The Priority of Constraints Handling and Policy Program on Sustainable Management of Mangrove Forest Ecosystem in Langsa City, Aceh Province, Indonesia

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Abstract

Management of mangrove ecosystems in Langsa City involves various stakeholders who have respectively different interests which encounter various obstacles and challenges in its implementation as well. In order to realize the sustainable management of mangrove forest ecosystems, it needs innovative and effective programs. The programs are expected to encourage changes to the right direction. This study was designed to formulate the structure and classify the obstacles and policy programs in management of mangrove ecosystems based on their sub-elements. Data analysis used Interpretative Structural Modeling (ISM) method. The result shows that the key to the conservation of mangrove forests in Langsa City is the lack of community understanding about mangrove forest management, low community participation in mangrove forest rehabilitation and lack of government support in mangrove forest management programs. Meanwhile the key to policy program in managing mangrove ecosystems in Langsa City is the integrated management of mangrove forests.

Keywords : mangrove forest ecosystem, Interpretative Structural Modelling, sustainable management, integrated management

INTRODUCTION*

Mangroves grow in 124 tropical and sub-tropical countries in the world with an area of mangrove around 15.2 million ha. Indonesia along with four other countries (Australia, Brazil, Nigeria and Mexico) represent 48% of the world's mangrove forests [1]. Mangrove ecosystem has biological function as a place for various marine biota to find food, spawn and lay eggs and also as habitat for fish that occupy coral reefs, seagrass beds, pelagic zones and other types of wildlife. It has as well economic function as producers of wood, non-timber and environmental services. Other function is physical function as shoreline protection from waves, regulating sedimentation, improving water quality, controlling sea water intrusion and microclimate stability [2; 3; 4].

Langsa City in Aceh Province has 8,840.6 ha of mangrove forest area. Based on its function, it consists of protected mangrove forests covering 1,231.5 ha and limited mangrove production forests covering 7,609.1 ha. From the total area, there are 14.96% area which are heavily damaged, 22.80% are damaged and 62.24% are still good. The Langsa City Government has made various efforts to manage mangrove forests in order to remain sustainable. The mangrove forest rehabilitation program has carried out since 2006. However, the result of this activity has not been able to restore the damaged mangrove forest [5]

Management of mangrove forest ecosystem in Langsa City is a complex problem which comprises diverse constraints and involves many stakeholders. During this effort, each stakeholder has a different understanding of the management of mangrove forest ecosystems. There are collisions which occur and it is sufficiently difficult to deal with whether it is observed only from one perspective. The effect is that the policy programs which have been carried out were mutually unrelated and lack of coordination among stakeholders.

The ability of the management institution is one aspect to manifest good governance and

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achieve the sustainable management of mangrove ecosystems. The central and regional government are the policy-making institution which need to consider various aspects of the condition and capacity of the resources to conduct mangrove forest management programs. It needs to understand that the obstacles encountered in managing mangrove forest ecosystems will be the key elements in formulating policy programs and involved institutions. This study aims to formulate the structure and classify the constraints and policy programs in mangrove ecosystem management based on their sub-elements. The result of this research will be the key sub-elements in the framework of sustainable management mangrove forest ecosystem in Langsa City.

MATERIAL AND METHOD
Place and Time
This research was conducted in Langsa City, Aceh Province from December 2015 to April 2016.

Data Collection
Data collection used purposive sampling technique that limited to involve stakeholders in managing mangrove forest ecosystems in Langsa City. The data were collected in the form of primary data and secondary data. Primary data are about the constraints and policy programs on mangrove forest ecosystems management. It was obtained through expert information and Focus Group Discussion (FGD) with The stakeholders. The stakeholders consist of the Environment and Forestry Service of Aceh Province, Regional Planning and Development Agency (Bapedda) of Aceh Province, Forest Management Unit (KPH) Region III Aceh, Marine and Fisheries Agency of Langsa City, universities, non-governmental organizations and traditional institutions. Secondary data were obtained from regulatory instruments, literature studies and reports from relevant agencies / agencies.

Analysis Method
Data analysis used the Interpretative Structural Modeling (ISM) method. ISM is a method that can be used in order to explain and describe complex situations therefore it will be understood and be able to control [6]. ISM is used to see the contextual relationships of various components in a system and determine the components that have a key role for a problem [7]. The basic principles of theory, concepts and calculations are used to achieve

efficiency through graphic or network representation among the ISM Elements [8].

This method is carried out through three stages, namely identifying the system (elements and related sub-elements), understanding and assessing contextual relationships between various sub-elements of each element, and last structuring and classifying existing sub-elements of each element analyzed [7; 9]. This model will help find key factors related to the problems. After identifying key factors or elements, there will be strategies which can be developed to deal with problems [7].

RESULT AND DISCUSSION
Identification of the Sub-elements
The sub-elements of the constraints and programs needed to manage sustainable mangrove forest ecosystems in Langsa City are the extraction from literature studies, Focus Group Discussion (FGD), expert information, and field survey results. Sub-elements which are the material of analysis have a direct influence on the management of forest ecosystems. Elements of the constraints in forest ecosystem management consist of eleven sub-elements and the required policy program elements consist of nine sub-elements.

Sub-element of Constraint Element
The obstacle element consists of eleven sub-elements that directly influence the management of sustainable mangrove forest ecosystems in Langsa City. The eleven sub elements of the constraint element consist of:
1) Lack of community understanding of mangrove forests
   This sub-element means that the importance to improve community understanding about the function of mangrove forests. This understanding is not only for the community at the village level (grassroots level), but also for the community at the district and national level [10].
2) Low community participation in the rehabilitation of mangrove forests
   This sub-element means that the members of community groups who work together on their own in forest management are more successful to maintain the forest resources. The existence of such cooperation makes them actively involved in forest management and more likely to invest in forest patrols in order to enforce the rules [11]. The successful mangrove forest management in Pred Nai

Village in Thailand was due to the high participation of local communities. In the mangrove forest management process, villagers were encouraged to participate in every forest management and planning activity [12].

3) Lack of government support in mangrove forest management programs

Many policies were made by the government to manage mangrove forests in Indonesia. But unfortunately, the implementation at the field has not been conducted properly. There were many mangrove rehabilitation activities which were carried out were failed because of the activity form only focus on planting program without maintenance and supervision.

The successful Community-Based Ecological Management (CBEM) program which was carried out in Thailand, was under full support from the government and the similarity of stakeholder perceptions of political equality, cost sharing for conservation activities and socio-economic benefits from sharing ecosystem services provided by mangrove forests [13].

4) Illegal logging of mangrove forests

Ecologically, mangrove forests logging destroys species, habitat, biogeochemical and biological cycles, production of organic matter, seeds, young plants, conservation of soil genetic exchange and fertility, decrease of coastal protection, and aesthetic values. There are long-term economic losses for the community if mangrove forests are damaged [14].

5) Mangrove forest conversion.

The main causes of mangrove forests deforestation in South Asia are conversion to agriculture, shrimp ponds and settlement development [4]. The main drivers of the mangroves loss in Southeast Asia are the conversion of mangroves to aquaculture, agriculture and oil palm plantations [15; 16].

6) Institutional government and community have not developed and functioned optimally.

The successful mangrove forest management in Southern Trang Thailand was conducted by the community. It can be observed through the higher stand mangrove structure which was compared to the state-managed mangrove forest. The success is based on the community perception that mangrove forest resources are the main source of livelihood for the local community, and for people who

commit that violations in mangrove forests management are subject to sanctions as well. Mangrove forest management was running well and there were village institutions that monitor it [17]. The Community Based Conservation (CBC) approach must be carried out by local community mangrove institutions. CBC affects the willingness of communities to participate in mangrove forest rehabilitation [10].

7) The high rate of community poverty around the mangrove forest.

Based on data projection, the total population of Langsa City in 2016 was around 168,820 people. Poor people of Langsa City in 2016 amounted to 11.09% with a poverty line of Rp323,246 per/capita /month. Kuala Langsa Village in Langsa Barat Sub-district is one of the villages in Langsa City which has the highest poor proportion [18].

Mangrove forests in Cameroon were exploited by local people through fishing, hunting, and especially logging of mangroves for fuel wood and charcoal raw materials. The area of mangrove forest that lost every year was approximately 1,000 ha. The Rhizophora species were the mostly exploited, with around 200,000 trees cut down annually. As a result, the ecological and economic functions of mangrove forests have been reduced and then caused the local communities economy decreased [19].

8) Weak coordination among stakeholders

Sustainable management of mangrove forests will not be achieved without full participation of all stakeholders, strong technical support and strict law enforcement by the government which view their mangrove ecosystem as a very important resource [2].

9) Fault in choosing mangrove types for rehabilitation.

The unsuccessful mangrove rehabilitation in Philippines in the past two decades was caused by mis-selection of the mangrove type and location and gave impact inappropriate planting [20]. In many cases the failure of mangrove rehabilitation in Malaysia was caused by mistaken selection of planting locations and inappropriate types of mangroves [21].

10) Poor integration and implementation of policies and regulations

The Pred Nai Village community in Thailand has succeeded in reforesting 1,920 ha of mangrove forest area where was previously

converted into shrimp farming in the mid-1980s. The village government formed a community forest committee and established a regulation on the use of resources and management plans to regulate, control and manage community members' use of mangrove forests [12].

11) The high cost of managing mangrove forests

The most important problem in mangrove forests management in Langsa City is the availability of adequate and sustainable budget allocations which is intended for mangrove management. Due to limited funds, frequent program activities can only be carried out for one budget period. The costs needed to restore vegetative cover and the ecological functions of damaged mangrove forests range from USD $ 225 / ha to USD $ 216,000 / ha [22]. The costs required for mangrove rehabilitation amount to 1000 USD / ha [23].

Sub-elements of the Policy Program Element

To overcome the obstacles in mangrove forest management, an appropriate and structured policy program are needed. There are nine sub-elements in the policy program elements that have an influence on sustainable mangrove forest management in Langsa City based on identified constraints. The nine sub-elements of the policy program element among others:

1) Integrated mangrove forest management

Integrated mangrove forest management is a process of planning, utilizing, monitoring and controlling mangrove resources among sectors, government and local government, between land and sea ecosystems, and between science and management to meet needs and improve community welfare. In this context, integration contains three dimensions, namely sectoral, scientific fields, and ecological linkages [24].

To keep the mangrove ecosystem of Langsa City remain sustainable in the future, it is necessary to establish Mangrove Working Group (Pokja Mangrove). This working group involves all relevant agencies across sectors, as well as academics, NGOs and the community. Its duty and authority in mangrove management are: encouraging synergy, carrying out monitoring and evaluation, providing advice and input on various issues of mangrove management, encouraging the development of data integration and information, helping to provide guidance and socialization to increase community awareness and participation in mangrove conservation, and encourage the issuance of Qanun (regulations) on mangrove ecosystems management.

2) Utilization of mangrove forests that are right on target and sustainable

Many programs are carried out by related institutions to improve sustainable management of mangrove forests. The mangrove forest management is carried out by considering scientific approach, integrated ecosystem based, spatial approach, and community approach to optimize its functions in climate change mitigation, sources of livelihood, food security, disaster risk reduction, and pollution control.

3) Increase in coordination among stakeholders.

For successfull mangrove forest management in the future, stakeholders should coordinate the planning and formulate integratively mangrove forests management as the common goal. The coordination among stakeholders mangrove forests management will create long-term relationships that involves patterns of interaction among stakeholders. Over time, the longer the relationship is built, the more likely the interaction can be institutionalized because the connections developed between the parties will result in reciprocity and commitment [25].

4) Increase in income of community around mangrove forests,

Increase in community welfare accompanied by sustainable resource management is the core of community-based mangrove management [26]. Community management of mangrove resources has proved beneficial to the community because of guaranteed livelihoods, access to resources, mechanisms for conflict resolution and sustainability orientation [27].

5) Increase in support from the government, non-governmental organizations (NGOs) and universities,

Collaboration among community leaders, researchers, NGOs, village government, religious institutions and formal education institutions is an important aspect which became the main pillar and key to successful mangrove forests rehabilitation in Tiwoho Village, North Sulawesi [28]. Some efforts to suppress the destruction of mangrove forests

as little as possible are by cooperation between local governments, related agencies and the community [29]. In Malaysia, to achieve mangrove forests sustainability, the management is carried out jointly by involving local communities, government institutions and NGOs [10].

6) Community-based mangrove management, Conservation strategies that emphasize the role of local communities in decision-making and being actively involved as partners in protected area management are the key to successful conservation programs [30]. Community-based mangrove forest management policies can increase local community participation in mangrove forest management. They are involved in nursery activities, rehabilitation and utilizing non-timber forest products [31]. Management of mangrove forest ecosystems that involve communities is a dynamic and sustainable process that brings together various interests (government and community), science and management, and sectoral interests and the general public [32].

7) Making Mangrove Seedlings
Mangrove seedlings are an important part of the reforestation program. These nurseries can provide healthy plant seeds and have a high growth rate to plant. Rehabilitation of mangroves requires healthy propagules and seeds. Nurseries which are established near restoration sites will provide employment and involvement of local communities. In addition, seedlings have 100% survival and are available for transplantation within three months, at a low cost. Nursing procedures and techniques are based on local practices and knowledge [33].

8) Application of silvofishery system,
Silvofishery is a form of mangrove forest management which is integrated with ponds as an aquaculture form with low input [34]. The silvofishery mangrove system with shrimp needs low capital, diversifies livelihoods through polyculture and provides fixed income. In addition, silvofishery system can reduce conflicts in the management of mangrove forests by communities, increase biodiversity and preserve wider ecosystems. Silvofishery system which requires relatively low investment costs are sustainable and environmentally friendly [35; 36].

9) Establishment of a mangrove charcoal cooperative

In Langsa City there are 67 active charcoal kitchens with an average magrove charcoal production capacity of 0.5 tons / month and an average production of 115.6 tons / month on average. The number of people working in charcoal kitchens is 34 people. The raw material for making charcoal is taken from mangrove forests in Langsa City [5]. All of the charcoal kitchens do not have official permits in their operations, because they do not have a legal area for collecting raw materials for charcoal production. The solution to overcome this situation is the establishment of cooperatives. There are two advantages of this cooperative, namely the existence of business legality and more prosperous farmers because of wider market channels and more competitive selling prices. Ecologically, it can minimize the damage of mangrove forests in Langsa City, because charcoal farmers have permission to collect forest products whose working area has been determined

The Structure of Constraint on Sustainable Management Mangrove Ecosystem in Langsa City

Some planning and development process are carried out because of there found constraints factors which encounter mangement activity [37]. Identification result from literature, focus group discussion (FGD), expert information, and field survey results found eleven sub-elements of the constraints which affect directly the management of sustainable mangrove forest ecosystems in Langsa City. The eleven sub-elements are:

K1= Lack of community understanding of mangrove forest management

K2= Low community participation in the rehabilitation of mangrove forests

K3 = Lack of government support in mangrove forest management programs

K4 = Mangrove forest conversion

K5 = Illegal logging of mangrove forests

K6 = High rate of poverty of the community around the mangrove forest

K7= Lack of development and optimal function of Government and community institutions

K8 = Weak coordination among stakeholders

K9 = Fault in choosing mangrove type for rehabilitation

K10 = Poor integration and implementation of policies and regulations

K11 = High cost of managing mangrove forests

The Driver Power-Dependent (DP-D) diagram of the sub-elements of the constraints on sustainable mangrove forest ecosystem management in Langsa City is presented in Figure 1.
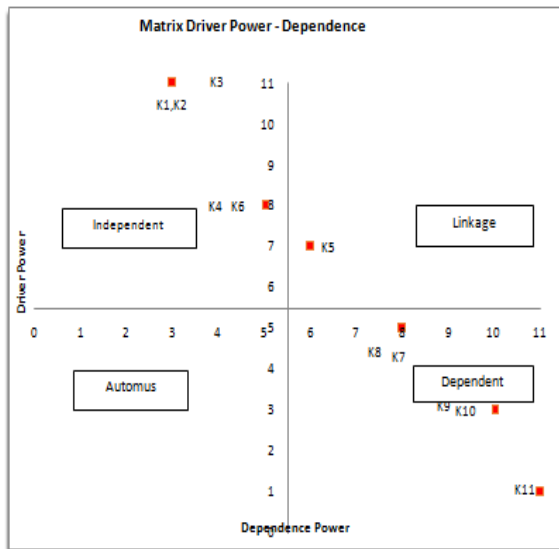

Figure 1. DP-D diagram of the sub-elements of the constraints

Figure 1 shows that the eleven sub-elements of the constraint can be divided into three quadrant groups, namely dependent (quadrant II), linkage (quadrant III) and independent (quadrant IV). In the second or dependent quadrant there are five sub-elements found in this study, namely: Lack of development and optimal function of Government and community institutions (K7), weak coordination among stakeholders (K8), Fault in choosing mangrove type for rehabilitation (K9), poor integration and implementation of policies and regulations (K10) and high cost of managing mangrove forests (K11). The dependent group is a group which has a weak driving force and high dependence on other sub-elements in the management of sustainable mangrove forest ecosystems in Langsa City.

In quadrant linkage (quadrant III) there is only one sub-element of the constraints in the mangrove ecosystems management, namely illegal logging of mangrove forests (K5). This sub-element which is located in linkage quadrant has driving power and dependency that is influenced by its own interaction. Each sub-element in this quadrant can influence other factors, but on the other hand it is influenced by other factors as well. Sub-element which exist in this linkage quadrant need to get more attention because they are unstable of labile. If it is not managed properly it can be a threat to the sustainability of the mangrove forest ecosystem in Langsa City.

Whereas in the independent quadrant (quadrant IV) there are five sub-elements of constraints in the of sustainable mangrove management in Langsa City, namely: Lack of community understanding of mangrove forest management (K1), Low community participation in the rehabilitation of mangrove forests (K2), Lack of government support in mangrove forest management programs (K3), Mangrove forest conversion (K4), high rate of poverty of the community around the mangrove forest (K6). These five sub-elements are the key sub-elements which are the most influential of mangrove forest management in Langsa City because they have high driving force in influencing other sub-elements and low level dependence on other sub-elements.

From the description of the driving force and dependence level of all elements in the constraints element in this study, we obtained a model of constraint structure in the management of sustainable mangrove ecosystems in Langsa City. The structure model shows the level of importance or priority to be addressed in order to support the management. The higher up the hierarchy shows the priority scale of the constraints which must be handle decreases. The structure model of constraints on the management of sustainable mangrove forest ecosystems in Langsa City is presented in Figure 2.

Referring to the constraint structure model (Figure 2), the sub-element of mangrove forest conversion and the high rate of poverty of the community around mangrove forests is not an urgent obstacle to be addressed immediately in the management of sustainable mangrove forest ecosystems in Langsa City. The main constraints which should become the main concern and key sub-elements are the lack of understanding of the mangrove forest management, low community participation in mangrove forest rehabilitation and lack of government support in mangrove forest management programs.
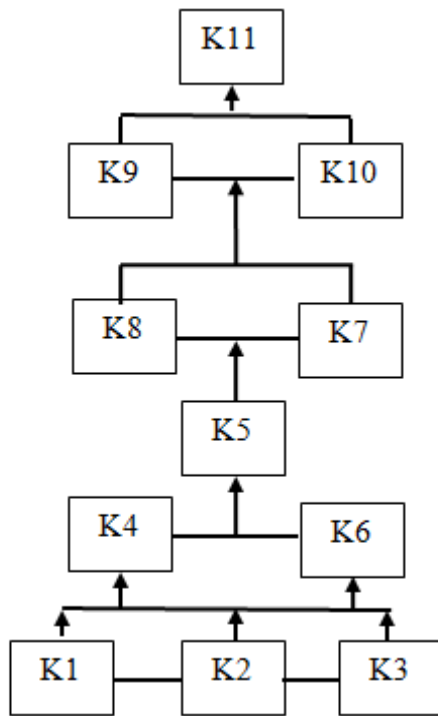
Figure 2. The structure model of constraints

The Structure of Policy Programs on Sustainable Management Mangrove Ecosystem in Langsa City

This program is designed to improve the management of sustainable mangrove ecosystems in Langsa City. Based on the identification of the policy programs, there are nine sub-elements needed in the management of the mangrove ecosystem, among others:

P1 = Integrated mangrove forest management
P2 = Utilization of mangrove forests that are right on target and sustainable
P3 = Improving coordination among stakeholders
P4 = Increasing income of community around mangrove forests
P5 = Increasing support from the government, NGOs and universities
P6 = Community-based mangrove management,
P7 = Producing Mangrove Seedlings
P8 = Application of a silvofishery system
P9 = Establishment of a mangrove charcoal cooperative

The DP-D diagram of the sub-elements of the policy program for sustainable mangrove forest ecosystem management in Langsa City is presented in Figure 3.
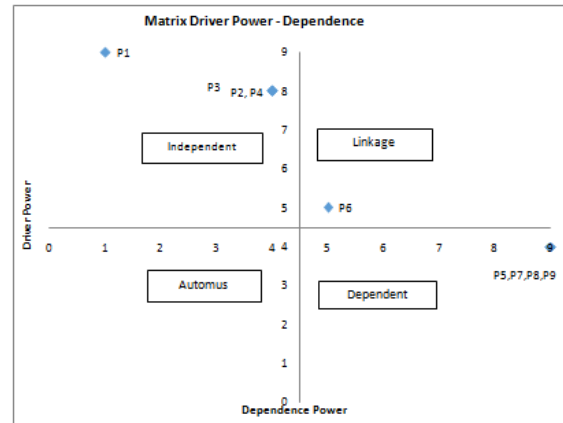

Figure 3. The DP-D diagram of the sub-elements of the policy program

The results of the analysis classify the nine sub-elements into three groups, namely quadrant II group (dependent), quadrant III (linkage) and quadrant IV (independent). The linkage group consists of four sub-elements, namely: increasing support from the government, NGOs and universities (P5), producing mangrove seedlings (P7), implementing the silvofishery system (P8) and establishing a mangrove charcoal cooperative (P9). These four sub-elements have strong drivers, but on the other hand have a high dependence on other sub-elements. Interventions on this element will affect other sub elements which are at the level below it.

There is only one sub-element of the program in the management of mangrove ecosystems in the linkage group (quadrant III), namely community-based mangrove management (P6). The sub-element which are located in linkage quadrants have driving power and dependency that are influenced by their own interactions. Each sub element in this quadrant are able to influence other factors, but on the other hand they are influenced strongly as well by other factors.

The last group is an independent group which includes sub-elements of integrated mangrove forest management (P1), utilization of mangrove forests that are right on target and sustainable (P2), increasing coordination among stakeholders (P3) and increasing income of community around mangrove forests (P4). The four sub-elements are the most influential to the management of sustainable mangrove forest ecosystems in Langsa City because they have a high driving force in influencing other sub-elements, as well have a low level of dependence on other sub-elements. The model structure of the policy

program for sustainable mangrove forest ecosystem management in Langsa City is presented in Figure 4.
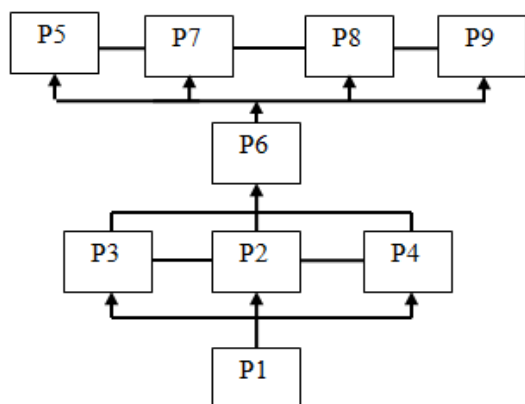
Figure 4. The model structure of the policy program

Based on the ability to influence other sub-elements, and the level of its role in the management of sustainable mangrove forest ecosystems in Langsa City, it can be stated that the integrated mangrove forest management program is the key force in driving the sustainability of mangrove forest management in Langsa City. This program is considered to provide the most important role and can provide a strong and very significant influence to encourage the sustainability of mangrove forest ecosystems.

Pentahelix Synergy is needed between Forest Management Unit (FMU) Aceh III, Langsa City Government, PT Pekola, NGO Balee Jurong, Academics from Samudra University and IAIN Zawiyah Cot Kala with local communities and print or electronic media to integrate mangrove forest management. Furthermore, people around the mangrove forest ecosystem of Langsa City must carry out alternative economic activities. In order for the community, and especially young people, to be empowered in creative economic activities by providing technical assistance and increasing soft skills with vocational training, compensation for starting new activities and providing funds to buy work equipment.

To implement an integrated mangrove ecosystem management policy, the government must provide funds for program implementation in the field so that all planned programs can be implemented and produce optimal results. Without the support of adequate funding sources, this policy will not move forward. Furthermore, for the effectiveness of the management of mangrove forest ecosystems in

Langsa City, accurate data is needed about the existing conditions of mangrove forests. Without the support of accurate data, proper analysis cannot be carried out and the effects of various policies will remain ambiguous. Thus, all stakeholders involved in the management of mangrove forest ecosystems in Langsa City need to develop a database of mangrove forest ecosystems including inventory and identification of mangrove forest ecosystems that are routinely carried out and scheduled. The results of this activity are information about the identification of mangroves, location of distribution and boundaries, characteristics of biodiversity and socio-economic conditions.

In addition, relevant educational materials need to be designed and made to be used by the formal and informal education sectors, taking into account the needs of local communities and users of other mangrove forest ecosystems. Education provided to the community is expected to provide information about values, status and threats to the mangrove forest ecosystem will encourage effective education and public awareness. The database can be obtained, managed and disseminated using spatial analysis (Remote Sensing and Geographic Information Systems) and satellite imagery.

CONCLUSION

The sustainability of mangrove forest ecosystems management in Langsa City face various problems which have to be addressed by prioritizing and deciding policy programs. Some efforts to handle various obstacles and determine appropriate policy programs which based on priority scale are the most effective ways in managing sustainable mangrove forest ecosystems. The priority scale of the obstacle elements and policy programs which are projected by a hierarchical structure, can be built by identifying contextual relationships between the key sub-elements of of the constraints and policy programs.

The lack of level of community understanding of mangrove forest management, the low level of community participation in mangrove forest rehabilitation and the lack of government support in mangrove forest management programs are key constraints in the management of sustainable mangrove forest ecosystems in Langsa City. For this reason, the key policy program is integrated management of sustainable mangrove forests in Langsa City. The handling of the obstacles and priorities of the

right policy program will ultimately encourage the effectiveness and efficiency of the budget to meet the main objective of managing sustainable mangrove forest ecosystems in Langsa City.

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