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UTILIZATION OF GEOGRAPHIC INFORMATION SYSTEMS IN IMPROVING SOCIAL RESILIENCE OF FARMER COMMUNITIES IN DEMAK

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Abstract
Coastal abrasion that occurred in Demak Regency caused the loss of agricultural land due to drowning and brought social changes to the community among farmers. In anticipating this, it is necessary to overcome abrasion and increase the social resilience of the community. The ability of GIS in monitoring and mapping the area can be used as a means of useful information for the community. This study uses a quantitative approach. Data processing is carried out using satellite image data with different temporal, namely 1991, 2002, 2012, and 2021. Analysis of shoreline change predictions is carried out using the Digital Shoorelines Analysis System Method. The results of the analysis using the Digital Shoreline Analysis System (DSAS) method found that changes in the northern coastline of Demak Regency tend to experience significant abrasion from year to year. The coastline prediction obtained from the map is known to predict the coastline in the next 10 years the north coast of Demak Regency will experience abrasion. The highest abrasion occurred in Sayung District. Abrasion has an impact on changes in farmers' economic income which changes the behavior of the farming community so that efforts are needed to increase the resilience of the farming community, efforts that can be made include: 1). Prevention of coastal abrasion in areas that have the potential to experience coastal abrasion. 2). Building synergy to increase social resilience between the Government and the community. 3). Build and revive strategic leadership oriented to farmer welfare. The results of the research can also be used as material for consideration in policy making by the relevant government in disaster management efforts that may occur.

Keywords: GIS; Abrasion; Farmers' Social Resilience

Introduction

Indonesia has a very strategic geographical area and is also very rich in resources, both on land and at sea. On the other hand, coastal areas in Indonesia are disaster-prone areas, especially on the North Coast of Java and of course greatly affect the existence of the people who inhabit these coastal areas. Demak is one of the regencies in Central Java, Indonesia whose territory is on the North Coast of Java. Administratively, the area of Demak Regency is 897.43 km2. In 2021, the agriculture, forestry and fisheries sectors will contribute 22.14 percent to the Gross Regional Domestic Product (GRDP) in this district (BPS, 2021). On the other hand, Demak Regency is the worst hit in Indonesia because the coastline in that area has retreated 5 kilometers and has consumed more than 2 thousand hectares of land, which of course greatly affects the agricultural sector in Demak.

In general, the beach is defined as an area that is dynamic because it is a meeting place

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and interaction between land, sea and air. Beaches always have a continuous adjustment towards a natural balance to the impacts that occur that affect shoreline changes. Changes in the coastline is one form of dynamics of the coastal area that occurs continuously. Based on Triatmodjo (1999) in Fajrin (2016), abrasion is one of the problems that threatens coastal conditions, which can threaten the coastline so that it retreats backwards, destroys ponds and rice fields located on the coast, and also threatens buildings that are directly adjacent to the water. sea, both buildings that functioned as tourism support and residents' homes. In preventing and overcoming these disasters, real efforts are needed. The implementation of disaster prevention and management in Indonesia is one of the real manifestations of maintaining national security.

Geographic Information Systems (GIS) can be used as a monitoring tool to protect life, property, and critical infrastructure against natural or non-natural disasters. With data from GIS, the government can be more comprehensive in gathering input for decision making, mapping disaster-prone areas, and making anticipation and adaptation scenarios for maritime disasters that may occur. The implementation of GIS through prediction of shoreline changes can be used to see the potential for abrasion in Demak Regency.

Literature Review

The worst abrasion that occurred on the north coast of Java was in Demak Regency, it was even stated that the abrasion that occurred in Demak was the worst in Indonesia, and is in danger of sinking in the next 20 years (Lukmono, 2021). The area affected by erosion in Sayung District, Demak, for the last 20 years has reached 2,116.54 hectares which caused the coastline to retreat along 5.1 kilometers from the coastline in 1994. The same thing was also stated by Wicaksana (2020) that there was a significant change in the coastline in Sayung District within a period of 25 years. Sayung Subdistrict experienced significant abrasion with an abrasion rate of 85.91 meters/year and an accretion rate of 4.64 meters/year (presented in Figure 2). This study was strengthened by Ramadhani (2021), who stated that the results showed that the coastline of Sayung District with a beach length of 20,953.59 m, and coastal abrasion of 141.49 ha. The average rate of abrasion that occurs in the period 2013-2020 is 13.08 meters/year.

According to Manumono's research (2009), Abrasion that occurred in Demak Regency had an impact on changes in the livelihoods of farmers and fishermen who lost their ponds, namely to become casual laborers, seser fishermen or capture fishermen (sampans and nets) while the remaining farmers, formerly skipper, turned into farmers. cultivator. This is reinforced by the research of Desmawan (2012) which states that tidal flooding due to abrasion causes changes in land use, becomes narrower or even disappears due to drowning. People who used to be pond farmers switched professions to become industrial workers because they no longer owned land. Geographically, abrasion also has an impact on the distance between rice fields and the coast which results in a mixture of seawater and groundwater. This causes failure at harvest because the high salt content can damage the rice and the worst thing is that the rice will die. Efforts to prevent abrasion and increase social resilience of the community really need to be done, unpreparedness in dealing with disasters, especially in areas with high economic value will cause huge losses.

Research Method

The research location chosen in this study is along the North Coast of Demak. The method used in this study is a quantitative approach, namely a research approach that represents positivism (Mulyadi, 2011). The data used in this study are primary data and secondary data. Primary data is in the form of Landsat 5,7 and 8 satellite image data at different periods of taking satellite images with the same interval of 10 years. Primary data in the form of satellite images for 1992, 2002, 2012, 2021 was obtained by downloading satellite images through the website

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http://eartheexplorer.usgs.gov/. The Landsat types used are Landsat 5 TM with a spatial resolution of 30m (1992), Landsat 7 ETM+ (2002 and 2012) with a spatial resolution of 30m and Landsat 8 OLI/TiRS with a spatial resolution of 15m (2021). Landsat satellite image data used in this study can be seen in the table below.

No.	Satellite Image Data	Acquisition Date	Sensor Type	Satellite Image
1	LT05_L1TP_120065_19920614_20200914_02_T1.tar	14/06/1992	MMS	Landsat 5
2	LE07_L1TP_120065_20020821_20200916_02_T1.tar	21/08/2002	TM & ETM+	Landsat 7
3	LE07_L1TP_120065_20120901_20200908_02_T1.tar	01/09/2012	TM & ETM+	Landsat 7
4	LC08_L1TP_120065_20210427_20210501_02_T1	27/04/2021	OLI & TIRS	Landsat 8

In addition, secondary data as support is in the form of tidal prediction data which can be obtained through the site http://ina-sealevelmonitoring.big.go.id/ipasut/data/ based on the adjustment of the time of taking satellite images, for satellite image data for where the tide data is. low tide is not available, it is assumed that the satellite image is taken at low tide. Other supporting data are in the form of the administrative RBI map of the Demak Regency which was downloaded from https://tanahair.indonesia.go.id/portal-web and the SRTM 30m Digital Elevation Model (DEM) data throughout Indonesia which was downloaded from the source data from the official USGS website. https://eartheexplorer.usgs.gov/.

The software used in satellite image processing is ENVI 5.3 and ArcGIS 10.5. ENVI 5.3 software was used for radiometric correction and ArcGIS 10.5 was used to calculate shoreline changes which were then processed and analyzed to determine shoreline changes in the study area. Coastline Change Analysis using the Digital Shoreline Analysis System (DSAS) method. The type of data used in this research is secondary data. Secondary data is data or information in the form of notes obtained from someone's journal or literature.

In the research flow there are several processes or stages that are passed. This stage begins with data collection to obtain the final results of the analysis of shoreline changes. The process of analyzing and interpreting Landsat data consists of: image cropping, image recovery, image enhancement, geometric correction, digitization, and overlays. Image cropping is done to take the focus of the research area with consideration to save memory storage on the computer. Image pre-processing begins with geometric correction using the polynomial method with resampling type to the nearest neighbor using the WGS 1984 S UTM Zone 49S coordinate transformation system.

Radiometric correction using the FLAASH Atmospheric Correction method. Danoedoro (2012), stated that the FLAASH program corrects images by suppressing or eliminating the effects of water vapor, oxygen, carbon dioxide, methane, ozone and scattering molecules and aerosols based on the radiation transfer code MODTRAN4. In addition, image restoration is also carried out in order to improve the quality of satellite images due to satellite damage or due to atmospheric disturbances such as; gapfill correction and radiometric correction. Then delineated land and sea images of Landsat TM and ETM+ using ENVI 5.3. In general, MNDWI depictions are carried out to emphasize the differences between water areas and urban areas. This depiction uses the Modified Normalized Difference Water Index (MNDWI) formula from Xu (2006) which is written in equation (1). A different formula was carried out on the Landsat 8 OLI satellite image, namely using the formula from Ko et al. (2015), written in equation (2).

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$$MNDWI = \frac{Green - MIR}{Green + MIR} \quad \text{..... (1)}$$

with:
Green = Band 2 Landsat 7 (Green)
MIR = Band 5 Landsat 7 (Medium IR)

$$MNDWI = \frac{Green - SWIR}{Green + SWIR} \quad \text{..... (2)}$$

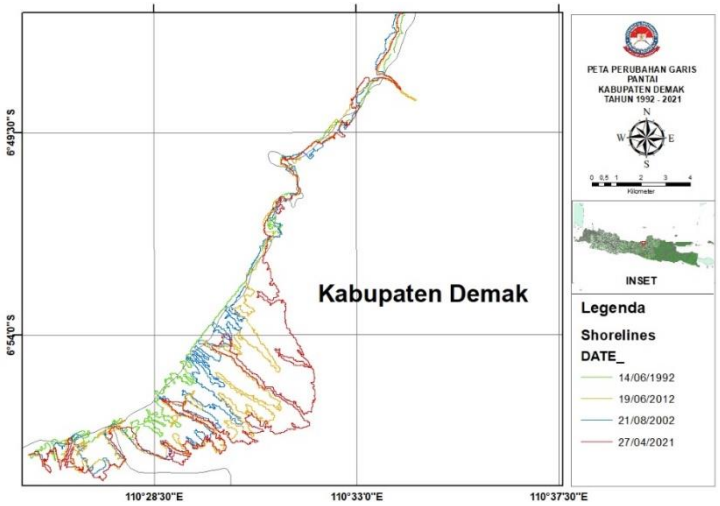
with:
Green = Band 3 Landsat 8 (Green)
MIR = Band 6 Landsat 9 (Medium Short Wave IR)

After the prediction of shoreline change is made, a map of shoreline change and a map of shoreline change prediction is produced. The next step is to analyze the social resilience of farming communities based on areas that have the potential to experience the greatest abrasion in the next 10 years.

Results and Discussion

The North Coast of Java, including the Demak Regency, is a maritime disaster-prone area, especially coastal abrasion that can occur at any time. The large number of Indonesians living on the coast makes them at high risk of becoming victims if a disaster occurs. This is because there is still uneven socialization about the threat of coastal erosion for coastal communities, coastal communities do not know information about disasters that are expected to occur. The loss of settlements, plantations and community infrastructure due to abrasion is one of the causes of many people being threatened.

If seen from the visual results, the coastline along the north coast of Demak Regency is experiencing abrasion from year to year. This can be seen from the line changes in 1992, 2002, 2012, and 2022. The results of the analysis using the Digital Shoreline Analysis System (DSAS) method show that changes in the coastline of Demak Regency tend to be significant from year to year. The shoreline changes from 1992, 2002, 2012 and 2021, as shown in (figure 1) can be seen as continuous abrasion.



Gambar 1. Demak Regency Coastline Change Map (1992-2021)

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Information Technology and Science (ITScience)

Journal of Agriculture (JoA)
Volume: 1 | Number 2 | July 2022
E-ISSN: 2829-2421
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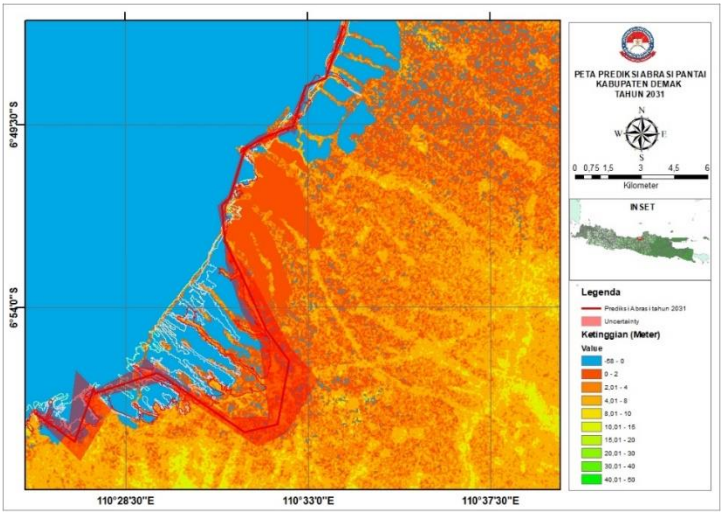
(Source: Author's Interpretation)

After the analysis of shoreline changes obtained results, then predictions were made using ArcGIS 10.5 software using the Digital Shoreline Analysis System (DSAS) method. The shoreline prediction results obtained are shown in (Fig.2). Based on the map, it is known that the predicted coastline in the next 10 years the North Coast of Demak Regency will experience abrasion. The highest abrasion occurs in Sayung District.

The prediction of the resulting abrasion is also supported by the relatively low ground level condition in the area, which is no more than 15 meters above sea level. Abrasion that occurs on the coast of Demak Regency is also often exacerbated by the arrival of Rob floods, especially in the rainy season. As for the impact of abrasion and tidal flooding that occurred in the coastal area of Demak, among others; Damage to residential buildings, decreased quality of ground water and surface water, loss of land on the coast sinking and can no longer be used, sinking land including residential land, pond land, plantations, rice fields and others.



Gambar 2. Prediction Map of Coastline Change in Demak Regency in 2031

(Source: Author's Interpretation)

For farmers, the loss of plantation and agricultural land is a very big disaster. This is because plantations and rice fields are places for farmers to fulfill their daily needs. Plantations and rice fields are the source of the Demak community's economy. Based on the Head of Reconstruction of the Regional Disaster Management Agency (BPBD) of Demak Regency, Parjan said that the flooding in Sayung Village also had an impact on agricultural land. From reports received, more than 300 hectares of agricultural land were damaged due to abrasion and tidal flooding (Setiawan, 2022). The abrasion that has occurred so far in Demak Regency has eliminated the livelihoods of farming communities, many of whom have switched professions from being "farmers" to "non-farmers". Not a few farmers who also lost their homes. Many people who used to be farmers and fishponds chose to switch professions to become industrial workers because they no longer owned land.

Changes in the economic income of farmers that occur directly or indirectly will change the behavior of the farming community. These changes can be positive or negative, it doesn't matter if the impact of the changes is positive, but if the changes make the farming community even worse off, then this will cause new problems. In avoiding the bad social impact of society,

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it is necessary to strengthen the resilience of the farming community in Demak Regency. In areas that are prone to abrasion, it is appropriate to build community resilience. Technology that is increasingly developing can be used as a tool to build social resilience in the community. Utilization of Geographic Information Systems (GIS) is one that can be the best choice. The ability of GIS in monitoring and mapping the area can be used as a means of useful information for the community. In mapping the potential for abrasion areas in Demak Regency, it can be used as a means of increasing community social resilience. Especially Farmers.

Efforts to build social resilience can be realized by increasing the awareness of the farming community to be aware of their own safety and the environment. Resilience as a process enables farming communities not only to be able to face disruptions but also to be able to face challenges that can worsen their lives and facilitate more actions to improve their own quality of life. Efforts to measure indicators of social vulnerability stem from the understanding that social vulnerability refers to exposure, namely acceptance of exposure to a hazard or the presence of stressful conditions at the group or individual level due to exposure to a disaster.

There are several supporting aspects in forming community resilience in the form of physical, social, economic and institutional aspects. These aspects can also be used as a benchmark for the level of resilience that encourages communities to increase their capacity in dealing with pressures engulfing an area. Based on the physical, social, economic and institutional aspects in measuring the social resilience of farming communities and supported by analysis of shoreline changes and predicting shoreline changes, as well as predictions of abrasion that will occur in the future, efforts are needed to increase the resilience of farming communities in Demak Regency, such as:

1. Prevention of coastal abrasion in areas that have the potential to experience coastal abrasion

   This prevention effort is closely related to the physical aspect of resilience, which can be done in several ways, including: Water-breaking buildings. Break water is made from a pile of crushed stone with the size of the stone adjusted to the slope of the building used. With this building, the waves that will hit the beach have broken somewhere a bit far from the beach, so that the energy of the waves reaching the beach is small enough to reduce the danger of abrasion that may occur. The second prevention effort is to implement the Mangrove Planting Program. Mangrove planting is carried out with the aim of reducing the level of abrasion that occurs, filtering sea water into the land, and reducing the threat of sea water intrusion. Third, Increase Public Awareness. The rapid development of information technology is very helpful in disaster management. The role of information technology provides a very large contribution because it is connected so that the delivery of information becomes fast and integrated.

2. Build synergy to increase social resilience between the Government and the community.

   The development of this synergy is very important because the threat of abrasion and its impact on the social community cannot only be resolved with certain parties. Increased awareness of personal and environmental safety will make this synergy possible. Therefore, the development of information systems and socialization needs to be carried out continuously. For example, it can be done by building a disaster information center, building housing relocations for farming communities, building new jobs for disaster-affected farmers, or by providing capital for disaster-affected farmers.

3. Build and revive strategic leadership oriented to farmer welfare

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The leadership of a leader is absolutely necessary in a critical situation. The decision of a leader will also have a major impact on the welfare of the people he leads. Therefore, a person's leadership pattern becomes a determining factor in what kind of goals will be achieved. Farmers who experience the disaster of losing the land where they are gardening, losing their profession, losing their income, and even losing their place of residence will certainly really need a leader who is on their side. Changes in the social attitudes of the people among them need to be considered so that they do not have a negative impact on the lives of farmers. But how can the government make farmers rise from adversity with the limitations they have.

Conclusion

The results of the analysis using the Digital Shoreline Analysis System (DSAS) method showed that changes in the northern coastline of Demak Regency tend to be significant from year to year. shoreline predictions in the next 10 years the North Coast of Demak Regency will experience abrasion. The highest abrasion that occurred in Demak Regency was in Sayung District. Geographic Information Systems (GIS) can be used as monitoring tools to protect life, property and critical infrastructure against natural or non-natural disasters. The results of the research can also be used as material for consideration in policy making by the relevant government in efforts to overcome maritime disasters that may occur.

Abrasion that occurs in Demak Regency has an impact on changes in the economic income of farmers that occur directly or indirectly will change the behavior of the farming community. To avoid the bad social impact of society, it is necessary to strengthen the resilience of the farming community. The efforts to increase the resilience of the farming community in Demak Regency which can be done include: 1). Prevention of coastal abrasion in areas that have the potential to experience coastal abrasion. 2). Building synergy to increase social resilience between the Government and the community. 3). Build and revive strategic leadership oriented to farmer welfare.

Suggestions in this study need to do a site survey to ensure the results of the analysis are the same as the actual conditions that occur in the field. Related to abrasion prevention efforts must be carried out by considering the existing coastal environmental factors. So that the efforts that have been made are as expected.

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References

Badan Pusat Statistik Kab. Demak. (2021). Demak Dalam Angka: Demak in Figures 2021. CV Citra Yunda: Demak.

Danoedoro, P. (2012). Pengantar Penginderaan Jauh Digital. PUSPICS Fakultas Geografi Universitas Gadjah Mada, Yogyakarta, Indonesia: 2012.

Desmawan, B. T. (2012). Adaptasi Masyarakat Kawasan Pesisir Terhadap Banjir Rob Di Kecamatan Sayung, Kabupaten Demak, Jawa Tengah.

Journal of Agriculture (JoA)
Volume: 1 | Number 2 | July 2022
E-ISSN: 2829-2421
https://doi.org/10.47709/joa.v1n02.1504

Fajrin, F. M., Muskananfola, M. R., dan Hendrarto, B. (2016). Karakteristik Abrasi dan Pengaruhnya Terhadap Masyarakat di Pesisir Semarang Barat. Diponegoro Journal Of Maquares Volume 5, Nomor 2, Tahun 2016, Halaman 43-50.

Ko, B. C., Kim, H. H., & Nam, J. Y. (2015). Classification of potential water bodies using Landsat 8 OLI and a combination of two boosted random forest classifiers. Sensors, 15(6), 13763–13777.

Lukmono, A. (2021). Abrasi di Demak Paling Parah di Indonesia, Terancam Tenggelam 20 Tahun Mendatang. https://www.ayosemarang.com/regional/pr-77809966/Abrasi-di-Demak-Paling-Parah-di-Indonesia-Terancam-Tenggelam-20-Tahun-Mendatang

Manumono, D. (2009). Dampak Abrasi dan Rob terhadap Perilaku Masyarakat Kawasan Pesisir di Kabupaten Demak. Fakultas Pertanian, Instiper Yogyakarta.

Mulyadi, M. (2011). Penelitian Kuantitatif dan Kualitatif serta Pemikiran Dasar Menggabungkannya. Jurnal Studi Komunikasi dan Media. Vol. 15 No. 1 (January – June 2011).

Munasikhah, S. and Wijayati, P. A. (2021). Dari Hutan Mangrove Menjadi Tambak: Krisis Ekologis Di Kawasan Sayung Kabupaten Demak 1990-1999. Journal of Indonesian History http://journal.unnes.ac.id/sju/index.php/jih

Ramadhani, Y. P., Praktikto, I., and Suryono, C. A. (2021). Perubahan Garis Pantai Menggunakan Citra Satelit Landsat di Pesisir Kecamatan Sayung, Kabupaten Demak. Journal of Marine Research, vol. 10, no. 2, pp. 299-305, May. 2021. https://doi.org/10.14710/jmr.v10i2.30468.

Setiawan, W. 2018. BPBD Demak: 300 Hektar Lahan Pertanian di Desa Sayung Terendam Banjir. https://news.detik.com/berita-jawa-tengah/d-3882185/bpbd-demak-300-hektar-lahan-pertanian-di-desa-sayung-terendam-banjir.

Wicaksana, S. (2020). Analisis Perubahan Garis Pantai Di Sepanjang Pesisir Kabupaten Demak, Jawa Tengah Dengan Menggunakan Metode Digital Shoreline Analysis System (DSAS). Fakultas Perikanan Dan Ilmu Kelautan Universitas Brawijaya.

Xu, H. (2006). Modification of normalised difference water index (NDWI) to enhance open water features in remotely sensed imagery. International Journal of Remote Sensing, 27(14), 3025–3033.