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Mangrove governance: Establish a new paradigm of mangrove management "from village to the world"

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Abstract. Mangrove ecosystems are one of the main ecosystems in coastal areas that have high productivity that serves and support the productivity of fisheries resources. This high productivity is due to mangrove ecological functions of mangroves as a nursery ground, feeding ground, and spawning ground. In the global warming context, the mangrove ecosystem has served as a sink and storage carbon. Mangroves also play a process of disaster mitigation, especially to current and waves, erosion, and coastal abrasion. Mangrove, in functional status, will be able to protect the wave movement from sea to land. Except for tree density, the mangrove root's shown an ability to protect waves from the sea. The effort to conserve and protect coastal areas from climate and tsunami can be started from the local community in the coastal. The local government that has close connectivity to the coastal ecosystem is a village particularly. This is a critical point to increase local coastal village, and then, the village autonomy according to Law Number 6 of 2014 concerning villages to conserve the ecosystem and environment as the village's responsibility. Thus, the village is no longer just managing the administration but also saving the environment and the world one of them through mangroves

1. Introduction

The 2019 Global Risks Report launched by the World Economic Forum explains that environmental risks, including extreme weather plus failure to address climate change, are the dominant topics. Also, the risk of biodiversity loss will affect health and socio-economic development, with implications for regional welfare, productivity, and even security. Along with the increase in human activity at this time, they are causing an increase in carbon dioxide (CO_2) levels resulting in global warming.

Global warming due to climate change is one of the issues in the world today due to various human activities [1,2]. One result of global warming is climate change, which causes the melting of icebergs in the polar regions resulting in rising sea levels [3]. Rising sea levels are a serious threat to mangrove ecosystems and other ecosystems in coastal areas.

Mangrove ecosystems have a role in utilizing CO_2 for photosynthesis, which is then stored in the form of biomass and sediments [4]. Carbon stored in mangroves is higher than in other forest types, where carbon is embedded in mangrove sediments [5]. The decomposition process of mangrove twigs and leaves that fall by microorganisms is one source of organic material in mangrove sediments.

According to [6], Blue Carbon is carbon storage/reserves contained in the mangrove, tidal salt marshes, and seagrass ecosystems along with its sedimentary components. The component also includes living biomass, which is above sediment (leaves and stems), under sediments (roots), and non-living biomass such as waste and dead leaves.

The large potential of carbon stocks in mangrove ecosystems illustrates that Blue Carbon is an important element in coastal management that is integrated into the process of adaptation to climate change. Aside from being a carbon sink, mangroves also have a function as a wave barrier, habitat for various marine life including fish. According to [7], each ha of mangrove is able to support the life of fish (1,070.42 kg), absorbs of carbon (196.8 tons/ha), and can withstand the rate of movement of seawater during high tides or tides and tsunamis. Thus, mangroves can play a role in these three functions.

To ensure the implementation of these three functions, a more operational mechanism needs to be designed. One of the best approaches is to give the village a role in conservation. Villages as community entities close to mangroves can play a role as managers, controllers, supervisors for economic, ecological, social, and world protection functions. The village-based mangrove management program for the welfare of the people and the world has become a new paradigm involving multi parties.

This paper is organized as an effort to explain how the mechanism of village-based mangrove management for the welfare of the community and the world is implemented. Therefore, we are able to realize responsibility at one common ground, conservation, and rehabilitation of mangroves.

2. Methods

This study is part of the ecological, economic, social, and environmental management of mangrove management policies. Approaches to determining carrying capacity, tamping power, tourist attraction, carbon sequestration become important information for some of the inputs from the policy analysis built.

In the ecological context, an analysis of fisheries production calculations is approached from the tropic system through litter production. Average litter production at each station for a certain period is the basis of energy consumption and biomass [8]. Furthermore, the estimation of fish stocks using the litter approach is to determine the amount of energy converted into fish biomass or biota that lives around the area of mangrove forests [9].

Other hand, mangroves may, in certain circumstances, offer limited protection from tsunamis. Some models using realistic forest variables suggest a significant reduction in tsunami wave flow pressure for forests at least 100 m in width. The magnitude of energy absorption strongly depends on tree mangrove density, stem and root diameter, shore slope, bathymetry, spectral characteristics of incident waves, and a tidal stage upon entering the forest [10].

The analysis constructs the paradigm of "mangroves from the village for the welfare of society and the world" using a hierarchical logic approach. The logic hierarchy approach is a part of a Logical Framework Analysis (LFA), which is composed of various information available to solve various problems at one point in the integrated thinking framework.

In this case, some policies are putting as a logical framework of thought by the manager. The intended policy can be at the national or regional level. The existence of the policy is elaborated to obtain a piece of interrelated information and is a solution to the existing problem. The focus of efforts to resolve existing issues through formulates a comprehensive and inclusive integrated program. In the context of mangrove management, the most appropriate approach is village-based, such as a planter. “A new paradigm” is a contributing of the village in mangrove planting that we call as a part of a commitment to sink and absorb carbon through the village. The carbon reduction (absorb) is an international commitment. In this context, the village participation in carbon reduction is a global commitment through the village. This is the reason why a village commitment is set as a commitment

to the world as a new paradigm about mangrove governance. The logic framework of the method developed is like the following flowchart.

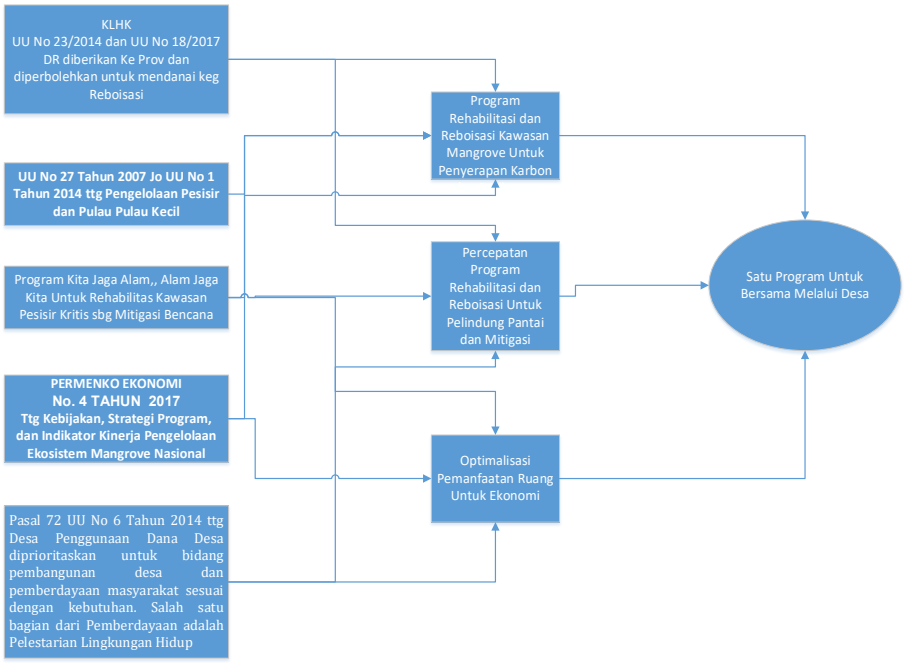

Figure 1. Policy analysis of one village-based program for mangrove governance

LFA is a policy formulation technique for developing strategy and program formulations. Therefore, mangrove management forms that are appropriate and adaptive can be designed.

3. Result

3.1. Bio-Ecology Mangrove

In an effort to mitigate global warming, the mangrove ecosystem has a function as a carbon sink and storage [11,12]. Every 1 ha reconstruction cost about 15–20 million [13] and 196.8 tons/ha of stored carbon. The government's commitment to reduce carbon emissions by 26% until 2020 becomes a separate agenda. To strengthen Indonesia's commitment to the Intended Nationality Determined Contribution (INDC) with a target of reducing carbon emissions by 2030 by 29%.

In addition, there is a need for community involvement in playing a role in protecting the environment, especially the mangrove ecosystem, because the community is the first part to be directly affected by activities in the ecosystem. Communities also need to be given the socialization of the importance of regional development in supporting regional development [14]. Every 1 ha rehabilitation costs 15–20 million and will absorb 32 million tons of carbon per year through biomass growth [15].

Mangroves also play a role in the process of disaster mitigation, especially to withstand waves, erosion, and coastal abrasion. In a healthy mangrove program, it will be able to slow the wave movement from sea to land. The type of mangrove that has a strong ability to withstand the wave speed is *Avicennia* or *Rhizophora* type, which has a good density. Research conducted in the Jakarta Bay shows that the root's ability to withstand waves becomes the main.

The value of direct economic benefits from mangrove areas, namely as a source of fish suppliers and tourism activities, is one source of economic improvement for the community and villages. Each

hectare of mangrove land can support fish growth and development of 0.7–1.3 tons/ha. With the potential of crater forests reaching 1.8 million ha, we will be able to recover fish as much 1.8 million tons per mangrove area. Meanwhile, the value of tourism potential is also very high, with an average income of 5 million/ha of mangrove for mangrove tourism with a common endpoint of reaching 30 people/day. All of this potential can be developed and optimized through strengthening village performance. So the village base is the key driver of the mangrove program for the welfare of society and the world. The form of system integration in the village context is presented in the following figure.

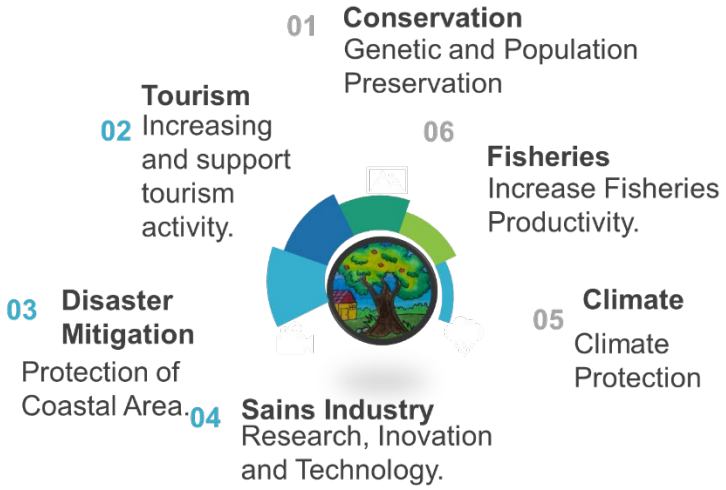

Figure 2. Integration of mangrove function

3.2. Mangrove LFA Analysis

Mangrove ecosystems are one of the ecosystems in coastal areas that have high productivity that serves to support productivity [16] of fisheries resources. The results of the village-based mangrove in LFA show the relationship model, as shown below.

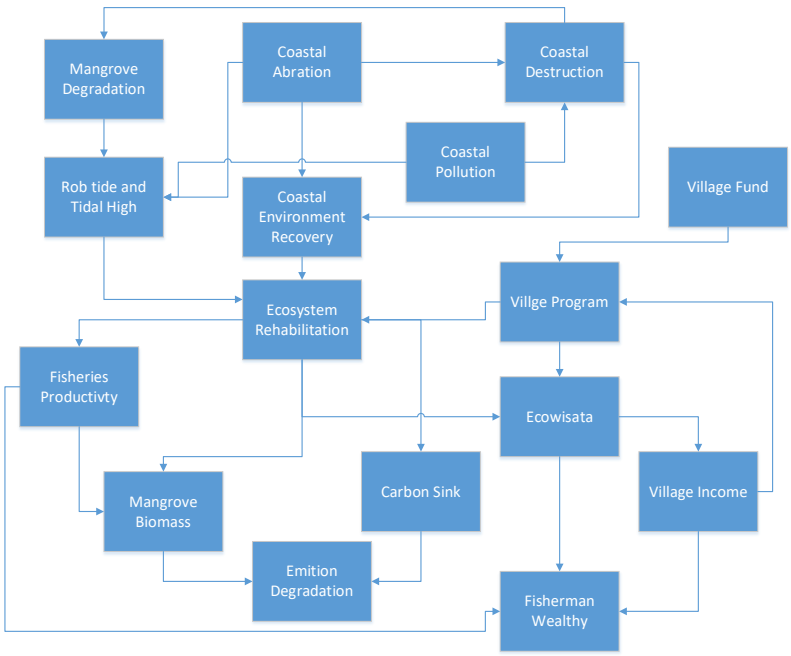

Figure 3. The logical framework of mangrove ecosystems

From this interrelated model, a plan and program based on a centralized approach to the LFA component were developed to determine the priorities of the village-based mangrove management program.

3.3. Village Formulation

This paradigm that established aimed at encouraging community life in enhancing the capacity of coastal villages by carrying out a mangrove ecosystem conservation program. This conservation is also part of the village work program as well as in the framework of implementing the Law on Villages. [17] states the success of mangrove ecosystem-based approaches programs depends on wide-spread civil society participation, particularly in the village. The capacity of the village was able to restore the critical mangrove ecosystem so that the capacity of its supporting capacity and the capacity and resilience to protect various risks and disasters increased again.

Village autonomy, according to Law Number 6 of 2014 concerning Villages, also includes resources including the environment as the village's new responsibility. Thus, the village no longer only manages the administration but also saves the environment and the world one of them through mangroves. Based on [18], the remaining mangroves currently reach 3.49 million ha, of which 1.67 million ha is in good condition, while 1.82 million ha is in a critical condition. Because of the existing mangrove area in the village, the role of the village must be strengthened as a national agenda and save the international as well as to reduce carbon, increase fish production in the saved land, and strengthen the beach as a means of disaster mitigation. In addition to fisheries, another economic benefit for villages in the use of mangroves as mangrove tourism areas.

4. Discussion

4.1. Program Formulation

Based on the logical framework model from Figure 3, a model that depicts priority programs from village funding analyzed. In the context of mangrove management, the program divided into groups of 3 interests with five priority programs. The priority programs are rehabilitation of mangrove ecosystems (ER), strengthening of village programs (VP), improvement of coastal abrasion (CA) conditions, coastal degradation (CD) as well as ecotourism program development. In contrast, the other programs include the second and third groups with a pattern of distribution of village programs to improve mangrove ecosystems as follows.

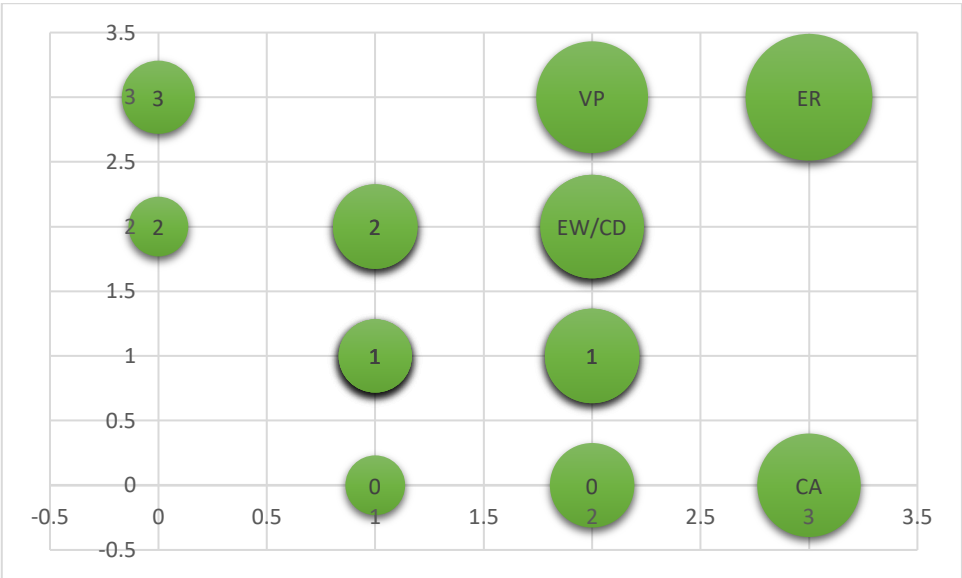

Figure 4. Scatter of mangrove program from LFA analysis

Currently, the Indonesian coastal region and environment are facing uncertain conditions and pressures. Some areas experienced tsunami disasters, abrasion, seawater intrusion, loss of containment habitat, and decreased ability of the ecosystem due to the burden of pollution. Coastal areas, beaches, and small islands are areas that are vulnerable to disasters, especially mangrove ecosystems while the function of this area is very much in supporting long-term ecosystem sustainability.

A total of 10,664 villages have beaches that have the potential to experience the risks and impacts of these changes. The autonomy of village authority also developed not only in managing village funds but also in managing village resources, including mangrove. The village then needs to be encouraged to formulate a vision in village governance, including in facing coastal disasters. The Community management of mangroves in Thailand has been successful as a part of community awareness in the district level [19].

For this reason, there are at least four main agendas that need to carry out related to the role of mangroves as supporting the productivity and welfare of the community, absorbing carbon, and protecting the coast from natural disasters. Our four main agendas in the village's mangrove program for community and world welfare include mangrove rehabilitation and restoration, accelerating the improvement of village-based governance capabilities, increasing coastal carrying capacity, encouraging global commitments in reducing Greenhouse Gas (GHG) emissions, and Industrial Revolution 4.0 (IR 4.0) adaptation in mangrove monitoring and disaster.

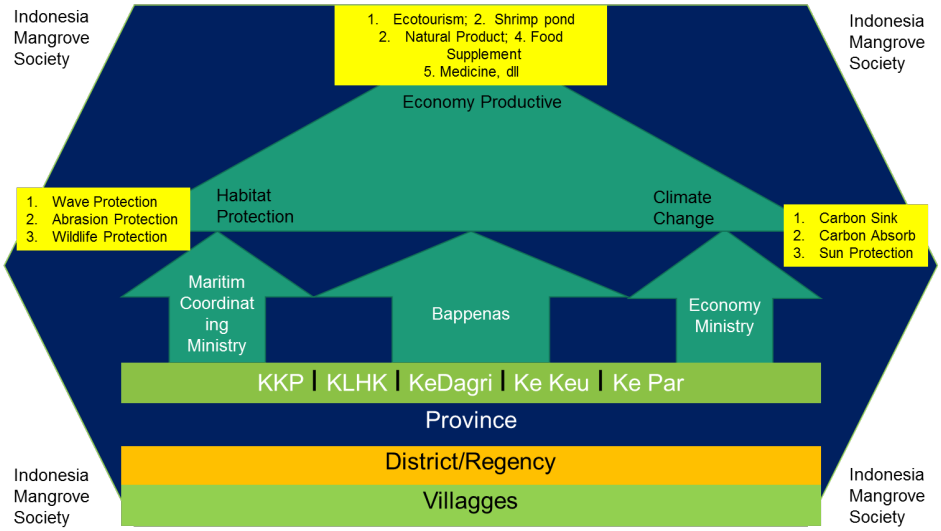

Figure 5. Village formulation in mangrove governance

4.2. Strategic Program

The first agenda is to encourage the acceleration of the village's ability to manage mangrove ecosystems. Two important steps that need to be taken to maintain mangroves in good condition are to rehabilitate and restore critical mangrove areas. If the rehabilitation target is targeted to end in 2045 without any other damage, then with the current condition of damage, we will at least only be able to rehabilitate 67 thousand ha per year. The area is estimated to require financing support of 1.1 trillion per year, with an estimated rehabilitation cost of 15–20 million/ha. Meanwhile, if done massively by speeding up the recovery time until 2025, every year, it must be rehabilitated 260 thousand ha with total financing reaching 3.9 trillion/yr. This condition will become even faster if all villages are involved with designing mechanisms for managing village-based mangrove ecosystems while

continuing to adopt technological developments and information systems as part of disaster management adaptation in coastal villages.

The second agenda in mangrove rehabilitation will increase the carrying capacity of coastal areas, especially mangrove areas. Village-based conservation is an important step as the village is responsible for the environment in the presence of village funds. With a rehabilitation fund of 15 million/ha, Rp 150 million can be budgeted annually through villages or (equivalent to 10 ha/yr). This number reaches 1.05 billion in 2025 from villages that will undertake mangrove rehabilitation of 70 ha from now in every coastal village. With the mangrove carrying capacity of 1,134 kg/ha/yr [7], it will produce fish as much 1.1 tons/ha/yr or 79 tons of fish resources until 2025 (linear and accumulative assumptions). Rehabilitation of 1.82 million ha of critical mangrove land, the estimated potential carrying capacity of fisheries on the coast that can be recovered reaches 2.06 million tons of fish. In Philippine, mangrove carbon using (PES approach) could contribute an additional 2.3-5.8% to current village income [20].

The third agenda is to strengthen global commitment through villages in reducing GHG emissions. The government's commitment to reduce carbon emissions by 26% until 2020 becomes a separate agenda. According to [21] is used as a reference, all critical mangrove lands planted with Rhizophora species will be able to absorb 36.2 million tons of carbon and will store 133.09 million tons of carbon. This means that the number of emission reductions in addition to forest land can also be pushed through mangroves in the coastal areas. In this case, it is important to ensure the extent of the conserved area of the existing area for the restoration of the mangrove ecosystem.

The fourth agenda is to strengthen the tracking system in the management of coastal ecosystems based on industrial technology 4.0. Mangrove rehabilitation can require commitment from all carbon donors. The automotive industry, although it has developed Low Emission Carbon Vehicles (LECV), is still a carbon contributor. The industrial area in the coastal area, the port area, and the mooring anchorage, as well as carbon contributors, must be involved together with the village. With the information technology system, rehabilitation, and restoration activities in mangrove areas that are contributors to carbon emissions can be monitored. Villages that re-rehabilitate well with the support of the parties will be automatically recorded as green villages. Thus, the government's commitment to reduce village-based carbon emissions will always be monitored. But even greater is the involvement of villages and mangrove rehabilitation as part of village efforts in improving global ecosystems through reducing GHG emissions.

The fifth agenda is to strengthen the ability of villages in disaster mitigation in coastal areas due to tidal waves and tsunamis. Many tsunami incidents such as in Palu and Banten cost trillions of rupiah in losses. The loss of mangrove ecosystems was felt to have lost its ability to protect coastal areas from these disasters. For this reason, it is important to see the ability of mangroves in their role as a barrier to waves and tsunamis as well as tides and floods. Avicennia mangroves with breath roots are able to withstand more significant pressure at low waves, while high waves will be helped if the density of mangroves is large enough.

Based on this description, it is necessary to develop a village work roadmap to ensure that our mangrove ecosystems are saved. The existence of the technology industry 4.0 is also involved in creating ease in managing ecosystems. We need information technology, big data, mangrove application track record applications so that every program related to mangroves can be appropriately recorded. The mangrove paradigm roadmap from the village for the welfare of the community and the world is as follows.

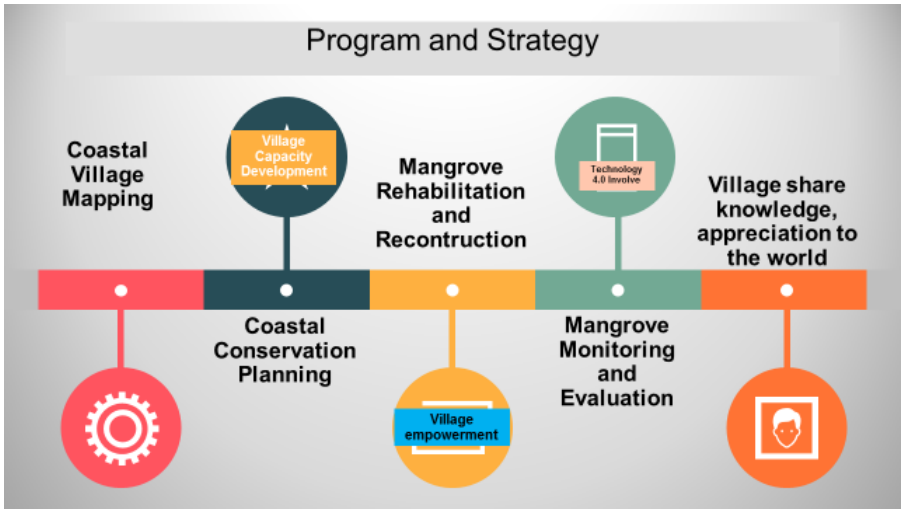

Figure 6. Roadmap of program and strategy for mangrove governance based on village

4.3. Incentive for Village

As the smallest government unit, desa/village is also loaded with diverse institutional systems and mechanisms. The village approach to a more inclusive bottom-up approach involving community participation [22]. This reason, it is very relevant to design various incentive mechanisms to strengthen village performance. Some incentives that can be prepared are as follows.

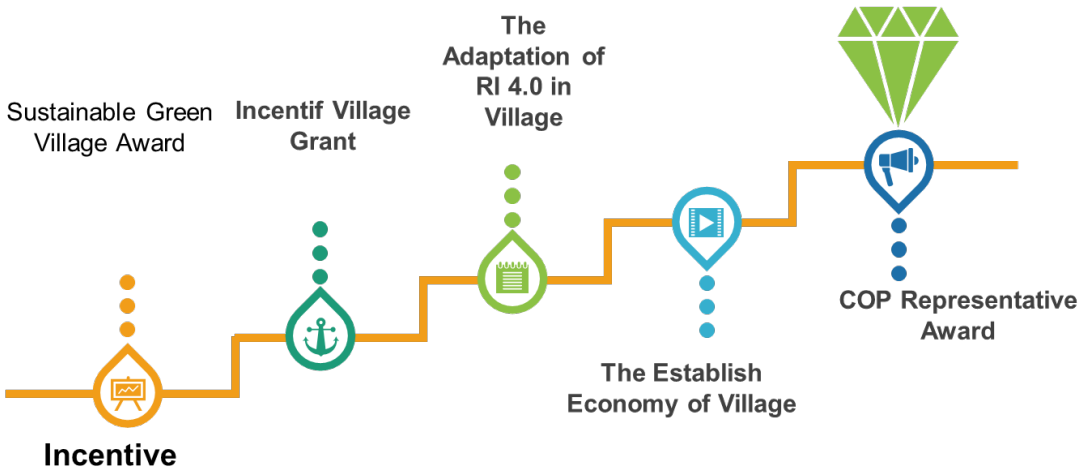

Figure 7. Incentive mechanism for villages that implement mangrove programs

At the initial level, every village that has developed a good conservation system can be given incentives as a recipient of a green village award. If the capacity of the village continues to improve, it needs to be designed through increased village funding. Villages that have successfully utilized 4.0 technology can be prepared as green villages 4.0. If the ability of villages increases in strengthening the economy, then incentives need to be prepared as an economically independent village. If the village's capacity continues to increase to become a green and competitive village, the village head can be appointed as the Village Head Ambassador in every international event related to carbon, the village-based fisheries economy, and in dealing with disasters. The incident can be carried out during the annual Conference of the Parties (COP) meeting or as a delegation in the United Nations (UN)

meeting. An attractive incentive mechanism will be an attraction for villages to work and move forward to save mangroves.

5. Conclusion

The conclusions of this study are ecologically the mangrove area is an area that has the carrying capacity of fisheries, coastal protectors, and the provision of high-value ecosystem services. Mangrove management, as part of a conservation program, must be a responsibility of the village, and the program can use the services of village funds. Globally the concept of mangrove conservation from the village is part of the achievement of the nation's commitment carried out through the village. The national responsibility imposed on this village should be a paradigm that conservation and economic programs are part of what comes from villages to save the world.

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