



Implementation strategy of mangrove area conservation based on social capital development: A case study in the east coastal area of Karawang Regency, Indonesia

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Abstract. Conservation of mangrove areas is a factor in achieving the Sustainable Development Goals (SDG's) by 2030 in protecting terrestrial ecosystems. Several strategies are needed to support mangrove conservation efforts based on the strength of social capital owned by local communities to attain sustainable mangrove management. This study aims to develop a strategy for implementing mangrove conservation on the east coast of Karawang Regency, Indonesia, based on social capital development. The analytical method uses the Participatory Rural Appraisal (PRA) through individual interviews and the Causal Loop Diagram. The study results provide four strategies to support the implementation of mangrove conservation, namely a design of capacity building, community empowerment strategy, conflict resolution strategy, and community education strategy. Some of the social capitals required to achieve each of these strategies are trust, cooperation, and care. Support from various relevant stakeholders is required to achieve the successful implementation of these strategies.

Key Words: causal loop diagram, mangrove resources, PRA, Sustainable Development Goals.

Introduction. Indonesia's coastal areas have become the habitat for more than 20% of the world's mangrove areas. However, during the last six centuries, mangrove areas in Indonesia have experienced extensive degradation (Ilman et al 2016). One of Indonesia's coastal areas undergoing damage to mangrove areas at an alarming rate is in Karawang Regency (Nopiana et al 2020b). Komarudin (2013) has reported a decrease in the mangrove ecosystem area, reaching 47.8% from 1994 to 2012. This shrinkage has occurred due to the conversion of mangrove areas, in no small part, to aquaculture areas (Aliah 2013).

Efforts are needed to implement conservation of mangrove areas to attain the goals of the Sustainable Development Goals (SDG's) in 2030, especially those related to the 15th goal of protecting terrestrial ecosystems. This conservation effort requires various related stakeholder roles in a harmonious collaboration (Randy et al 2015). As a stakeholder, the community has an essential role in supporting the sustainability of mangrove conservation efforts in their area, now that community-based management has become mainstream in the management of coastal resources in general (Hutabarat et al 2009). In other words, mangrove conservation efforts primarily require efforts to enable communities through the process of self-development, with thoughts and actions that they formulate themselves. The development of social capital owned by the local community can support the sustainable management of mangrove areas.

Limited research discussed the role of social capital in mangrove management. Several studies had revealed that the success of social capital-based mangrove management had improved the condition of mangrove areas in various regions. Nababan et al (2016) reported that the condition of mangroves in East Lampung Regency, Indonesia, started to improve through the involvement of local communities by delivering social capital into their management. Suharti (2016) stated that mangrove forests that

grow well in East Sinjai, Indonesia, had displayed success when implementing rehabilitation independently, through utilizing social capital owned by the local community.

Research related to the development of social capital in managing mangrove areas, especially in the coastal areas of Karawang Regency, has yet to be conducted. Research by Randy et al (2015) discussed social aspects in mangrove ecosystem restoration efforts through stakeholder collaboration, but did not specifically discuss community social capital. Previous research also focused more on discussing the condition of the mangrove ecosystem (Pranoto et al 2019; Nopiana et al 2020b). Meanwhile, several other studies discoursed the use of mangrove areas for the development of the fisheries (Budiyana 2005; Aliah 2013; Lovapinka et al 2014; Amrial et al 2015; Nugraha 2018), tourism (Hidayat et al 2020), and coastal land rehabilitation sectors (Muharam 2014; Wahyudin et al 2017). This study intends to develop a strategy for implementing mangrove conservation on the east coast of Karawang Regency, Indonesia, based on social capital development.

Material and Method

Research time and location. This research was conducted for three months, from September to November 2020. Taking place in the coastal area of Karawang Regency, West Java Province, Indonesia, the research included three villages and sub-districts (Table 1). The selection of the research location was done using a judgment sampling method. The selected sites represent the ecological and social characteristics of the eastern coast of the Karawang Regency. Pusakajaya Utara is the largest of the three research villages, covering an area of 8.66 km². Sukakerta and Sukajaya come second and third, covering areas of 6.36 and 6.2 km², respectively. Meanwhile, Sukakerta is higher than two other research locations, as it is situated 24.1 m above sea level. Sukajaya and Pusakajaya Utara, correspondingly, are at 7.6 and 5 m above sea level (BPS 2020a, 2020b, 2020c). Pusakajaya Utara has the longest coastline, which stretches for 6.3 km, followed by Sukajaya and Sukakerta, with 3.6 km and 1 km, respectively (Fauzie 2017).

Table 1

Research location

No	Village	Sub-district	Geographical location
1	Sukakerta	Cilamaya Wetan	6°21' South Latitude and 107°55' East Longitude
2	Sukajaya	Cilamaya Kulon	6°19' South Latitude and 107°54' East Longitude
3	Pusakajaya Utara	Cilebar	6°08' South Latitude and 107°41' East Longitude

Note: source: BPS (2020a, 2020b, 2020c).

The coastal area consists of 9 sub-districts, with an area of 681.47 km² or 38.87% of the total area of Karawang Regency. The length of the coastline reaches 73.65 km, while almost the entire area is characterized by sloping land with flatlands (0-2%). The population of the coastal area was 577231 in 2018, which was 24.71% of the entire population of 2336009 recorded for the entire Karawang Regency (Komarudin 2013; Fauzie 2017; BPS 2019).

Data collection. This study used secondary and primary data. Secondary data was obtained from literature review and the Central Bureau of Statistics. The primary data required is to enrich the analysis in the form of observations and in-depth interviews with several key personnel members, like Pokmaswas members, village officials, community leaders, and selected community members. The selection of key personnel is based on the assumption that they are the parties who understand the problems in mangrove

conservation efforts in their respective areas. The method of determining respondents was nonprobability sampling based on judgment and convenience sampling.

Mangrove density class was determined following the Decision of the State Minister of the Environment No. 201 of 2004, about Standard Criteria and Guidelines Determination of Mangrove Damage. It states that the density of mangroves is dense if there are more than 1500 trees per ha, moderate if the number of trees per ha is between 1000 and 1500, and sparse if there are less than 1000 trees per ha.

Analysis. The analytical method applied in this research is Participatory Rural Appraisal (PRA), through individual interviews. PRA is a learning method and approach regarding the community's condition and life from, with, and for the community itself. PRA is a process in which the community will analyze the situations they face and decide how to solve existing problems (Adi 2008). In addition, the analysis method used systems thinking approach in the form of a causal loop diagram. This qualitative modeling illustrates the relationships between elements in a system (Setianto 2016).

Results and Discussion

Mangrove areas condition description. The total area of mangroves in the entire coastal area of Karawang Regency in 2018 only reached 421.95 ha. The mangrove species that generally dominate in this coastal area is *Avicennia marina*, which grows naturally on accretionary land. Meanwhile, *Rhizophora mucronata* and *R. apiculata* are widely planted and regenerated naturally in aquaculture areas. *Sonneratia caseolaris* grows naturally on river borders, which have a salinity of 0 ppt, or the mangrove plant groups that grow on low salinity land. Pusakajaya Utara has the largest mangrove area among other research locations, 33.15 ha (Table 2). The largest mangrove forest area with high density is also located in this village, with 22.07 ha. Furthermore, the mangrove areas in Sukajaya and Sukakarta have 16.32 ha and 12.36 ha, respectively, most of which grow along the coastline (Nopiana et al 2020b).

Table 2

The total area of mangroves in all research locations in 2018

No	Village	Sub-district	Density class	Area (ha)
1	Pusakajaya Utara	Cilebar	Sparse	3.51
			Moderate	7.57
			Dense	22.07
			Total	33.15
2	Sukajaya	Cilamaya Kulon	Sparse	1.83
			Moderate	4.15
			Dense	10.34
			Total	16.32
3	Sukakarta	Cilamaya Wetan	Sparse	1.08
			Moderate	3.36
			Dense	7.92
			Total	12.36

Note: source: Nopiana et al (2020b).

Mangrove areas in the three research locations have been successful in overcoming coastal erosion. The results of coastal rehabilitation through mangrove planting have maintained the coastline's stability and have even created land, as a result of sedimentation trapped by mangrove vegetation, reaching 500 m. The results of mangrove planting are developed as a coastal ecotourism area managed by several community groups (Nopiana et al 2020c).

Socio-economic conditions of the community. In 2019, Sukajaya had the largest population among other research locations, consisting of 3057 families, with 7372 people

or 10.80% of Cilamaya Kulon Sub-district's total population. Sukajaya was seconded by Sukakarta, which consisted of 2559 families, with 6548 people, or 7.66% of the total population of Cilamaya Wetan Sub-district. Furthermore, Pusakajaya Utara held 1793 households, with 5634 people, or 12.66% of the total population of Cilebar Sub-district (BPS 2020a, 2020b, 2020c).

Most of the three research locations had their main income source from lowland agriculture, fishpond fisheries, and sea capture fisheries. This fact affected land use in coastal areas, dominated by rice fields and aquaculture areas (Komarudin 2013). The majority of land in all research locations was dedicated to paddy fields, namely 4.10 km² or 56.01% in the Sukakarta area, 2.10 km² or 33.87% in the Sukajaya area, 3.59 km² or 41.46% in Pusakajaya Utara area. Only a small portion of the land in the research location was utilized for aquaculture land, namely 0.60 km² or 9.68% in Sukajaya area, 0.11 km² or 1.27% Pusakajaya Utara area (BPS 2020a, 2020b, 2020c).

Social capital condition of the community. Social capital is a resource that arises from social relations and can be used as a social glue to keep group members together in achieving common goals (Anggita 2013). Social capital can support the creation of sustainable management of mangrove areas, which is reflected in the conditions that are getting better so that the area can provide optimal ecosystem services. Social capital cannot be felt directly, but will affect the sustainability of the environment and mangrove resources in the area.

The identifiable characteristics of social capital include cooperation, caring, reciprocity, and trust. Social interaction based on cooperation that is commonly owned by the community in the three research locations can be seen from the awareness of goals that need to be achieved together. The visible forms of awareness include forming public awareness (the majority coming from young people) to form groups with specific goals. The groups are founded, among other things, to save the condition of the coastal environment and coastal ecosystem (especially mangrove conservation) in the area. These groups include Community Monitoring Group (Pokmaswas), Tourism Awareness Group, and other community groups. Within groups, member participation tends to be high by carrying out tasks in cooperation based on relatively high solidarity. However, each group runs independently in carrying out mangrove conservation efforts and tends not to know each other. They do not share knowledge or work together, even groups within one village (the case in Sukajaya in Cilamaya Kulon and Sukakarta in Cilamaya Wetan).

In addition, community groups have built partnerships with the private sector in funding mangrove conservation through the Corporate Social Responsibility (CSR) program. The private parties that have been involved include PT Pertamina Hulu Energi Offshore North West Java or PT Toyota Motor Manufacturing Indonesia. CSR efforts included planting and supplying mangrove seedlings, supporting the construction of wave barriers to protect newly planted mangrove seedlings, and community empowerment programs.

Care that the community has applied is an element of social capital. In rural communities, such a work model still applies as a form of the collective norm recognized as a norm in society (Supriyati 2015). Related to this aspect, some people are worried about the coastal environment condition. People around the coastline experience the impact of coastal erosion. They have a strong desire to help ease the burdens of others experiencing difficulties, even though this is limited to labor contribution (Sawitri & Soepriadi 2014). One of the initiatives is planting mangroves along the coastline, which gradually creates natural coastal protection.

Reciprocity is a positive attitude from the individual responding to the behavior of others, which can represent an equal or comparable behavior (Supriyati 2015). Deckop et al (2003) stated that reciprocity embraces the concept of social exchange, in which the individual involved will benefit either now or in the future. In a reciprocal relationship, people have the habit of repaying someone's kindness voluntarily, either in the same or different ways (Balitbangda Prov. Jawa Barat 2008), such as the Nganteuran tradition. Even though these habits exist, communication blockages cause social conflict between

groups and communities in mangrove conservation efforts. Until now, social conflicts have not been resolved sincerely by all parties, which is indicated by feelings that are still hidden and not directly expressed honestly (Case of Sukajaya, Cilamaya Kulon). Such dissensions were triggered by the lack of transparency in the management of assistance from the private sector and other external parties and the excess arising from the general election.

The level of trust that the community has in the three research locations is generally relatively high (Balitbangda Prov. Jawa Barat 2008). One of them is the feeling of security in entrusting others. For example, there is a custom in the community to leave the house with neighbors when traveling. Besides, community trust is in the form of close kinship with each other, especially with neighbors within the village (Sawitri & Soepriadi 2014). It is possible because the majority of neighbors have a kinship. Subsistence community life tends to settle and gather in its homeland, so that most relatives live in one village. Therefore, the composition of the community tends to be homogeneous, causing relatively high social inclusiveness.

Mapping problems in implementing mangrove conservation programs. The eastern coastal area of Karawang Regency faces many problems in implementing the mangrove conservation program. Based on the results of in-depth interviews, in general, these various problems stem from environmental factors inside and outside the mangrove area and socio-economic factors of the community around the mangrove area itself. One of the environmental factors in the mangrove area comes from the sea water hydro-oceanographic conditions in this coastal area. Most of the implementation of the mangrove rehabilitation program in this coastal area is implemented through planting mangroves along the coastline. This program's main objective is to protect the coastline from the threat of coastal erosion that often hits the area. Mangrove planting activities carried out by the community often fail due to hydro-oceanographic dynamics, especially sea waves. It is mainly due to the absence of a sea wave barrier construction to protect the newly planted mangrove seedlings (Case in Pusakajaya Utara and Sukakarta). Although the ocean wave energy in the three research locations is generally not very strong, in certain seasons, the ocean wave energy crashes firmly onto the shoreline. As a result, the newly planted mangrove seeds are swept away by the sea waves.

In contrast to the two research locations above, the maintenance of mangrove seedlings in the reforestation program in Sukajaya is facilitated by coastal protection structures with the Longitudinal Geotextile Sack (KGM) technology as a result of the implementation of the Coastal Belt Program by the Ministry of Marine Affairs and Fisheries. The protection of mangrove areas in the area is also carried out by building a beach protector in the form of a wave breaker (APO) (Nopiana et al 2020a). This type of coastal protection using APO has been carried out in other areas, including Semarang Municipality's coast (Hartati et al 2016; Yesiana et al 2016) and Bekasi Regency (Wulandari et al 2019).

Meanwhile, environmental factors outside the mangrove area come from the problem of waste coming from the upper area (upland) through the river flow. The solid contents of inorganic waste (mainly plastic) affect the growth of mangrove trees, even causing the death of newly planted mangrove seedlings (cases in Sukakarta and Sukajaya villages). It is because the mangrove areas in the two villages are close to a large river estuary. The presence of waste can affect mangrove regeneration. According to Lestari & Kusmana (2015), waste has killed many peg roots, which can reduce the surface area of respiration and nutrient uptake surface of plants, thereby reducing the growth of mangrove trees.

Factors outside other areas that affect the mangrove conservation program come from oil pollution that has occurred recently. The existence of oil and gas exploration activities, especially in offshore locations, also influences the mangrove conservation program's sustainability at the research location. For example, the oil spill incident that occurred in July 2019, due to the leakage of the PT Pertamina Hulu Energi Offshore North West Java (ONWJ), had an impact on coastal vulnerable ecosystems, including mangroves. This incident resulted in mangrove vegetation's death along the coastline in

the coastal area of Karawang Regency and adjacent regencies. According to Dahuri et al (2001), mangrove death due to this type of pollution probably occurs due to the pneumatophores' coating by an oil layer. Mangroves are ecosystems that are ecologically highly sensitive to oil spills. The recovery period for damaged mangrove ecosystems takes a very long time because oil can be trapped in sediments for more than four years (Muarif et al 2016).

Apart from the above factors, the socio-economic factors of the community around the mangrove area also threaten the sustainability of the mangrove conservation program. According to Nopiana et al (2020c), conflict over mangrove land use is an issue that often becomes a problem in mangrove conservation programs. Even though it only has arable land status, the community has significant power to control and use it for their interests. The majority of mangrove areas in all research locations are located in coastal border areas due to coastal rehabilitation in the context of preventing and overcoming coastal erosion. Conflict over mangrove land use occurs due to differences in motivation between the Pokmaswas and the mangrove farmer groups interested in the conservation function and the surrounding communities (either as landowners or cultivators), who have economic motives.

Furthermore, the economic and social pressures of the community to meet its daily needs have prompted the conversion of mangrove areas into various other uses, especially aquaculture. Such pressures have happened in Pusakajaya Utara and Sukajaya. The shrimp and milkfish farming in this area are potential businesses that bring benefits to the community. The conversion of mangroves into aquaculture areas also occurs in other areas in Indonesia. Rusdianti & Sunito (2012) reported that the increase in the intensity of mangrove conversion to aquaculture land in Indramayu Regency was triggered by the large number of immigrants who used coastal lands for shrimp and fish cultivation. The profit obtained encourages an increase in the scale of the aquaculture business. As a result, the increasing demand for coastal land has penetrated mangrove areas for business use. Yulianti & Ariastita (2012) conveyed that the mangrove area in the Segara Anakan lagoon, Cilacap Regency, had been converted into rice fields, ponds, gardens, and settlements in line with the increasing population.

The dormant threat to the mangrove conservation program in this area is related to the low level of understanding of the mangrove ecosystem role and function. One of the reasons for the low level of understanding is the low education level of the communities around the mangrove area. The aspects above are the cause of the low perception, and the community's participation in the mangrove conservation program is also low (Nugraha 2018; Nopiana et al 2021). So far, the spearhead for carrying out these activities is Pokwasmas. NGO activities have not yet reached the research location. The government's role is also limited in carrying out these activities.

Mangrove conservation implementation strategy. The formulation of a strategy for implementing mangrove conservation based on social capital development is carried out according to each of the problems faced. First, there is no construction of a wave barrier to protect mangrove seedlings. Second, there is an overflow of waste originating from upstream areas and oil spill incidents from offshore exploration. Third, there is a social conflict in using mangrove land between the group and the surrounding community. Fourth, the low level of community understanding of the role and function of the mangrove ecosystem.

1. Capacity building strategy

The main problem faced in planting mangroves, especially in the zone facing the sea, is the absence of a sea wave barrier construction to support and protect the newly planted mangrove seedlings. From a social science perspective, the problems in mangrove planting can also be addressed by raising community awareness to build groups. The social capital required includes trust and cooperation. Capacity-building strategy can be propounded to increase the role of the group. This strategy's main objective is to enhance the group's ability to build cooperative networks, especially with external parties, from the government, the private sector, universities, and other groups (both

within one village and outside the village and even outside the regency). Moreover, the implementation of this strategy must increase the group's ability to manage assistance, especially assistance that comes from external parties. The capacity-building strategy is implemented in collaboration with the government, universities, or other parties supported by community participation. It is expected that the implementation of this strategy will explore funding sources for the construction of ocean wave resistors and obtain input on innovation and application of technology related to the construction (Figure 1).

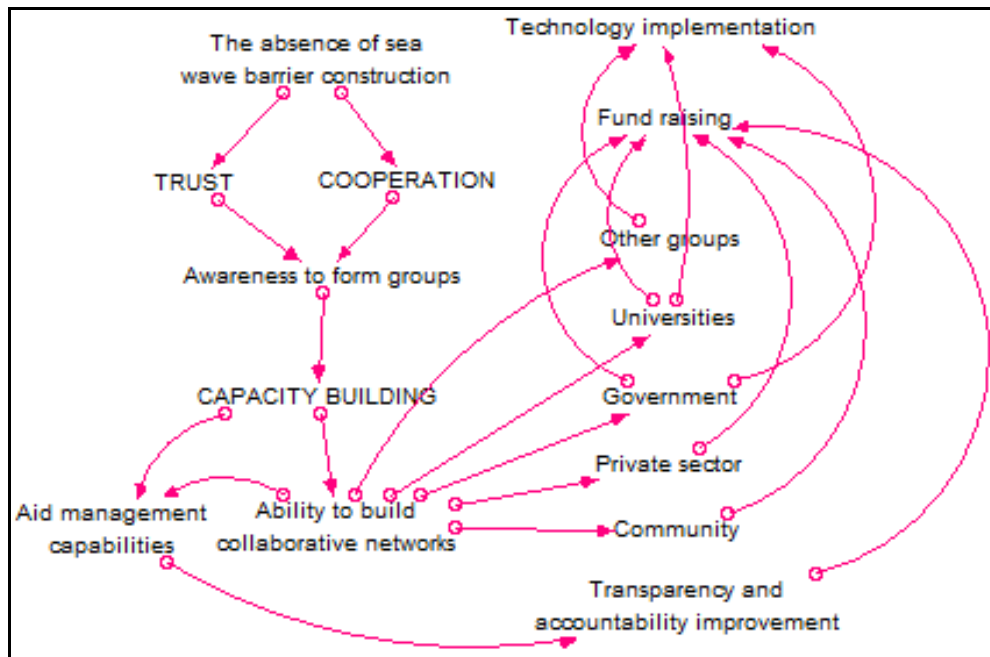


Figure 1. Causal loop diagram of the use of social capital to overcome protection construction problems in mangrove planting.

2. Community empowerment strategy

Other problems faced in mangrove conservation at the research location are waste overflow originating from upstream areas and incidents of oil spill from offshore exploration. One of these problems can be handled by increasing public awareness to save the environment and coastal ecosystems, especially mangroves. The social capital necessary includes care and cooperation. The strategy that can be proposed to raise public awareness in saving the environment and coastal ecosystems is the community empowerment strategy. The implementation of this strategy aims to build partnerships with external parties, such as the government, the private sector, and universities.

Programs that can be carried out are public education and recycling of waste, namely through counseling, discussions, and training activities, as carried out by Yuliani et al (2018) in the Seribu Islands Regency, Jakarta Special Capital Region Province. The extension material discusses the coastal environment and the dangers of waste to human life, coastal, and marine ecosystems. Discussion activities explore related alternatives to waste processing based on reducing, reusing, and recycling (3R). Waste utilization training activities are carried out by recycling plastic waste and used bottles and making compost, so that it has a higher economic value to increase local community income. The implementation of these two programs is expected to encourage the community to increase community participation in waste management to reduce disturbance to the growth of mangrove seedlings and the life of adult mangroves and all the biota in the area.

Meanwhile, the social capital suggested to block oil spills places more emphasis on cooperation. Although it does not happen all the time, the community empowerment

strategy in an oil spill incident is primarily aimed at disaster mitigation. Like in the problem of waste spills, the community empowerment strategy to tackle oil spills is carried out by building cooperation with external parties, such as the government and the private sector (especially PT Pertamina Hulu Energi ONWJ) and universities (Figure 2).

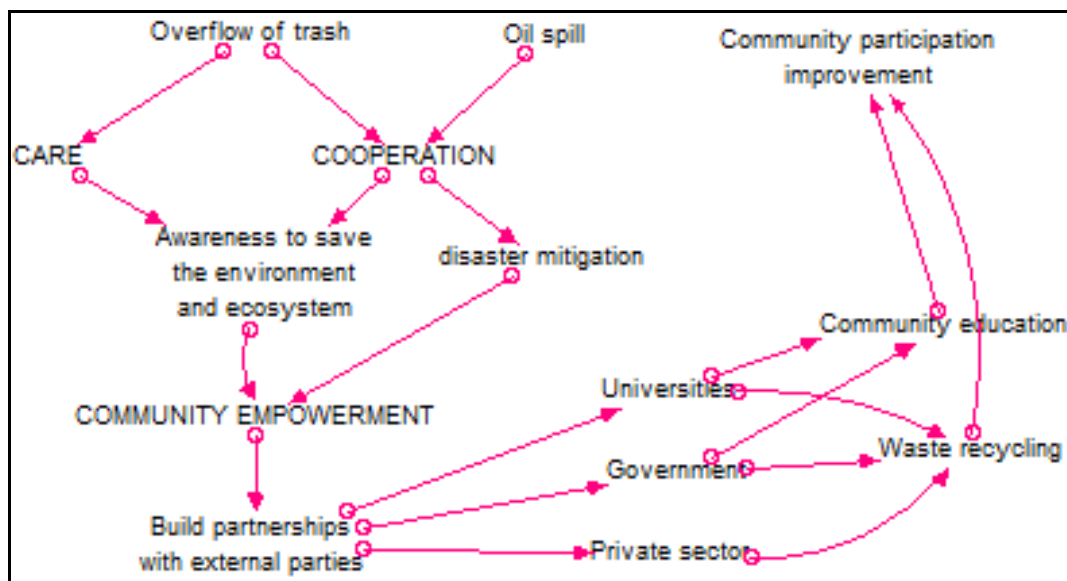


Figure 2. Causal loop diagram of the use of social capital to solve the problem of overflow of waste and oil spills.

3. Conflict resolution strategy

The occurrence of conflicts over the use of mangrove land in the research location can be resolved by developing social capital in the form of care, trust, and cooperation (Figure 3). The strategy offered by developing some of these social capitals is a conflict resolution strategy. This strategy's implementation is based on the community's concern for the coastal environment and each other, a kinship between fellow communities in one village, and relatively high collective action and solidarity for the common interest. Implementing a conflict resolution strategy can be carried out by embracing religious and community leaders and involving neutral mediators, both from religious and community leaders themselves and external parties (especially the armed forces and the police, government, and universities). Conflict resolution efforts can be instigated through policy dialogue (joint-problems solving) and conflict mediation. Joint-problems solving is a forum benefitted by representatives from different interest groups to find common ground between them by involving other parties who act as facilitators. Meanwhile, mediation is a conflict resolution through negotiations with a neutral third party (mediator) to search and find a solution that all parties can agree upon (Hutabarat et al 2009). These efforts are expected to result in social reconciliation, especially for groups that manage mangrove areas with the surrounding community.

Furthermore, Hutabarat et al (2009) have argued that efforts to resolve conflicts in conservation areas should meet several criteria. Firstly, settlement efforts must be able to satisfy the various interests of the disputing parties. Secondly, settlement efforts must be able to lead the parties to achieve maximum forms of resolution. Thirdly, these efforts result in the form of settlements that have legitimacy and can be accepted by the parties concerned. Fourthly, neither party feels victimized, all parties feel that they have reached a fair agreement. Fifthly, these efforts can produce a solution that can encourage good relations between the parties in the future.

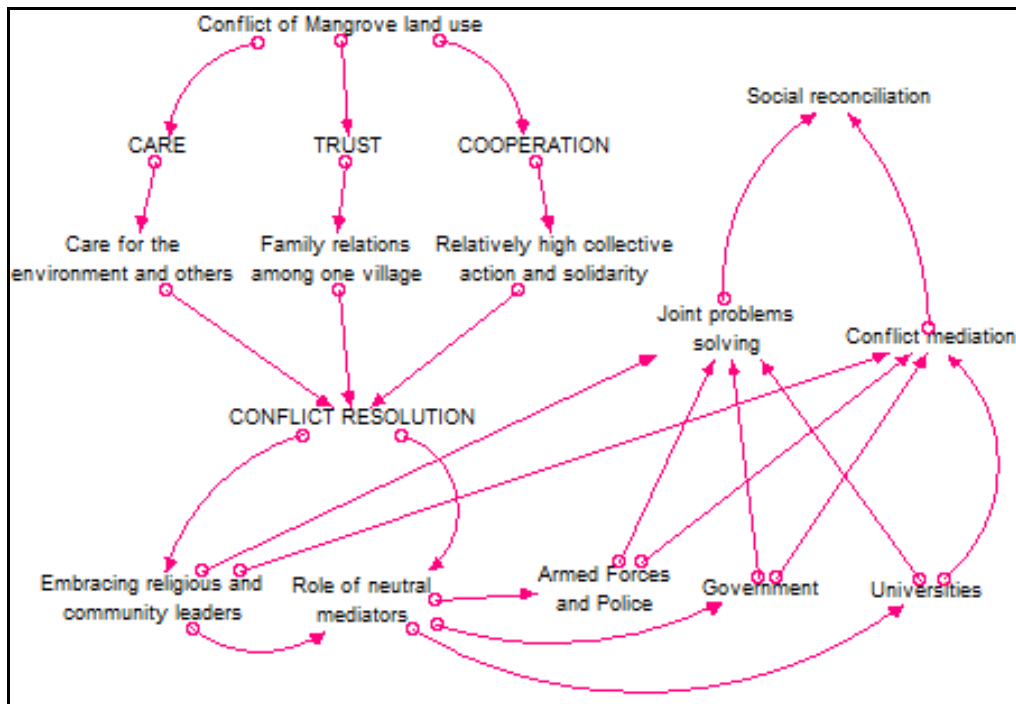


Figure 3. Causal loop diagram of the use of social capital to solve conflicts over mangrove land use.

4. Community Education Strategy

The classic problem that often occurs in coastal areas is the low level of community understanding of the mangrove ecosystem role and function. It is crucial to develop social capital in care, trust, and cooperation to respond to these problems. The strategy posed is in the form of a public education strategy, taking into account people's concern for the environment, religious beliefs, collective action, and relatively high solidarity community. This public education strategy can be performed by cooperating with external parties, especially with the government and universities. In addition, the implementation of this strategy can involve the roles of religious and community leaders. To implement this strategy, integrating conservation principles into local content in elementary schools and field and community service activities conducted by students and lecturers from universities is essential. Environmental awareness campaign activities are expected to increase public understanding and perception of mangrove areas in the region. It is also longed that it can create regeneration and cadres of environmentalists from young people in the area (Figure 4).

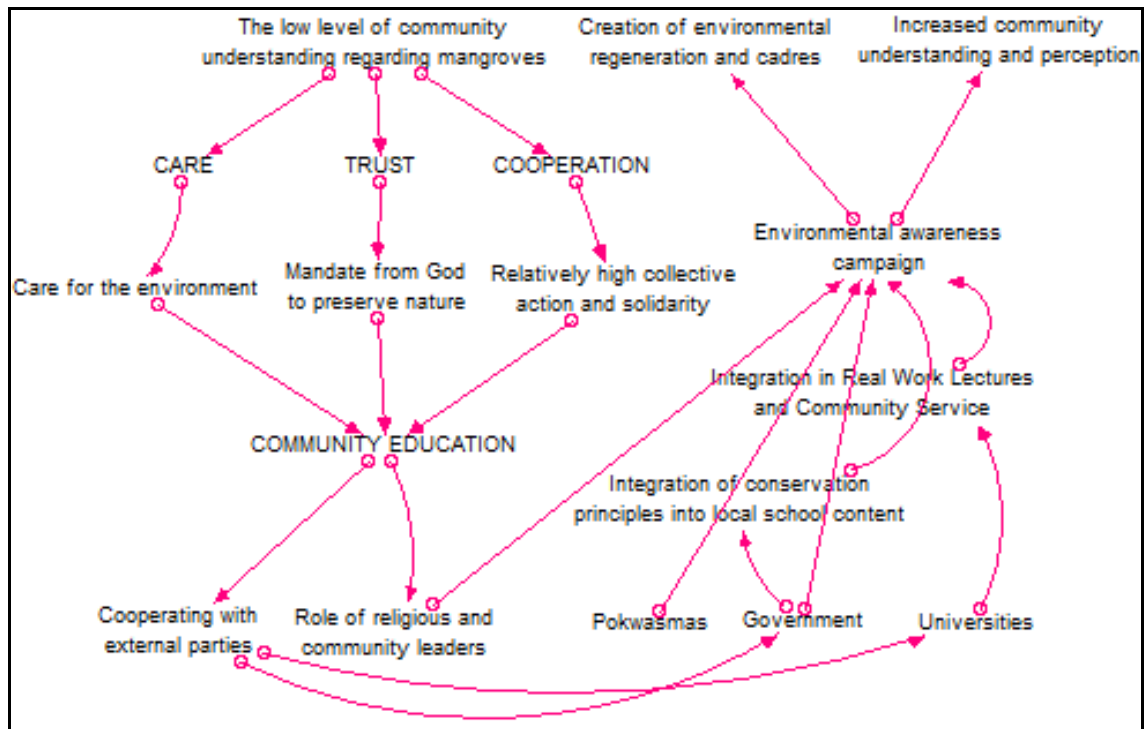


Figure 4. Causal loop diagram of the use of social capital to increase the level of community understanding regarding mangroves ecology.

Conclusions. This study provides four strategies to support the implementation of mangrove conservation in three research locations based on the development of social capital. A capacity strengthening strategy is needed to overcome the absence of a wave barrier construction that supports and protects the newly planted mangrove seedlings. Community empowerment strategies are needed to solve the overflow of waste originating from upstream areas and oil spill incidents from offshore exploration. A conflict resolution strategy is needed to resolve conflicts over mangrove land use that occur between interested communities. Finally, a community education strategy is indispensable to address the low level of community understanding of the mangrove ecosystem role and function. Some of the social capital demanded to achieve each of the strategies above are trust, cooperation, and care. Support from various relevant stakeholders is vital to successfully implement these strategies to attain the sustainable mangrove management goals mentioned above.

Acknowledgements. All authors would like to express their deepest gratitude to the Institute for Research and Community Service or the LPPM at University of Singaperbangsa Karawang for this research's facilitation and funding. The highest appreciation is conveyed to village government leaders, Pokmaswas, and community leaders in each research location for their information and data support for this research.

Conflict of Interest. The authors declare that there is no conflict of interest.

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Received: 01 January 2021. Accepted: 17 February 2021. Published online: 18 May 2021.

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How to cite this article:

Santoso M. P. T., Putra A. S., Hendriyani R. M., Nopiana M., 2021 Implementation strategy of mangrove area conservation based on social capital development: A case study in the east coastal area of Karawang Regency, Indonesia. *AACL Bioflux* 14(3):1295-1307.