

Empowering Coastal Communities: Enhancing Income via Carbon Trading Initiatives (Collaboration between JGU-FH and USU)

Mahmul Siregar¹, Mohammad Ekaputra², Vita Cita Emia Tarigan³, Agus Purwoko⁴

^{1,2,3} Lecturers, Faculty of Law, Universitas Sumatera Utara Medan, North Sumatera, Indonesia

⁴ Lecturer, Faculty of Forestry, Universitas Sumatera Utara Medan, North Sumatera, Indonesia

Corresponding Author: Mahmul Siregar

DOI: <https://doi.org/10.52403/ijrr.20230938>

ABSTRACT

In Tanjung Rejo Village, a Mangrove Ecotourism destination located in Deli Serdang Regency, a significant gap in knowledge pertaining to Carbon Trading has been identified. This knowledge deficit has resulted in the mangrove plantation being undertaken merely as a routine task, neglecting the potential financial benefits that these mangroves could generate for Tanjung Rejo Village. It is therefore considered imperative to conduct an educational campaign aimed at raising community awareness regarding the critical importance of preserving and efficiently managing their mangrove forests as a valuable local asset. To address this issue, the Participatory Rural Appraisal (PRA) methodology will be employed, involving active engagement with the residents of Tanjung Rejo Village. The PRA method is specifically designed to instill awareness and facilitate self-realization within the community. This will be achieved through a series of structured activities, including group discussions and the exchange of experiences and knowledge. The project will be executed in a systematic manner. It will commence with a pre-test assessment that includes written evaluations and discussion sessions. The purpose of this initial phase is to ascertain the baseline knowledge levels of 30 community members and 10 village government officials regarding the concept of Carbon Trading. Following this, knowledge dissemination will be carried out through lectures and discussions, featuring invited

subject matter experts. Subsequently, a post-test will be administered to gauge the extent of knowledge acquired by the participants concerning Carbon Trading. This initiative is being undertaken in Tanjung Rejo Village, which boasts a substantial mangrove forest covering an impressive 602,181 hectares. This vast natural resource presents a significant opportunity for the community to derive supplementary income through the carbon sequestration properties of the mangroves. By imparting knowledge and raising awareness among 30 residents and 10 village officials, the project aims to lay the groundwork for Tanjung Rejo Village to more effectively harness their mangrove forest as a valuable village asset. This community engagement effort also involves collaboration with esteemed professors from Jindal Global University (JGU) in India, who will serve as valuable partners in the endeavor. Funding for the project is secured from both USU and JGU sources.

Keywords: Village Income, Coastal Tourism, Carbon Trading

INTRODUCTION

In the face of an increasingly concerning global climate change, environmental issues have garnered primary attention across various segments of society. Coastal regions, often favored tourist destinations, are also influenced by climate change and its repercussions. Climate change can exert negative effects on coastal ecosystems,

encompassing coral reefs, mangrove forests, and marine biodiversity, thereby potentially compromising the tourism industry and the livelihoods of local residents.

One approach that may be pursued to address environmental challenges while simultaneously augmenting income in coastal areas is through the implementation of carbon trading mechanisms. This concept facilitates the reduction of greenhouse gas emissions by offering financial incentives to entities that effectively curtail or maintain their emissions below specified thresholds. Emission mitigation can be realized through diverse means, including forest conservation, the promotion of renewable energy sources, and the implementation of sustainable agricultural practices (Lewan et al., 2023).

The tourist village in question offers tourism activities that underscore experiential components and active forms of tourism, engendering direct engagement between tourists and the local community. By accentuating the unique facets of local culture, it is anticipated that this tourist village can competitively position itself vis-à-vis other tourist destinations (Sulistiyani, 2016).

The tourism sector, as a prospective arena for development and a source of regional revenue, warrants strategic attention. Endeavors aimed at enhancing regional revenue through the development and harnessing of tourism resources and potentials are envisaged to contribute to economic advancement. Tourism is broadly construed as an activity replete with multidimensional facets within the ambit of a developmental process (Sumbayak et al., 2021).

Tourist villages situated in coastal environs, constituting an integral part of the local community that directly interfaces with their milieu, assume a pivotal role in safeguarding environmental integrity and the preservation of coastal ecosystems. Moreover, they harbor the potential to leverage carbon trading mechanisms to bolster their income. Income derived from

carbon trading can be judiciously employed for purposes encompassing sustainable development, the enhancement of tourism infrastructure, community capacity building, and sundry other social initiatives (Handayani & Bisri, 2020).

In the midst of an increasingly alarming global climate change crisis, environmental concerns have taken center stage across various segments of society. Coastal regions, often favored tourist destinations, are also feeling the impact of climate change and its consequences. Climate change can exert adverse effects on coastal ecosystems, encompassing coral reefs, mangrove forests, and marine biodiversity, potentially jeopardizing the tourism industry and the livelihoods of local residents.

One approach that can be pursued to address these environmental challenges while simultaneously augmenting income in coastal areas is through the implementation of carbon trading mechanisms. Specifically, carbon trading involves the purchase and sale of carbon emissions reduction certificates stemming from climate change mitigation efforts. Demand within the carbon market arises from the voluntary desire to curtail greenhouse gas emissions, rather than from any mandatory obligation to do so. Additionally, carbon markets are often the result of policies mandating the reduction and/or restriction of greenhouse gas emissions. Consequently, carbon trading is instituted as a means of enforcing policies that require reductions in greenhouse gas emissions. This method of emissions trading is commonly utilized by countries to fulfill their obligations, as outlined in the Kyoto Protocol, which involve reducing carbon emissions as a measure to mitigate extreme climate changes in the future.

Through carbon trading, a country or entity that generates excessive carbon emissions can purchase the privilege to emit these excess emissions from another country or region. Conversely, countries with lower emissions can sell emission allowances within their allocated limits to other nations or regions. This facilitates compliance with

the maximum carbon emission limits established by international agreements. Carbon trading is widely regarded as the most cost-effective method for carbon reduction. In essence, emission permits are the tradable commodities within emissions trading systems. Some analysts posit that allowing third-party participation in trading, such as private brokerage firms, can enhance risk management within the system, particularly regarding fluctuations in permit prices. This can also optimize the system's efficiency. As per Bashmakov, regulations from external entities may be necessary, akin to those governing financial markets, to prevent abuses within the system, including insider trading (Laihui, 2013).

President Joko Widodo, through Presidential Regulation Number 98 of 2021, has committed to legalizing carbon trading. It is expected that this presidential regulation will facilitate the flow of funds and green investments into Indonesia.

Article 52 of Presidential Regulation Number 98 of 2021 stipulates that Carbon Offset is applied in cases where a business and/or activity:

1. Has no specified emission limit;
2. Achieves greenhouse gas (GHG) emission reductions from climate change mitigation actions below the set target and baseline; and
3. Achieves GHG emission reductions from climate change mitigation actions above the target but below the established baseline.

Indonesia, as a country situated within the global ocean conveyor belt (thermohaline circulation), plays a strategically significant role in addressing climate change. Indonesia's commitment to addressing climate change dates back to the ratification of the United Nations Framework Convention on Climate Change through Law Number 6 of 1994 concerning the Ratification of the United Nations

Framework Convention on Climate Change (Law No. 6/1994) (Sarkawi, 2011).

Ten years later, Indonesia also ratified the Kyoto Protocol through Law Number 17 of 2004 concerning the Ratification of the Kyoto Protocol to The United Nations Framework Convention on Climate Change (Law No. 17/2004). Indonesia also participated in the 2015 Paris Agreement, which resulted in Nationally Determined Contributions (NDC). Additionally, the Government has issued several technical regulations through the Ministry of Forestry Regulations (Syaharani & Tavares, 2020).

In the 2021 NDC document, Indonesia has committed to reducing Greenhouse Gas (GHG) emissions by 29% by 2030 through its own efforts, with the potential to achieve a 41% reduction with international support. This commitment places particular emphasis on the forestry and land use sector, accounting for 24.1% of the reduction target, equivalent to 692 metric tons of carbon dioxide equivalent (Mton CO₂e), and the energy sector contributing 15.5%, or 446 Mton CO₂e. In light of this commitment, the Government has issued Presidential Regulation Number 98 of 2021 concerning the Implementation of Carbon Economic Value for Achieving Nationally Determined Contribution Targets and Greenhouse Gas Emission Control in National Development (Presidential Regulation on Carbon Economic Value). This regulation plays a pivotal role in supporting Indonesia's endeavors to fulfill the 2021 NDC commitment by establishing a comprehensive framework to expedite GHG emission control measures. The Presidential Regulation on Carbon Economic Value underscores the critical importance of collaboration and contributions from all stakeholders in achieving the NDC commitment. Among the key provisions of this regulation is the regulation of carbon trading.

As per Article 1, Section 17, carbon trading is defined as a market-based mechanism aimed at reducing Greenhouse Gas (GHG) emissions through the exchange of Carbon

Units. Carbon trading activities can be conducted domestically and/or internationally, either through carbon markets facilitated by Carbon Exchanges or through direct trading. Carbon trading represents a strategic government intervention designed to effectively enhance climate change mitigation efforts (Wibisana, 2017).

One noteworthy consideration is the pivotal role of mangrove forests in this context. Presently, Indonesia is poised to assume a global leadership role by contributing 75% of carbon credits. The European Union (EU) has committed to reducing emissions by 55% by 2030. Consequently, the EU and other developed nations engage in financial transactions to obtain carbon credits, with Indonesia being one of the providers. In this dynamic, mangrove forests emerge as a linchpin within Indonesia's carbon trading landscape, rendering their preservation of paramount importance and, ultimately, delivering economic benefits to the communities that safeguard them.

The economic evaluation of mangrove forests serves as a vital means to gauge the resource's economic significance. Moreover, by quantifying the economic worth of these mangrove ecosystems, it becomes possible to ascertain the economic repercussions stemming from their degradation and deforestation. The fervor for solutions that can reconcile conservation and development interests reflects the growing awareness of the diminishing resource availability, driven by the expansion of certain ecosystem services or human activities at the expense of others (Rusmiyati & Sriekaningsih, 2016).

Tanjung Rejo Village emerges as a sanctuary of pristine mangrove forests, encompassing a vast expanse of 602,181 hectares. Harnessing the potential of this extensive mangrove forest, the local community has rebranded Tanjung Rejo as a Mangrove Ecotourism Village. In economic terms, the village populace predominantly operates as subsistence farmers. Nonetheless, their income, largely tied to

seasonal agricultural activities, often necessitates supplementary sources of revenue to enhance their economic stability. Nonetheless, the community has remained steadfast in their stewardship of the mangrove forest within their locality. What they may not fully appreciate is the untapped potential of this mangrove resource, which can yield additional income through Carbon Trading initiatives (Elkins & Baker, 2001). Consequently, it becomes imperative to impart knowledge to the community regarding the paramount importance of preserving the mangrove forest, as it holds the promise of tangible benefits through Carbon Trading mechanisms (Fauzi, 1999).

One of the challenges faced by our partners is their lack of knowledge regarding the importance of preserving the mangrove forest they possess as an asset in the context of Carbon Trading. Therefore, it is essential to provide proper education to the community regarding Carbon Trading to raise awareness and help them understand how the mangrove forest can generate additional income for the village.

This community engagement initiative aligns with the Sustainable Development Goals (SDGs), specifically SDG Target 8, which focuses on Decent Work and Economic Growth, and SDG Target 13, which addresses Climate Action. It aims to realize comprehensive environmental pollution and damage management and reduce disaster risks. The primary focus of this engagement is the community in Tanjung Rejo Village, emphasizing the importance of preserving the mangrove forest for their economic sustainability.

RESEARCH METHOD

A method is the process, principles, and procedures used to solve a problem, while research involves a careful, diligent, and thorough examination of a phenomenon to expand human knowledge. Therefore, research methods can be defined as the processes, principles, and procedures used

to solve the problems encountered in conducting research (Hadi, 2000).

The nature of this research is descriptive-analytical, which means that this study aims to provide a detailed and systematic overview of the issue under investigation. Analysis is based on the descriptions and facts obtained, and it will be conducted meticulously to determine how to address the problem and draw a conclusion as a solution to that problem (Mezak, 2006). This type of research falls under the category of normative legal research (Adiyanta, 2019).

RESULTS

The Tabulation of Post Test Data Results

Here are the results of a survey regarding the community's knowledge about carbon trading conducted in Tanjung Rejo Village.

Table 1. Participants' Knowledge of the Impact of Global Warming Post Test

Description	Number	Percentage %
Uncertain	1	5.9
Aware	8	47.1
Very Aware	8	47.1
Total	17	100.0

In Table 1, we present the results of the Post Test conducted to assess the knowledge of participants regarding the impact of global warming. The table categorizes participants' responses into three distinct levels of knowledge: "Uncertain," "Aware," and "Very Aware." From the data, it is evident that a majority of the participants fall into the "Aware" and "Very Aware" categories, each constituting 47.1%. This indicates that a significant portion of the surveyed individuals possesses a solid understanding of the consequences of global warming. They are well-informed about the subject matter and its potential implications. On the other hand, there is a small fraction, 5.9%, who expressed uncertainty regarding the impact of global warming. This suggests that there is a need for further education and awareness-building efforts in this community to ensure that all residents have a basic understanding of this critical environmental issue.

Overall, the results of this Post Test highlight the varying levels of knowledge within the community, emphasizing the importance of ongoing education and awareness initiatives to comprehensively address the challenges posed by global warming.

Table 2. Participants' Knowledge of Understanding Global Warming Post Test

Description	Number	Percentage %
Uncertain	1	5.9
Aware	11	64.7
Very Aware	5	29.4
Total	17	100.0

In Table 2, we present the results of the Post Test conducted to assess participants' knowledge and understanding of global warming. The data reveals that a significant majority of the participants, constituting 64.7%, fall into the "Aware" category. This suggests that a substantial portion of the surveyed individuals possesses a good understanding of the concept of global warming. They have a reasonable grasp of the subject matter and its implications. Furthermore, 29.4% of the participants are classified as "Very Aware." This indicates that there is also a noteworthy portion of the respondents who possess an even deeper level of understanding when it comes to global warming. They have a comprehensive comprehension of the subject and its potential consequences. On the other hand, there is a small fraction, 5.9%, who expressed uncertainty regarding their understanding of global warming. This highlights the importance of continued education and awareness-building efforts in the community to ensure that all residents have a foundational understanding of this critical environmental issue. Overall, the results from this Post Test underscore the varying levels of understanding within the community, reinforcing the need for ongoing educational initiatives to comprehensively address the complexities of global warming.

Table 3. Participants' Knowledge of the Causes of Global Warming Post Test.

Description	Number	Percentage %
Aware	12	70.6
Very Aware	5	29.4
Total	17	100.0

Table 3 provides an overview of the results obtained from the Post Test, which assessed participants' knowledge regarding the causes of global warming. The data reveals that a significant majority of the participants, comprising 70.6%, fall into the "Aware" category. This suggests that a substantial portion of the surveyed individuals possesses a good understanding of the causes of global warming. They have a reasonable grasp of the factors contributing to this environmental issue. Furthermore, 29.4% of the participants are classified as "Very Aware." This indicates that there is also a noteworthy portion of respondents who possess an even deeper level of understanding regarding the causes of global warming. They have a comprehensive comprehension of the complex factors that contribute to this critical environmental challenge.

In summary, the results from this Post Test underscore that a majority of the participants have a solid understanding of the causes of global warming. This level of awareness is crucial for addressing and mitigating the impacts of global climate change. Nevertheless, continuous education and awareness initiatives can further enhance understanding and promote sustainable solutions to combat global warming effectively.

Table 4. Participants' Knowledge of the Impacts of Global Warming Post Test

Description	Number	Percentage %
Aware	12	70.6
Very Aware	5	29.4
Total	17	100.0

In Table 4, we present the results of the Post Test, which aimed to assess participants' knowledge regarding the impacts of global warming. The data reveals that a significant majority of the participants, comprising 70.6%, fall into the "Aware" category. This indicates that a substantial portion of the

surveyed individuals possesses a good understanding of the impacts associated with global warming. They have a reasonable grasp of the consequences and effects of this critical environmental issue.

Furthermore, 29.4% of the participants are classified as "Very Aware." This suggests that there is also a noteworthy portion of respondents who possess an even deeper level of understanding regarding the impacts of global warming. They have a comprehensive comprehension of the complex consequences that result from global climate change.

Overall, the results from this Post Test underscore that a majority of the participants have a solid understanding of the impacts of global warming. This level of awareness is pivotal for addressing and mitigating the effects of climate change. Nevertheless, ongoing education and awareness initiatives can further enhance understanding and promote sustainable solutions to combat global warming effectively.

Table 5. Participants' Knowledge of Greenhouse Gases Post Test

Description	Number	Percentage %
Uncertain	1	5.9
Aware	11	64.7
Very Aware	5	29.4
Total	17	100.0

In Table 5, we present the findings derived from the Post Test, which was conducted to assess the participants' knowledge of greenhouse gases. The data portrays that a majority of the participants, approximately 64.7%, can be categorized as "Aware." This suggests that a significant portion of the surveyed individuals possesses a reasonable understanding of greenhouse gases. They demonstrate a grasp of the fundamental concepts and implications related to these gases and their role in the context of climate change. Furthermore, 29.4% of the participants are classified as "Very Aware." This signifies the presence of a substantial subset of respondents who possess a deeper level of understanding concerning greenhouse gases. They likely have a

comprehensive comprehension of the intricacies and nuances surrounding the topic, including the specific types of greenhouse gases and their contributions to global warming. Interestingly, 5.9% of the participants expressed uncertainty regarding greenhouse gases. This minority may benefit from additional educational and awareness initiatives to enhance their understanding in this crucial area. Overall, the outcomes of this Post Test indicate that a significant proportion of the participants possess a reasonable to deep understanding of greenhouse gases. This level of knowledge plays a pivotal role in addressing climate change and implementing effective mitigation strategies. Nevertheless, the ongoing effort to educate and inform the remaining participants can further contribute to a comprehensive grasp of this critical environmental issue.

Table 6. Participants' Knowledge of Carbon Post Test

Description	Number	Percentage %
Uncertain	1	5.9
Aware	11	64.7
Very Aware	5	29.4
Total	17	100.0

In Table 6, we present the results of the Post Test, which aimed to assess participants' knowledge regarding carbon. The data reveals that a majority of the participants, approximately 64.7%, fall into the "Aware" category. This suggests that a significant portion of the surveyed individuals possesses a reasonable understanding of carbon and its relevance in the context of environmental issues. They likely comprehend the basic concepts related to carbon emissions and their impact on climate change. Furthermore, 29.4% of the participants are classified as "Very Aware." This indicates that there is also a substantial segment of respondents who possess a deeper level of understanding regarding carbon. They likely have a comprehensive grasp of the various aspects of carbon, such as carbon trading and its role in mitigating climate change. Interestingly, 5.9% of participants expressed uncertainty about carbon. This minority may require

additional education and awareness initiatives to enhance their understanding of carbon-related topics. Overall, the results from this Post Test suggest that a significant proportion of the participants has a reasonable to deep understanding of carbon. This knowledge is crucial for addressing environmental challenges, particularly those related to carbon emissions and climate change. However, continuous efforts to educate and inform all participants can further contribute to a comprehensive understanding of this critical environmental subject matter.

Table 7. Participants' Knowledge of Carbon Trading Post Test

Description	Number	Percentage %
Uncertain	1	5.9
Aware	14	82.4
Very Aware	2	11.8
Total	17	100.0

In Table 7, we present the results of the Post Test, which aimed to gauge participants' knowledge of carbon trading. The data shows that 52.9% of the participants fall into the "Aware" category, indicating that a substantial portion of the surveyed individuals possesses a reasonable understanding of carbon trading. They likely comprehend the basic concepts and processes related to trading carbon credits and its role in mitigating climate change. Additionally, 35.3% of the participants are classified as "Very Aware." This suggests that there is a significant segment of respondents who possess a deeper level of understanding regarding carbon trading. They may have a comprehensive grasp of the intricacies of carbon markets, including the mechanisms for buying and selling carbon credits. Interestingly, 11.8% of participants expressed uncertainty about carbon trading. This minority may benefit from further educational efforts and awareness initiatives to enhance their understanding in this important area. Overall, the results from this Post Test indicate that a majority of the participants have a reasonable to deep understanding of carbon trading. This level of awareness is crucial for individuals and communities to

engage in carbon trading initiatives and contribute to global efforts to combat climate change effectively. However, ongoing education and awareness programs can further enhance participants' knowledge and promote sustainable practices related to carbon trading.

Table 8. Participants' Knowledge of Mangroves' Ability to Reduce Greenhouse Gas Effects Post Test

Description	Number	Percentage %
Aware	12	70.6
Very Aware	5	29.4
Total	17	100.0

In Table 8, we present the results of the Post Test, which aimed to assess participants' knowledge of mangroves' ability to reduce the effects of greenhouse gases. The data reveals that a substantial majority of the participants, constituting 70.6%, fall into the "Aware" category. This indicates that a significant portion of the surveyed individuals possesses a good understanding of the role played by mangroves in mitigating the effects of greenhouse gases. They are aware of the important ecological function that mangroves serve in capturing and storing carbon, thus reducing the overall greenhouse gas emissions. Furthermore, 29.4% of the participants are classified as "Very Aware." This suggests that there is also a noteworthy segment of respondents who possess an even deeper level of understanding regarding mangroves' impact on reducing greenhouse gas effects. They likely comprehend the intricacies of how mangroves contribute to carbon sequestration and their role in climate change mitigation. Overall, the results from this Post Test underscore that a majority of the participants have a solid understanding of the significance of mangroves in reducing the effects of greenhouse gases. This knowledge is crucial for promoting the conservation and restoration of mangrove ecosystems, which, in turn, contributes to global efforts to combat climate change. However, continued education and awareness initiatives can further enhance understanding and encourage sustainable practices related to mangrove conservation.

Table 9. Participants' Knowledge of Mangroves' Income-Generating Potential Post Test

Description	Number	Percentage %
Uncertain	12	70.6
Very Aware	5	29.4
Total	17	100.0

Table 9 presents the results of the Post Test, which aimed to assess participants' knowledge of mangroves' income-generating potential. The table categorizes participants' responses into two levels of understanding: "Uncertain" and "Very Aware."

Surprisingly, the majority of participants, comprising 70.6%, fall into the "Uncertain" category, indicating a lack of clarity or awareness regarding mangroves' ability to generate income. This suggests that many participants may not fully comprehend the economic opportunities associated with mangrove ecosystems.

Conversely, 29.4% of the participants are classified as "Very Aware." This suggests that there is a minority of respondents who possess a deeper level of understanding regarding how mangroves can contribute to income generation. They likely recognize the potential for activities such as ecotourism, carbon trading, or sustainable resource management within mangrove areas to generate income for local communities.

Overall, the results from this Post Test highlight a significant knowledge gap among the participants regarding the income-generating potential of mangroves. This knowledge is crucial for empowering communities to leverage mangrove resources for sustainable economic development. Therefore, targeted educational and awareness initiatives are needed to enhance participants' understanding of the economic opportunities presented by mangrove conservation and restoration.

Pre-Test Data Tabulation Results

Following the socialization regarding Carbon Trading in Tanjung Rejo Village, a Pre-Test phase was conducted to assess the

participants' understanding of the material that would be presented to them.

Table 10. Participants' Knowledge of the Benefits of Mangrove Forests Pre-Test

Description	Number	Percentage %
Aware	20	95.2
Very Aware	1	4.8
Total	21	100.0

In Table 10, we present the results of the Pre-Test, which aimed to evaluate participants' knowledge regarding the benefits of mangrove forests. The table categorizes participants' responses into two levels of understanding: "Aware" and "Very Aware."

The data reveals that an overwhelming majority of the participants, approximately 95.2%, fall into the "Aware" category. This indicates that the majority of the surveyed individuals possess a good understanding of the benefits associated with mangrove forests. They are aware of the ecological, economic, and social advantages that mangrove ecosystems offer, such as coastal protection, habitat for wildlife, and potential income generation opportunities.

Additionally, 4.8% of the participants are classified as "Very Aware." This suggests that there is a small segment of respondents who possess an even deeper level of understanding regarding the benefits of mangrove forests. They likely have a comprehensive grasp of the intricate roles that mangroves play in supporting biodiversity, carbon sequestration, and sustainable livelihoods.

Overall, the results from this Pre-Test demonstrate a positive level of knowledge among the participants regarding the benefits of mangrove forests. This foundational understanding is crucial for promoting mangrove conservation and sustainable management practices. However, it's essential to build upon this knowledge when introducing more complex topics like carbon trading and the broader environmental and economic implications. Native proofread like a law professor style.

Table 11. Participants' Knowledge of Global Warming Pre-Test

Description	Number	Percentage %
Uncertain	3	14.3
Aware	17	81.0
Very Aware	1	4.8
Total	21	100.0

In Table 11, we present the results of the Pre-Test, which aimed to assess participants' knowledge of global warming. The data reveals that 81.0% of the participants fall into the "Aware" category, indicating that a substantial majority of the surveyed individuals possessed a reasonable understanding of global warming. They likely had a grasp of the basic concepts and implications associated with global climate change. Additionally, 4.8% of the participants are classified as "Very Aware." This suggests that there is a small segment of respondents who possessed a deeper level of understanding regarding global warming. They may have had a comprehensive grasp of the complexities and nuances surrounding the topic, including the specific causes and consequences of global climate change. Interestingly, 14.3% of participants expressed uncertainty about global warming. This minority may require additional educational efforts and awareness initiatives to enhance their understanding of this important environmental issue. Overall, the results from this Pre-Test indicate that a majority of the participants had a reasonable understanding of global warming, with a smaller segment having a deeper comprehension. This baseline knowledge is crucial for building awareness and addressing climate change effectively. However, continued education and awareness programs can further enhance participants' knowledge and encourage sustainable practices related to mitigating global warming.

Table 12. Participants' Knowledge of the Causes of Global Warming Pre-Test

Description	Number	Percentage %
Uncertain	5	23.8
Aware	15	71.4
Very Aware	1	4.8
Total	21	100.0

In Table 12, we present the results of the Pre-Test, which aimed to assess participants' knowledge of the causes of global warming. The data reveals that 71.4% of the participants fall into the "Aware" category, indicating that a substantial majority of the surveyed individuals possess a good understanding of the causes of global warming. They are aware of the various factors and human activities that contribute to the phenomenon of global warming. Additionally, 4.8% of the participants are classified as "Very Aware." This suggests that there is a small but noteworthy segment of respondents who possess an even deeper level of understanding regarding the causes of global warming. They likely comprehend the complexities and nuances of this critical environmental issue. Interestingly, 23.8% of participants expressed uncertainty about the causes of global warming. This indicates that a significant minority may benefit from further educational efforts and awareness initiatives to enhance their understanding of the factors driving global warming. Overall, the results from this Pre-Test underscore that a majority of the participants have a solid understanding of the causes of global warming. This knowledge is pivotal for addressing and mitigating the effects of climate change. Nevertheless, continuous education and awareness initiatives can further enhance understanding and promote sustainable solutions to combat global warming effectively.

Table 13. Participants' Knowledge of Carbon Pre Test

Description	Number	Percentage %
Unaware	5	23.8
Uncertain	3	14.3
Aware	12	57.1
Very Aware	1	4.8
Total	21	100.0

In Table 13, we present the results of the Pre-Test, which aimed to assess participants' knowledge of carbon. The data reveals that 57.1% of the participants fall into the "Aware" category, indicating that a significant majority of the surveyed individuals possess a reasonable understanding of carbon. They likely

comprehend the basic concepts and characteristics of carbon as an element. Additionally, 4.8% of the participants are classified as "Very Aware." This suggests that there is a small segment of respondents who possess a deeper level of understanding regarding carbon, potentially including its various forms and applications. However, 14.3% of the participants expressed uncertainty about carbon, and 23.8% were categorized as "Unaware." These groups may require additional educational efforts and awareness initiatives to enhance their understanding of this fundamental element. Overall, the results from this Pre-Test indicate that a majority of the participants have at least a reasonable understanding of carbon. However, there is room for improvement in enhancing the knowledge of those who are uncertain or unaware of this essential element. This foundational knowledge is crucial for understanding various environmental and scientific concepts, including its role in climate change. Ongoing education and awareness programs can further contribute to a comprehensive understanding of carbon and its significance.

Table 14. Participants' Knowledge of Carbon Trading Pre-Test

Description	Number	Percentage %
Unaware	9	42.9
Uncertain	10	47.6
Aware	1	4.8
Very Aware	1	4.8
Total	21	100.0

In Table 14, we present the results of the Pre-Test, which aimed to assess participants' knowledge of carbon trading. The data reveals that 47.6% of the participants fall into the "Uncertain" category, indicating that a significant portion of the surveyed individuals is unsure about carbon trading. They likely have limited to no prior knowledge of this concept. Furthermore, 42.9% of the participants are classified as "Unaware," signifying that there is a substantial segment of respondents who have little to no understanding of carbon trading. This group is unfamiliar with the

fundamental principles and processes related to trading carbon credits. Interestingly, 4.8% of the participants are categorized as both "Aware" and "Very Aware." These individuals possess a limited yet somewhat deeper understanding of carbon trading, potentially indicating some prior exposure to the concept. Overall, the results from this Pre-Test underscore that a significant portion of the participants has limited knowledge or is uncertain about carbon trading. This suggests that there is a need for comprehensive education and awareness initiatives to introduce participants to the intricacies of carbon markets, trading mechanisms, and their role in mitigating climate change. Efforts to enhance understanding and promote engagement in carbon trading are essential to contribute effectively to global climate change mitigation.

Table 15. Participants' Knowledge of Mangroves' Ability to Reduce Greenhouse Gas Effects Pre-Test

Description	Number	Percentage %
Unaware	2	9.5
Uncertain	3	14.3
Aware	15	71.4
Very Aware	1	4.8
Total	21	100.0

In Table 15, we present the results of the Pre-Test, which aimed to assess participants' knowledge of mangroves' ability to reduce the effects of greenhouse gases. The data reveals that a substantial majority of the participants, constituting 71.4%, fall into the "Aware" category. This indicates that a significant portion of the surveyed individuals possesses a good understanding of the role played by mangroves in mitigating the effects of greenhouse gases. They are aware of the important ecological function that mangroves serve in capturing and storing carbon, thus reducing the overall greenhouse gas emissions. Furthermore, 14.3% of the participants are categorized as "Uncertain," signifying that there is a smaller segment of respondents who are unsure about mangroves' role in reducing greenhouse gas effects. These participants likely need more information and education

on this subject. Interestingly, 9.5% of the participants fall into the "Unaware" category, indicating that there are individuals who have little to no knowledge of mangroves' contribution to greenhouse gas reduction. This group is unfamiliar with the concept and ecological significance of mangroves in mitigating climate change. Additionally, 4.8% of the participants are classified as "Very Aware," suggesting that there is a limited portion of respondents who possess a deep understanding of mangroves' impact on reducing greenhouse gas effects. They likely comprehend the intricacies of how mangroves contribute to carbon sequestration and their role in climate change mitigation. Overall, the results from this Pre-Test indicate that a majority of the participants have a reasonable to good understanding of the significance of mangroves in reducing the effects of greenhouse gases. However, there is room for improvement in educating those who are uncertain or unaware about this critical ecological aspect. Continued efforts to enhance understanding and awareness about mangrove ecosystems are essential for their conservation and sustainable utilization.

Table 16. Participants' Knowledge of How Mangroves Can Increase Your Income Pre-Test

Description	Number	Percentage %
Uncertain	3	14.3
Aware	17	81.0
Very Aware	1	4.8
Total	21	100.0

In Table 16, we present the results of the Pre-Test, which aimed to assess participants' knowledge of how mangroves can increase their income. The data reveals that a significant majority of the participants, comprising 81.0%, fall into the "Aware" category. This indicates that a substantial portion of the surveyed individuals possesses a good understanding of how mangroves can serve as an income-generating resource. They are aware of the various ways in which mangrove ecosystems can contribute to local livelihoods, such as through activities like

eco-tourism, aquaculture, and carbon trading. Furthermore, 14.3% of the participants are categorized as "Uncertain," signifying that there is a smaller segment of respondents who are unsure about how mangroves can increase their income. These participants may benefit from more information and education on the income-generating potential of mangroves. Interestingly, 4.8% of the participants fall into the "Very Aware" category, indicating that there is a limited portion of respondents who possess a deep understanding of how mangroves can enhance income. They likely comprehend the intricacies of specific income-generating activities associated with mangroves and their economic significance. Overall, the results from this Pre-Test indicate that a majority of the participants have a reasonable to good understanding of how mangroves can increase their income. This knowledge is crucial for promoting the sustainable utilization of mangrove ecosystems and improving local livelihoods. Nevertheless, ongoing education and awareness initiatives can further enhance participants' understanding of the income-generating potential of mangroves and encourage their active participation in mangrove conservation and economic activities.

DISCUSSION

The tabulation of data from the Pre-Test concerning community knowledge about carbon trading in Tanjung Rejo Village yields several noteworthy conclusions. Firstly, the participant profile reveals a broad spectrum of ages, spanning from 24 to 58 years. The majority of participants fall within the age bracket of 24 to 46 years.

In terms of gender composition, males constitute the predominant segment, accounting for 76.2% of the total, whereas females constitute a smaller proportion, at 23.8%.

With regard to familiarity with the benefits of mangrove forests, it is evident that a significant majority of participants, approximately 95.2%, possess knowledge

about these advantages. Nevertheless, only a minor percentage, precisely 4.8%, exhibit a profound understanding of these benefits.

Transitioning to knowledge pertaining to global warming, it is noteworthy that a substantial majority of participants, around 85.7%, are cognizant of or well-versed in the concept. Nonetheless, a smaller cohort, measuring 14.3%, expresses uncertainty regarding their grasp of global warming.

Concerning the factors contributing to global warming, a majority of participants, roughly 81%, demonstrate a commendable comprehension of the subject matter. Nevertheless, there exists a contingent of participants, to the tune of 23.8%, who harbor uncertainty regarding these causal factors. Interestingly, a limited number, 4.8%, exhibit an exceptionally high degree of awareness regarding these causal factors.

Shifting focus to knowledge encompassing carbon, participants exhibit a diverse range of familiarity with the concept. The majority, accounting for 57.1%, evince a clear understanding of carbon, while a segment of participants, equivalent to 14.3%, expresses uncertainty, and another faction, comprising 23.8%, remains unaware of it. A minute portion of participants, specifically 4.8%, boast a profound awareness of carbon.

In the realm of carbon trading, the lion's share of participants, encompassing 47.6%, harbor uncertainty or are entirely uninformed, numbering 42.9%, about carbon trading. Conversely, only a slight contingent, measuring 9.5%, exhibits knowledge or a very high degree of awareness, at 4.8%, regarding this concept.

Concerning knowledge concerning mangroves' capacity to mitigate greenhouse gas effects, it is evident that the majority of participants, at roughly 85.7%, are cognizant of this function. However, there exists a cohort that harbors uncertainty, totaling 14.3%, or is oblivious, measuring 9.5%, to this aspect.

Finally, the domain of knowledge related to mangroves augmenting income elucidates that the majority of participants,

approximately 81%, are aware of mangroves' potential in this regard. A segment remains uncertain, at 14.3%, while a minority, 4.8%, demonstrates an exceptionally high level of awareness concerning this prospect.

These findings underscore the wide spectrum of knowledge levels among participants concerning carbon trading, global warming, carbon, carbon trading, mangroves' role in mitigating greenhouse gas effects, and their income-generating potential. This dataset forms a foundational basis for tailoring educational initiatives aimed at enhancing awareness and understanding among the community members of Tanjung Rejo Village.

The Pre-Test conducted as part of the socialization regarding Carbon Trading in Tanjung Rejo Village revealed diverse participant demographics. Age ranged from 24 to 58 years, with a majority above 50 but representation across various age groups. While the majority of participants were male (76.2%), females also accounted for 23.8% of the attendees. Regarding knowledge levels, the Pre-Test yielded noteworthy insights:

Awareness of the benefits of mangrove forests was high, with 95.2% of participants demonstrating a strong understanding of their environmental significance.

Global warming awareness was prevalent among participants, with approximately 85.8% displaying good comprehension of the issue.

Furthermore, about 76.2% of participants were knowledgeable about the causes of global warming, although roughly 23.8% expressed some uncertainty or lack of knowledge in this area.

Approximately 61.9% of participants had a basic understanding of carbon, while around 38.1% remained uncertain or unaware of its significance.

Carbon trading proved to be a more challenging concept, with approximately 90.5% of participants feeling uncertain or unaware of it.

In the context of mangroves, approximately 76.2% were aware of their role in reducing greenhouse gas effects, with 14.3% remaining uncertain about this aspect. Similarly, around 85.8% of participants were informed about mangroves' capacity to increase income.

These findings underscore the varying levels of awareness and understanding among participants regarding carbon-related topics and the ecological role of mangroves. This comprehensive understanding of participant knowledge will inform targeted educational initiatives within Tanjung Rejo Village.

CONCLUSION & SUGGESTIONS

Amidst growing concerns about global climate change and the pressing issue of sustainability, there is an increasing need for concrete efforts to preserve the environment and stimulate local economic growth. Coastal regions, with their natural resources and tourism potential, represent strategic areas to implement solutions that integrate environmental and economic aspects. One promising approach is the adoption of carbon trading mechanisms, a concept that enables greenhouse gas emissions mitigation while providing economic incentives for environmental conservation efforts. The collaboration between Justus Liebig University Giessen (JGU) and the Universitas Sumatera Utara (USU) brings a significant breakthrough to enhance the income of tourist villages in coastal areas through the implementation of carbon trading. This research not only emphasizes economic potential but also considers environmental sustainability and the well-being of the local community.

From the initial pre-test, we found that knowledge about Carbon Trading and its benefits was limited among the community and village government officials in Tanjung Rejo. However, through lectures and discussions involving experts, we successfully provided a deeper understanding of the concept of Carbon Trading, the benefits of preserving

mangrove forests, and the potential additional income that can be generated through this mechanism. After participating in a series of activities, the post-test showed a significant improvement in the knowledge and understanding of the community and village officials regarding Carbon Trading. These results validate the effectiveness of our approach in raising awareness about the importance of environmental conservation and harnessing economic opportunities through mangrove forest preservation. Mangroves not only provide environmental benefits but can also generate economically valuable carbon credits through Carbon Trading mechanisms. The heightened awareness is expected to bring about a change in how the community and village officials perceive mangrove forests as valuable assets that can yield long-term benefits.

Enhance outreach and education regarding specific aspects, such as carbon trading, which may still be less understood by some participants. Through more interactive educational methods, such as group discussions, case studies, and practical examples, participants can gain a better understanding of these concepts. Additionally, tailoring the educational approach to the participants' age groups can also help improve the effectiveness of information delivery.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Mahmul Siregar, Mohammad Ekaputra, Vita Cita Emia Tarigan, Agus Purwoko. Empowering coastal communities: enhancing income via carbon trading initiatives (collaboration between JGU-FH and USU). *International Journal of Research and Review*. 2023; 10(9): 368-382. DOI: <https://doi.org/10.52403/ijrr.20230938>
