Mount Anak Krakatoa geomorphology modelling with kinect-based augmented reality sandbox based on digital elevation model data

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Abstract. Indonesia has a diversity of landscapes due to it being located at the confluence of several tectonic plates and traversing the Ring of Fire. This diversity of landscapes creates many interesting geological objects that are used for research in studying geomorphology. The research location for this study focuses on the topographic conditions of Mount Anak Krakatoa located in the Sunda Strait. A volcanic peak can be divided according to its landscape, which is the center of the volcanic eruption at the peak, down towards the slope of the mountain foot, and the terrain around it. This landscape-based division is based on topographical and geographical conditions. These parameters will then be made into a 3-dimensional model. Topographic modelling using Kinect based augmented reality sandbox uses a digital elevation model (DEM) from the GIS. Sandbox modelling data can be accepted when it reaches natural state conditions, i.e. augmented reality sandbox data is compatible with DEM satellite image data. Results from this modelling can then be used for follow-up studies on the geomorphology of Mount Anak Krakatoa with a more direct approach.

Keywords: Geomorphology, krakatoa, sandbox, modelling, DEM

1. Introduction

Indonesia is a country that has a quite diverse and complex morphology. This is due to Indonesia’s position flanked by large plates, such as the Eurasian Plate, the Indo-Australian Plate, and the Pacific Plate. In addition, Indonesia is also traversed by, the ring of fire. Morphological and topographic diversity makes Indonesia one of the most unique and interesting geological objects to study. The object of this study is Mount Anak Krakatoa located in the Sunda Strait which is geographically located at the coordinates of 6°06’05.8” S and 105°25’22.3” E as shown in figure 1. Mount Anak Krakatoa is an underwater volcano that is currently still active.

Mount Anak Krakatoa is a volcano formed after the eruption of Mount Krakatoa in 1883, the eruption of Mount Krakatoa produced Mount Anak Krakatoa which has a diversity of morphology and topography. Through this research, topographic modeling of Anak Krakatoa can be done by using the application ArcGIS and sandbox. So that the model produced by this study can be used for research of Anak Krakatoa’s morphology using a more direct approach.

Mount Anak Krakatoa is a volcanic mountain formed after the eruption of Mount Krakatoa in 1883. Mount Anak Krakatoa appeared on the surface at January, 1928. Originally formed as a cone consisting
of basaltic Andesite with a height of 152 meters above sea level until 1959 [1]. The position of Mount Anak Krakatia is inside the Caldera formed after the eruption of Mount Krakatoa in 1883.

The geomorphological appearance of the Krakatoa volcanic complex consists of the caldera wall, volcanic cone formation, lava flows, plains and coastal areas. The morphology of the caldera is characterized by very steep walls formed in the northern part of Rakata with a concave shape facing north. The morphological appearance of the islands is characterized by the topography of the slope shape that can be found on the south of Rakata Island, west of Sertung Island and east of Panjang Island. The shape of the slope morphology consists of looping the valley and ridge. Rakata Island shows a radial pattern while Panjang Island and Sertung Island shows a semi-radial pattern. This part of the morphology is composed of pyroclastic flow deposits of the 1883 eruption [2].

Volcanic cone morphology is found on Rakata and Anak Krakatoa Islands. Rakata volcanic cones are clearly observed from the height of 500 m to the peak, 813 m above the sea. Anak Krakatoa’s volcanic cone consists of old volcanic cones and active young volcanic cones. The old volcanic cone shows no actual cone because the top of the cone disappeared because of eruption and leaves a large crater wall with the highest peak of 155.66 m above sea level. The crater wall is open to the southeast, but in 1999 old volcanic cones and active cones merged forming a large volcanic cone composed of falling pyroclastic layers and lava flows. Before that, this active cone was formed in the center of the old cone crater and its highest peak in 1983 was 201,446 m. Due to eruptions that occur periodically, these young cones grows larger and covers the old cone [2].

2. Experimental
According to Scarpa & Tilling (1996), there are several techniques used in monitoring volcanoes, namely seismic methods, deformation methods, thermal methods, chemical gas methods, and remote sensing methods [3]. In this study, the method used is the remote sensing method by utilizing digital elevation model (DEM) data imagery. DEM data is obtained from the United States Geological Survey (USGS) and can be used for desktop survey [4].

![Figure 1](image-url)
This data is then processed using ArcGIS to obtain a 2-dimensional cross section of the topography of the study area. Then after obtaining a 2-dimensional model, this data is processed using ArcScene to obtain a 3-dimensional cross section of the study area. This 3-dimensional cross section is then used as a reference for making Mount Anak Krakatoa topographic modeling using Kinect-based Augmented Reality Sandbox. The steps is clearly shown in figure 2. Augmented Reality Sandbox [5] is a continuous shape display sandbox. As users sculpt the sand sensor continuously scans the surface generating a stream of depth maps. The depth is filtered to remove noise and the user hands [6].

3. Results and discussion

3.1. 2-D Topography Cross Section
The DEM data obtained from the USGS is then processed using ArcMap software such as figure 3. The open DEM is in the form of black and white images with the black showing the lowest elevation while the white shows the highest elevation [7]. To be more informative, DEM data is processed so that it shows elevation classes and is given hillshade as in figure 3 so that the Topographic 2-D cross section of Mount Anak Krakatoa is produced.

3.2. 3-D Topography cross section
The 3-D cross section is used as a reference in making Mount Anak Krakatoa topographic modelling using Kinect-based Augmented Reality Sandbox. Processing is done by processing the 2-D data using a raster project in the ArcMap software. Raster results are then saved and opened using the ArcScene software. In ArcScene, DEM data is then displayed with 3-D as in figure 4.
3.3. Cross section with augmented reality sandbox

Topographic modelling of Mount Anak Krakatoa is made by referring to the 3-D DEM data indicated by ArcScene. Users can do modelling directly by hand. The sand formation results will then be recorded by the Kinect sensor and emitted by the projector to show height information in the form of colors calibrated with software. Sandbox modelling can be accepted if the results reach the natural state. The sandbox modelling results shown in figure 5. From the sandbox modelling can be seen the topography of the research area indicated by satellite imagery and the sandbox cross section shows similar results, but for geomorphological modelling and the geological structure has not found suitability due to complex processes in the geomorphological formation of Mount Anak Krakatoa.

Figure 3. Topography map of Mount Anak Krakatoa complex.

Figure 4. 3-D cross section from several point of view.

Figure 5. Modelling results with the augmented reality sandbox.
4. Conclusion
Based on the results of the physical experimental modelling of augmented reality sandbox capable of modelling the topographic conditions of the Mount Anak Krakatoa area based on DEM satellite image data, physical experiments for geomorphological modelling and the presence of outcrop structures in the field have not shown the overall results because there are outcrop formation processes more complex. So that the results of this experiment can only be a simple analogue modelling of the actual conditions in the field.

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