Mitigation Climate Change: Strengthening Agroforestry at the District XIII Koto Kampar, Riau. Indonesia

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Abstract. Plant management system on land owned by agroforestry pattern in the district. XIII Koto Kampar in Riau Province indirectly was a form of community participation as one of the efforts to mitigate and adapt to climate change. Interview methods and questionnaires with the community were used to find out the primary purpose of the city in developing agroforestry on their land and to know the perception and knowledge of the community on the role of agroforestry in climate change mitigation efforts. Land utilization with agroforestry patterns has been applied 25\% of respondents, but the area of land used as agroforestry was still relatively small at 10\% with the dominant types of plants are rubber, agarwood, and durian. The results showed that most people developed agroforestry patterns with two or more types because this pattern is more profitable regarding fulfilling the needs of short-term and long-term life. From an economic standpoint, the community developed rubber plants that are combined with other crops that have commercial value with the primary objective as an additional income especially with frequent fluctuations in the prices of the planted commodities. Meanwhile, regarding the environment, agroforestry has a vital role in protecting flora and fauna, protecting the environment, and reducing global warming.

Keywords: Agroforestry, community knowledge, climate change, mitigation

1. Introduction

Human activities have led to an increase in greenhouse gas (GHG) emissions that cause the phenomenon of global warming and resulted in climate change. Climate change occurs undoubtedly. Climate change occurs slowly but surely. Also, climate change has an impact on all sectors of life. Agroforestry is one form that can be an alternative in climate change mitigation efforts because it has an excellent ability in carbon sequestration, reducing erosion and landslide hazard in the highlands. Agroforestry as one of the planting system of various types of plants that combine woody or perennial forestry plants with other plants is one form of planting activities undertaken by farmers in different regions. This pattern has an advantage over the ecosystem and climate change mitigation because it resembles a secondary forest that has carbon sequestration capability, environmental services, prevent landslides and floods.
Based on the results of research conducted in District XIII Koto Kampar there are models of rubber-based agroforestry found are three forms of Rubber-Gaharu-Durian model, Rubber-Durian and Rubber-agarwood model with the composition of agroforestry plants comprises a mixture of rubber-gaharu-durian and other varied plants in each plot. Agroforestry in this area can absorb carbon content of 46.54 tons/ha, with biomass of 101.17 ton / ha (insanity, et.al 2018a). Types of crops grown by farmers are rubber plants combined with durian and agarwood plants that are expected to produce yields to farmers for a land area of 1-2 ha per farmer (insusanty et al., 2018b)

Agroforestry management system in the community has a problem because of the low income that is derived from agroforestry activities so that in some places community land is now also found the presence of oil palms. Overcome this; it is necessary to strengthen agroforestry efforts for farmers to be able to use their land more productively while maintaining the pattern of agroforestry planting because it is one of the solutions in mitigating climate change. The average profit of agroforestry farmers per year on average is Rp 57,568,692 with a land area of 1-2 ha per farmer.

The research aims to study the development of agroforestry as a climate change mitigation effort in the district XIII Koto Kampar, Kampar Regency, Riau Province. By knowing the primary purpose of the community in developing agroforestry in their land and the perception and knowledge of the city on the role of agroforestry in climate change mitigation efforts, it is hoped that agroforestry development at the community level can be used as an effort in climate change mitigation and adaptation.

2. Research Methods

2.1. Location and Time

This research was conducted in District XIII Koto Kampar Kampar regency, Riau Province in February - June 2018. District XIII Koto Kampar, Kampar Regency was chosen purposively (purposive sampling) because the community mostly develops rubber plant conducted in monoculture and agroforestry in the field theirs. The three villages that were the focus of this activity were Pulau Gadang Village, Koto Masjid Village, and Tanjung Alai Village.

2.2. Data and Research Methods

Data used in this research are primary data and secondary data related to the research focus. Primary data in the form of public perception by using questionnaire with purposive sampling method. Primary data are socio-economic characteristics of the community, motivation in agroforestry development and community knowledge and understanding of environmental issues and climate change mitigation. The socio-economic characteristics data include education level, occupation, age, income, the area of land ownership and community planted species. Respondents were selected from villages sampled from the study area to obtain information on climate change, community conservation behavior. Conditions in the selection of respondents are a) residents who have long lived in the area, at least 20 years; b) Adults; c) be willing and can explain the theme or topic being discussed; d). Community leaders or village apparatus; e). Farmers landowners. In each village, 25 respondents were chosen to represent various community groups. Among these respondents, there were critical informants including community leaders. The secondary data were taken in the affected institutions, among others: Village Office, BLH Kampar Regency, Central of Statistics, and research literature.

2.3. Data Analysis

Data obtained from the field are then analyzed descriptively qualitative and quantitative to know the main objectives of the community in the management of agroforestry and the extent to which people's perceptions and knowledge on climate change mitigation
3. Results And Discussion

3.1 Biophysical Research Locations

In general, XIII Koto Kampar district in Kampar Regency is an area in Riau Province with an area of 92,036 Ha with a total of 13 villages. The land is used by the community with plantation business and borders on the province of West Sumatra. This village is also charming and has a natural reserve of the Koto Panjang PLTA lake so that it has the potential of natural tourism which many people are starting to glance at. So that the sustainability of vegetation will have an impact on the water source in the Koto Panjang hydropower lake with the presence of a lake is also a high potential for fisheries. Being on the crossroads of Riau - West Sumatera makes good accessibility but not reach as a whole.

There are no boundaries of this sub-district bordering the sea, but there are some areas that are bounded by lakes, rivers as natural boundaries with other districts. The limitations of XIII Koto Kampar Subdistrict include:

• North borders with Tapung District
• South borders with Kampar Kiri Hulu District.
• West border with KotoKampar Hulu district and Lima PuluhKota regency Sumatera Barat province.
• East border with Bangkinang Barat District, Salo District, and Kampar Kiridistrict.

The largest village in district XIII Koto Kampar is Balung Village with an area of about 60,000 ha or approximately 65.19% of the city of XI Koto Kampar District. District XIII Koto Kampar is generally located in the plains area, Lake PLTA, which is traversed by the Kampar River and several another small river (BPS Kampar Regency, 2016).

The population of district XIII Koto Kampar was 25,379 in 2016 with a total male population of 13,127 and a total female population of 12,125 with a total of 6,539 households (BPS Kampar Regency, 2017). In general, in 2016 the number of male population compares the comparison with the number of female society. Agriculture is the main economic activity of the community in district XIII Koto Kampar, the average town in several villages in region XIII Koto Kampar depends on the rubber farming sector, the percentage for rubber farming in the entire XIII district Koto Kampar is above 70%. In addition to rubber, communities in several villages in District XIII Kampar, Kampar, fulfill their daily needs by relying on Palm Oil, almost reaching a percentage of 15% and partly planted Palawija. There is one village that has been named as the center of Patin fish in Kampar Regency, namely the community of Koto Mesjid. Of the 535 households (KK), it can be said that 98% are trying to cultivate Patin Fish other than the rubber farming sector (BPS Kampar Regency, 2016).

The majority of people in XIII Koto Kampar are inhabited by indigenous / Malay tribes. But people, in general, are very open to the existence of other tribes, for example, the Javanese, Mining, Batak, and other tribes are very easy to find. The difference between the culture and the local population tribe with the incoming population does not make divisions in the community, even it further adds to the diversity of tribes and cultures in District XIII Koto Kampar. Residents in Kampar Regency have diverse cultures and customs. The indigenous people of this Regency are Malay, but there are also tribes who come from outside. Inter-tribal communication in everyday relationships generally uses the language Oct and Indonesian. As for communicating with fellow tribes, they use the regional languages of each tribe.
3.2. Agroforestry in District XIII Koto Kampar

The people in district XIII Koto Kampar who were respondents in this research activity were mostly farmers who planted their land with plantation crops in the form of rubber, oil palm, cocoa mixed with forestry plants such as gaharu, durian, and others. From Figure 1 it can be seen that 86% of the respondents are farmers, 5% of them are traders, 4% are civil servants, and 3% of respondents are private workers, while the remaining 2% are those who work outside the fourth category of the work.

![Figure 1. Respondents' livelihoods](image)

Most of the respondents are farmers, that rubber plantation farmer is accustomed to managing land by planting plantation crops in monoculture or mixed with various types of timber plants. But the agricultural system practiced is a traditional farming system that is simple and has not been touched by technology so that the productivity of the land is not optimal. This can be seen from the lack of simple application of crop cultivation. In some locations, the community still has not set spacing, use of superior seeds, and eradication of pests and diseases.

For this reason, the introduction of technology is needed to increase the productivity of land owned by the community. According to Sukirno (2007), it is also necessary to improve the application of technology to be able to increase crop productivity from economic activities in the community. This, of course, includes economic activities in agriculture carried out by the people in Kampar District. The location and location of the people in the village, which is relatively close to the community's living quarters, ranges from 2-3 km, but there is also a distance of 6 km. This has a positive impact on land management because they can do more intensive, especially regarding supervision and maintenance. Land management will be more intensive because the location of the garden close to the farmer's house can save time commuting to work, so they will often go to the garden and manage the land (Ruf, 2005).
Figure 2. The education level of respondents

Based on Figure 2 it can be seen that the majority or 35% of respondents have a primary school education 35%, junior high school 44%, high school as much as 15%, and undergraduate 7%. The level of education of respondents influences the level of knowledge in managing land. As previously explained that people still maintain their property with traditional farming systems and are not familiar with crop cultivation technology, this is also influenced by their low level of education. Usman and Abdi (2010) revealed that farming knowledge plays a vital role in efforts to increase land productivity because the use of technology in farming will affect farmers' income.

Table 1. Characteristics of respondents based on their age, income, land owned and the quantity of tree that were Planted

| Variable            | Min  | Mean   | Max   |
|---------------------|------|--------|-------|
| Age (year)          | 25   | 45     | 70    |
| Income (Rp/month)   | 900.000 | 2.354.000 | 4.500.000 |
| Land area (Ha)      | 0.5 | 1.8    | 4     |
| Tree quantity (poles) | 600 | 1200   | 3000  |

Table 1 explains that the age of respondents is between 25 to 70 years old or an average of 45 years. The average income is Rp. 2,354,000 per month. This figure is quite large for people in rural areas, but because the cost of living is also quite high (for the Riau region), and the only source of income is from the land, the dependence on land is very high, especially to meet basic needs. As a result, many of the community members are only able to meet basic needs. The average land area owned by the 1.8 ha respondent used for rubber plants with 1200 trees per ha. Agroforestry is one of the most appropriate ways for this purpose so that people can get cash from plantation crops (annual crops) such as rubber, cocoa, and palm oil to meet their daily needs. They also still get results from fruit crops such as durian and coconut.

The development of rubber business that has been done since 20 years ago provides a source of income for the community. Especially if the planting with agroforestry pattern developed by the community. Although it is still managed merely. The type of tree planted in the community area is dominated by rubber either grown in monoculture or mixed with other plants. Based on the questionnaire, it was obtained that 19 people (25%) and rubber monocultures planted mixed or agroforestry 56 people (75%)
Figure 3. Farmer's land management

For planted species are rubber planted in monoculture while for agroforestry is mixing rubber plant with other plants such as gaharu, durian, cacao, etc.? The types planted in agroforestry are 600 poles consisting of various types dominated by tree crops, fruits, and plantations. Selection of this type of plant is adjusted by the wishes of the farmers and the government support to provide certain types of seeds such as gaharu plants. So that the agarwood plants are chosen by the respondents as one of the cultivated plants. This is by Insusanty (2017) types of agroforestry plants consisting of various kinds of plants which are dominated by rubber, durian, and agarwood

Table 2 Number of Agroforestry Respondents

| No | Varieties of plant | Mount |
|----|--------------------|-------|
| 1  | Durian             | 75    |
| 2  | Rambutan           | 31    |
| 3  | Coconut            | 20    |
| 4  | jengkol            | 17    |
| 5  | Jackfruit          | 7     |
| 6  | Agarwood           | 300   |
| 7  | Cacao              | 150   |

Of the 19 respondents, there were seven types of plants with some plants combined with rubber plants. Rubber trees are planted with 1200 poles per ha. The land area carried out by this agroforestry is 9.5 ha or 10% of the available land area. Even though the community has done agroforestry security as much as 25%, the city of land that is managed agroforestry is still small. The existence of gaharu trees grown by farmers will increase the area of land planted in agroforest. The gaharu tree planted by farmers is currently 8.9 years old, and ten years old with an average diameter of 9-10 cm (Sulistiono, 2017). It is Messerly to inject isolates on the agarwood tree so that the next two years can be harvested for agarwood. For this reason, farmers can improve their capabilities by holding an injection training for agarwood.
For increasing the capacity and economic capacity of the community by providing various efforts such as the development of agroforestry with types that are economical and in demand by the community. The fruit plants have been benefited by the city while the existing agarwood plants cannot be used because the population does not have the skills to inject these plants. So that efforts to strengthen communities with agroforestry as climate mitigation was carried out with agroforestry counseling and training on injections of agarwood plants, the injected agarwood plants were successful within three months after inoculation with isolates. Based on the results of the training that has been done obtained the success rate of plants with the number of gaharu trees as much as 20 poles are 92%.

3.3. Community perception and knowledge about agroforestry development

Table 3. Community knowledge of agroforestry development objectives

| No | Variable                              | Strongly Agree | agree % | hesitant % | disagree % | strongly disagree % |
|----|---------------------------------------|----------------|---------|------------|------------|---------------------|
| 1  | Source of income                      | 34             | 56      | 10         | 0          | 0                   |
| 2  | Fluctuating commodity prices          | 20             | 55      | 25         | 0          | 0                   |
| 3  | The management is relatively easy     | 20             | 57      | 18         | 5          | 0                   |
| 4  | Protect flora and fauna               | 15             | 58      | 19         | 8          | 0                   |
| 5  | Protecting the environment            | 12             | 62      | 20         | 6          | 0                   |
| 6  | Prevent global warming                | 34             | 56      | 10         | 0          | 0                   |

Agroforestry development can be a source of income for the community by planting various types of plants that are considered to have a high selling value where 34% strongly agree, and 56% approve. The fluctuating commodity prices were also positively responded by respondents, where 20% strongly agreed, and 55% decided that the amount of karet sap was often unstable and also influenced by the weather, namely rainy days. While the palm oil commodity also experienced the same thing. Likewise, other commodities such as durian, cocoa, and areca nut, so if only planting one type of crop, you will experience the risk of price fluctuations. Therefore, so that basic needs can be met, the community adopts the pattern of agroforestry. The types of agroforestry plants chosen by the city are durian, cacao, and agarwood.

Agarwood trees planted by the community because these plants are native plants or local plants that are well known by the city, where people used to take gaharu in the forest, and until now there are still villagers who make a living looking for natural agarwood or other NTFPs in the woods and can thrive in this region. To find out the purpose of the community in the development of agroforestry related to environmental issues, three things that became the focus of this research were the knowledge of the city about efforts to protect flora fauna, protect the environment (prevent flooding, prevent landslides, protect groundwater, and maintain fresh air), as well as reduce global warming (climate change mitigation). Of these three things, it can be seen that 58% of respondents agreed that the agroforestry developed could protect the flora and fauna that live in it, but 8% of the respondents disagreed with this because they did not understand. Respondents did not realize that the presence of agroforestry plants in private land would attract several species of birds to live, as well as honey bees, butterflies and several other types of animals, and actually the existence of agroforestry in private land formed an ecosystem suitable for some birds and other animals.
This is supported by the statement of Tisdell and Elgar (2007) which revealed that the existence of trees has a vital role for the survival of several species of animals that live wild in nature. The next environmental issue is protecting the environment, according to the recognition of 62% of respondents that the agroforestry they have developed has participated in greening the environment, preventing flooding, preventing landslides, protecting groundwater, and keeping the fresh air around it. However, 6% of them disagree with this, because according to them without agroforestry their environment is indeed quite beautiful and green, and there have never been landslides despite floods and strong winds in this village. The tendency to disagree because the context in which they live is still in the form of a rural environment that is not densely populated so that it still leaves plenty of room for the growth of plants and trees, whether intentionally planted or which grow wild. As many as 56% of respondents said they agreed that agroforestry in private land could reduce global warming. Because of a large number of trees, the environment becomes more refreshing, and groundwater is guaranteed its sustainability even though there is a long dry season.

The negative impact of climate change is already quite felt in the Kampar Regency region. This is also affirmed by the community that climate change has caused uncertainty in the difference of seasons, namely between the rainy and dry seasons. Climate change has affected changes in fruiting seasons and high rainfall which has caused rubber production to be lower. Also, many fish ponds owned by the community have failed with the death of fish in the lake. Also, there are also impacts on crops and vegetables grown by farmers. Durian fruit also affects reduced fruit production.

4. Conclusion

Land utilization with agroforestry patterns has been applied 25% of respondents, but the area of land used as agroforestry is still relatively small at 10% with the dominant types of plants are rubber, gaharu, and durian. Most people develop agroforestry patterns with two or more types of crops because this pattern is more beneficial regarding meeting short-term and long-term living needs. From the economic side, the community develops rubber crops combined with other plants that have commercial value with the primary objective as an additional income especially with frequent fluctuations in the prices of the commodities grown. Meanwhile, from the environmental side, agroforestry has a vital role in protecting flora fauna, protect the environment, and reduce global warming.

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