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# Community-Based Mangrove Protection to Mitigate Climate Change: A Socio-Ecological Approach

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**ABSTRACT**

Protection of the mangrove ecosystem in the Climate Village Program (ProKlim) is a government effort to reduce climate change and reduce Greenhouse Gas (GHG) emissions from an ecological perspective. This study aims to analyze the protection of mangrove ecosystems based on community empowerment in the climate village program (ProKlim) in Pangkalan Jambi Village, Bengkalis Regency. The method used in this research is mixed method by combining quantitative and qualitative technique through observation and in-depth interviews. From the observation results, it was found that the condition of the mangroves in Pangkalan Jambi Village had been damaged. Based on interviews, it was found that community involvement was carried out with the concept of empowerment accompanied by PT. Pertamina Indonesia Refinery (KPI) Sungai Pakning, Bengkalis Regency Government and Riau Provincial Government so that the mindset of the people in Pangkalan Jambi Village, Bukit Batu District, increases positively in protecting the mangrove ecosystem. In protecting the mangrove ecosystem, real action is carried out through planning, implementing nurseries, planting and using technology by involving the community. The novelty of the paper lies in its novel combination of socio-ecological and mixed method approaches to highlight the importance of community-based conservation efforts in mitigating climate change impacts in a mangrove ecosystem protection.

## 1. INTRODUCTION

The effect of greenhouse gas emissions is referred to as a natural phenomenon but is caused by human activities as the origin of climate change [1]. Deforestation and forest degradation, particularly in mangrove forests, are often instigated by human activity. This destruction of forests has resulted in the introduction of a forest mitigation strategy that promotes conservation and sustainable management of the forests in developing countries. The aim of this approach is to minimize the negative impact of human activities on forests. Similar institutional restoration projects have considerable potential to reduce carbon emissions in order to reduce the impact of climate change [2]. Even though climate change and extreme weather events are negatively affecting people's ability to adapt globally, it is clear that particular vulnerabilities exist among individuals or groups, particularly those who depend on agriculture and fishing to support themselves. This means that individuals who rely heavily on agriculture and fishing to sustain their way of life may benefit from tailored support to address the severe impacts of climate change and extreme weather events. Such assistance will help them adjust to the new realities brought about by changes in weather patterns. This could, in turn, reduce their vulnerability and build resilience towards the negative effects of climate change. Under such circumstances, the local wisdom of the community is recognized for its potential to play a key role in climate change adaptation [3], resource management, conservation, and sustainable use of biodiversity and ecosystems [4]. One of the efforts to tackle climate change in Indonesia, the Ministry of Environment and Forestry initiated the climate village program. The Climate Village Program (ProKlim) is the government's effort to reduce climate change and reduce greenhouse gas (GHG) emissions. The implementation of ProKlim is carried out through a bottom-up approach, namely by encouraging various parties to collect information about activities that have been carried out by the community and can provide real benefits to efforts to deal with climate change.

Implementation of the ProKlim strategy certainly reduces the impact of climate change by strengthening community capacity in carrying out climate change adaptation and mitigation efforts, establishing partnerships with relevant ministries/agencies/stakeholders, socializing the success of climate change adaptation and mitigation efforts at the local level, developing and implementing appropriate technology, and optimizing potential sources of funding to support the implementation of ProKlim. Increasing the involvement of the community and other stakeholders to strengthen adaptation capacity to the impacts of climate change and reduce GHG emissions. In addition, there are efforts to provide recognition for climate change adaptation and mitigation efforts that have been carried out which can increase welfare at the local level according to regional conditions in accordance with the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No.

P.84/Menlhk/Setjen/Kum.1/11/2016 concerning the Climate Village Program.

Climate change impacts and solutions transcend traditional administrative boundaries and sectoral policy systems. There is a large body of literature arguing that cross-sectoral social issues such as climate change can be managed most effectively by recognizing and anticipating the fragmented nature of governance regimes in which they exist [5-9]. Integration broadly refers to the process of inserting cross-sectoral policy issues across compartmentalized, fragmented, traditional, or veiled policy subsystems [10, 11]. where most of the decision-making in modern democracies takes place. Policy integration is also referred to as 'mainstreaming' or 'climate policy integration' in the climate change literature [5, 7, 12], or 'coordination' in the policy literature. This study aims to analyze the protection of mangrove ecosystems based on community empowerment in the climate village program (ProKlim) in Pangkalan Jambi Village, Bengkalis Regency, Riau Indonesia. In terms of approach, this research activity utilizes a combination of quantitative and qualitative methods. The purpose of incorporating a mixed method approach is to enhance the validity and reliability of the obtained data and information.

The article was divided into some parts. The first part was introduction which outlines the importance of mangrove protection in mitigating climate change and the role of community-based approaches in achieving this goal. The second part was literature review covering relevant studies and frameworks on community-based natural resource management, mangrove protection, and climate change mitigation. The third section was research method with mixed methods approach, including surveys, interviews, and focus group discussions, to gather data on community participation in mangrove protection and the effectiveness of the socio-ecological approach. The fourth section outlined the research results indicating that community participation in Pangkalan Jambi Village, Bukit Batu District, positively increased in protecting the mangrove ecosystem and that involving the community in the mangrove protection effort enhances the livelihoods and resilience of the community. Lastly, the final part was conclusion highlighting the main findings of the research and highlighting the need for policymakers and development practitioners to recognize the vital role that communities play in achieving global environmental goals.

## 2. LITERATURE REVIEW

Earth is the place where all living things live, and the earth experiences changes that can affect the lives of living things themselves, including humans. Earth changes are caused by human life by creating various technologies for the convenience of life. These various technologies bring economic and social benefits, but an increase in the earth's temperature will cause the GHG effect and the average temperature on earth (atmosphere, earth and oceans) will cause global warming. Global warming is caused by increasing concentrations of greenhouse gases due to human activities such as burning of fossil fuels and deforestation. The only sure method of reducing greenhouse gas emissions today is to reduce consumption of energy and other resources [13]. The involvement of carbon dioxide in the greenhouse effect is quite worrying because it plays a big role in the atmosphere and absorbs more radiation so that the earth's air temperature heats up. Therefore, there will be a partial melting of the polar ice caps, which of course will result in a significant rise in sea level with catastrophic consequences due to climate change. Forest governance is increasingly responding to global claims on forests as a key strategy to address deforestation issues [14].

Global warming will affect the earth and its living things, this global warming also makes the climate on earth change and is called climate change. Climate change on earth will affect human life, flora and fauna, and significant climate change conditions such as air temperature or rainfall over a period of 30 years or more. Climate change will worsen existing health. The population is currently most affected by climate change. Climate change is driven by a dramatic increase in GHG emissions from anthropogenic activities, potentially affecting human health due to rising global average temperatures, increased frequency of heat waves, weather events such as hurricanes, cyclones, and periods of drought, plus changes in the distribution of allergens and transmitted infectious diseases. through animal vectors affected by climate change, resulting in a higher risk of typhus, cholera, malaria, dengue fever, and West Nile virus infection [15].

Climate change is important for humans, and must be handled together, so there is a need to reflect on how to take advantage of 50 years of experience from countries in the world in managing their environment gained since the Stockholm Conference on the Human Environment [16]. Climate change also affects every aspect of development, for this reason environmental aspects must be considered in a sustainable manner, including in building buildings that use electrical energy. Energy-efficient reinforcement for sustainable buildings is a complex system that involves various sustainable dimensions and operational technical schemes [17]. In the development of the environment is part of the aspect of development in Indonesia. The purpose of development is basically carried out to increase the level of community welfare, so that in the development process it is on the macro dimension with state institutions carrying out policies and regulations to influence the process of change in society, as well as the micro dimension with individuals, families and small groups in society influencing the development process itself. Development is a process of change for the better through planned efforts. The process of environmental change is closely related to concerns about the threat of environmental damage to humans, and it is increasingly evident that there is ecological damage, thereby reducing the carrying capacity of nature for human life [18]. Indonesia's commitment to take an active role in controlling the rate of increase in the earth's temperature must be transformed into activities with stakeholders in a more strategic and intelligent approach than usual [8]. The Climate Village Program (ProKlim), which was established as a national movement for community-based climate change control, is one of the government's strategic steps in grounding the global issue of climate change into joint action at the local level [19].

The government has established policies in anticipating global issues, namely climate change with efforts to preserve the environment as stipulated in Law no. 11 of 2020 concerning Job Creation. This policy is described in Government Regulation no. 22 of 2022 concerning Implementation of Environmental Protection and Management and Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No P.84/Menlhk/Setjen/Kum.1/11/2016 concerning the Climate

Village Program. The Climate Village Program (ProKlim) to increase the involvement of the community and other stakeholders to strengthen adaptation capacity to the impacts of climate change and reduce GHG emissions and to provide recognition for climate change adaptation and mitigation efforts that have been carried out which can improve welfare at the local level according to conditions territory. In efforts to strengthen climate villages, strategies are implemented to strengthen community capacity in carrying out climate change adaptation and mitigation efforts, establishing partnerships with relevant ministries/agencies/stakeholders, socializing successful climate change adaptation and mitigation efforts at the local level, developing and implementing appropriate technology, and optimizing potential funding sources to support the implementation of ProKlim [20].

## 3. METHODOLOGY

Methodologically, the design of this research activity uses a mixed method approach. Mixed method is a quantitative approach to opening data and serves to support/strengthen the data and information obtained with a qualitative approach [21]. Mixed methods analysis can provide a more comprehensive understanding of the complex socio-ecological factors influencing mangrove protection for climate change mitigation. By combining quantitative and qualitative data, researchers can gain a more holistic understanding of the issue. Utilizing mixed method is also deemed able to increased validity in term of triangulation, or the use of multiple methods to verify findings, can increase the validity of the research. This can help to ensure that the results accurately reflect the reality on the ground. Moreover, the mixed method approach can provide decision-makers with a nuanced understanding of the community-based mangrove protection efforts. This can help decision-makers make informed choices about how to allocate resources and design policies to support successful outcomes. The mixed method approach can also empower communities by giving them a stake in the process. By including their voices and perspectives, researchers can help to build trust and encourage participation, which can lead to more successful community-based efforts. Qualitative data can provide unique insights into the social, cultural, and political factors influencing mangrove protection. Combining this data with quantitative measurements of ecosystem health can help to identify key challenges and develop effective strategies for climate change mitigation.

The time of the research was carried out in 2022. The research location was in Pangkalan Jambi Village, Bukit Batu District, Bengkalis Regency. The research location can be seen in Figure 1.


**Figure 1.** Administrative map of Pangkalan Jambi Village, Bukit Batu District, Bengkalis Regency

**Table 1.** Research variables and indicators

| Variable | Research Indicators |
|---|---|
| Climate Village Program (ProKlim) / X1 | 1. Climate Change Adaptation Management;<br>2. Management of climate change mitigation;<br>3. Community groups and ongoing support on Ecological, Economic and Social aspects. |
| Community Empowerment / X2 | 1. The effectiveness of the MEC organization in Pangkalan Jambi Village;<br>2. Corporate Social Responsibility (CSR);<br>3. Human Resources (HR) at the MEC of Pangkalan Jambi Village. |
| Policy Effectiveness / M | 1. Effectiveness of ProKlim Policy in Pangkalan Jambi Village;<br>2. MEC institutional capacity in Pangkalan Jambi Village;<br>3. Support from stakeholders in the MEC of Pangkalan Jambi Villagei. |
| Sustainable ecology / Y | 1. Real action on planting and rehabilitating mangroves on the coast of Pangkalan Jambi Village;<br>2. Real action on waste management;<br>3. Real action on integrated coastal management with the integration of ecotourism activities. |

Source: Research Processed Data, 2022.

Data collection techniques were carried out by observation, interviews, questionnaires, FGDs, and documentation which were carried out in the climate village of Pangkalan Jambi Village. Observations were made to observe the types of mangroves that exist in the climate village, namely Pangkalan Jambi Village using a 10×10 m transect with three observation stations. Mangrove ecosystem management as part of the climate village program uses the ProKlim assessment criteria. Interviews and questionnaires were conducted randomly (simple randam sampling) to the community, MEC group managers and the Provincial Environment and Forestry Service (DLHK) Riau, Bengkalis Regency Environmental Service, Bengalis Regency Maritime Affairs and Fisheries Service, Bukit Batu Sub-District Head, Pang Kalan Jambi Village Head. The variables of this study include: 1) ProKlim in the form of real adaptation and mitigation actions in Pangkalan Jambi Village; 2) Community empowerment of MEC Group members and local communities. The research variables and indicators in this study can be seen in Table 1.

The population size based on the unit of analysis above is a resident of Pangkalan Jambi Village, Bukit Batu District, Bengkalis Regency, with a total of 1,195 people consisting of 608 men and 587 women, while the number of household heads is 340 families. Sampling to measure quantitatively in this study is to use the Random Sampling Technique. This sampling method was chosen with the consideration that there were no heterogeneous samples because they were in the same area or location, namely in Pangkalan Jambi Village, Bukit Batu District. Bengkalis without regard to certain characteristics of the respondents, and taking into account the number of samples. The next stage takes into account the number of samples using the Slovin formula [22]. Interactive Analysis is applied to qualitative data collected to strengthen and reinforce quantitative findings. There are three components in interactive analysis, namely data collection, which is a process of selecting, focusing and simplifying and abstracting data from fieldnotes. This stage takes place continuously from the initial stage to the final stage of the research; data display (presentation of data), is a set of information that allows a conclusion to be drawn; and conclusion drawing (drawing conclusions). From the beginning of data collection, the researcher must begin to understand what the things that are found mean.

## 4. RESULTS

### 4.1 Brief overview of research location

The forestry sector owned by Pangkalan Jambi Village is a mangrove ecosystem. The mangrove ecosystem is found in Pangkalan Jambi Village, namely on the coast and the estuary of the Siak Kecil River, while the function of the mangrove ecosystem is as a habitat that plays an important role as a spawning ground and a place for raising various types of fish, shrimp and other biota and is a habitat for various types of birds. mammals, reptiles and mangrove plant species. Mangrove forests located on the coast are used by the community, namely as fishermen, small food and beverage industries, and ecotourism. The potential of this mangrove forest is managed by the community with the main focus being to rehabilitate critical land from the mangrove forest area as an effort to preserve mangrove forests by replanting damaged/dead plants, and the results are very beneficial for the community, especially fishermen. This mangrove forest area is managed by the Harapan Bersama Mangrove Plant Group which is based on an appointment from the Head of Pangkalan Jambi Village. Mangrove forest management is growing, furthermore the Harapan Bersama Mangrove Plant Group formed the Peat Coastal Green Gem which specifically manages mangrove forests. To further maximize the management of this mangrove forest, a Mangrove Education Center (MEC) was formed, to manage mangroves from nurseries, planting, maintenance, supervision and ecotourism as well as educating the community about mangroves in Pangkalan Jambi Village.

The efforts of Permata Hijau Pesisir Peat yielded results and in 2021 thanks to its achievements, Pangkalan Jambi Village, Bukit Batu District, Bengkalis Regency received appreciation in the form of the Best ProKlim award in Riau Province (1st Place) as a village that was successful in managing ProKlim and received the Main Proklim Trophy from the Minister RI Environment and Forestry. At the research locus, observations were made of mangrove ecosystems that are located and live on the coast of Pangkalan Jambi Village based on the 2022 Satellite Image Map (NDVI Analysis) (Figure 2).

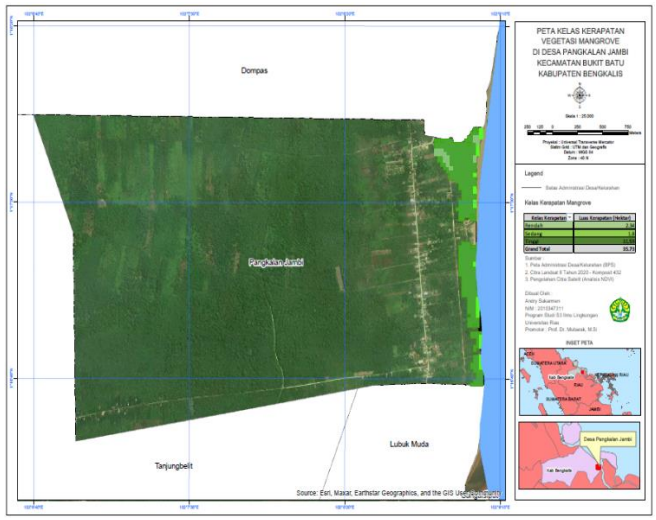


**Figure 2.** Map of mangrove vegetation density class in Pangkalan Jambi Village, districts. Bukit Batu District. Bengkali

The condition of the mangrove ecosystem in the coastal area of Pangkalan Jambi Village is already critical, this is shown by the critical land area data as shown in Table 2.

**Table 2.** Critical land area

| No. | Condition of Mangrove Forest | Area (ha) |
|---|---|---|
| 1. | Somewhat Critical | 150.79 |
| 2. | Critical | 118.83 |
| 3. | Critical Potential | 751.73 |
| 4. | Very Critical | 0.00 |
| 5. | Not Critical | 0.94 |
| 6. | Water Body | 0.09 |
| | Amount | 1,022.40 |

Source: Bappeda Litbang Prov. Riau in 2022.

From Table 2, it can be seen the condition of the mangrove forest in Pangkalan Jambi Village, Kec. Bukit Batu has experienced degradation. It can be seen that the slightly critical condition is 150.79 ha and the critical potential is 118.83 ha.

While the condition of mangrove forests that are good or not critical is 0.94 ha.

### 4.2 Characteristics of mangrove ecosystems

The survey results of the mangrove ecosystem in Pangkalan Jambi Village, Kab. Bengkalis can be seen in Table 3.

**Table 3.** Characteristics of the mangrove ecosystem

| No | Parameter | Station 1 | Station 2 | Station 3 |
|---|---|---|---|---|
| 1 | Number of Types | 7 | 4 | 7 |
| 2 | Diversity index | 1.22 | 1.10 | 1.29 |
| 3 | Number of individuals | 48 | 54 | 60 |
| 4 | Dominant type | *Rhizophora apiculata*, *Nypa fruticans*, *Xylocarpus granatum* | *Rhizophora apiculata Avicennia marina, Sonneratia ovata* | *Scyphiphora hydrophylacea, Rhizophora apiculata, Excoecaria agallocha* |

Source: Survey data, 2022.

Based on Table 3, it can be seen that the number of species found in Pangkalan Jambi Village is 10 species with a range of 4-7 species per station. This type is less than the number of types of mangrove vegetation found in Dumai Bakau Airport based on research [23] which found 17 types of mangroves and research [24] which found as many as 17 types of mangroves in Riau Coastal as well as [25] who found 17 species in the Rawa Mekar Jaya Siak mangroves. This difference can be caused by damage to mangroves in Pangkalan Jambi Village.

This damage can occur due to exploitation and negative dependency levels in the form of logging. If the level of dependence in the form of non-timber forest products will increase the sustainability of mangroves. This is in line with research [26] which examined the level of dependence of the people of Sundarbands Bangladesh on mangroves in the form of food and honey. The damage to the mangroves in Pangkalan Jambi Village has raised the awareness of some people to make this location a restoration location. This restoration location can become a conservation area for fish and other animals. This is in line with research [27] which makes the mangrove location in Pacitan a conservation area by considering ecological aspects. Protection of the mangrove ecosystem in Pangkalan Jambi Village is a major issue in climate change management and mitigation. The protection of this ecosystem is also a concern of the government so that the success of this protection also comes from the share of the central and regional governments. Besides, there is also a relatively large role from the private sector, especially from PT. Pertamina Indonesia Refinery (KPI) Sungai Pakning. Policy interventions by stakeholders play a major role in protecting the mangrove ecosystem in Pangkalan Jambi Village. This is in line with research [28] where government intervention was very helpful in saving mangroves from extinction in Bandar Lampung.

### 4.3 Management of the climate village program (ProKlim) in Pangkalan Jambi Village, Kab. Bengkalis

The condition of the mangrove forest in Pangkalan Jambi Village, Bukit Batu District, is in the critical category, for this reason, the people who are members of the Mangrove Education Center (MEC) are replanting mangrove trees, albeit in stages. MEC has a mangrove forest management area of 18 ha, and has planted 3.5 ha. Initially, this planting was carried out independently, but since 2017 it has received CSR assistance from PT. Pertamina Indonesia Refinery (KPI) Sungai Pakning in the form of goods and assistance. Currently the mangrove forest managed by MEC is used as a Mangrove Ecotourism area, managed with community involvement so that it can be used as an effort to increase community income. Management of Mangrove Ecotourism and preservation of mangrove forests is ProKlim's real action and has received positive responses from the community and even community leaders. The following is the protection of the mangrove ecosystem in ProKlim in Pangkalan Jambi Village (Table 4).

**Table 4.** ProKlim management

| Management | Process |
|---|---|
| Planning | The plan for protecting the mangrove ecosystem was jointly prepared by PT. (KPI) Sungai Pakning and the Harapan Bersama group |
| Organizing | The organization that carries out the protection of the mangrove ecosystem is the Harapan Bersama group based on a joint plan |
| Implementation | The implementation of the protection of the mangrove ecosystem is carried out on a schedule determined jointly by the sponsor and implementer |
| Supervision | Supervision of the protection of the mangrove ecosystem is carried out by PT. (KPI) Sungai Pakning and the Village Government of Pangkalan Jambi |

Source: Processed data, 2022.

Based on Table 4, it can be seen that all aspects of protecting the mangrove ecosystem as part of ProKlim have been going according to the plans made. Each party has a role in managing ProKlim in Pangkalan Jambi Village in relation to reducing global warming. This management has carried out coaching for humans, creating businesses, fostering the environment and fostering institutions. Thus, a coherent and effective plan is needed to get the desired results in protecting the mangrove ecosystem with its various stages. This is in line with the study of Dachi and Djakman [29], who suggested that there are four stages that must be carried out in carrying out stakeholder engagement mapping activities, namely by identifying, analyzing, mapping and prioritizing empowerment, emphasizing the importance of community involvement. Community involvement in protecting mangrove ecosystems is developed both at the program planning, implementation, and development stages [30].

The concept of empowerment in protecting mangroves is related to other aspects such as managers, involvement and related agencies. It is usually always associated with the concepts of independence, participation, networking, justice and sustainability [31]. Wahyudi and Santoso [30] stated that Community Empowerment through the Climate Village Program in Gunung Mulya Village, Gunung Sahilan District, Kampar Regency has carried out the scope and stages of community empowerment activities, namely: human development, business building. environmental development, institutional development. Global warming is a natural event that occurs in human civilization. While others argue that human activity (anthropogenic) has caused an increase in GHG emissions which causes global warming. However,

experts agree that the earth's temperature has increased and this has an impact on the environment and human life. One way to reduce global warming is by protecting the mangrove forests in the research location, namely the mangrove forests in Pangkalan Jambi Village. These forests support unique biodiversity and provide multiple benefits to coastal communities, but as a result of large-scale conversion for aquaculture, agriculture, and urbanization [32]. Furthermore, real action data in Pangkalan Jambi Village can be seen in Table 5.

**Table 5.** ProKlim real action data based on research variables

| Parameter | Data |
|---|---|
| **A. Climate Village Program** | |
| 1. Preparation of rainwater reservoirs (PAH); | 1. The number of PAHs is 325 pieces; |
| 2. Construction of embankments to resist mud abrasion on the coast; | 2. Development of hybrid engineering and Triangle Mangrove Barrier (Trimba):<br>a. Stage I is 340 m long;<br>b. Stage II is 330 m long;<br>c. Stage III is 340 m long; |
| 3. Planting mangrove trees. | 3. The number of trunks planted with mangrove trees is 35,000. |
| **B. Community empowerment** | |
| 1. Utilization of natural resources; | 1. Management of 78 ha of mangrove forest land; |
| 2. Food and beverage products processed from mangrove trees; | 2. Types of food and beverage products as many as 10 types of food and beverage from mangroves; |
| 3. Members of the MEC in Pangkalan Jambi Village. | 3. The number of members in the MEC of Pangkalan Jambi Village is 52 people. |
| **C. Policy Effectiveness** | |
| 1. Rehabilitation of mangrove forests; | 1. Mangrove nursery capacity of 40,000 trees; |
| 2. Management of fish ponds; | 2. The number of tilapias is 50,000; |
| 3. Policy Support from Stakeholders. | 3. The number of facilities and infrastructure consisting of: Production sites, packaging areas, places for drying processed food products, prayer rooms, tourist tracks, monitoring towers, production marketing huts, and nurseries are 1 unit each. |
| **D. Sustainable Ecology** | |
| 1. Mangrove tree planting area. | 1. The total area of planting mangrove trees is 3.5 ha.<br>b. There are 325 trash bins in community housing |
| 2. Waste management facilities; | 2. Area of waste management building:<br>a. 1-unit management area with a size of 150 m² and an office with a size of 48 m². |
| 3. Management of ecotourism | 3. The number of tourists per month is approximately 286 people. |

Source: Interview Results, 2022.

Based on Table 5, it can be seen the activities carried out in protecting the mangrove ecosystem starting from building the capacity of managers through community empowerment programs. This management capacity building activity already has a role in reducing carbon dioxide and producing oxygen. Activities that increase the oxygen content in the air are planting mangroves. The involvement of carbon dioxide in the greenhouse effect is quite worrying because it plays a big role in the atmosphere and absorbs more radiation so that the earth's air temperature heats up. This change is significant with the consequences of a disaster due to climate change. Forest governance is the main strategy to overcome the problem of deforestation, especially the management of mangrove forests. Community involvement is carried out with the concept of empowerment guided by PT. Pertamina Indonesia Refinery (KPI) Sungai Pakning, Bengkalis Regency Government and Riau Provincial Government so that the mindset of the people in Pangkalan Jambi Village, Bukit Batu District, increases in protecting the mangrove ecosystem. In protecting the mangrove ecosystem, real action is carried out in accordance with the Climate Village Program (ProKlim) policy from the Indonesian Ministry of Environment.

One of the problems in implementing mangrove ecosystem protection activities is the lack of knowledge from the community and activity implementers. This resulted in slow implementation of the program. Lack of in-depth knowledge about vulnerability, neglect of local community needs, and inadequate integration of policies and programs have also been identified as challenges to climate change adaptation [33]. In addition, mangrove ecosystem protection activities are only handled by a few community groups. Climate change is important for humans, and must be handled together, so there is a need to reflect on how to utilize 50 years of experience from countries in the world in managing their environment gained since the Stockholm Conference on the Human Environment [34]. Climate change also affects every aspect of development, for this reason environmental aspects must be considered in a sustainable manner, including in building buildings that use electrical energy. Energy-efficient reinforcement for sustainable buildings is a complex system involving multiple dimensions of sustainability and operational technical schemes [17]. Despite addressing some critical challenges, research suggests that these efforts may actually worsen the governance of the system's ability to address cross-cutting policies. sectoral issues in some cases.

In recent years, the pursuit of climate policy integration has gained more traction as a result of policy accumulation and 'responsiveness traps' [35]; citizens are calling for more climate action by governments and governments tend to respond to this call by developing more policy outputs that create complex and often incoherent policy landscapes [36] which in turn need to be strengthened and integrated to overcome their negative impacts. Efforts to pursue policy integration are almost always a combination of structural and process reasons. In general, various facilities are useful for the community, especially protecting the rivers and mangroves in Pangkalan Jambi Village. Protection of open areas also exists in other countries [37]. The mangrove area in Pangkalan Jambi Village is also useful as a tourist area. The promotion of this area already uses technology as has been researched by Saputra et al. [38]. Even though this area was closed due to the Covid-19 pandemic like other places, one of which was Pelabuhan Ratu [39]. Pangkalan Jambi Village Planning has implemented good management and implemented sustainable management with its principles [40]. Besides that, it also uses sustainable energy [41]. All decisions in this management have been taken democratically and involve all stakeholders [42, 43].

## 5. CONCLUSION

The results concluded that the protection of the mangrove ecosystem as part of the climate village program (ProKlim) in Pangkalan Jambi Village, Kab. Bengkalis has been successfully carried out by involving the community. Community involvement is carried out with the concept of empowerment guided by PT. Pertamina Indonesia Refinery (KPI) Sungai Pakning, Bengkalis Regency Government and Riau Provincial Government so that the mindset of the people in Pangkalan Jambi Village, Bukit Batu District, increases in environmental preservation. In managing the environment, concrete actions are carried out in accordance with the Climate Village Program (ProKlim) policy from the Indonesian Ministry of Environment. This provides a positive example of how environmental management can be effective when implemented through a multi-stakeholder approach. The findings also have broader implications for environmental management policies in other areas, as they highlight the importance of community involvement in achieving sustainability goals.

As practical implications, the study highlights the importance of community involvement in protecting the mangrove ecosystem, as it can lead to a greater understanding and appreciation for the environment. This can motivate people to take concrete actions towards preserving the mangroves and other ecosystems. Furthermore, as theoretical implications, the study provides evidence to support the concept of empowerment in environmental management. Empowering the community can help to increase their sense of ownership and responsibility towards the environment. This in turn can lead to greater commitment to environmental protection and sustainability.

One limitation of this study is the lack of long-term data on the effectiveness of the ProKlim program in maintaining the mangrove ecosystem. Future research could track changes in mangrove density and health over time to gauge the program's long-term impact. Additionally, it would be useful to expand this study to other villages to determine if the success in Pangkalan Jambi is replicable in other contexts. Another avenue for future research would be to explore the potential for scaling up the ProKlim program to a national level and to assess the cost-effectiveness of such a program.

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