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Prevention of Coastal Erosion-Sediment using the Building with Nature Approach in the Coastal of Indramayu

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ABSTRACT

On the other hand, this region is also increasingly facing threats to its sustainability, both from land and sea. One of them is the result of erosion-sedimentation in coastal areas. Building with Nature aims to meet the community's need for infrastructure and to stimulate the development of nature at the same time. It is a new philosophy in hydraulic engineering that harnesses the forces of nature and social cohesion and solves them to simultaneously strengthen nature, economy and society.This study aims to create a model of a coastal erosion-sedimentation control building based on a building with nature approach on the coast of Indramayu Regency. The results obtained are expected to provide up-to-date information on the coastal erosion-sedimentation control building model based on a building with nature approach. Monitoring research on the dynamics of the ecological system includes changes in currents, waves and shoreline morphology in the area around the erected coastal erosion-sedimentation control structures. Monitoring research on the dynamics of the social system is the level of community participation, especially community groups driving conservation, in the maintenance of erosion control and sedimentation control buildings and bamboo plants along the Sigadang River. It is also necessary to conduct monitoring research on the dynamics of the distribution of economic benefits from the development of coastal erosion-sedimentation control based on this natural development approach.

Keywords: Erotion and coastal sedimentation, building with nature, Indramayu Regency.

INTRODUCTION

Currently, more than 40% of the human population lives in coastal areas, i.e. areas up to 100 km from the coastline and up to 50 meters above sea level (Dayton et al., 2000). This is because the coastal area has abundant resources, both as a source of food and other socio-economic cultural activities that support human life. On the other hand, this region is also increasingly facing threats to its sustainability, both from land and sea. One of them is the result of erosion-sedimentation in coastal areas.

In Indramayu Regency, one of the coastal areas in the north coast of West Java, it is estimated that since 2005 the erosion has been able to submerge the land between 2-10 meters per year, and now from a beach length of 114 kilometers, there has been coastal erosion along the coast of 50 kilometers. Darlan (2007) in mapping the characteristics of the Indramayu coast, stated that the area from the Karangsong-Balongan, Tirtamaya, Dadap to Tanjung Ujungan areas experienced changes in the beach slope, which was previously sloping to steep due to abrasion. The breaker zone which was previously far from the shoreline has now been changed to near the coast. This shows that the Inramayu coastal area has undergone destructive changes.

These changes in the biosphere are often initiated by human intervention as a form of interaction with environmental systems. The view of human ecology sees that the relationship between ecological systems (ecosystems) influences each other with social systems. The existence of mass, energy, and information flows that connect ecosystems and social systems, causes the quality of ecosystems to be influenced by social systems or social systems are also influenced by ecological conditions. Changes that occur in one system can affect the sustainability of other systems.

A social–ecological system is defined as an integrated system of nature and humans through the interrelationships between them (Berkes and Folke 1998, Holling 2001, Anderies et al. 2004, Carpenter et al. 2004, Folke et al. 2016). According to Anderies et al. (2004), a social-ecological system is a system of biological/ecosystem units that are related and influenced by one or more social systems, in the sense of forming cooperative and interdependent relationships with others. Thus, this socio-ecological system includes an ecosystem unit such as coastal areas, mangrove ecosystems, lakes, coral reefs, beaches associated with social structures and processes that exist in them.

In the context of coastal area management, this concept is very important considering the characteristics and dynamics of aquatic ecosystems, coastal resources and actors who use coastal resources are interrelated. This is based on the characteristics and dynamics of the coast which is a dynamic system that is interrelated between the human community system and the natural system so that these two systems change dynamically in the same magnitude (magnitude). For this reason, it is necessary to integrate knowledge in the implementation of coastal area management. This integration is known as the Social-Ecological System (SES) paradigm in the management of coastal and ocean areas (Adrianto and Aziz 2006).

In the end, the SES approach is expected to be able to increase resilience or resilience through several actions within the framework of local and national systems and fulfill the following four principles (Berkes and Folke 1998): a) It is carried out based on the framework of a coherent system of biophysical and social factors that regularly interact in a resilient and sustainable way; b) Conducted by understanding the possibility of hierarchical linkages with other socio-ecological systems, both spatially, temporally and organizationally; c) Conducted through a combination of ecological and social systems that regulate the flow and use of a set of important resources (natural, socio-economic and cultural); and d) Conducted dynamically and continuously adaptively.

In engineering, the SES approach as mentioned above has been used since 2008 (Vriend and vanKoningsveld 2012). That year, two very similar initiatives were launched, namely the “Working with Nature” introduced by PIANC and the “Building with Nature” program by the EcoShape Foundation which was started in the Netherlands. Both aim to combine natural, socio-economic and institutional aspects in developing sustainable design methods to address hydraulic engineering challenges. Both of these approaches require different ways of thinking, acting, and interacting than traditional approaches. The integration of biophysical, socioeconomic and institutional aspects has been considered from the beginning to all stages of the project.

Building with Nature aims to meet the community's need for infrastructure and to stimulate the development of nature at the same time. It is a new philosophy in hydraulic engineering that harnesses the forces of nature and social cohesion and solves them to simultaneously strengthen nature, economy and society.

This study aims to create a model of a coastal erosion-sedimentation control building based on a building with nature approach on the coast of Indramayu Regency.

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The results obtained are expected to provide up-to-date information on the coastal erosion-sedimentation control building model based on a building with nature approach.

RESEARCH METHODS

Time and Location

This research was conducted in Tanjakan Village, Krangkeng District, Indramayu Regency, which naturally experiences coastal erosion processes (Kusnida and Astjario 2008, Ilahude and Usman 2009) as presented in Figure 1 and Table 1. The study was conducted for 3 (three) months, which is from August to October 2018.

Data Colleting Method

This study uses secondary data and primary data. Secondary data, in the form of tidal elevation, were obtained from Naotide, while data on wind speed and direction were obtained from the Jatiwangi weather station which was downloaded from Ogimet.

Primary data in the form of bathymetry obtained through a survey. The area for the bathymetric survey is a strip with a width of 20 meters, towards the sea at least 1 km or a depth of 10 m (depending on which one is found first on the LLWS datum) and a minimum length of 5 km long parallel to the coast. The results are then mapped to a certain scale and contour interval. Bathymetric maps will be combined with topographic maps to form a base map that will form the basis for planning.

Other primary data are the availability and prices of building materials, socio-economic conditions and community institutions of Tanjakan Village and its surroundings. Data was collected through a survey where the informants were determined by using purposive sampling method, which is based on consideration of the parties who can provide information related to the research objectives. The informants in question are technical service officers and village government officials as well as community leaders.

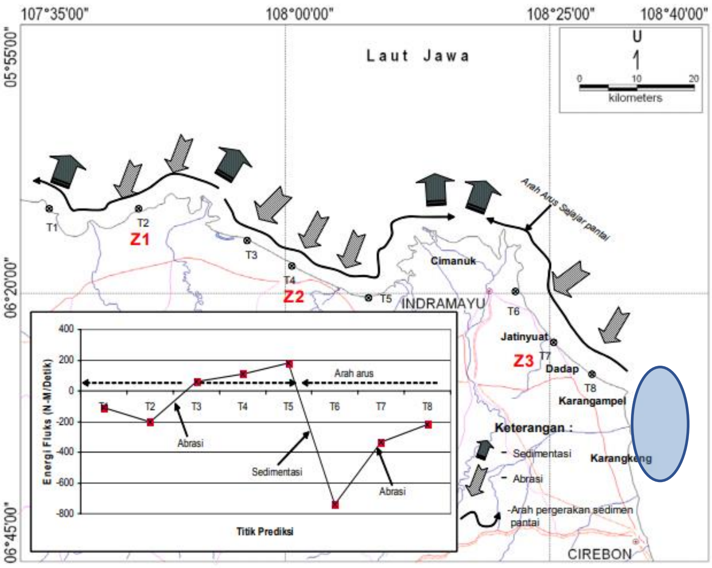


Figure 1. Analysis of erosion and sedimentation zones and movement of coastal sediments in the waters of Indramayu and its surroundings (Ilahude and Usman 2009) and research locations (areas in the shaded circle).

Table 1. The coordinates of the planned erosion-sedimentation control location using the Building with Nature approach in Indramayu Regency, 2018.

Point	East longitude	South latitude
0	100°29'9.601	6°26'54.565
1	100°26'51.764	6°27'21.771
2	100°31'35.916	6°26'6.960
3	100°31'22.106	6°26'35.439
4	100°29'29.205	6°26'39.631
5	100°31'31.545	6°26'39.612

Source: Primary data (2018)

Data Analysis Method

The data used in the model include bathymetry, concentration of sediment and bottom sediment, tidal elevation as well as wind speed and direction. These data are used to simulate wave-current interactions, sediment transport and morphological changes using the CMS (Coastal Modeling System) 4.1 release cms2d_v4p1r37 model which is free software from USACE-CIRP (US Army Corps of Engineers-Coastal Inlets Research Program).

The model was simulated for a time span of 15 days in August 2018. In addition, the model was simulated for the West monsoon (wave direction from the north), the transition season (wave direction from the northeast) and the east monsoon (wave direction from the east). This is done for the existing conditions and conditions after the addition of erosion-sedimentation control buildings.

The results of the modeling along with data on the availability of materials and the socio-economic and institutional conditions of the Tanjakan Village community were then analyzed descriptively, using a socio-ecological system approach (SES), as the basic concept of a building with nature approach, to produce a model for erosion-sedimentation prevention. beach at the study site.

RESULTS AND DISCUSSION

The modeling results of bathymetry, sediment concentration, tidal elevation and also wind speed and direction prior to the construction of coastal erosion-sedimentation control are presented in Figure 2. In Figure 2 it appears that erosion will continue at this location because there is no sedimentation process. Sediments will be broken down by longshore currents.

The opposite condition, namely coastal sedimentation, is indicated by the presence of a coastal erosion-sedimentation control building as shown in Figure 3 and at the location presented in Table 2. In the area behind the building sedimentation occurs and produces raised soil with an area of approximately 1 hectare in a period of 1 hectare. (one) year after the coastal erosion-sedimentation control structure is constructed. The building was not fully constructed, especially the area near the mouth of the Sigadang River which has been a shipping lane and fish landing for fishermen from Benda Village, Krangkeng District in Tegalagung TPI. The technical details of the coastal erosion-sedimentation control structures used are presented in Figure 4.

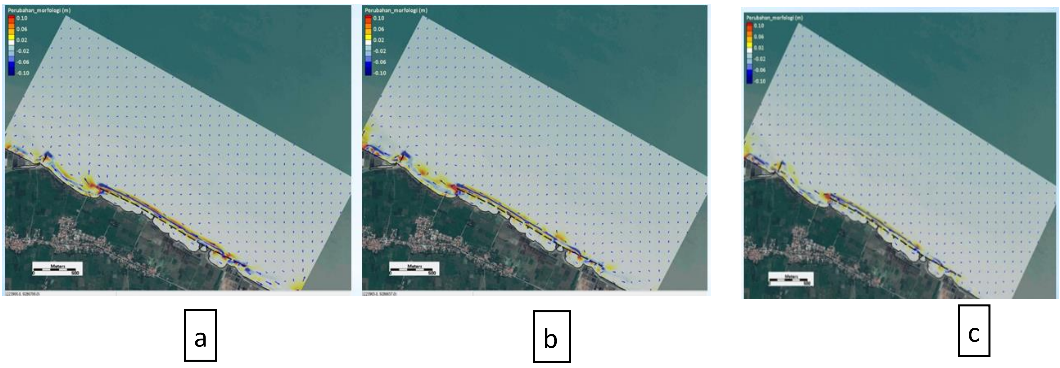


Figure 2. Morphological Change Model (Sedimentation-Erosion) with an incoming wave height (Ho) of 1 m and a wave period (P) of 8 seconds for (a) west season, (b) transitional season and (c) east season on the coast of Tanjakan Village, Krangkeng District , Indramayu Regency, 2018.

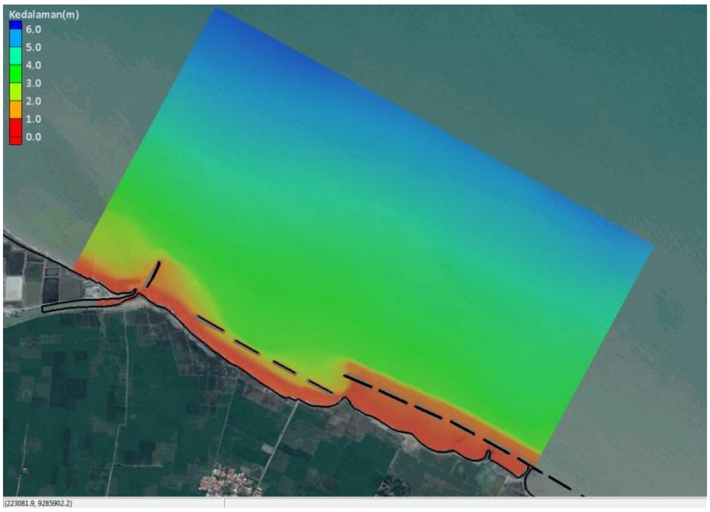
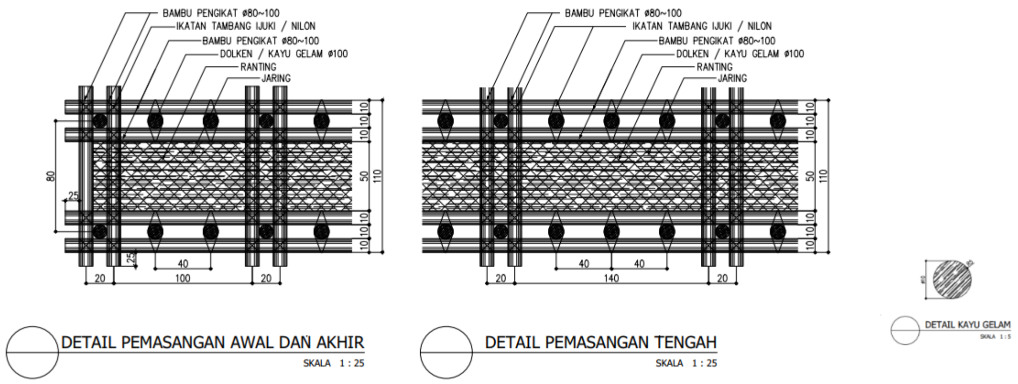


Figure 3. Model of coastal erosion-sedimentation control building (shaded area) and coastal sedimentation produced in Tanjakan Village, Krangkeng District, Indramayu Regency, 2018.



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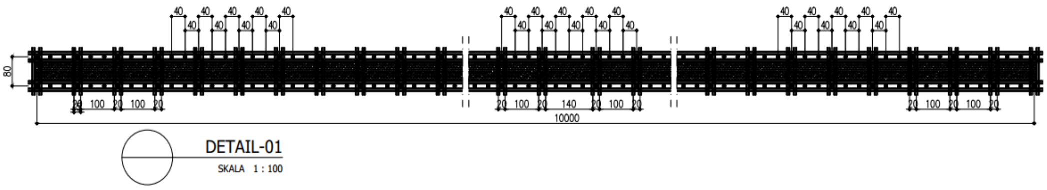

Figure 4. Erosion-sedimentation control building detail design in Tanjakan Village, Krangkeng District, Indramayu Regency, 2018. (Source: Primary data, 2018)

For coastal erosion-sediment control buildings, the material chosen is bamboo with a diameter of 8-10 cm with a length of 6 m with approximately 2000 stems. Bamboo was chosen because it has a high regeneration ability (Jansen 1976). From 1 shoot it can produce 2 new bamboos and to produce bamboo that can be used as building maintenance material only takes 3 (three) years. The type of bamboo used is a type of bamboo that grows in an environment with a habitat similar to the prospective planting area and has a good growth rate.

For the initial stage, bamboo was obtained (purchased) from the Majalengka area. However, for the maintenance phase and the next development phase, the source of the material is expected to come from the local area (Tanjakan Village). This happened because of the planting of bamboo seedlings on the banks of the Sigadang River for approximately 1000 meters (see Figure 5). Thus, it is hoped that the use of bamboo will not cause new pressures on the environment when it is used as a building material to control coastal erosion-sedimentation. In addition, bamboo roots, called bamboo shoots, can also be a source of food that is of economic value for the local community.

Meanwhile, other materials, namely waring installed in the center of the building, were obtained (purchased) at a local material store. Likewise with the straps between the building poles.

Figure 5. Location of bamboo planting (shaded area) along the Sigadang River, in Tanjakan Village, Krangkeng District, Indramayu Regency, 2018. (Source: Google Earth Map, accessed 10 October 2018).

The construction of a hybrid structure and planting bamboo along the river requires a large amount of funds. For the procurement of bamboo materials only, with prices ranging from US$ 2,-/stem, already requires funds of approximately US$ 4,000,-. Not to mention the need for funds for supporting materials (waring, rope) as well as labor wages of 175 people if it is done for 2 (two) months.

The calculation results from the DP3K team (2018) show that the total cost needed to build a coastal erosion-sedimentation controller as intended is approximately US$ 88,158 (DP3K 2018). This amount does not include the cost of planting and maintaining bamboo plants along the Sigadang River, as a reserve of material needed for the maintenance and addition of coastal erosion-sedimentation control structures.

From an ecological perspective, these costs can be translated as energy inputs (sourced from humans as part of a social system) needed by an ecological system (Indramayu coastal area) to repair or create a new balance (homeostasis). Energy cannot be created but only moves from one place with a high degree of order to another with a low degree of order. The energy is then transformed into a building to control erosion and coastal sedimentation as well as bamboo plants along the Sigadang River.

The approach to building with nature also requires an understanding of the formation of a social system in the form of institutions that support the realization of coastal erosion-sedimentation control buildings and their sustainability functions. The support in question is the establishment of cooperation between several stakeholders, which are social sub-systems. They interact with each other through a collective agreement on the construction and maintenance of coastal erosion-sedimentation control structures and the distribution of the resulting benefits. Collective agreement is reached through a series of dialogues between stakeholders, at the planning stage or at the stage before coastal erosion-sedimentation control structures are constructed.

The collective agreement in question includes the following:

a. The government, namely the ministries and local technical services, plays a role in fighting for the funding needs for the development of coastal erosion-sedimentation control and bamboo planting along the Sigadang River. In this case, the government is a sub-system that has a high degree of regularity related to the energy (cost) needed to control erosion and sedimentation that occurs on the Indramayu coast.

b. The village government, plays a role in the formation and development of community groups driving conservation (KOMPAK). These stakeholders ensure the establishment of channels for the distribution of energy that is channeled by the government to the coastal ecosystem of Indramayu to control erosion and sedimentation that occurs. The village government supervises the use of funds provided by the government for the provision of materials, the construction of coastal erosion and sedimentation control structures and the planting of bamboo along the Sigadang River as a material and source of funding for the maintenance of coastal erosion and sedimentation control buildings.

c. Community groups driving conservation, participate in the construction and maintenance of coastal erosion-sedimentation control buildings and bamboo plants planted along the Sigadang River. In addition, the role of these community groups is to build collective rules among members and other community groups for the utilization of the results of collective action. This community group is an important part of the coastal ecosystem of Indramayu so that the energy (funds) that have been channeled by the government are not eroded. It is known, in every energy transformation, nothing is perfect or something must be lost. This community group ensures the existence of new energy (in the form of materials and maintenance funds) that can replace lost energy (damage to buildings).

The interaction relationship between social sub-systems as described will support the work of the socio-ecological system in improving the condition of the coastal ecosystem of Indramayu. This can be seen from the presence of raised soil in the area behind the erosion control building and coastal sedimentation. This material is a new energy provided by nature (ecological system) with the support of the social system to it. If this condition is realized, and there is no longer a need for funds from outside the ecosystem (government) to mitigate coastal erosion on the Indramayu coast, then the Indramayu coastal socio-ecological system, especially in Tanjakan Village, already has a high degree of regularity in maintaining the condition of its ecosystem as intended. expected.

CONCLUSION

It is necessary to conduct panel research, namely monitoring research on the socio-ecological system of the Tanjakan Village community after the construction of erosion control and coastal sedimentation and planting of bamboo along the Sigadang River.

Monitoring research on the dynamics of the ecological system includes changes in currents, waves and shoreline morphology in the area around the erected coastal erosion-sedimentation control structures. Monitoring research on the dynamics of the social system is the level of community participation, especially community groups driving conservation, in the maintenance of erosion control and sedimentation control buildings and bamboo plants along the Sigadang River. It is also necessary to conduct monitoring research on the dynamics of the distribution of economic benefits from the development of coastal erosion-sedimentation control based on this natural development approach.

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