Identification of Areas at Risk of Abrasion Application of *Electrical Resistivity Tomography* (ERT) Method on Nangai Beach, North Bengkulu

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Abstract: A study of the underground structures in areas prone to abrasion of Nangai Beach, North Bengkulu Regency. In this study, 2D images of the subsurface structure at the Nangai Beach site were obtained using the Wenner-Schlumberger configuration, while 3D representations were obtained using the *Electrical Resistivity Technique* (ERT). To protect coastal materials, the main objective of this research is to identify rock types that are resistant to seawater erosion and measure the resistivity of rocks that can be eroded. In addition, software (ERT LAB 64, View Lab 3D and Res2Dinv) was used to analyze the data by processing it and displaying an image of the resistivity value. The interpretation results show that the coastal zone of the study area is dominated by clays with resistivity (> 34 m). The shoreline of Nangai beach consists of shale clay (>> 437 m). Rocks having a resistivity value (437 m) are not easily eroded by erosion in shale clay. This is because the rocks known as shale clay have low porosity, resulting in compact rock density. Restoring damaged soil and planting trees near the coast are two ways to slow down the abrasion process.

Keywords: Abrasion; Electrical resistivity technique; Nangai Beach; 3D

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I. INTRODUCTION

One of the provinces in Sumatra island Bengkulu province, located on the coast with a coastline length of ± 586 km. One of them is North Bengkulu Regency, given that north Bengkulu regency, which is rangked 70 in indonesia, in terms of susceptibility to coastal abrasion [1].

North Bengkulu recency has beaches, one of wich is nangai beach. One of the tourist attractions in North Bengkulu regency. The increasingly prominent impact in the last 5 years of coastal abrasion has caused changes in the coastline [2, 3]. Abrasion reaches approximately 2-5 meters per year, so the damage to the coastline in the North Bengkulu region is considered very severe [4].

The condition of Nangai Beach has suffered severe abrasion in several places, affecting existing facilities and infrastructure [5]. This abrasion may also threaten the various coastal resources of Nangai Beach, especially the existence of plantations near the coast such as coconut and oil palm plantations near the shoreline. Thus, it may lead to the destruction of some beach land along the Nangai Beach coastline.

Studies on abrasion in Bengkulu by several researchers including [6] Studies conducted at Pantai Padang Betuah in Central Bengkulu revealed that the rock texture in areas prone to abrasion varies widely and is composed mostly of weak rock, sand, clay, gravel, and sandstone layers.

It is necessary to study the subsurface rock structure in areas subject to abrasion in order to determine an estimate of areas that will be subject to abrasion based on rock resistivity values. The implementation of *Electrical Resistivity Romography* (ERT) allows the determination of the resistivity values of rock formations and facilitates the establishment of two-dimensional and three-dimensional descriptions of the subsurface structure [7].

Fig.1 shows that the coastal geological conditions at Nangai Beach are dominated by Bintunan formation consisting of tidal marshes, Holocene sediments containing marine sediments are formed [8]. while BintunanFormation on the coast is a geological trace millenia ago in a shallow marine to land-sea transition. The layers of rock along the shore sandstone, claystone and limestone were laid down by countless ocean waves and tidal currents. However, factors such as erosion and human activities around the coast caninfluence these formations hence the need to safeguard these geological formations.

Abrasion occurs due to erosion caused by sea waves that are constantly hitting the coastal rocks, so coastal abrasion can occur at the tourist attraction of Nangai Beach [4, 9]. Therefore, to find the subsurface structure in abrasion-prone locations using rock resistivity measurements, this study will use the *Electrical Resistivity Tomography* (ERT) technique [10, 11].

II. METHODOLOGY

2D and 3D studies of subsurface structures using the ERT geoelectric method were conducted at the abrasion-prone zone of Nangai beach, North Bengkulu, located at coordinates 3°38'10.37' N and 102°11'16.70' E, with the location of the

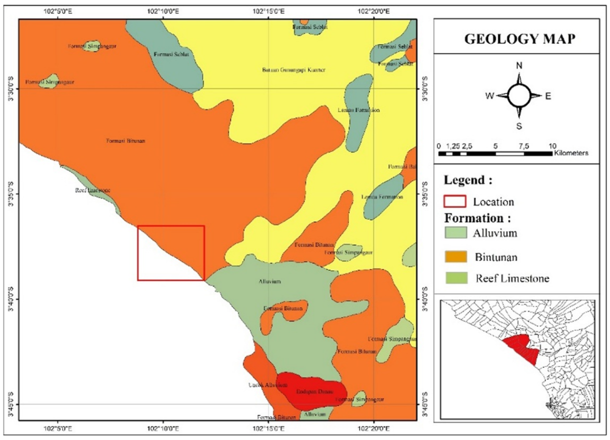


FIG. 1: Geological Map of Nangai Beach.

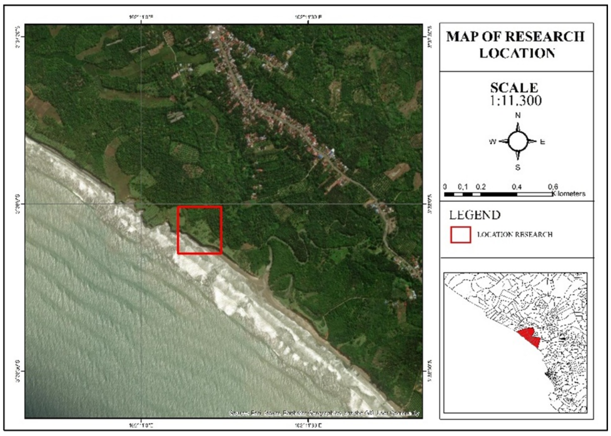


FIG. 2: Location of Research.

beach shown in Fig. 2.

In the investigation of subsurface structures in abrasion-prone areas using the *Electrical Resistivity Tomography* (ERT) method. The tool used is the MAEX612-EM multichannel subsurface electrical resistivity meter, which consists of four resistivity cables and 48 electrodes [12]. Other supporting tools are a 12 V battery, a meter and a GPS device, as shown in Fig. 3.

FIG. 3: Multichannel resistivity MAEX612-EM.

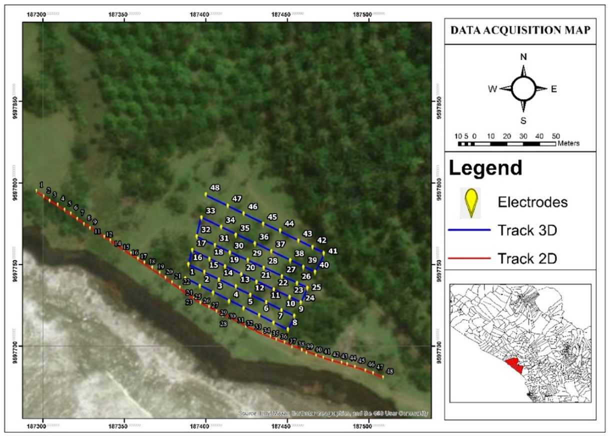


FIG. 4: 2D track (red) 3D track (blue).

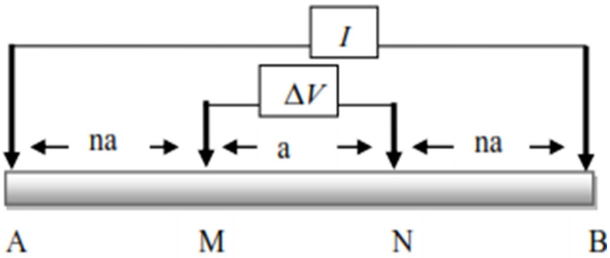


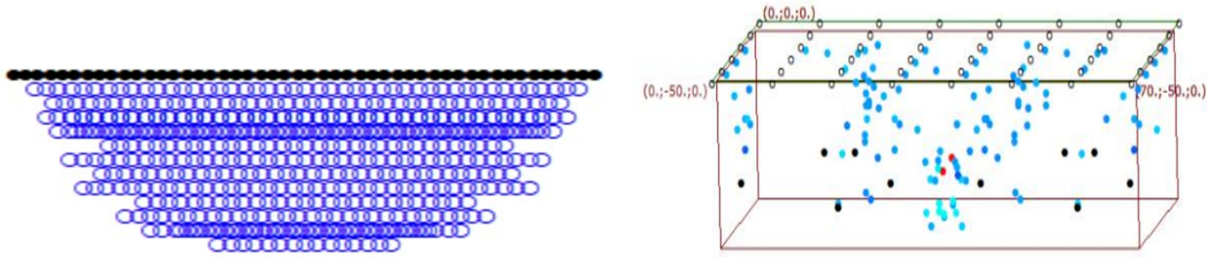
FIG. 5: Wenner Schlumberger configuration.

The data acquisition used in this study was the Wenner-Schlumberger method: 2D measurement design, a single stretch of cable was used, and the measurement points were distributed in a line as shown in Fig. 4 to perform 3D measurements.

The Wenner-Schlumberger configuration is also used in this study. As shown in Fig. 5, the distance between current electrodes (A and B) is $2na + a$ and the distance between potential electrodes MN is a [13]

$$k = n(n+1)\pi a \tag{1}$$

Using the electrical characteristics of rocks, *Electrical Resistivity Tomography* (ERT) is a geophysical method that measures geological conditions beneath the earth's surface using electric currents. Investigation of abrasion-prone locations is needed to reduce the impact of abrasion, which is a serious problem [12]. To evaluate the condition of the subsurface structures and the lithology of the rock in 2 and 3 dimensions and to ascertain the depth of the rock, investigation of the lithology and rock structure in the areas endangerd by abration must be carried out based on rock resistivity values or rock layers to be abraded can be determined, and through 2D and 3D modelling to determine the extent to which ground abrasion will occur. Processing the *Electrical Resistivity Tomography* (ERT) data using the ERT lab and view lab software will provide rock resistivity values at depth that can provide the subsurface structure condition of potential and non-potential abrasion zones [14].



(a) (b)

FIG. 6: Electrical resistivity tomography (ERT) datum point for (a) 2D measurement and (b) 3D measurement.

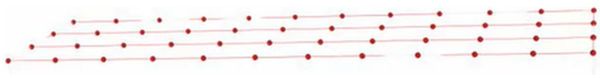


FIG. 7: Electrical resistivity tomography (ERT) datum point for.

Electrical Resistivity Tomography (ERT) 2D using the wenner-schlumberger configuration produced 576 datum points as well as 3D using *Electrical Resistivity Tomography* (ERT) shown in Fig. 6.

Fig. 7 shows the 3D model track spans with several spans resembling the 2D track. The data processing results are followed by the interpretation of the best model results provided by the software. ERTLab and ViewLab are software used for the inversion process and the creation of 3D cross-section models. This software also has the capability to create and convert 3D models into 2D by slicing along specific axes. We can interpret various types of rocks with this software.

By using 2D and 3D geoelectric measurements, we can obtain resistivity/cross-sectional profiles of the subsurface against depth, which can provide information about rocks that have undergone cracking and are ready for abrasion. The results of the data collected include the current value (I), voltage (V), geometric factor (K), and specific resistance value (a) [15].

III. RESULTS AND DISCUSSION

The results of data processing with Res2Dinv are the results of inversion to obtain the actual value of specific gravity that produces a cross-section of specific gravity to depth, and the results of data processing are as shown in Fig. 8. For the results of 2D resistivity measurements in abrasion-prone areas are shown in Table I.

Seawater is identified as a corrosion factor due to relatively low sensitivity values <14 (Ωm). The 2D cross-section results are stacked because it contains fine-grained sandstone with high porosity [18].

The resistance value of mudstone is > 34 (Ωm), and sand is combined with the subtance. When exposed to heat for a

TABLE I: Results of 2D measurements at the research object.

Stone type	Resistivity value
Seawater/sandstone	2.67-14.6
Claystone	34.1-187.7
Clay slate stone	>437

long time, this claystone is easily cracked, has water impermeable properties and cracks, as a consequence of wich the clay substance splits and is quickly eroded by seawater, being destroyed. Clay-dominated land therefore has a high potential for loss due to coastal abrasion processes. The coastal area of Nangai Beach should receive special treatment because otherwise it may reduce the land used by the surrounding community for earning income and damage public facilities such as roads, among others [19].

The clay shale rock has a resistivity value $>> 437$ (Ωm), which prevails a little further from the shoreline, will not erode because this rock is less important than other rocks, hence it will stay in place. The clay-slate rock is formed by the deposition of fine-grained clay and has the properties of a rock that is more tightly packed than other rocks, which results in poor porosity and prevents seawater from depositing on it. This clay shale is a dry rock whose components are so firmly bonded together that external influences cannot easily topple the material.

Changing apparent resistivity into true resistivity ready for interpretation of rock layers.The materials that make up the Nangai beach research area are displayed in a 3D model. The 3D modeling can be used to show more clearly which parts will be eroded and which will withstand the effects of seawater. The results of this 3D modeling show that low resistivity values will easily disappear, which is colored in (purple), while high resistivity values will remain colored in (red), as shown in Fig. 9.

A 3D model of the abrasion-prone area will show the remaining rocks in the case of continuous abrasion on land. Climatological and geological factors affect the conditions in this study area, that rock structures and sea water in coastal areas will be affected[20]. This modeling provides resistivity value > 437(Ωm) for rocks composed of clay shale underlying the

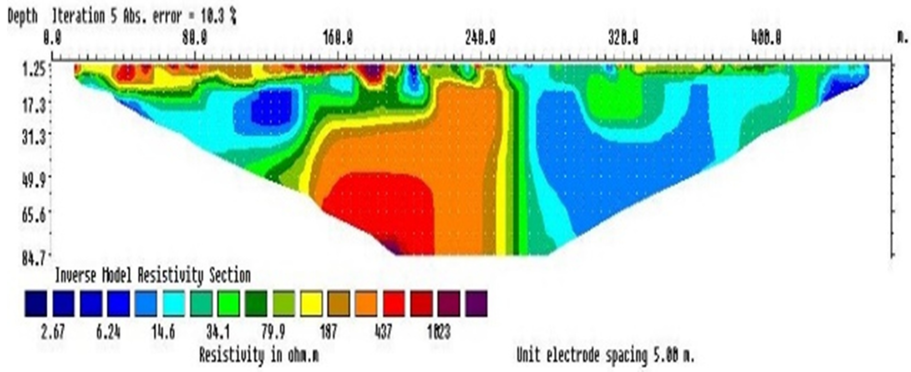


FIG. 8: 2D modelling of the resistivity.

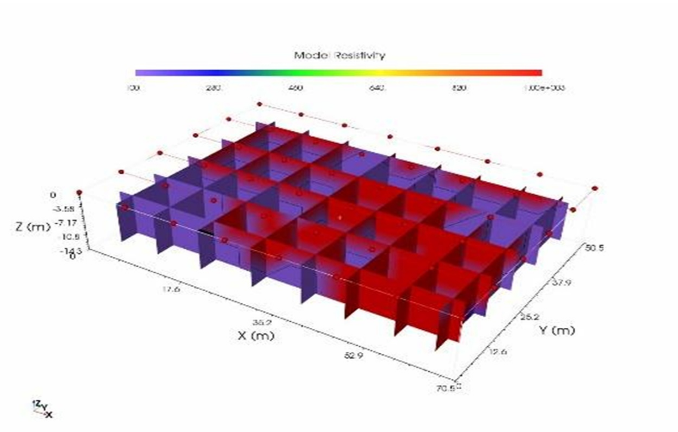


FIG. 9: 3D modelling of Resistivity.

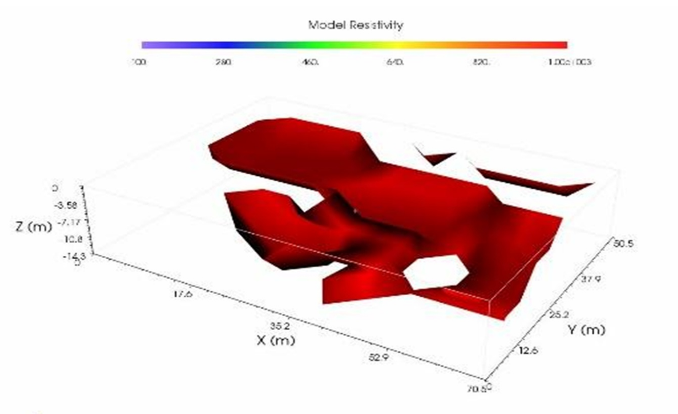


FIG. 10: 3D modeling of the remaining rocks if the study site continues to experience abrasion.

study area. The focus of this 3D modeling is the residual clay shale rock after the research area in Fig. 10 has been eliminated. The landforms in the coastal area are inserted in vague and abstract forms due to the uneven distribution of rocks. Nangai Beach's coastal scenery has an intriguing and distinctive shape. Because of the previously mentioned wear and

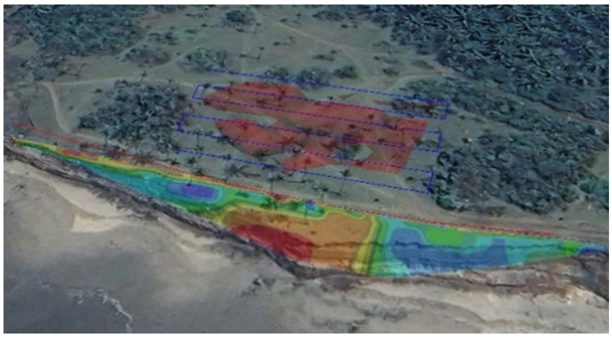


FIG. 11: Subsurface structural conditions with 2D and 3D modeling.

tear, the influencing forces in this coastal area have a distinct natural shape.

The resistivity value of rocks containing water will be analyzed using geoelectric measurements with porosity and then calculate the resistivity value compared to relatively compact rocks [16]. Due to its coastal location and the fact that rocks are constantly deposited at Nangai beach in accordance with sea conditions, the research site is primarily affected by seawater [17]. The results of this study are shown in Fig. 11, which displays the state of the Earth's subsurface structure based on 2D and 3D modeling.

IV. CONCLUSION

The main factor causing abrasion in the coastal area of Nangai Beach is the accumulation of seawater on fine-grained sand, clay layers, and clay shale. Based on 3D modeling, there is a residual layer of clay shale rock, and the resistivity value is $>> 437$ (Ωm). This analysis reveals that the research location has an uneven rock structure and an abstract landscape. Three-dimensional modeling describes the location and shape of residual rock at the research location. Geologic and climatic factors in the coastal zone are factors that contribute to the continuous occurrence of abrasion. The geophysical hazard indicates that Bengkulu Province will be very concerned about mass abrasion on Nangai Beach. The conclusions of this research are relevant to the construction of jetties and breakwaters, and geotechnical engineering can be used to further investigate local governance. Rehabilitating damaged land and planting trees near the coast are examples of conventional measures that can help slow erosion. The current level of success of each component in preventing the abrasion disaster at Nangai Beach cannot be assessed, so an objective investigation of the measures to be used is needed.

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