Optimization of livelihoods variations in vulnerable to climate change impacts through carbon pricing

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Abstract. Climate change is a threat to the environment, especially dryland ecosystems, coastal areas, and forests. People who live in the forest area and depend on the forestry sector need to get protection, especially in terms of variations in livelihood sources to not depend on the forest sector and exploitation of forest resources. One prospective livelihood option is through carbon pricing. This study aimed to analyze the role of government in terms of creating livelihoods for vulnerable communities in the face of climate change, especially through carbon pricing mechanisms. The study used a qualitative approach with the literature review and desk study. Based on research results, it is known that the government had tried to establish international cooperation for carbon pricing. At present, the partnership had been established with 2 institutions in the European Union with a carbon trade value of 5 USD/ton CO₂eq. Through this mechanism, people who live around forest areas have new livelihood options that can withstand land conversion and exploitation of timber resources. Thus, the rate of climate change can be reduced, and mitigation efforts can be strengthened through the carbon trading mechanism.

1. Introduction

In the last few decades, climate change shows that environmental damage is occurring slowly but surely [1]. Climate change has a major impact on the stability of the earth's biome. The impact of climate change is entirely negative and threatens the sustainability of the earth's life [2]. Negative effects as a result of climate change include rising sea levels, mass death of marine microorganisms, shifting the rainy and longer dry seasons, triggering crop failures, deterioration of soil chemistry, loss of habitat for terrestrial and aquatic organisms, increasing earth temperature, and the drought is expanding [3].

The complexity of the impact caused by climate change increases the sense of human concern about the destruction of the earth's biome. This condition gave rise to a crisis that led to various social movements to save the earth [4]. Various international and national efforts have been agreed to reduce emissions as the main factor causing climate change [5]. The agreed international efforts include the Kyoto Protocol and the Paris Agreement, which fundamentally regulate all countries' emission reduction efforts that have ratified the policy, including Indonesia [6]. Indonesia ratified the Kyoto Protocol and the Paris Agreement to reduce emissions by 29% national or 41% with international
assistance. This effort is strengthened by developing a Nationally Determined Contribution (NDC) to reduce emissions from 5 sectors: forestry, industry, energy, waste, and agriculture.

The NDC establishment proves that Indonesia is very concerned about climate change and is committed to mitigation and adaptation [7]. Mitigation is very important because based on the First Biennial Update Report (BUR) document that was submitted to the United Nation Framework Convention on Climate Change (UNFCCC) in January 2016, national greenhouse gas (GHG) emissions amounted to 1,453 GtCO$_2$eq in 2012, indicating an increase of 0.452 GtCO$_2$eq from 2000. The main sectors that contributed to emission were land-use change and forestry sector including peat fires (47.8%) and the energy sector (34.9%) [8]. The forestry sector's large contribution to Indonesia's emissions has received attention from various parties and even the international community [9]. Indonesia has the third-largest tropical forest in the world after the Amazon and Congo, but land-use change occurs massively emissions.

The focus on the forestry sector, especially land conversion and land fires, raises concerns considering that many people live around forest areas [10]. People who have traditionally relied on the land sector to fulfill their daily needs are marginalized by this issue, even though there are problems beyond that which are doing land conversion sporadically [11]. Therefore it is necessary to diversify the types of work and income sources for people living around the forest area to meet their daily needs. Life needs also continue to be a major challenge for people living in dryland areas because climate change results in more extreme dry seasons [12]. The extreme dry season has resulted in the land becoming increasingly difficult to manage so that farming has declined and a variety of types of work are needed to survive [13]. The same thing is faced by people on the coast who experience difficulties maintaining their jobs as fishermen, especially with small boat capacities [14]. Climate change results in the mass death of some types of marine producers and changes organisms' community structure and fish to become more difficult to find [15]. Most people living around forest areas depend on timber and another biodiversity, whose conditions are under threat and reaching a critical. Research is needed to show other sources of income from forest by utilizing secondary production like carbon trading without exploiting the biodiversity. Most people living around forest areas depend on timber and another biodiversity, whose conditions are under threat and reaching a critical. Research is needed to show other sources of income from forest by utilizing secondary production like carbon trading without exploiting the biodiversity. Previous research has examined non-timber forest products that have concentration on biodiversity harvested. Diversification of livelihood must be carried out to maintain community resilience and harmony with a sustainable environment.

2. Methods
The research was conducted using a qualitative approach through the literature view and desk study methods. Researchers conducted tracing of various secondary data sourced from articles, journals, research reports, government reports, and various articles that had been published in various publishing media. Researchers carried out secondary data tracing employing clusterization, climate change mitigation, climate change adaptation, carbon trading, and new jobs. Furthermore, the data were processed through tabulation analysis and descriptive exploratory analysis.

3. Results and discussion
Indonesian government, for the last few years, has taken the issue of climate change very seriously. Government decisions were the ratified of the Kyoto Protocol in 2004 and the Paris Agreement's ratification in 2016. It shows the government’s level of seriousness in mitigating climate change and overcoming it [8]. This effort was spearheaded by the ministry of environment and is the medium and long-term agenda for controlling climate change. The scheme carried out by the government can be seen in Figure 1.

In general, the Indonesian government's climate change control is still top-down and the pattern is voluntary [7]. This means that the government still has not fully put pressure on the parties to reduce emissions or provides legal consequences for those who do not implement efforts to control climate
change. This shows that the government is still providing concessions so that the parties have the opportunity to transition to a new, more climate-friendly pattern in carrying out their socio-economic activities.

Socio-economic activities become the main factor determining whether or not climate change control efforts take place. It is a form of horizontal interaction in both the community and government context that are linked through top-down or bottom-up interactions [16]. However, in efforts to control climate change, as mentioned in the previous section, striking is the form of top-down interaction, namely the government's policies regulating people's lives and socio-economic interactions in them [17]. Furthermore, the government as the party ratifying the Paris Agreement as a legal product of international agreements from the UNFCCC will report the results of its monitoring and evaluation periodically.

The people most affected by climate change live in coastal areas, mountainous areas, and dryland areas [18]. These affected communities need serious attention from various parties and social and technical interventions to reduce vulnerabilities. Social intervention means that the community needs assistance and guidance to increase resilience including socialization to increase knowledge and awareness [12]. Technical intervention is then needed to introduce and provide technology transfer that plays a role in increasing social and environmental resilience in an affected area. In detail, this mechanism can be seen in Figure 2.

Figure 2 shows that climate change impacts greatly impact 3 sectors, namely the coastal, mountainous, and dryland sector. The high rate of climate change has a broader impact on all sectors of life. However, especially in Indonesia, 3 sectors are most affected by climate change and require countermeasures [19]. It can be mitigation and adaptation in nature as an integral part of efforts to control climate change. Figure 2 is a general mapping of 3 sectors and the impact of each is taken from 2 examples that are easily observed. Each of the examples presented illustrates that climate change impacts affect humans' ability and other living things to live in terms of shelter, food needs, and life-supporting elements such as ecosystem stability [6].

![Figure 1. Climate change control scheme [7].](image-url)
All of these aspects are directly related to meeting the primary needs of humans and other living things so that if the impacts of climate change cannot be controlled, the sustainability of life on earth cannot be realized [21]. This is exacerbated by the risk of losing several types of work, especially those related to land and water. Therefore, new job opportunities are needed to support community life, especially in these 3 areas and throughout the region in general [22]. Job opportunities can be created or will naturally arise as the pace of climate change increases. One of the things that can generate new types of work is the increasing awareness of the parties about the climate crisis.

The climate crisis with increasingly fast demands, humans can adapt quickly and precisely for the sustainability of life. Whether we realize it or not, the climate crisis has pressured humans to move out of conventional patterns towards future thinking that can harmonize economic, social, and ecological interests [23]. The integration between the 3 factors makes the harmony of life more optimal and the rate of climate change can be slowed down. Optimizing climate change mitigation efforts can provide opportunities for new sources of livelihood for the community, including those related to the land sector, water sector, and ecosystem services [24]. In detail, the new sources of livelihood that can be utilized are shown in Table 1.

**Table 1.** Opportunities for diversifying livelihoods during the climate crisis [17][25]

| Sector            | Type / source of livelihood                                      |
|-------------------|------------------------------------------------------------------|
| Land              | Silvopasture                                                    |
|                   | Agroforestry system                                             |
| Waters            | Riparian ecosystem for water purification                       |
|                   | Carbon sink                                                     |
| Ecosystem services| Carbon pricing                                                   |
|                   | Vegetation for nursery ground                                   |

Figure 2. Climate change impact and how to build resilience [20]
Table 1 shows that opportunities arise for adopting new types of work that can be optimized in their management as a source of livelihood. Researchers grouped 3 sectors based on the potential that exists in every aspect of the ecosystem's landscape. In the land sector, for example, silvopastoral, which integrates agriculture with livestock and fisheries. Of course, with the increasing impact of climate change, the seasons become uncertain, so that an integrated and mutually supportive management effort is needed [26]. For example, in this aspect, agriculture that is managed by its biomass can be used as animal feed both fresh and fermented and does not depend on forage from grass [27]. Furthermore, manure production can be used as a source of organic fertilizer for managed agriculture and no longer rely on inorganic fertilizers, which are increasingly poisoning agricultural land [28]. Soil chemicals cause damage to the soil's chemical components, so it will decrease soil production and make it more difficult to manage [29]. Therefore, the existing land can cultivate trees with non-timber products, including sapwood, resin, and forest honey [13]. Through this mechanism, forests will continue to be sustainable and not easy to cut down so that the carbon sink will continue to increase and help mitigate climate change while the community's economy also continues to grow and non-timber forest products [30]. It can be done for the conservation of riparian areas as a zone for natural water purification. The selection of plant species in this zone must be carried out based on their ecological function, not just economic considerations, which trigger deterioration of water quality and ecological health of the waters.

The deterioration of the waters' ecological health has led to the loss of the ecological role in carbon sequestration, the aquatic ecosystem with a large number of zooplankton, phytoplankton, and algae are one of the potential carbon sinks [12]. If the riparian ecosystem is appropriately managed, water quality will improve and ecological health can be maintained so that the role of aquatic carbon sinks can be optimized [19]. Furthermore, in ecosystem services, it is currently being intensified for international carbon trading, so the government has begun to formulate regulations to respond to this [31]. Regulations regarding carbon trading mechanisms and the participation of parties, especially businesses in carbon trading, will also be emphasized can maintain environmental conservation, especially forest cover, and empower the surrounding communities [30]. Similar efforts are also being made in mangrove ecosystems that can absorb a large amount of carbon and at the same time use it as a nursery ground for tidal organisms such as shrimp, crab, and several types of fish [32]. This is very important considering that vegetation cover has begun to decline and results in loss of ecological function for the nursery ground, which leads to reproductive failure for organisms. On the other hand, this mechanism strengthens efforts to trade carbon. Through the National Development Planning Agency, the government has agreed to buy and carbon trading with the European Union and Norway for 5 USD per tonne of carbon.

4. Conclusion
The government has not provided full protection to the people living in forest areas in various livelihoods. Carbon trading still needs to be optimized because there is no official price and government binding regulations. Collaboration of related parties (government-industry-community) is needed to optimized carbon trading for environmental conservation and the local community welfare.

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