, and scanner [20]. GIS can connect various data at a certain point on earth, combine them, and analyze and map the results. [21].

This research aims to map flood-prone areas by utilizing a Geographic Information System (GIS) through a Geo-Artificial Intelligence (Geo-AI) approach. The results of this research are expected to be the initial basis for flood disaster mitigation in Bengkulu City.

2. Method

2.1. Research Locations

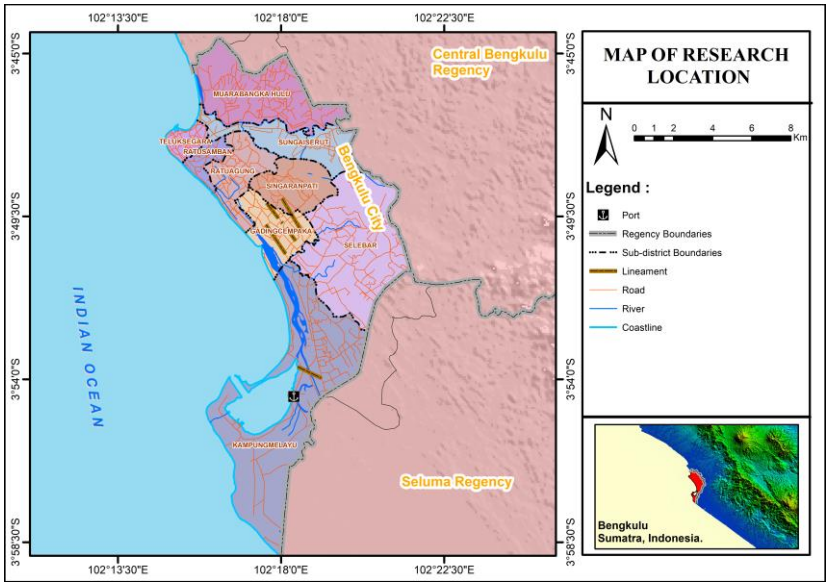

Figure 1. Map of Bengkulu City.

2.2. Materials

The data used in this study are DEMNAS data, Bengkulu City Shapefile data, and sentinel channel 1. This dataset provides a detailed global map and associated information on the extent of surface waters around the world. It includes information on lakes, rivers, swamps and other surface waters with a spatial resolution of about 10 meters. The sentinel data used in this research is data from 2019-2022. Data processing and analysis were carried out using Microsoft excel software, GIS software, and Google Earth Engine (GEE). For DEMNAS data, and Shapefile data of Bengkulu city are processed in Arcgis Softwere.

2.3. Processing of DEMNAS data and Bengkulu city Shapefile data

For data DEMNAS data, and Shapefile data of Bengkulu City were processed in ArcGis Software. The stages carried out, namely, select Add data throughout the DEMNAS data grid, then Open ArcToolbox, point to Raster > Raster Dataset > Create Raster Dataset. This stage creates raster data with the parameters needed for the digitization process. Classify the data into spatial data, and the data is organized into tables that will be used to process the data. Select Raster Calculator to run the AI-jabar expression that will produce the output value. After the digitization process, the mapping for the research location was done. Shapefiles of the data used are in RAR format, and other data are in XLSX format. After doing the digitization and mapping, it was continued with data processing in Microsoft Exel to determine the value of the parameters that have been created.

2.4. Data analysis on Google Earth Engine (GEE)

Data analysis on Google Earth Engine (GEE) to determine flooded areas with the modified Otsu algorithm and AI Script. For the first step, search first on Google Chrome, namely the Google Earth engine, then click the platform then select the code editor if loading is complete. editor if loading is complete point the map to the research location, namely Bengkulu City. If you have clicked on assets then new, then select save file. After that, select the folder, the folder must be zipped, then Open and upload. Navigate to the text section where the upload process is being processed if the upload process is complete mark with the writing viewashed then click and make sure the uploaded file is the correct file if you are sure it is correct directly import the file. After that, it will appear in the new script section then search sentinel-1. At the very top click import after that it will appear in the new script in the table section changed to roi then in the image collection section change to S1 for the next step copy and paste the AI script that has been created if you have clicked Run then select tools console. In this tool, the image that will be used zero image is used. Then for the ID don't forget to copy it next will call one of the Sentinel images on the one that is adjusted to the image that was that was already selected.

If you have finished clicking Run, the next step is making permanent water data by using Hansen data and then filtering and updating the mask. Next, we will plot the chart on the console using the Otsu algorithm. The last step is to classify the image and export data. If you click Run, the results will appear in the form of a display of flood-prone areas in Bengkulu city using the Otsu algorithm. In addition, the console window can be seen in the resulting graphs and the threshold value of flooding in the image used.

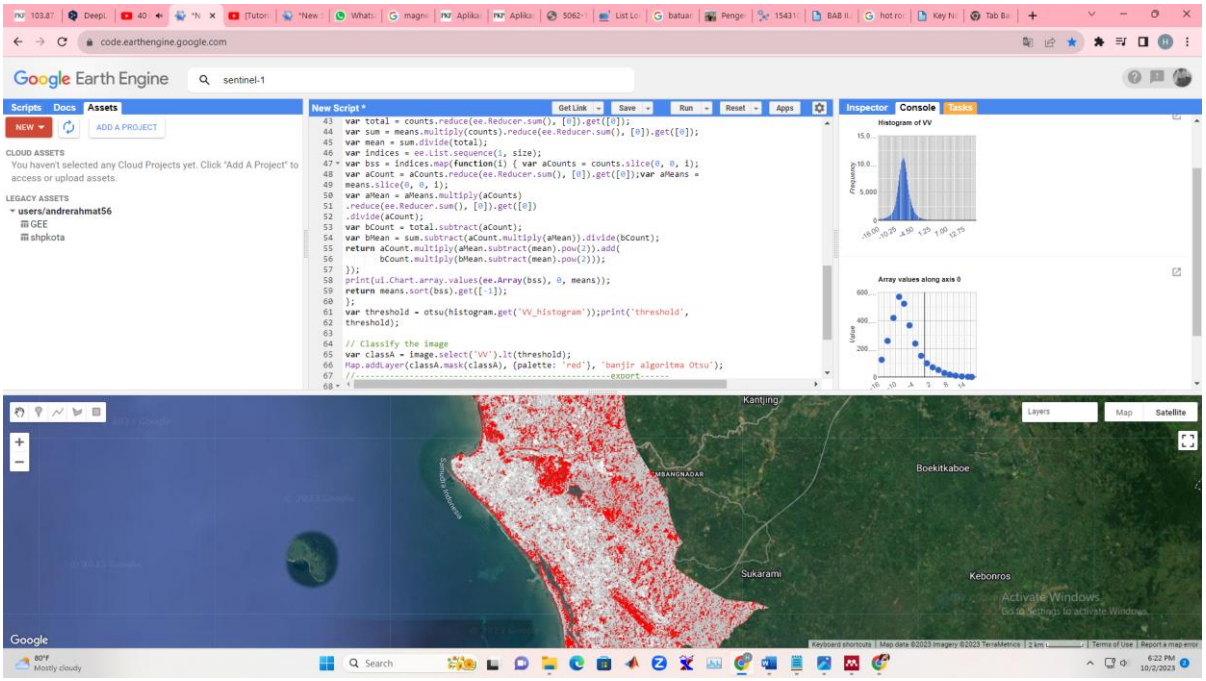

Figure 2. Display of data processing in Google Earth Engine.

3. Results and Discussion

Utilization of Geo-Artificial Intelligence (Geo-AI), Google Earth Engine (GEE) and Geographic Information System (GIS) to identify flood-prone areas is an innovative and highly effective combination of flood-prone areas is an innovative and highly effective combination for addressing flooding issues and improving mitigation efficiency [22]. Geo-AI leverages artificial intelligence technology to analyze geospatial data and discover relevant patterns and trends. GIS handles geo-referenced data, i.e. data entry, and data management, and Google Earth Engine provides a very fast infrastructure for processing geospatial data at scale [23].

Utilization of Geo-AI, GIS, and GEE to identify flood-prone areas provides significant benefits, namely the use of Geo-AI with an algorithm allows the identification and mapping of flood-prone areas with high accuracy, and reduces the risk of errors. Earth Engine provides a powerful infrastructure for processing large-scale geospatial data, enabling fast and efficient analysis. With an AI location-based early warning system, authorities and communities can quickly receive warnings about potential flooding, so that preventive and evacuation measures can be taken quickly.

Geo AI data and analysis can provide a strong basis for better and more informed decision-making in the face of disasters. Geo-AI can monitor and predict floods more accurately based on real-time satellite imagery and weather data, helping proactive and more timely weather data, helping proactive and more timely management [24]. The use of Geo-AI in combination with, GIS, and GEE to identify flood-prone areas provides enormous benefits in mitigating and limiting flood risks. With satellite image analysis, flood forecasting, early warning systems, and risk assessment, Geo-AI and Google Earth Engine provide an effective, accurate, and efficient solution to the flooding challenges in the modern era. The result of this research is a map of areas that are prone to flooding in Bengkulu City.

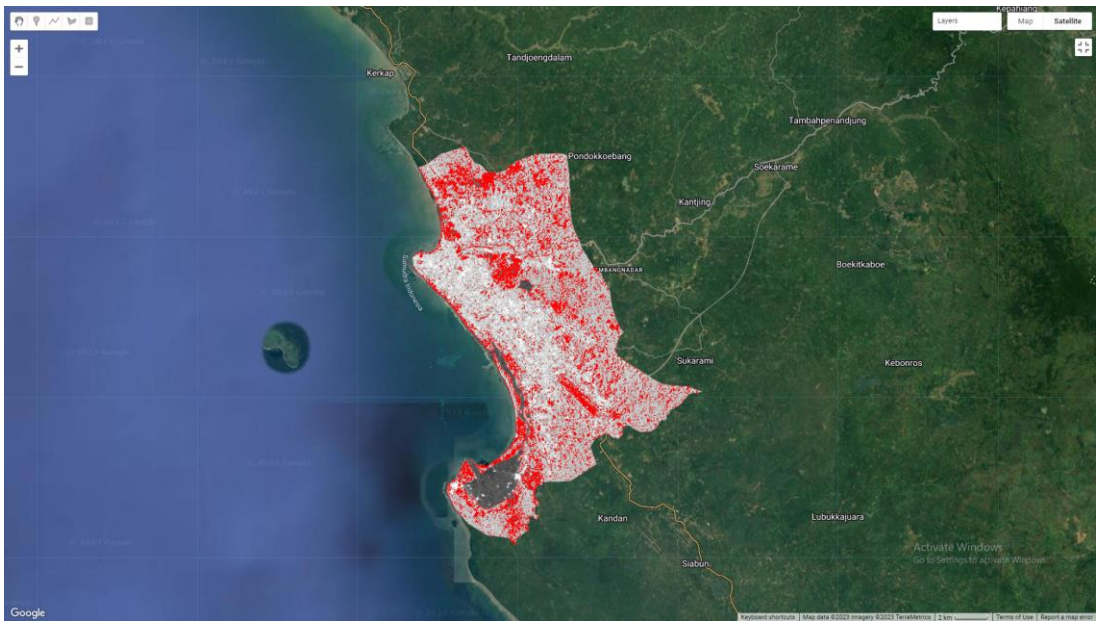

Figure 3. Map of flood prone areas in Bengkulu city.

Figure 3 is a map of Bengkulu City. In the picture, it can be seen that some are white and some are red. The white part shows that the area is a safe area from flood disasters, while the red part shows areas that are prone to flood disasters. The red color explains that the area is often inundated by water. The map above shows that flood-prone areas in Bengkulu City include Rawa Makmur, Tanjung Agung, Bentiring, Kebun Tebeng, Penurunan, Sukarami, Pekan Sabtu and Air Sebakul.

4. Conclusion

Research Utilization of Geo-AI for mapping flood-prone areas in Bengkulu City has many benefits in the effort to deal with flood disasters. The research results show that areas that are prone to are those that are colored red. The red color can be interpreted as the area is often inundated by water so the area is prone to flooding. With more accurate and effective data analysis, this research can contribute to mitigating flood disasters in Bengkulu City, protecting the community of the environment from impacts of the environment from the impact of flooding, as well as creating a safer and more sustainable city. sustainable city. In addition, this research can open up opportunities for the development of Geo-AI technology and can serve as a reference for similar research in other areas. for similar research in other areas that are also prone to flooding.

Acknowledgments

There is nothing that the author can give other than the greatest gratitude to Direktorat Jenderal Higher Education, Riset, and Technology for the financial support that has been provided to this research. Thank you to everyone who has contributed to this research and thanks to the developer of the google earth engine for helping and facilitating data for us in the process of processing data mapping flood-prone areas in the city of bengkulu.

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