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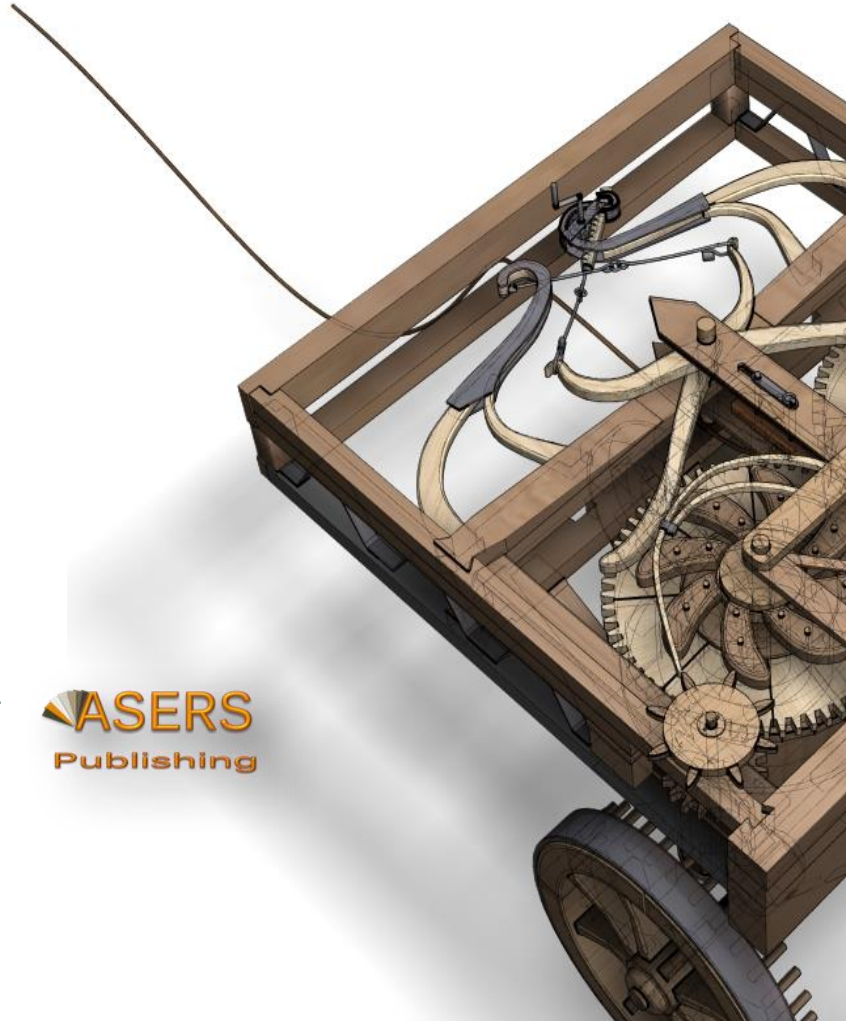
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Sustainable Development of the Coastal Environment through Participatory Mapping of Abrasion-Prone Areas

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Abstract:

Indonesia is one of the countries with the longest coastline, so Indonesia has many coastal areas with all its natural resources. However, these natural resources are starting to be disturbed due to abrasion. Abrasion is known not only to occur due to natural factors but also human behavior factors. Therefore, abrasion in Kragan District, Rembang Regency must be handled immediately through participatory mapping involving the community. Research with qualitative and quantitative approaches through questionnaires, interviews, observation, and FGD techniques was conducted to collect data. The results showed that participatory mapping was effective in increasing community capacity. In addition, participatory mapping also produces a map of the hazard to abrasion, which is one of the considerations for policymakers in making decisions regarding the handling of abrasion. Community capacity and the resulting map is a provision for the community to handle abrasion properly, so it is hoped that the chances of a sustainable coastal area will be even greater.

Keywords: sustainable development; coastal environment; participatory mapping.

JEL Classification: Q01; Q56.

Introduction

Indonesia is a country that has abundant natural resources. One of Indonesia's natural resources is the natural resources on the coast. Indonesia's sea area is 3.25 million km² with a total coastline that is the second-longest in the world with a length of 54,716 km, along with all the diversity and abundance of natural resources in it. If it is dredged and destroyed continuously without any control, then these resources will gradually run out and become unsustainable. Various human activities such as excessive development in coastal areas, sand mining, illegal fishing using explosives, and so on can trigger coastal damage (Khakim 2021; Park 2020). This damage is shown by the latest data released by the Center for Oceanographic Research of the Indonesian Institute of Sciences (2017), which states that only 29.52% of the 2.52 million ha of coral reefs in Indonesia are still in good condition; the percentage of seagrass cover is only 42.23% or less than 60% so that it can be categorized as "unhealthy" status, and 52% of the total 3.62 million ha of mangroves in Indonesia are in a damaged condition.

The destruction of natural resources on the coast certainly cannot be tolerated. Damage to resources in coastal areas, if not addressed immediately, will result in more severe damage. If this happens, the carrying capacity of nature on the coast towards human needs as heterotrophs who cannot meet their needs without the support of natural resources will also be weaker. These resources are needed in the short term by the Indonesian people today and in the long term by future generations. Therefore, existing natural resources, especially in coastal areas, must be used wisely, so that future generations can still use them to meet their needs (Davidson 2014).

Among the efforts that can be done in conserving natural resources is to implement development based on the principles of sustainable development. Sustainability, in this case, means that natural resources can support people's welfare in the present and the future. In order to achieve this, Indonesia has committed together with 192 other member states of the United Nations (UN) to implement sustainable development by starting to implement the 17 Sustainable Development Goals (SDGs) that have been agreed since 2015, of which goal number 11 is Cities and Settlements. Goals in sustainable development can be disrupted by several factors, including natural disasters (Shaw *et al.*, 2016). Therefore, the integrated management of disaster-prone areas is the National Medium Term Development Plan (RPJMN) Policy for 2020-2024 in Indonesia.

Natural disasters that occur and damage coastal areas include abrasion (Hossain *et al.* 2020). One of the areas prone to abrasion in Indonesia is Krangan District, Rembang Regency, Central Java Province, Indonesia. This sub-district has suffered considerable losses due to abrasion. Based on data obtained from the Regional Disaster Management Agency (BPBD), the total loss suffered by the District due to abrasion in 2019 was 800 million rupiah (BPBD Kabupaten Rembang, 2019). These losses do not include the damage suffered by residents personally in the form of damage to houses and other impacts such as health, economic, and socio-cultural impacts to tourism. The losses were too significant because the community's preparedness in dealing with disasters was still low.

One of them is low preparedness indicated by the community's knowledge about abrasion, which is still low. The low level of public knowledge is partly due to the lack of socialization and training on abrasion as a form of disaster risk reduction (Shaw *et al.* 2015). The government, in particular, has not made non-structural preventive efforts against abrasion. Prevention efforts through abrasion education are only carried out in schools through disaster learning (Ronggowulan, 2018). Based on the Strategic Plan of the Rembang Regency Regional Disaster Management Agency for 2016 to 2021, there is also no mention of abrasion education that is specifically given to the community (Suharto 2017). Based on interviews with several people at random, it is known that the community also does not try to increase their knowledge about abrasion by self-taught. Many people have not carried out disaster education for their children early. At the same time, people who live in disaster-prone areas need disaster education (Hamid 2020). Especially for children, disaster education can be obtained from their parents as well as through environmental education and disaster education given in schools (Hamid *et al.* 2021).

Knowledge plays a vital role in reducing disaster risk. The knowledge that is taught well and its practice in the field can improve community preparedness and resilience in dealing with disasters. Knowledge also plays a significant role in the effectiveness of disaster management carried out (Seneviratne *et al.* 2010). In addition, knowledge will affect people's attitudes in dealing with disasters. The knowledge and attitudes of the community have a significant effect on preparedness in dealing with disasters (Chotimah 2019). If the community has high preparedness in dealing with disasters, then the impact or losses resulting from the disaster will be more negligible, and vice versa. Therefore, efforts to improve community preparedness through increasing knowledge and attitudes in dealing with disasters are significant (Setyowati *et al.* 2021).

The possible efforts to increase community knowledge and attitudes are through participatory mapping of disaster-prone areas by involving the community (Reichel and Frömming 2014). Through mapping disaster-prone areas, there will be an exchange of information owned by the community and scientific knowledge possessed by disaster experts. Through these activities, it is hoped that the knowledge and attitudes of the community in dealing with abrasion will increase. If these two aspects increase, a community ready to face abrasion will be formed (Cadag and Gaillard 2012). Participatory mapping of abrasion-prone areas will also produce abrasion-prone areas. Through this map, it will be possible to identify areas that are prone to disasters and areas that have the potential to experience abrasion in the future. Based on the map, it will be possible to anticipate as early as possible so that the handling of abrasion in the future will also be more effective and efficient (Amri *et al.* 2016). The abrasion-prone map can also be used as a guide for the local community and the outside community so that outsiders can be more careful if they are in the disaster-prone area. That way, the community will be more alert so that the risk of abrasion will be further suppressed.

Based on this background, this research was conducted. This study will map the abrasion-prone areas in Kragan District, a sub-district in Rembang Regency that has experienced the most severe abrasion impact compared to other sub-districts. Through this mapping, it is hoped that community preparedness in dealing with abrasion will increase. In addition, an abrasion-prone map is also produced that can be used to increase the effectiveness of abrasion prevention. Both of these are expected to reduce the intensity of abrasion and the magnitude of the risk so that, in the end, it will be able to create a sustainable coastal environment in Kragan District.

1. Literature Review

Indonesia is one of the countries with the longest coastline in the world. However, some kinds of literature mention different results regarding the length of the Indonesian coastline. The World Factbook (TWF) states that Indonesia's coastline is the second-longest in the world after Canada, with 54,716 kilometers. Measurements carried out by the World Resources Institute (WRI) mention different lengths, which are 95,181 kilometers, so that Indonesia ranks 4th out of 182 countries in the world. Meanwhile, based on data collected by the Indonesian Central Statistics Agency (BPS Indonesia) through the Provincial Marine and Fisheries Service throughout Indonesia, the length of Indonesia's coastline was 99,093 kilometers in 2014. Although there are differences, the three institutions certainly agree that Indonesia is one of the countries in the world with the most extended beach length.

The long coastline is also directly proportional to the area of the Indonesian ocean. Indonesia, which is also an archipelagic country, has a larger sea area than the land area. Of the total 8.3 million km² of the territory of the Republic of Indonesia, 6.4 million km² of it is territorial waters (Kementerian Kelautan dan Perikanan 2018) (Ministry of Maritime Affairs and Fisheries, 2018). In this area, there is phytoplankton, which is the main contributor to oxygen on earth and various other marine biotas. Abundant resources such as fish, shrimp, lobster, crab, squid, and various other marine biotas can also be utilized to meet food needs and improve the community's welfare. In addition, the existence of the sea and its beautiful beaches can also be a source of the community's economy through tourism (Aly *et al.* 2021). However, all of these benefits will only be taken if the coastal area remains sustainable.

Climate change due to natural and human factors ultimately poses a significant threat to coastal areas. USAID (2017) stated that around 42 million Indonesians who live less than 10 meters above sea level will face the threat of various disasters such as floods, extreme waves, abrasion, and the various consequences it causes. The community in Sarang Sub-district, Rembang Regency, is one of the people under this threat, even having experienced it for decades. Various natural disasters such as floods to abrasion have occurred in this District. Incredibly abrasion, the latest data states that during the period 2010 to 2020, this sub-district continues to experience abrasion. As a result, several meters of land have been submerged, houses and public facilities have been damaged, and the community has experienced economic constraints because their fishing equipment has been damaged due to abrasion (BPBD Rembang Regency, 2019) (BPBD Kabupaten Rembang, 2019).

The capacity of coastal communities in dealing with disasters must be increased in order to be able to deal with various disasters on the coast (Hamid, 2018). The knowledge and attitudes of the community are part of the community's capacity that is urgent to be improved, considering that both affect preparedness in dealing with disasters. One of the efforts to improve it is by mapping disaster-prone areas in a participatory mapping. Participatory mapping is a mapping effort that involves the active role of the community. Through participatory mapping, there will be an integration between the knowledge possessed by the community about the location of the abrasion in their area and the scientific knowledge possessed by the experts. The knowledge possessed by

the community about their area will be explored by researchers to be used as a basis for preparing disaster-prone maps. Furthermore, researchers will also explore other knowledge possessed by the community regarding abrasion, ranging from knowledge about the meaning, causes, effects, how to deal with it, and so on. The expert will provide confirmation and internalization if there are misconceptions or information that is not yet known by the public (Cadag and Gaillard 2012).

Participatory mapping involving the community is recommended. This is because compared to conventional mapping, this mapping can provide more detailed and complete results. Through participatory mapping, information is explored in-depth about regional vulnerabilities from various layers of society who have faced natural disasters with different experiences. This information is crucial in identifying disaster-prone points of an area and will result in more effective and sustainable coastal management because the management is carried out directly by the community on a bottom-up basis (Trihatmoko *et al.* 2021; Amiruddin and Rozalinna 2020). Through the participatory mapping of disaster-prone areas, the community will understand more about the area's condition, especially points prone to abrasion (Fisu and Marzaman 2020). Through participatory mapping, data about abrasion events that the community has experienced can be reported, and data collection is carried out. If no mapping is done, the data will not be explored further. The data is then managed as a consideration in making decisions related to environmental management to minimize the occurrence of abrasion. Through the mapped data, people who know about abrasion-prone points are also getting wider, including newcomers, tourists, and people who only live temporarily in the sub-district. At its peak, community resilience will also be formed (Wei *et al.* 2018)

2. Methodology

This research is research with quantitative and qualitative approaches or commonly referred to as mixed methods research (Creswell 2014). Mapping abrasion-prone areas conducted qualitative research in a participatory manner. Previous relevant research shows that participatory mapping involving the community can improve community preparedness in dealing with disasters. Therefore, this research is also equipped with quantitative research conducted by measuring community preparedness in dealing with disasters. Community preparedness in dealing with disasters is measured based on aspects of community knowledge and attitudes in dealing with disasters. This is based on the research of Chotimah (2019) and Yatnikasari *et al.* (2020), which states that community knowledge and attitudes affect community preparedness in dealing with disasters. These two variables are measured as the basis for determining community preparedness in this study.

The area chosen for mapping in this study was in the Kragan District, Rembang Regency, Central Java Province, Indonesia. The selection of areas was carried out purposively based on the research objectives (Creswell 2014). Considering the purpose of this study is to map areas prone to abrasion, Kragan District was chosen as the sample. Kragan Sub-district in the sub-district in Rembang Regency that is most severely affected by abrasion, so mapping this sub-district is considered the most urgent to do, because until now there is no disaster-prone map that precisely and in detail maps the vulnerability to abrasion in the Kragan District (BPBD Kabupaten Rembang, 2019).

This study collects qualitative and quantitative data. Qualitative data is in the form of a series of mapping activities, starting from planning and preparation so that an abrasion-prone map of the Kragan District can be produced, which can be recommended to local governments. The quantitative data is data on the preparedness of the people of Kragan District in facing abrasion. Qualitative data was obtained through data collection techniques in the form of FGD, observation, and interviews. The quantitative data were obtained through a community preparedness questionnaire technique consisting of aspects of knowledge and attitudes. The results of the community preparedness questionnaire are also supported by qualitative data obtained during the study. FGDs, observations, and interviews were conducted directly without using guidelines.

The resulting data were analyzed descriptively qualitative-quantitatively. Community preparedness data in the form of answers from the community on aspects of knowledge and attitudes are then converted into scores for each aspect. Scores from all aspects are added up so that a community preparedness score will be obtained. These scores can then be classified as community preparedness levels. Given that there are 15 questions on the knowledge aspect and five questions on the attitude aspect, the maximum score obtained is 100, and the minimum score is 20. Both scores are used to find the width of the interval that will be used as a basis for determining the category of community capacity. The width of the interval is searched using the following formula.

$$i = \frac{\text{Measurement Distance (R)}}{\text{Number of intervals}} \text{ (Hadi 2000)}$$

Where: i = width of interval; R = measurement distance; Highest score – Lowest score

Based on the calculation using this formula with five intervals, it is known that the value of R is 80, so it is known that i or the width of the interval is 16. Therefore, the category of community capacity based on the scores obtained is shown in the following Table 1.

Table 1. Community Capacity Category

No.	Score Interval	Category
1.	84-100	Very Good
2.	67-83	Good
3.	51-66	Enough
4.	34-50	Less
5.	17-33	Very Less

As for the qualitative data collected during the mapping implementation, the data will first be analyzed so that the data needed and not needed in the study will be found. Data that is not needed is reduced so that only data following the research objectives will be displayed. Furthermore, based on these data, it will be known about the mapping process carried out. In addition, a map was also produced containing the points of abrasion in the Kragan District. During the research, the community also pointed out the various disasters that had occurred at that point. However, the data shown is only data related to abrasion.

Finally, this study analyzes the effect of participatory mapping on the sustainability of the coastal environment in Kragan District, Rembang Regency. The analysis was carried out using the framework mentioned by Bradley & Yee (2015), namely the DPSIR (Driving forces-Pressures -States-Impacts-Responses) framework.

3. Result and Discussion

3.1 Participatory Mapping in Kragan District, Rembang Regency

The participatory mapping process is carried out through four main stages, namely planning, implementation, evaluation, and monitoring which can be detailed as follows.

1) Planning

This stage is done by making a design of the mapping activity to be carried out. The planning process involved the researcher and the sub-district head, and several village head representatives from villages in Kragan District. The researcher and the representatives then plan the time and place for the participatory mapping to be carried out. The next task of the village head is to convey to his village residents that they are willing to participate in jointly mapping the area. After the community knows about the mapping activity, then fixation is carried out on the number of people willing to participate in the activity from beginning to end. Thirty people are willing to participate. Participatory mapping is planned to be carried out on the coast of one of the beaches.

2) Implementation

The mapping implementation begins with conducting an initial assessment of the community's preparedness in dealing with abrasion. After knowing the initial capabilities of the community, then the participatory mapping of the area was carried out by involving all communities from various villages in the Kragan sub-district. However, considering that the community also has other activities that cannot be abandoned, the FGD implementation is carried out in rotation according to the community's free time. Researchers and disaster management experts will be waiting for the community at one of the beaches. Furthermore, as Figure 1 shows, if several communities have come, then the FGD will be conducted. The next FGD will be reopened with other communities until all the respondents have filled out questionnaires and provided information related to various abrasion events in their area.

As mentioned by various previous studies, this research also shows the same thing, that mapping activities result in interaction between the community and disaster researchers and experts. The community provides information related to locations that have experienced an abrasion. Meanwhile, disaster experts and researchers provide further knowledge about abrasion, especially information not yet known by the public. Through the initial assessment questionnaire, it can be known how far the community's knowledge about abrasion is. Given that knowledge is still low, researchers and disaster experts also provide knowledge about abrasion during the implementation of mapping. Among the new knowledge received by the community is about the causes of abrasion, the effects of abrasion for coastal life in the future, to the characteristics of locations that have the potential to experience abrasion. Through the FGD, the community can also ask about things that are

not known about the abrasion or ask about mitigation actions that are suitable for various coastal conditions in Kragan District.

Figure 1. FGD with several communities



The mapping activity was carried out for several days to form abrasion-prone maps in four Kragan District villages. Initially, the mapping was done manually using hand strokes. After the manual mapping is completed, the mapping results are digitized using ArcGIS software so that digital maps are produced that are neater and easier to understand by the wider community, as shown in Figures 2, 3, 4, and 5. The pictures show the points that are most prone to abrasion in each village.

Figure 2. Mapping Results of Abrasion Prone Areas in Kragan Village, Kragan District

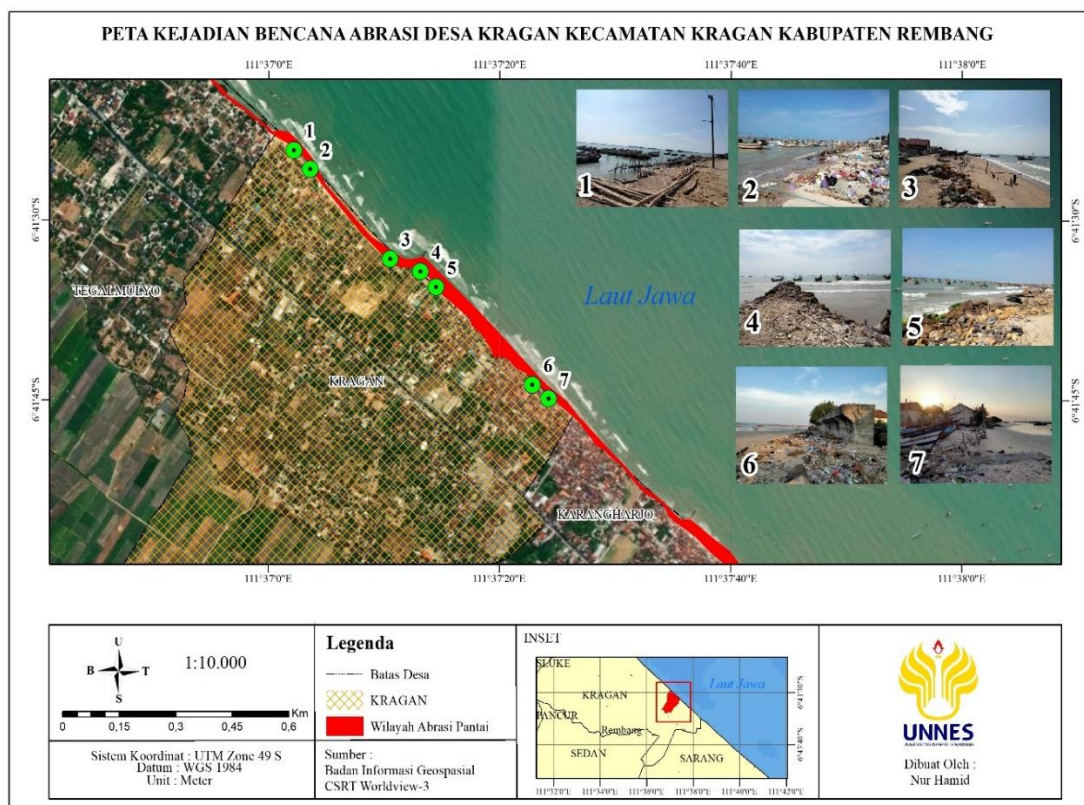


Figure 3. Mapping Results of Abrasion Prone Areas in Tanjungan Village, Kragan District

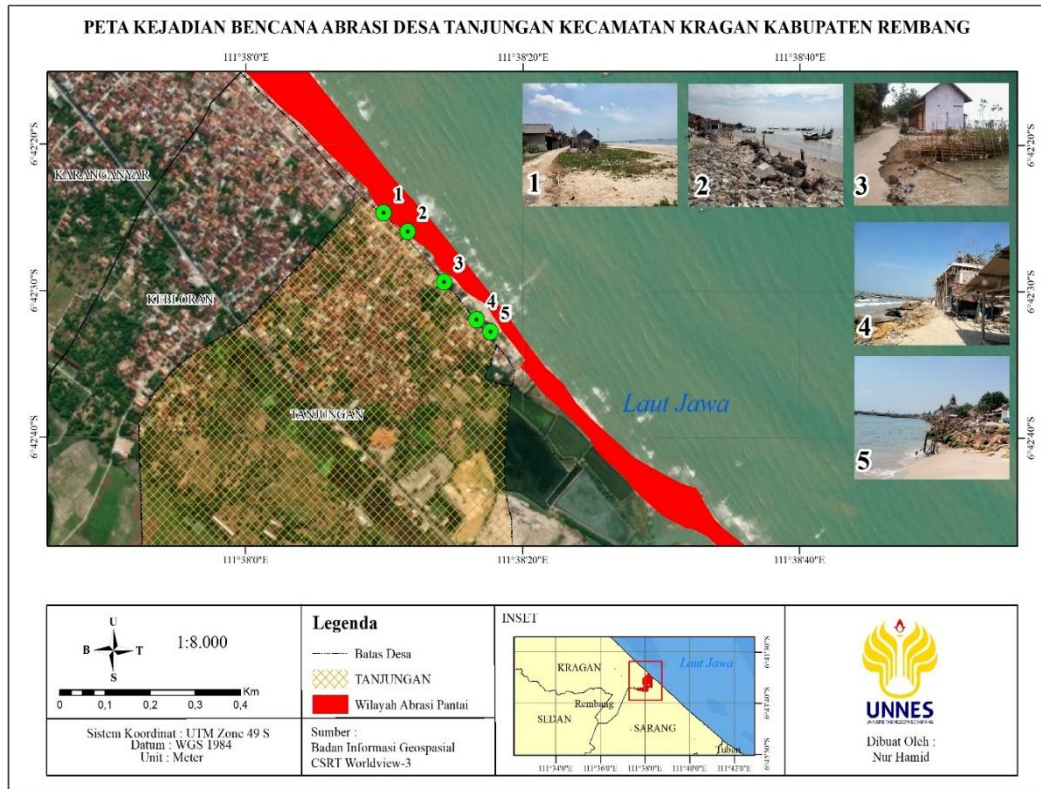


Figure 4. Mapping Results of Abrasion Prone Areas in Pandangan Kulon Village, Kragan District

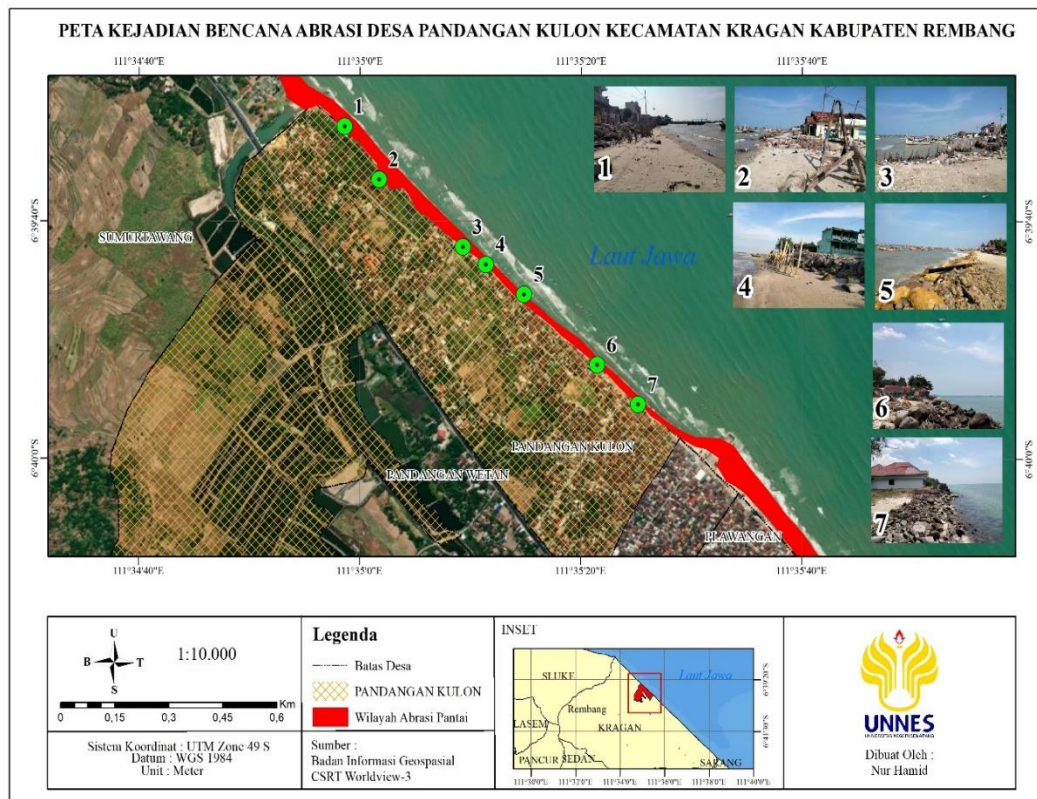


Figure 5. Mapping Results of Abrasion Prone Areas in Karangharjo Village, Kragan District



3) Evaluation

This stage is carried out to evaluate the implementation of the mapping that has been carried out. The researcher carried the evaluation with the sub-district head, village head, and several community representatives. The evaluation results show that the mapping carried out has been quite effective. This is indicated by the formation of an informative map, the enthusiasm of the community to take part in the activity, and the increased preparedness of the community in dealing with abrasion. The community is excited to carry out this mapping activity because the community is aware of the importance of future disaster management efforts. This mapping activity also has several limitations, including only mapping the four villages with the highest level of abrasion susceptibility. The other villages have not yet been able to do the mapping due to the researchers' limited time, energy, and cost.

4) Monitoring

This mapping activity is not only completed after the map is produced. Furthermore, researchers continue to monitor the development of abrasion that occurs in Kragan District, Rembang Regency through the WhatsApp group. The sub-district head, village head, and several communities are members of the group. Through this group, the community will actively report abrasion events that occur in Kragan District. This report from the community is then used as data to update the abrasion-prone map made previously. An Abrasion-prone map of a specific area must be constantly updated if abrasion continues to occur in that area.

3.2 Community Preparedness of Kragan District, Rembang Regency in Facing Abrasion

The preparedness of the Kragan District people to face abrasion before participatory mapping was carried out was still categorized as low. This is shown from the results of the preparedness questionnaire, which consists of indicators of knowledge and attitudes. Public knowledge about abrasion is still experiencing some misconceptions, among others, people think that abrasion is a disaster that purely occurs due to natural disasters, whereas various community activities also trigger abrasion; the community considers that the impact of abrasion is only felt by the current generation, even though the occurrence of abrasion will also cause the coast to become unsustainable, so that it will affect the opportunities for future generations to meet the needs of life; as well as people who still position themselves as objects that suffer from abrasion, but people have not positioned themselves as subjects who are trying to rise and carry out more optimal handling of abrasion.

The erroneous knowledge of abrasion has resulted in people's attitudes in dealing with abrasion are also still low. This is because the knowledge that a person has will affect the attitude to be taken. Given that public knowledge is still experiencing some misconceptions, it is not surprising that the attitude shown is not as it should

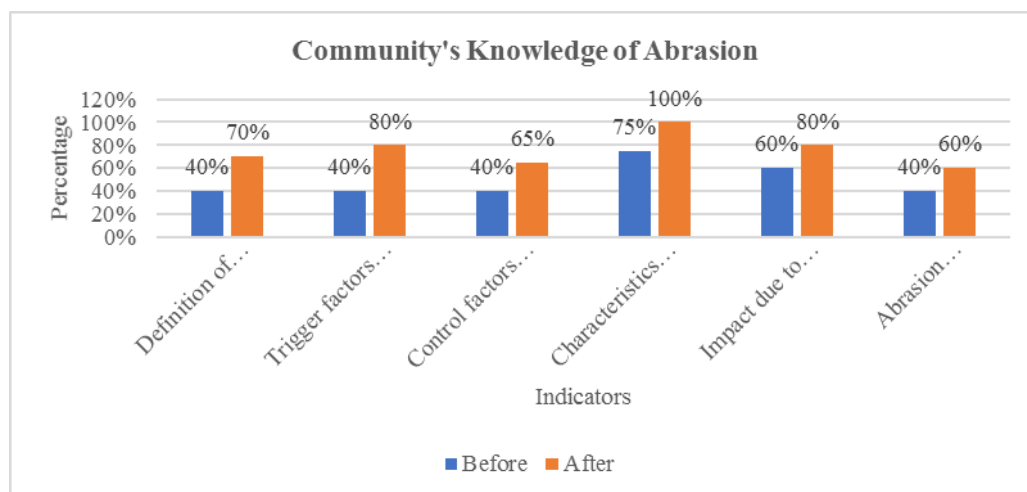
be. The community still considers some activities on the coast usual even though these activities trigger abrasion. If researchers and disaster experts have confirmed the community's knowledge through mapping activities, then abrasion knowledge will also increase. This increase is directly proportional to the increase in people's attitudes in dealing with abrasion. This is shown by the results of the measurement of knowledge and the community before and after the mapping is carried out.

The community in general, or about 75% of the people, already know about the characteristics of abrasion in their area, including the time and place where the abrasion occurs based on the experience of abrasion that has occurred before. Based on this experience, 60% of the community already knows about the impact of abrasion, even though the community has not been able to project the impact of abrasion on the sustainability of coastal life in the future. After conducting a search and analysis of the data, it is known that people who do not know about the characteristics of abrasion and do not know the consequences of abrasion in depth are people who are new residents in the area, so they have not had direct experience of abrasion and are indigenous people who have lived overseas for a long time, and then decided to return to the village after experiencing layoffs due to the impact of the Covid-19 pandemic.

Most people do not know the real meaning or meaning of abrasion and the factors that influence it. As many as 60% of the community only considers abrasion a natural or natural disaster on the coast. The community even considers that abrasion is an annual agenda because there is an abrasion almost every year in Krangan District. Regarding the factors that can trigger and control the occurrence of abrasion, only 40% of the people can understand them correctly. As many as 60% of the other people do not know that various human activities can also trigger that abrasion because this activity is considered normal. These activities are cutting down mangroves and other breakwater vegetation, mining for sand, and destroying coral reefs.

As for the post-participatory mapping, community knowledge is known to have increased. Previously, as many as 25% of the people who were new residents or moved from the city did not know about the characteristics of abrasion that occurred in their area and specific areas that had a high vulnerability to abrasion. Through this mapping, all communities gain knowledge about it. The community is finally becoming more aware of the impact of abrasion, both now and in the future. Through the provision of knowledge by disaster experts during the implementation of mapping, the community is also increasingly aware that abrasion is not a purely natural disaster or an annual event that is certain to occur but is also a disaster that can be triggered or suppressed by human activities. People who have committed acts of destruction such as coastal mining began to regret their actions because, previously, people did not know about it. The percentage increase in people's knowledge is shown in the following Figure 6.

Figure 6. Community's Knowledge of Abrasion Before and After Participatory Mapping



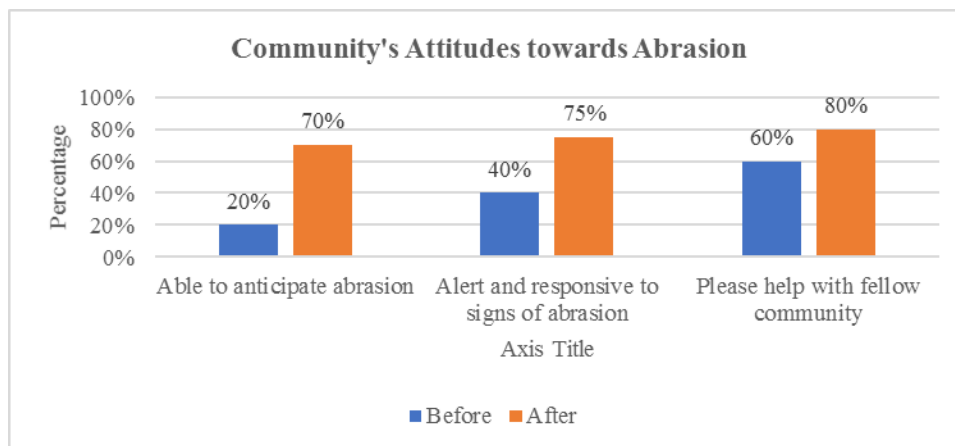
The second aspect examined in this study is the community's attitude in dealing with abrasion, as shown in Fig. This aspect has three indicators, with the highest indicator being an attitude of helping fellow citizens with a percentage of 60%. This attitude that characterizes the Indonesian people is also found in the people of Krangan Village in dealing with abrasion. The community does help other communities who need assistance, both in terms of labor and financial assistance. Energy assistance is usually given when the community's house or yard is damaged by abrasion, so the local community helps fix it to return to normal. The cost assistance is usually given voluntarily by the community willing to help their relatives experiencing difficulties.

The next attitude indicator is an indicator of alertness and responsiveness to signs of abrasion. This attitude has been owned by some of the people of Karagan Village with a percentage of 40%. The community understands the characteristics of disasters in their area, but sometimes people are complacent with this knowledge, where people only remember the times when abrasion usually occurs, even though abrasion can occur at any time. Therefore, knowledge about abrasion characteristics, which reaches a percentage of 75%, does not necessarily make an attitude of alert and responsive to be formed. This is also exacerbated by the lack of mastery of other indicators of public knowledge of abrasion.

The last indicator of the attitude aspect is the ability to anticipate abrasion. This can be seen from the community's response, which stated that the community did not make any meaningful preparations to face the disaster. The preparations made by the community include adjusting the physical environment around the house and the beach so that abrasion does not penetrate the house and does not erode the soil on the coast. However, through in-depth interviews with several community representatives, it is known that the community has not made any preparations if there will be a more severe abrasion so that the abrasion can damage the area around the coast. The community should have prepared for the worst by placing their belongings and securities in a safe place, making evacuation routes, making shelters equipped with food reserves, and teaching all family members to save themselves from abrasion.

Aspects of community attitudes after the mapping were carried out also increased. The attitude of helping others after the mapping was carried out also increased. This is possible because the community has positioned itself as a subject in handling abrasion so that their enthusiasm to help families or neighbors who have high vulnerability is greater. Through this mapping, the community is also more responsive to signs of impending abrasion because of community knowledge about signs of impending abrasion and signs of an area that has the potential to experience abrasion. The increasing knowledge of the community makes the public's response to these signs also increasingly sharp. Finally, the attitude of the community in dealing with abrasion is also getting more detailed and perfect. People are becoming more aware of simple things that must be prepared in the face of abrasion. The community then commits to doing simple things that will be very beneficial to reduce the number of victims and losses due to abrasion. Among the plans that the community will carry out are to start placing letters and valuables in safe and efficiently salvageable containers, to start providing disaster education and preparedness training to families, and together with the community to build evacuation routes and refugee camps equipped with a food barn where the food barn comes from community contributions after the harvest. The percentage increase in people's attitudes in dealing with abrasion is shown in the following Figure 7.

Figure 7. Community's Attitudes towards Abrasion Before and After Participatory Mapping



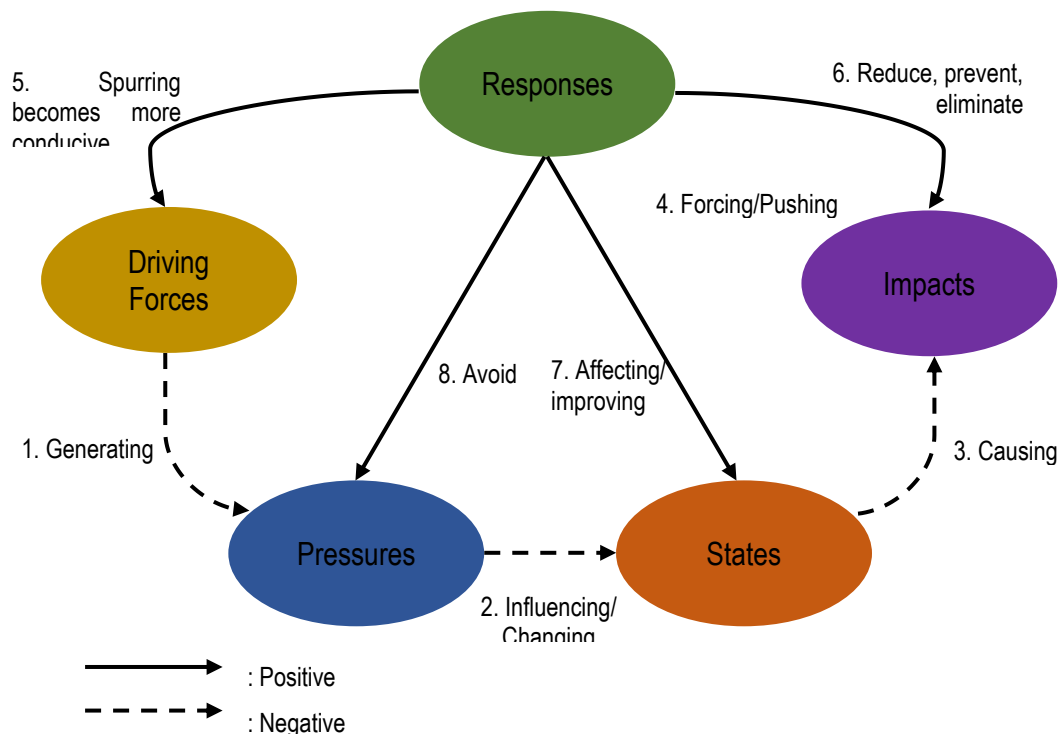
3.3 Participatory Mapping for Sustainable Development in the Coastal Area of Kragan District, Rembang Regency

This research shows that participatory mapping can improve people's knowledge and attitudes in dealing with abrasion. Public knowledge increases so that people can show a better attitude in handling abrasion. This knowledge makes the community more aware of the importance of the community's role in preventing abrasion and reducing losses to a minimum if abrasion occurs. Abrasion is one of the causes that make the coastal environment unsustainable, so when these causes can be suppressed to the maximum, the chances of the coastal environment becoming sustainable will be greater than when abrasion continues to attack the area.

A series of human activities on the coast can be described in the DPSIR Framework (Driving forces-Pressures -States-Impacts-Responses) mentioned by Bradley & Yee (2015), as shown in Figure 8. This framework is commonly used to conduct environmental management analysis that links between ecological and socio-economic factors. Before the mapping, driving forces pushed the coastal environment to become unsustainable, including community activities that carried out excessive development in coastal areas, mining for sand, and using mangroves and coral reefs for their interests. These activities will impact increasing pressures on the environment where these pressures can change environmental conditions to become unstable.

Damage to the coastal environment will have an impact. Damage to coral reefs, for example, will result in the loss of protection in coastal areas, eventually leading to abrasion. Abrasion is also triggered by damage and loss of mangroves due to logging by the community, even though mangroves with dense roots and are one of the blue carbon ecosystems play an important role in preventing abrasion (Indonesian Central Statistics Agency, 2020). (Badan Pusat Statistik Indonesia, 2020). The reduction in the amount of sand and coral due to excessive mining will result in greater wave energy hitting the beach so that the mechanism of attenuating wave energy by the bottom of the waters is reduced, and there is an increase in the intensity of abrasion. Coastal mining also causes coastal slopes to become steep and unstable, resulting in the formation of excavated craters, which reduces sediment transport and changes in wave direction patterns, which will also spur abrasion (Diposaptono, 2011). The people of the Kragan District also felt the severe impact of the form of abrasion.

Figure 8. DPSIR Framework (Bradley & Yee 2015)



Coastal conditions that have experienced dynamics due to abrasion have forced the community to respond, as stated in the DPSIR Framework. The position of mapping areas prone to abrasion, in this case, is as a "response" to the existing situation. The response given must be a positive response that can reduce the "Impacts" felt by the community. Responding to participatory mapping can have a positive impact, namely providing an overview of the abrasion disaster vulnerability in the Kragan District through the resulting spatial pattern. Therefore, the community and the government can plan countermeasures and make tough, effective, and efficient decisions or policies based on local perspectives or bottom-up principles (Amiruddin & Rozalina, 2020; Wei et al., 2018).

In addition, participatory mapping can also increase community capacity in dealing with abrasion disasters. Community capacity in the form of increasing knowledge and changing attitudes for the better result from the interaction between disaster experts and the community during the FGD process in the mapping activity. The knowledge that the community already has while dealing directly with abrasion will be explored in this participatory mapping process, where this knowledge plays a crucial role in developing abrasion prevention strategies in the future (Klonner et al. 2021). Public knowledge will then be integrated with scientific knowledge

possessed by experts. The integration allows for more effective two-way communication, a maximum collaboration between various stakeholders, reducing vulnerability, and increasing community capacity in dealing with disasters (Cheung *et al.* 2016). If the community's capacity has been formed, the community can continue applying it in daily life. The sustainability of the community's capacity in carrying out coastal management following the proper knowledge and attitude can ultimately make hope for the sustainability of the coastal area of Krangan District to be more significant. As stated by Fitriansah (2012), the sustainability of coastal areas starts from increasing community capacity.

Conclusion

Mapping of disaster-prone areas makes the management of coastal areas of Krangan District, which is prone to abrasion disasters, more optimal. Mapping makes decision-making in handling abrasion more effective because it has mapped vulnerable areas and must get more optimal treatment than other areas. In addition, mapping can also increase the knowledge capacity and attitude of the community in dealing with abrasion, which in turn can increase community preparedness in dealing with abrasion. The capacity of the community is also the capital for the community to carry out better coastal management so that the opportunity to produce a sustainable coastal environment will also be more incredible.

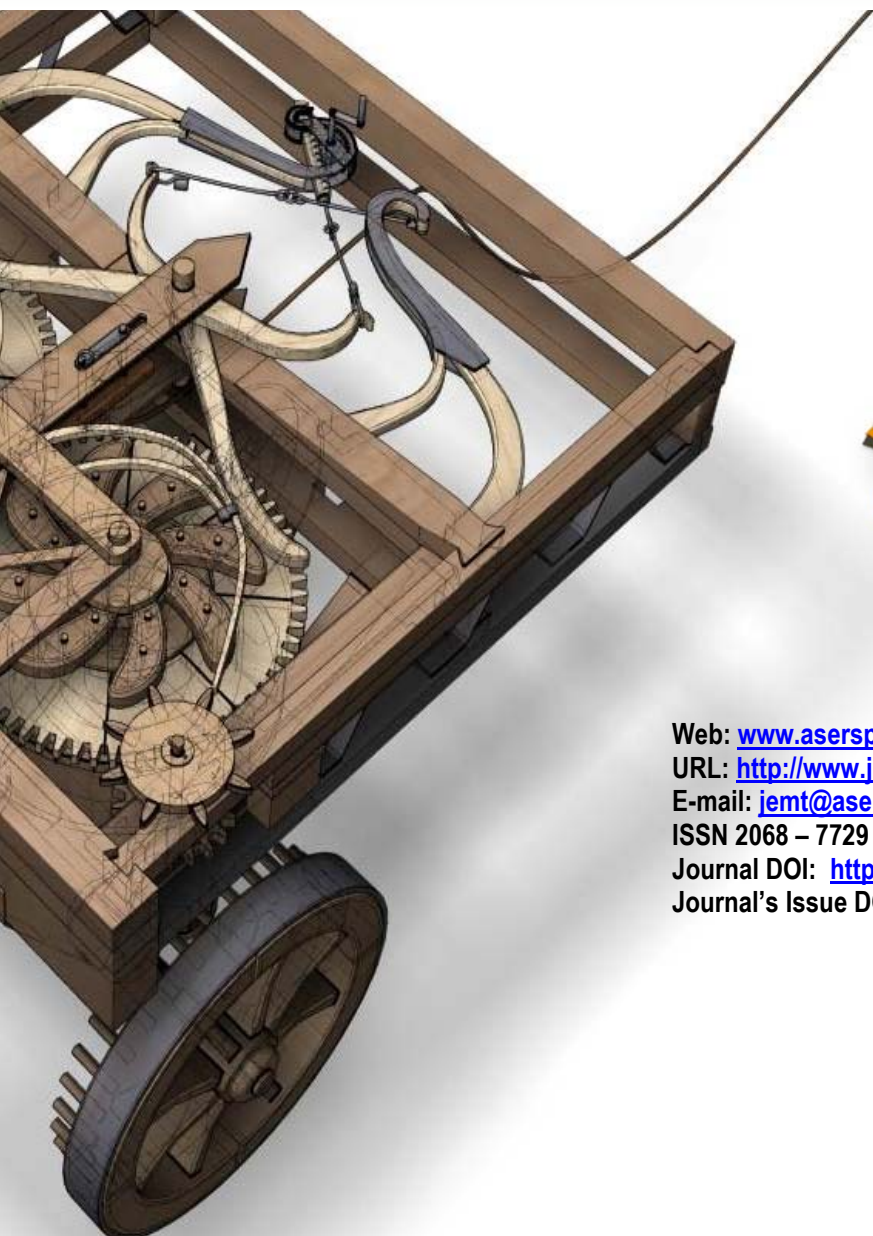
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