Alternative livelihoods strategy for coastal communities affected by coastal erosion in Sayung coastal area, Demak Regency, Central Java Province, Indonesia

[1,2]Setyo Handayani, [3,4]Luky Adrianto, [5]Dietrich G. Bengen, [3,4]I Wayan Nurjaya, [3,4,6]Yusli Wardiatno

[1] Study Program for Coastal and Marine Resources Management, IPB University, Dramaga, Bogor, Indonesia; [2] Marine and Fisheries Agency of Central Java Province, Semarang, Indonesia; [3] Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University, Dramaga, Bogor, Indonesia; [4] Center for Coastal and Marine Resources Studies, IPB University, Baranangsiang Bogor, Indonesia; [5] Department of Marine Science and Technology, Faculty of Fisheries and Marine Sciences, IPB University, Dramaga Bogor, Indonesia; [6] Environmental Research Center, Institute for Research and Community Development, IPB University, Dramaga Bogor, Indonesia. Corresponding author: S. Handayani, yanisetyo@gmail.com

Abstract. Over the last few decades the Sayung Coast has undergone significant and severe coastal erosion. Coastal erosion is affecting the decline of residential property, rice fields, and ponds. Damage to rice fields and ponds has contributed to loss of livelihoods and declining profits. The aim of this study was to identify alternative livelihoods and solutions for the community in the creation of alternative living conditions. The following analysis tools were used: the coastal livelihood system analysis, the rating scale analysis, the business feasibility analysis and the analytic network process. The results showed that based on the rating scale analysis, a very feasible livelihood to be developed was shellfish cultivation. The findings of the feasibility analysis showed that the shellfish cultivation business had a benefit-cost ratio (BCR) of 6.96, which means the business is financially feasible. The strategy for developing the shellfish cultivation business involves (1) determining of the appropriate location, (2) assuring the quality of the commodity, (3) enabling access to capital, (4) establishing and strengthening groups, and (5) providing extension and training in technical cultivation.
Key Words: coastal management, livelihoods, shellfish cultivation, benefit-cost ratio.

Introduction. The amount of pressure and exploitation in coastal areas and oceans affects the coast and their environments. KKP (2011) stated that Demak Regency coastal erosion amounted up to 1,016.22 ha. Marfai et al (2008) and Sartohadi et al (2009) reported that Semarang District, Tegal Regency, and Demak Regency are the most complex areas in central Java, in terms of coastal sedimentation and erosion processes. The findings of temporal image observations in 2009 and 2014 indicate that Demak Regency's coastal region has been eroded in 4 districts with a surface area of 2,431.12 ha. Sayung District (2,116.54 ha) was the area that experienced the most severe erosion. Coastal erosion occurring on the Sayung coast crosses 5 km inland (Marfai 2012).

The coastal erosion issue exists in all of the Sayung District coastal villages. The ground pressure in these areas is heavy, particularly with regard to the decline in land use due to coastal erosion and seawater flooding in residential areas, rice fields, and ponds. Damage to rice fields and wetlands has resulted in a reduction in community income and livelihoods. The erosion occurring on the Sayung coast has damaged the community's socio-economic life. Therefore there is a need for a solution in terms of issues of livelihood.

Livelihood can be defined as a unit of life-necessary capacities, assets (natural, physical, human, financial, and social capital), and activities (mediated by social relations and institutions) (Chambers & Conway 1992; DFID 1999; Ellis 2000). Livelihoods are sustainable when people can live under pressure and disruption, preserve or improve their properties and abilities, while gaining more autonomy related to the natural resources (Chambers & Conway 1992; Scoones 1998).

Figure 1 shows the concept of Coastal Livelihood System Analysis (CLSA) developed in coastal and marine resource management, where aspects of the natural (ecosystem) system and human systems cannot be separated. In this sense, CLSA is a policy approach defining alternative livelihoods for coastal populations relevant to coastal and marine management's ultimate goal, namely the protection of the resource system itself (Adrianto 2005).

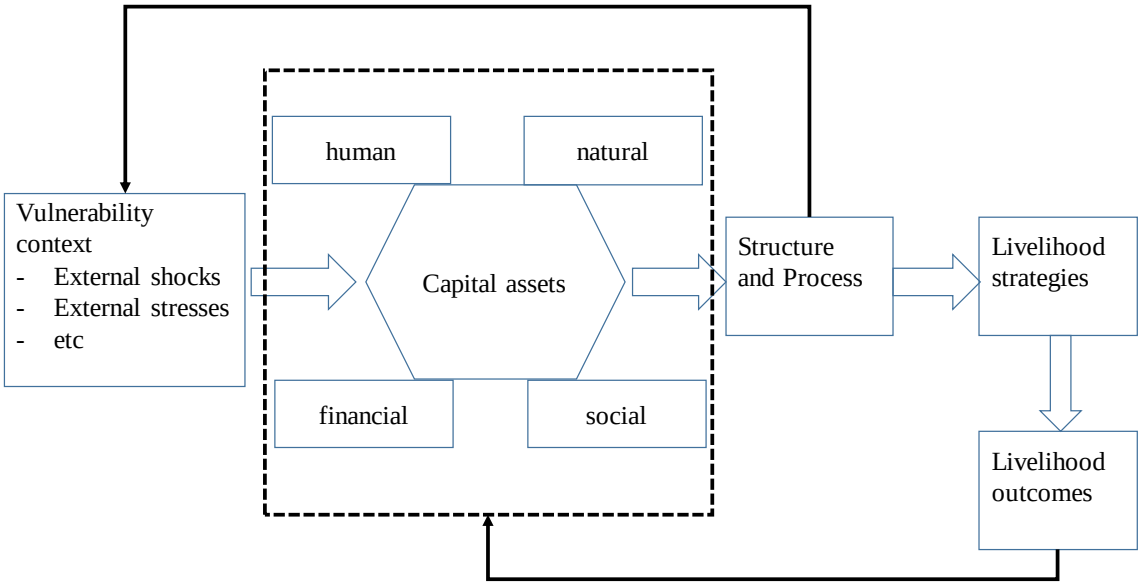

Figure 1. CLSA scheme (Adrianto 2005).

The basic concept of a sustainable livelihood strategy in Chambers (1994) is based on five foundations, which are five livelihood assets: human capital, social capital, physical capital, natural capital and financial capital. Goodwind (2003) explains the need for the five capitals to assure the sustainability of human life processes.

To solve the community's socio-economic problems in the Sayung Coastal District, the analysis of alternative livelihoods is required. It is expected that the concept of alternative livelihoods using the CLSA approach will produce alternative livelihood strategies for coastal communities that will ensure the sustainability of human life processes and the sustainability of existing resources systems. The aims of this research were: (1) identifying alternative livelihoods for the community so that they can boost the economy without compromising the ecosystem sustainability; (2) formulating the identified alternative livelihood strategies.

Material and Method

Description of research sites. The present research was carried out in three coastal villages of Sayung District, namely Bedono Village, Timbulsloko Village, and Surodadi Village, in July-October 2019 (Figure 2).

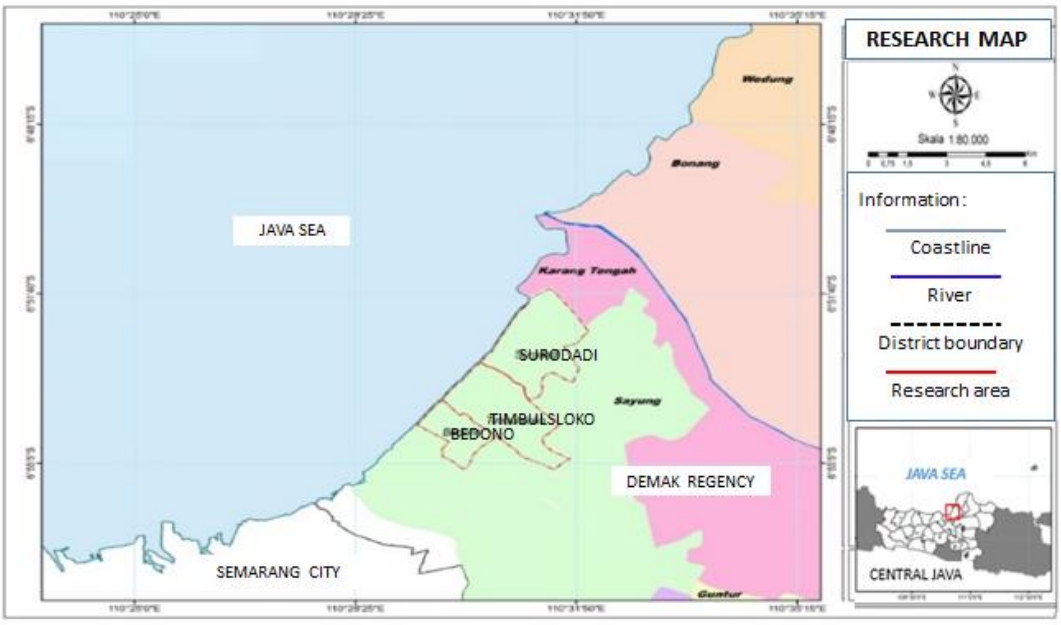

Figure 2. Research location.

Data collection. The method of data collection was a research, evaluation, and analysis of literature using the Participatory Rural Appraisal (PRA) method. Primary data comes directly from the community through interviews and observations, and Focus Group Discussion (FGD) for collecting knowledge and assessing livelihood problems, needs, and opportunities. Secondary data used in initial identification include village profiles from each village head office, statistics of Demak Regency, technical reports, and relevant agency details such as the Demak Regency Marine and Fisheries Service.

Data analysis. The determination of alternative livelihoods was analyzed using the CLSA approach. CLSA is an objective assessment in determining the sustainability of the livelihoods of coastal communities (Adrianto 2005). The analysis was carried out by modifying the stages of determining community livelihoods based on the incentive system by Emerton (2001). The steps for determining alternative livelihoods are shown in Figure 3.

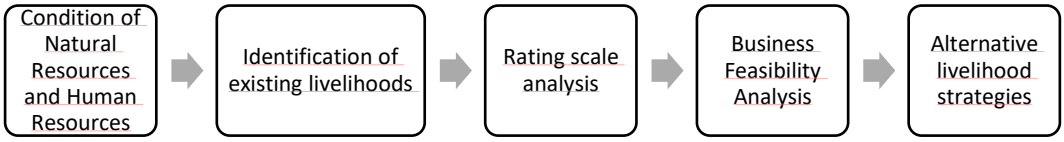

Figure 3. The stages of determining alternative livelihoods (modification from Emerton 2001).

Descriptive analysis. The conditions of natural and human resources were analyzed descriptively with the capital assets approach. According to Goodwind (2003), capital assets are made up of 5 capitals: natural, human, finance, physical, and social capital. Existing livelihoods were also identified and analyzed descriptively.

Rating scale analysis. Rating scale analysis is used in determining the priority of alternative livelihoods. The variables used in the rating scale analysis are: community interest, material resources and human capital (labor) availability and market opportunities (Coremap 2006). The weight of each variable is derived from interviews with respondents and from FGDs. Assessment (scoring) of these variables is done with a system of rating scales. The rating is on a scale of 1 to 4, with a value of 4, which means very good, a value of 3 means good, a value of 2 means relatively good and 1 means

poor. In addition, the score is multiplied by the weight, and then the sum of all variables is performed in order to produce the overall score. Prioritization of alternative livelihoods is based on the total score (Table 1).

Table 1

Alternative livelihood priorities are based on the total score

Score range	*Category*	*Priority*
>341	very potential	1
281–340	potential	2
221–280	potential enough	3
166-220	less potential	4
100-160	not potential	5

Business feasibility analysis. Analysis of business feasibility aims to determine whether a business is feasible to develop or not. To calculate the viability of the study, the Benefit Cost Ratio (BCR) analysis was used:

$$B/C = \frac{revenue}{total\ cost}$$

Criteria:
B/C > 1 Business continuous/feasible;
B/C < 1 Business stops/not feasible;
B/C = 1 Break-even point.

Analytical network process (ANP). The priority of alternative livelihood development strategies in the Sayung Coast was analyzed using the ANP through the Super Decision software. ANP is a development of Analytical Hierarchy Process (AHP). The ANP approach will strengthen the shortcomings of AHP that is being able to accommodate the relations between criteria or alternatives (Saaty 1999). The stages of ANP analysis are: (1) model construction, (2) model quantification, and (3) analytical synthesis and result. ANP model design is prepared on the basis of theoretical and empirical literature reviews and offers in-depth interviews and questions for experts and practitioners in the aquaculture field. The construction of the models is shown in Figure 4.

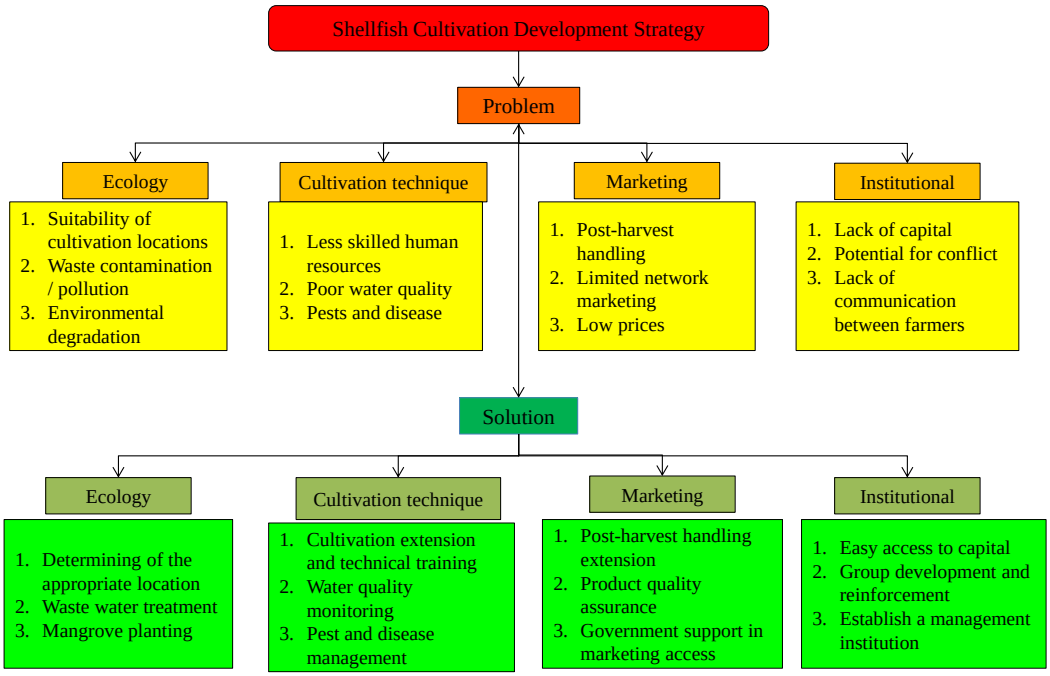

Figure 4. Research model construction.

The second stage is the quantification process, which is achieved by collecting questions in the ANP questionnaire in the form of pairwise comparisons between elements in the cluster. This stage aims to determine which of the two is more influential and how large the difference is, on a numerical scale of 1-9, as shown in Table 2. In this study the respondents came from academics, fisheries extension agents and shellfish cultivators.

Table 2

Scale used for criteria comparisons (Saaty 1999)

Verbal scale	*Numerical scale*
Absolute importance	9.8
Very strong importance	7.6
Strong importance	5.4
Moderate importance	3.2
Equal importance	1

The third stage is the interpretation of the findings and their analysis. The questionnaire results were used as input for the program for the super decision. The inter-rater agreement was calculated, a metric indicating the respondents' degree of consensus on a question, in one cluster. Kendall's coefficient of concordance (W) was used to calculate the inter-rater agreement. From the test results, it can be inferred that the respondents' views have a complete agreement if the value of W is 1. If W=0, there are differences between the participants' responses (or the responses are variable) (Ascarya 2005).

Results and Discussion

Condition of natural resources and human resources. The condition of the asset capital at the research location is shown in Table 3. In the three villages, the low scores on natural assets indicate the poor state of natural resources. This demonstrates the low support of natural resources for the livelihoods of the Sayung District people, most of whom are dependent on the agricultural and fishery sectors. Natural assets need attention as they are linked to the carrying capacity and benefits of the social and economic development of the society.

Table 3

Condition of capital assets at the research site

Capital asset	*Bedono*	*Timbulskolo*	*Surodadi*
Natural	11	13	15
Human	26	27	27
Social	8	9	9
Finance	10	10	13
Artificial	17	15	20
Total	72	74	84

Human assets consist of elements from both the physical and the social aspects of education and health. Human assets are in good condition overall, and appear to be fewer. The amount of infrastructure for education and health is adequate but the current facilities are incomplete. Some schools are in bad repair, and the buildings are beginning to break down because of the tidal inundations that flooded the yard and the houses. Social assets consist of components of the system for managing coastal resources, social institutions, social networks, and conflict levels. The social and the financial assets situation condition are in fair condition. Physical assets such as roads and buildings are in poor shape, due to the coastal erosion and tidal flooding that affect physical buildings along the Sayung District Coast.

Overall, the capital assets condition in Surodadi Village was better than in the other two villages (Figure 5). This is understandable, as there are no major environmental stresses in Surodadi Village such as coastal erosion and tidal flooding. It is in line with research by Irsadi et al (2019), which notes that Sayung District's worst coastal erosion occurred in the village of Bedono and Timbulsloko.

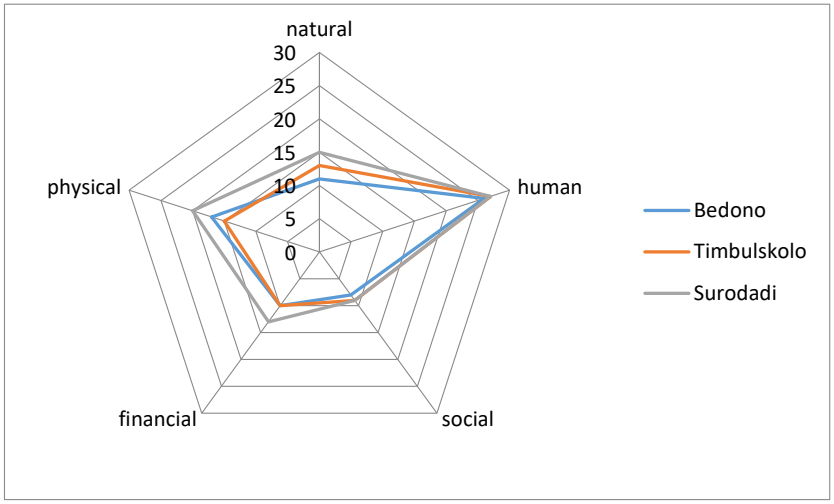

Figure 5. Kite diagram of capital assets at the research site.

Existing livelihoods. In general, agricultural laborers, factory workers, farmers, and fishermen are the most frequent livelihoods in the study region (Table 4). The Sayung coastal community's main livelihood is farm labor in rice fields and ponds. However, ponds are predominant because many of the rice fields have sunk.

Table 4

Community livelihood at the research site (BPS 2019)

Livelihood	*Village*		
	Bedono	*Timbulsloko*	*Surodadi*
Farmer	206	559	345
Farm worker	799	1176	503
Fisherman	716	208	197
Entrepreneur	4	3	9
Industrial worker	593	634	402
Construction worker	640	487	510
Traders	464	276	223
Transport workers	70	68	60
Government	55	33	36
Retired civil servant	11	10	11
Others	170	217	130
Total	3728	3671	2426

Damage to rice fields and ponds caused by coastal erosion has contributed to changes in livelihoods and generating revenue. Ismail et al (2012) reported that there was a 28% decline in the area of the ponds in Surodadi Village and 70% in Timbulsloko Village. This resulted in a 46% and 79% reduction in the income of pond farmers in each of these villages. People who formerly worked as farmers and fish farmers have now become farm workers, workers in factories, and fishermen (Damaywanti 2013; Marfai 2012).

Determination of alternative livelihoods. Based on the FGD results and interviews, the possibility of alternative livelihoods that could be created by Sayung District's coastal

communities was established. Many of these livelihoods have started to be adopted by the society, but they need to be more established to deliver better income. Table 5 shows the potential for alternative livelihoods, the scoring and weighting effects.

Table 5

Alternative livelihood rating scale analysis

Potential alternative livelihoods	*Availability of raw materials (30%)*	*Public interest (20%)*	*Availability of labor (10%)*	*Mastery of technology (10%)*	*Market availability (30%)*	*Score x weight*
			Cultivation			
Mud crab enlargement culture	3	4	4	3	4	360*
Shellfish cultivation	4	4	4	3	4	390*
Catfish culture in biofloc system	3	3	4	3	4	340
Shrimp cultivation in biofloc system	3	3	4	3	4	340
			Marine tourism			
Boat rental	4	3	3	4	3	340
Guest house	4	3	4	4	2	320
			Culinary			
Restaurant	4	3	4	3	3	340
Souvenir center	4	3	4	3	3	340
			Mangrove product			
Batik with natural dye from mangrove	4	3	3	3	2	300
Food (syrup, cake, chips)	4	3	3	3	2	300

*high value alternative livelihood based on rating scale analysis.

Table 5 above shows the social, market and technically feasible forms of business being shellfish cultivation and mud crab enlargement culture. The shellfish cultivation business is very appropriate from an ecological point of view to be implemented on the Sayung coast, given that many of the residents' ponds are destroyed and can no longer be exploited. Shellfish cultivation does not require a pond design with strong embankments; therefore it is ideal for abrasion-affected areas.

According to Rejeki (2011), one form of utilization of abrasive waters is conducting marine cultivation activities, also providing economic benefits for the community. Atmaja et al (2014) added that the condition of the terraced waters which are overgrown with mangrove trees to bioremediate the waters can be followed by the cultivation of blood cockles (*Anadara granosa*). Furthermore, the cultivation of shellfish is an environmentally friendly cultivation activity, not causing degradation of the environmental quality (Shumway et al 2003).

Business feasibility. A feasibility analysis needs to be performed to decide whether a bussiness is feasible for growth or not. Data for business analysis were obtained from the "Barokah" shellfish cultivator group, Morosari hamlet, Bedono village. The results of the feasibility study of the business blood cockles' cultivation are shown in Table 6.

Table 6

Analysis of blood clam cultivation business

Business analysis component	*Value*
Investment costs	Rp 20,750,000.00 (about USD 1,415.74)
Variable costs	Rp 17,500,000.00 (about USD 1,198.79)
Revenue	Rp 200,000,000.00 (about USD 13,639.20)
Profit	Rp 182,500,000.00 (about USD 12,431.88)
BCR	6.96

The cost of investment incurred was USD 1,415.74, with a technical age of 3 years. Cultivating *A. granosa* in 1 period was around 5-6 months, so that during 1 year there are 2 periods. The variable cost given is only for seed procurement, which is 5 tons. *A. granosa*' production requires no feeding because they live on the water's bottom and are filter feeders. All group members are collectively responsible for the maintenance and repair of the ponds.

From the results of the calculation it can be seen that cultivation of shellfish has a high profit. This is in line with the statement of Acosta et al (2009) that cultivation of shellfish can be done with low production costs but can provide high profitability. Revenue for 1 period is USD 13,639.20 with a profit of USD 12,431. Revenue is obtained assuming the price of the shellfish is USD 0.57 kg^{-1}, with a total production of 25 tons in 1 period. *A. granosa* production is obtained by assuming a 50% survival rate (Setyati et al 2019). The weight of *A. granosa* at the beginning of stocking is 2.5 grams, and the weight at harvest time is 25 grams and the total weight at harvest is 25 tons. The calculation results can be seen in Table 7.

Table 7

Calculation results at the time of stocking and harvesting

A. granosa	*Weight*
Total at the time of stocking	5 tons=5,000.000 g
Weight individual at beginning of stocking	2.5 g
Total number at time of stocking	2,000.000
Assumed SR 50%	
Total number at time of harvest	1,000.000
Weight individual at time of harvest	25 g
Total at time of harvest	25,000.000 g=25 tons

Studies by Atmaja et al (2019) found the highest survival rate of shellfish at 73.33% and the lowest at 28.67%. Overall the development of shellfish is affected by internal and external factors. Internal factors include inheritance, gender, age and disease, while external factors include availability of food and quality of water (Komala 2012). Stocking density (Atmaja 2019), and predation and competition from other species also impact growth and survival (Komala 2012).

The BCR analysis findings obtained a value of 6.96. The value of BCR>1 means it is feasible to develop the shellfish cultivation business. This is consistent with the findings of Setyati et al (2019), which also note that, according to the results of their study, the cultivation of the blood cockle in Bedono Village is feasible and can be operated (although they determine a different BCR value).

Alternative livelihood development strategies. An overview of the ANP was undertaken to see the problems faced in the growth of shellfish cultivation and the solutions to these problems. The results of the study indicate that the development of shellfish cultivation in the Sayung District coastal areas has four problematic aspects (ecology, cultivation technique, marketing, and institutional). The problems can be seen in Figure 6. Five priority problems in the development of shellfish cultivation are (1) low market prices, (2) poor water quality, (3) suitability of cultivation locations, (4) potential property-related conflicts (5) pests and diseases.

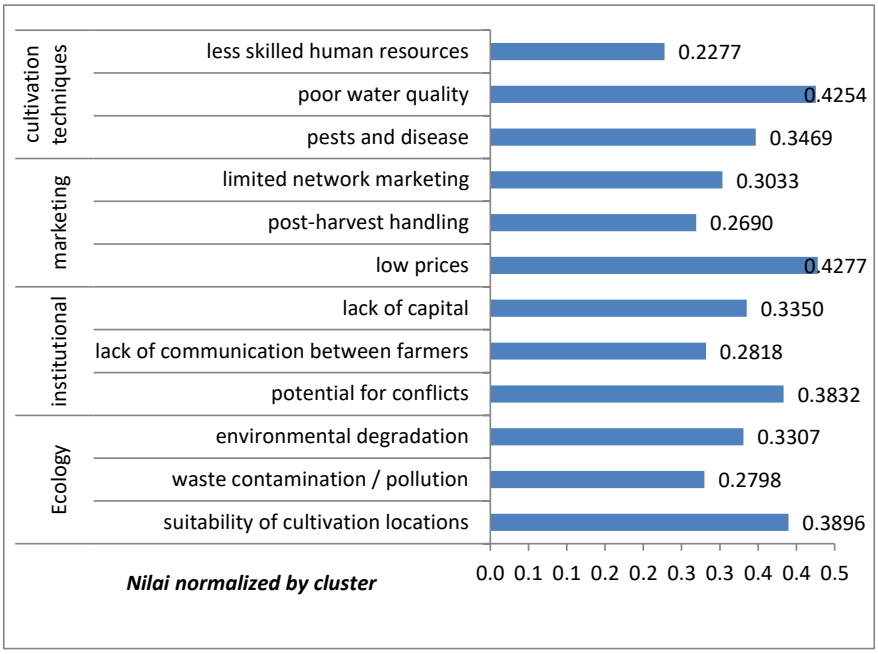

Figure 6. Issues in the development of shellfish cultivation.

For the sustainability of shellfish cultivation in the coastal sub-district of Sayung, solutions to the various above problems are needed. From the results of the ANP analysis, the priority of the solutions in each aspect of shellfish business development is shown in Figure 7. Five priority solutions in the development of shellfish cultivation were identified, including: (1) determining of the appropriate location, (2) product quality assurance, (3) easy access to capital, (4) group development and reinforcement, (5) cultivation extension and technical training.

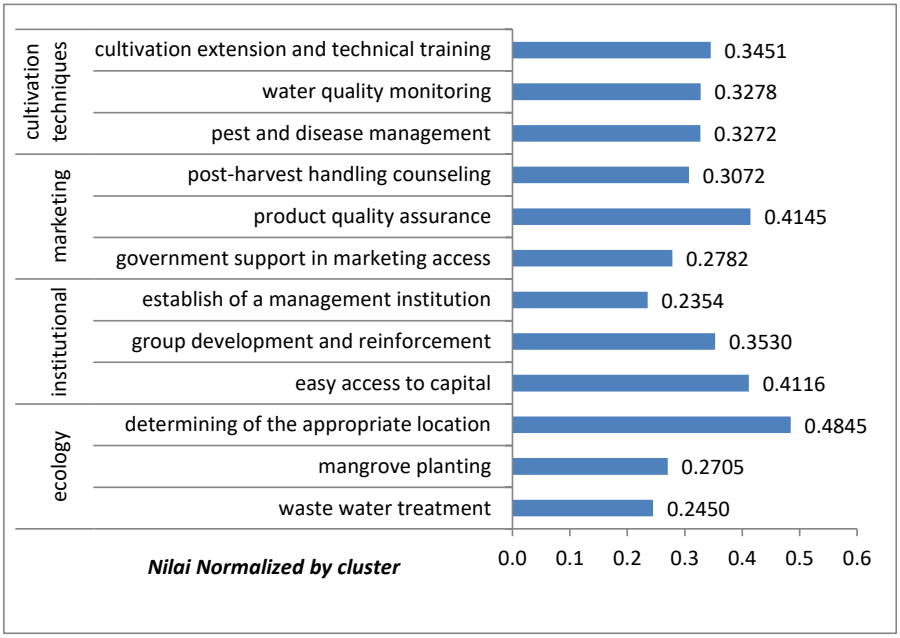

Figure 7. Solutions in the development of shellfish cultivation.

The first strategic priority in the development of the shellfish cultivation is the determination of the appropriate location. The success of the cultivation business is largely determined by the choice of location. Determining the location of shellfish cultivation can be seen from various aspects, such as socio-economic, biological, and technical aspects of cultivation. Socio-economic aspects include location security, easy access, the existence of markets and the availability of labor. The technical aspects of

cultivation include the presence of shellfish seeds, cultivation methods, handling of diseases, harvesting, and transportation to consumers. Aspects related to the aquatic environmental conditions include depth, current, dissolved oxygen (DO) content, salinity, temperature, pH, bottom water substrate (carrying capacity) and others (Putri 2018). Sagita (2017) adds that the choice of cultivation location must consider the coastal oceanography factor. Other topics that must be considered in selecting a location concern: the pollution levels; the protection degree against strong winds, big waves, strong currents; the water fertility, which is higher near river estuaries and mangrove forests; the distance from the shipping lanes; the overall security.

Product quality assurance is the second strategy in developing shellfish cultivation. Quality assurance and food safety are very important things in fishery products. The products' unsafety for consumption is the result of the presence of dangerous chemicals, microorganisms and physical contaminants, whose presence is not desired or their amount exceeds the stipulated provisions (Irianto & Poernomo 2000). Shellfish cultivation products can have a negative impact on human health if their cultivation is carried out in a polluted area (Chinabut et al 2006). The content of heavy metals in the meat of aquatic organisms is usually higher than in their aquatic environment, due to the bioaccumulation (Hutagalung 1991). Blood cockles can absorb harmful materials and then store them in the body. This is because blood cockles are filter feeders as well as suspension feeders that live at the bottom of the water by immersing themselves in a muddy substrate. These shellfish are highly dependent on the type of plankton or particles of organic material constituting their food source (Melinda et al 2015). According to the quality assurance of the shellfish cultivation products, cultivators should choose a cultivation location with clean water, in order to reduce the possibility of contamination with pathogenic bacteria and heavy metal.

The third strategy is an easy access to capital. To date, several projects have been initiated by central and regional governments, as well as the private sector, to improve capacity for fishermen and cultivators. One of the goals of the program implementation is to promote the fisheries value chain and to break the local social system's model reliance on conventional investors. Asiati & Nawawi (2016) noted that it would be safer and more effective to provide essentially material and technical assistance to fishermen groups than to directly provide them capital assistance. Supervision and assistance by relevant organizations is important for ensuring continuity and efficient coordination between providers of capital assistance and recipient groups.

The fourth strategy is group development and consolidation. The forming and strengthening of cultivator's institutions is important, especially for implementing different other strategies. In addition, the aims of various partnership and empowerment programs for cultivators' communities were always group-based. FAO (2011) states that aquaculture business groups are fish cultivators associations founded in the economic interests of cultivators, offering services that support aquaculture business activities such as: negotiating with clients; collecting market information; obtaining production inputs and credit; offering technical assistance; processing and marketing of aquaculture products. Hermawan et al (2017) mention the following benefits: (1) obtaining capital assistance and production facilities; (2) access to business information (fish demand, selling price, information technology); (3) managing and solving business problems; (4) assisting with business management; (5) facilitating the marketing access and (6) increasing partnerships.

The fifth strategy is to offer cultivation extension and technical training. The government plays an important role in cultivation group growth, by placing field assistants or field extension workers. With this program, cultivators can learn about the shellfish cultivation advantages, cultivation techniques, environmental support capacity for effective cultivation, the importance of maintaining water cleanliness to improve shellfish growth and reduce the contamination potential, and harvesting techniques. Dewi (2014) noted that mentoring and extension may increase the motivation of fish cultivators and affect programs for sustainable cultivation. Kustiari et al (2012) also reported that participatory extension would improve the productivity of the cultivators.

Participatory fisheries extension involves fish cultivators in the planning, implementation and evaluation processes (Rosiah 2018).

Conclusions. In summary, an alternative livelihood that can be established (priority 1) is shellfish cultivation, based on technical factors (public interest, availability of raw materials/natural resources, and availability of labor and market opportunities). Mud crab enlargement is a viable alternative livelihood (priority 2). The shellfish cultivation sector is feasible to develop based on the financial/business feasibility factor. Strategic goals that can be introduced for the development of shellfish cultivation include: (1) determining of the appropriate location, (2) assuring the quality of the commodity, (3) enabling the access to capital, (4) establishing and strengthening groups, and (5) providing extension and training in technical cultivation.

Acknowledgement. The authors would like to thank the Central Java Provincial Government for providing doctoral program scholarships.

References

Acosta V., Glem M. E., Natera Y., Urbano T., Himmelman J. H., Rey-Mendez M., Lodeiros C., 2009 Differential growth of the mussels *Perna perna* and *Perna viridis* (Bivalvia: Mytilidae) in suspended culture in the Golfo de Cariaco, Venezuela. Journal of The World Aquaculture Society 40(2):226-235.

Adrianto L., 2005 [Socio-economic analysis in a strategy for the conservation of coastal and marine resources: an approach (coastal livelihood analysis)]. Working paper. Center for Coastal and Marine Resources Studies, IPB University, Bogor, Indonesia, 15 p. [In Indonesian].

Atmaja B. S., Rejeki S., Wisnu R., 2014 [The effect of different stocking densities on the growth and survival of cockle (*Anadara granosa*) cultivated in the terraced waters of Kaliwlingi Village, Brebes Regency]. Journal of Aquaculture Management and Technology 3(4):207-213. [In Indonesian].

Ascarya, 2005 [Analytic network process (ANP) is a new approach to qualitative studies]. International Seminar for Masters Program in Accounting, Faculty of Economics, Trisakti University, Jakarta, Indonesia, 52 p. [In Indonesian].

Asiati D., Nawawi, 2016 [Partnerships in the capture fisheries sector: strategies for business continuity and employment]. Jurnal kependudukan Indonesia 11(2):103-118. [In Indonesian].

Chambers R., Conway G. R., 1992 Sustainable livelihood: practical concept for the 21st century. Institute of Development Studies, Discussion Paper, University of Sussex, England, 29 p.

Chambers R., 1994 Participatory rural appraisal (PRA): challenges, potential and paradigm. World Development 22:1437-1454.

Chinabut S., Somsiri T., Limsuwan C., Lewis S., 2006 Problems associated with shellfish farming. Revue Scientifique et Technique 25(2):627-635.

Damaywanti K., 2013 [The impact of coastal abrasion on the social environment: a case study in Bedono Village, Sayung Demak]. In: [Optimization of natural resources and environmental management in achieving sustainable development]. Hadi P. S., Purwanto, Sunoko H. R., Purnaweni H. (eds), pp. 363-367, National Seminar on Natural Resources and Environmental Management: Environmental Science, Diponegoro University, Semarang, Indonesia. [In Indonesian].

Dewi S., 2014 [Sustainable aquaculture analysis for food security and poverty reduction in Sumedang Regency, West Java Province]. MSc Thesis, Padjadjaran University, Bandung, Indonesia, 89 p. [In Indonesian].

Ellis F., 2000 Rural livelihood and diversity in developing countries. Oxford University Press, New York, 292 p.

Emerton L., 2001 Community-based incentives for nature conservation. IUCN, 43 p.

Goodwind N. R., 2003 Five kinds of capital: useful concepts for sustainable development. Global Development and Environment Institute, Working Paper No. 03-07, Tufts University, United States, 13 p.
Hermawan A., Amanah S., Fatchiya A., 2017 [Participation of fish farmers in aquaculture business groups in Tasikmalaya Regency]. Jurnal Penyuluhan 13(1):1-13. [In Indonesian].
Hutagalung H. P., 1991 [Marine pollution by heavy metals in several Indonesian waters]. Research Center for Oceanography-Indonesian, Institute of Science, Jakarta, Indonesia, pp. 45-50. [In Indonesian].
Irianto H. E., Poernomo A., 2000 Safety of consumption of fishery products. Warta Penelitian Perikanan 6(2):5-7.
Irsadi A., Anggoro S., Soeprobowati T. R., Helmi M., Khair A. S. E., 2019 Shoreline and mangrove analysis along Semarang–Demak, Indonesia for sustainable environmental management. Jurnal Pendidikan IPA Indonesia 8(1):1-11.
Ismail C. S., Hariyanto, Suharini E., 2012 [The effect of abrasion on the income level of pond farmers in Sayung District, Demak Regency]. Geo Image 1(1):57-61.
Komala R., 2012 [Ecobiological analysis as the basis for the management of Andara granosa resources in the Lada Bay of the Sunda Strait]. Post graduate dissertation, Graduate School of IPB University, Bogor, Indonesia, 231 p. [In Indonesian].
Kustiari T., 2012 [Effect of extension effectiveness on the competence of polycultural seaweed cultivators in the waters of the North Coast of Java Island]. Jurnal Sosek Kelautan Perikanan 7(1):79-95. [In Indonesian].
Marfai M. A., 2012 Preliminary assessment of coastal erosion and local community adaptation in Sayung coastal area, Central Java, Indonesia. Jurnal Quaestiones Geographicae 31(3):47–55.
Marfai M. A., King L., Singh L. P., Mardiatno D., Sartohadi J., Hadmoko D. S., Dewi A., 2008 Natural hazards in Central Java-Indonesia: an overview. Environmental Geology 56:335–351.
Melinda M., Sari S. P., Rosalina D., 2015 The habit of eating blue mussel (*Polymesoda erosa*) in the mangrove area of Pasir Padi beach. Oseatek 9(1):35-44. [In Indonesian].
Putri B., Noor N. M., Ali M., 2018 [Development of green mussel and fish farming in Pasaran Island, Lampung]. Jurnal Pengabdian Masyarakat 2(1):30-35. [In Indonesian].
Rejeki S., 2011 [Post-handling abrasive coastal water utilization for marine cultivation]. Post graduated dissertation, Coastal Resource Management Program, Diponegoro University, Semarang Indonesia, 307 p. [In Indonesian].
Rosiah E., Poernomo S. H., Hasan O. D. S., 2018 [Analysis of participatory fisheries counseling and the competence of fish cultivators in Sumedang District]. Jurnal Penyuluh Perikanan dan Kelautan 12(1):47–63. [In Indonesian].
Saaty T. L., 1999 Fundamentals of the analytic network process. Kobe, Japan, 14 p.
Sagita A., Kurnia R., Sulistiono, 2017 [The strategy of utilizing coastal waters for the cultivation of Green mussel (*Perna viridis* L.) in Kuala Langsa, Aceh Province]. Jurnal Ilmu Pertanian Indonesia 22(3):172-179. [In Indonesian].
Sartohadi J., Marfai M. A., Mardiatno D., 2009 Coastal zone management due to abrasion along the coastal area of Tegal, Central Java Indonesia. Proceeding International Coastal Conference, Nagoya, Japan, pp. 37–44.
Scoones I., 1998 Sustainable rural livelihoods: a framework for analysis. Working Paper 72, Institute of Development Studies, Brighton, 22 p.
Setyati W. A., Rezagama A., Sunaryo, Agustini T. W., Hidayat T., Safutri A. D., Amelia R., 2019 [Cultivation of cockle (*Andara granosa*) as a form of effort to utilize areas affected by abrasion in Bedono Village, Sayung, Demak]. National Seminar on Community Service Collaboration, Diponegoro University-Universitas Negeri Semarang, pp. 458-461.
Shumway S. E., Davis C., Downey R., Karney R., Kraeuter J., Parson J., Rheault R., Wikfors G., 2003 Shellfish aquaculture-in praise of sustainable economies and environments. World Aquaculture 34:15-17.

*** Coremap, 2006 [Final report on the study of alternative livelihood development in Selayar District, South Sulawesi]. Project Management Unit, COREMAP Phase II, Selayar Regency, 127 p. [In Indonesian].
*** Department for International Development, DFID, 1999 Sustainable livelihood guidance sheets. DFID, London, UK.
*** Food and Agricultural Organization of The United Nations, FAO, 2011 Aquaculture farmer organizations and cluster management: concept and expereineces. FAO Fisheries and Aquaculture Technical Paper, Rome, Italy, 563 p.
*** Ministry of Marine Affairs and Fisheries Republic of Indonesia, KKP, 2011 [Identification of damage and planning for rehabilitation of Central Java]. Semarang, Indonesia, 459 p. [In Indonesian].
*** Statistics Indonesia, BPS, 2019 Sayung District in Figure 2018. Statistics of Demak Regency, Indonesia.

Received:13 October 2020. Accepted: 30 November 2020. Published online: 15 December 2020.
Authors:
Setyo Handayani, Study Program of Coastal and Marine Resources Management, Graduated Program, IPB University; Marine and Fisheries Agency of Central Java Province, Imam Bonjol street No. 134, 50132 Semarang, Indonesia, e-mail: yanisetyo@gmail.com
Luky Adrianto, Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University; Center for Coastal and Marine Resources Studies, IPB University, 16680 Bogor, Indonesia, e-mail: lukyadrianto@apps.ipb.ac.id
Dietrich G. Bengen, Department of Marine Science and Technology, Faculty of Fisheries and Marine Sciences, IPB University, Bogor 16680, Indonesia, e-mail: dieter@indo.net.id
I Wayan Nurjaya, Department of Marine Science and Technology, Faculty of Fisheries and Marine Sciences, IPB University; Center for Coastal and Marine Resources Studies, IPB University, 16680 Bogor, Indonesia, e-mail: i.wayan.nurjaya@apps.ipb.ac.id
Yusli Wardiatno, Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University; Center for environmental Research and Community Development, IPB University; Center for Coastal and Marine Resources Studies, IPB University, 16680 Bogor, Indonesia, e-mail: yusli@ipb.ac.id

How to cite this article:
Handayani S., Adrianto L., Bengen D. G., Nurjaya I. W., Wardiatno Y., 2020 Alternative livelihoods strategy for coastal communities affected by coastal erosion in Sayung Coastal area, Demak Regency, Central Java Province, Indonesia. AACL Bioflux 13(6):3605-3617.