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Opportunities and Challenges of Mitigation and Adaptation of Climate Change in Indonesia

Gun Mardiatmoko

Abstract

The impacts of climate change are changes in rainfall patterns, sea level rise and extreme weather or extreme meteorological events. This impact will further provide dangers that threaten the sustainability of human life. The main causes of climate change are deforestation and forest degradation and the growth rate of industry and transportation modes that are not environmentally friendly. Therefore, Indonesia is participating in the Paris Agreement and implementing the Reducing Emissions from Deforestation and Forest Degradation program, role of conservation, sustainable management of forest and enhancement of forest carbon stocks in developing countries (REDD+). In an effort to increase the prosperity of the State, many forests have been transferred to other uses such as the development of oil palm plantations, agricultural land and urban expansion etc. In fact, many agricultural lands have changed their function into settlements. If this happens, the forest area will continue to decrease again because after the agricultural land has turned into residential land, the forest land is converted again for agricultural expansion, this happens continuously. When viewed from the CO_2 flux, there will also be changes in the basic CO_2 flux from forest land, plantation land, agriculture and urban areas. The problem of deforestation and forest degradation is inseparable from the large number of forest conversion functions into oil palm plantations, expansion of agricultural areas and other uses such as urban development and infrastructure. Opportunities for climate change mitigation and adaptation include the implementation of the REDD+ program, financing of climate change mitigation and availability of climate information. The challenges faced include the lack of synergy in the policy framework and implementation of climate change control, recognition of indigenous peoples' rights and uncertainty in the implementation of the REDD+ program.

Keywords: flux CO_2, REDD+, climate change, mitigation, adaptation, oil palm plantations

1. Introduction

This paper discusses the implications of climate change in Indonesia and discusses the challenges to and opportunities for climate change mitigation and adaptation within Indonesia.

It is widely known that one of the reasons for climate change is global warming which is marked by an increase in air temperature. Climate change is associated with increased atmospheric temperature caused by the "Green House Effect" which occurs due to the increase in green house gases (GHG) in the atmosphere. Carbon dioxide (CO_2) is one of the gases that causes global warming. According to the IPCC [1], the average temperature of the earth's surface over the past century has increased by 1.3^0 F. The presence of CO2 is related to the condition of forests in an area. The trees that make up forests of various types and growth rates, known as forest structure and composition, have a role in storing CO_2. Forests are dominated by vegetation that has chlorophyll which functions in the photosynthesis process by requiring light energy, water and CO_2 to form carbohydrates. Thus the forest will absorb carbon from the air and accumulate in the plant body in the form of stems, branches, twigs, leaves, flowers, fruit and roots and soil. In general, this process is known as Carbon Sequestration [2, 3]. Thus the forest can function as a carbon sink. Therefore, well-well-maintained forests can increase carbon sequestration or reduce the amount of carbon in the atmosphere. In addition, by expanding the forest area, of course, its ability to absorb carbon will be higher. The development of various ecosystems over millions of years has resulted in certain patterns of carbon flow in global ecosystems. However, human (anthropogenic) activities in the use of fossil fuels, conversion of forest land and others have resulted in changes in the exchange of carbon in the atmosphere, land and marine ecosystems. As a result of these activities, there was an increase in the concentration of CO_2 into the atmosphere by 28% from the CO_2 concentration that occurred more than 150 years ago.

Indonesia's swamplands, which are around 33 million ha, 20.6 million ha of which are peatlands. Most of the peatlands are spread across three major islands, namely Sumatra (35%), Kalimantan (32%), Papua (30%), Sulawesi (3%), and the rest (3%) is spread over a narrow area [4]. The role of peatland is important because it has a high carbon sequestration and is a natural resource that has a hydrorological function. The existing peatlands need to be protected from fire. Because if a fire occurs in the peat forest, it will cause large CO_2 emissions and the resulting smoke will disrupt airlines and cause shortness of breath, etc. Peatlands play a major role in the development of agriculture, oil palm plantations or industrial plantations. For this reason, peatlands are managed with the principle of sustainable peatland management so that they can minimize environmental damage. Apart from peatlands, there are also mangrove forests that are found on the coast of the Indonesian archipelago which have a high carbon content known as blue carbon.

Peatlands planted with oil palm and acacia function as a carbon sequester through the photosynthetic process and carbon is stored as plant biomass. The carbon tethering process through the photosynthesis process is able to offset the loss of carbon stocks in the soil which are oxidized to CO2 gas emissions. However, if the expansion of oil palm plantations is excessive to the point where many natural forests are converted, it will have a negative impact on the biodiversity of the peatlands. The existing mangrove forests have also suffered a lot of damage because the area is used for the construction of ponds, excessive mangrove wood extraction and the large number of mangrove forests that have turned into settlements in coastal areas. The area of mangrove forests in Indonesia reaches 3.49 million ha but 52% or 1.82 million ha is in a damaged condition [5].

Carbon emissions from forest land including peat and mangrove forests generally fluctuate depending on many factors including climate, soil and hydrology. Environmental factors that greatly influence the amount of carbon

emissions, especially from peatlands, are temperature, soil moisture and electrical conductivity (EC) [6]. These three factors fluctuate greatly from day to day depending on climatic and hydrological factors, resulting in high fluctuations in carbon emissions [7, 8]. High carbon content in natural and plantation forests is usually found in forests where the potential for wood or wood volume unit (m3/ha) is also very high. Therefore, if an area is only used for seasonal plant development, of course the carbon content is low. The lowest carbon content is when forest land has been converted into urban areas with the development of housing, markets, offices, development of road networks and infrastructure. Even with the construction of urban areas with various tall buildings, it has triggered the emergence of a heat island. One of the safety valves so that forest areas can maintain carbon content is the application of the agroforestry system. This system is a cultivation in an area with a mixture of perennials and seasonal plants.

In an effort to increase the prosperity of a country, a lot of forest is transferred to other uses such as the development of oil palm plantations, agricultural land, livestock grazing and urban expansion etc. In fact, many agricultural lands have changed their function into settlements. If this happens, the forest area will continue to decrease again because after the agricultural land has turned into residential land, the forest land is converted again for agricultural expansion, this happens continuously. In other words, deforestation and forest degradation have triggered climate change.

If viewed from the CO_2 flux, there will also be changes in the basic CO2 flux from forest land, plantation land, agriculture and urban areas. It is certain and inevitable that the forest area will decrease and be used for non-forestry development. One of the reasons is the increase in population which is difficult to control every year. Thus, changing a forest area to non-forest will have an impact on the lack of carbon sequestration as shown in **Figure 1**.

The conversion of forest land to non-forest land actually occurs as a result of economic motivation. For example, more forest land will be converted into oil palm plantations if the results of oil palm management turn out to be more profitable from an economic perspective. Therefore, forest management must endeavor to be able to generate more tangible benefits from non-forest uses.
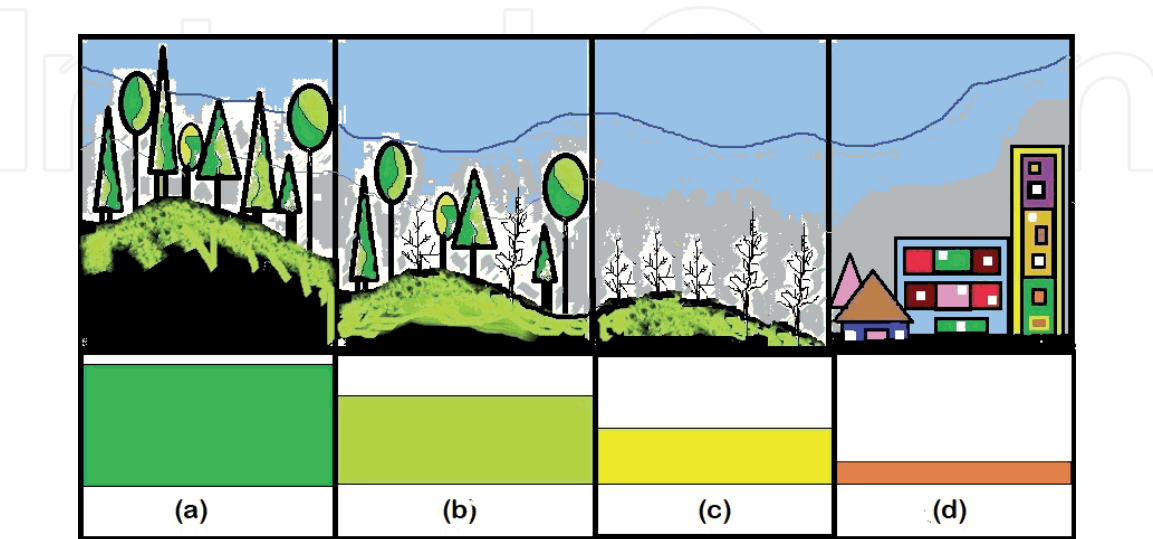
Figure 1.
The lower carbon sequestration of forest to non-forest areas. (a) Forests: very high carbon sequestration, (b) Agroforestry: high carbon sequestration, (c) Agricultural crops: low carbon sequestration, (d) Cities with infrastructure: very low carbon sequestration.

2. Expansion of oil palm plantations and the issue of deforestation

Indonesian oil palm plantations have grown rapidly in large parts of Indonesia. Sumatra and Kalimantan are two large islands which are the main centers of oil palm plantations in Indonesia. About 90% of oil palm plantations in Indonesia are located on these two oil palm islands, and the two islands produce 95% of Indonesia's crude palm oil (CPO) production. In the period 1990–2015, there was a revolution in the exploitation of oil palm plantations in Indonesia, which was marked by the rapid growth and development of smallholder plantations, namely 24% per year during 1990–2015. During this period, the forest land changed into oil palm plantations. This marks the end of the logging era and the drastic reduction of the plywood industry. The Ministry of Forestry has revoked many HPH licenses and an increasing number of plywood industries have closed due to a shortage of log raw materials. So in addition to the development of oil palm plantations, it is also planting industrial tree plantations which encourage the construction of pulp and paper mills. The area of Indonesian oil palm plantations in 2015 reached 11.3 million ha [9]. In 2017 it has reached 16 million ha. The largest proportion of oil palm plantations is smallholder plantations 53%, large private plantations 42%, and state plantations 5%. The rapid development of the palm oil industry has attracted the attention of the world community, particularly the world's major vegetable oil producers. In 2019 the area of oil palm plantations has reached 14.6 million ha [10]. Indonesia has become the world's largest palm oil producing country since 2006. Indonesia managed to surpass Malaysia in 2016 where Indonesia's CPO production share has reached 53.4% of the world's total CPO. Meanwhile, Malaysia only has a share of 32%. Likewise in the global vegetable oil market, palm oil has also managed to outperform soybean oil since 2004. In 2004, total CPO production reached 33.6 million tons, while soybean oil was 32.4 million tons. In 2016, the share of world CPO production reached 40% of the world's main vegetable products, while soybean oil had a 33.18% share [11].

Indonesia with its enormous reserves of oil palm plantations needs to ensure that these resources contribute to its national energy plan. Therefore the central government has compiled a Biodiesel Mandate which is among the most ambitious in the world. By 2016, liquid fuels must contain at least 20 percent of biofuels (and by 2025, 30 percent). A subsidy program has also been established to account for the substantial difference in production costs between biofuels and conventional diesel. One can feel considerable optimism because this funding is based on taxes on Crude Palm Oil (CPO) exports rather than on national budget expenditures which are negotiated annually [12]. With the mandate of biodiesel, in an effort to achieve national energy independence, expansion of oil palm plantations is something that cannot be avoided.

The rapidly increasing share of palm oil in the world vegetable oil market has influenced the dynamics of competition between vegetable oils and has even led to a negative / black campaign against palm oil. In addition, the sustainability aspect of oil palm plantations is under the spotlight. The development of oil palm plantations in Indonesia is perceived as unsustainable and is accused of being the main cause of deforestation and loss of wildlife habitat. The rapid clearing of forest land into oil palm plantations has led to the perception that Indonesia has carried out deforestation on a large scale. Actually this action was taken by the Government of Indonesia in carrying out national development in order to improve the welfare of its people. So there are stages for a country to deforest for the welfare of its people. When viewed from the development history of a number of major countries in the world, both the United States and Europe have deforested their countries. Therefore, it is unfair if the issue of deforestation is used to suppress the growth of Indonesian oil palm plantations.

So far there have been many accusations stating that 67% of oil palm plantations are obtained from forest conversion [13]. Gunarso et al. [14] tried to examine the truth of forest conversion in Indonesia for oil palm plantations. This is done by using data from disturbed and undisturbed forest land cover classes according to the carbon stock sequence published by the Forestry Planning Agency in 2011. Carbon stock of natural/production forests, either undisturbed forest or disturbed forest, contains carbon stocks higher than carbon. Oil palm plantation stock. Thus, if there is conversion of production forest to oil palm plantations, there will be a decrease in land carbon stock or deforestation. Meanwhile, timber plantation, agricultural land (mixed tree crops, dry cultivation land) and shrubs/ abandoned land (schrub) contain lower carbon stocks than oil palm plantations. Thus, the conversion of scrub agricultural land/abandoned land, including industrial plantation forest land, into oil palm plantations is categorized as an increase in land carbon stock or reforestation. This study turns out to provide conclusions that are different from the allegations by Koh and Wilcove [13]. The Indonesian oil palm plantations planted until 2010, namely 8.1 million ha, turned out to be 5.5 million ha of which came from the conversion of agricultural land and abandoned land (reforestation). While the rest, namely 2.5 million ha, comes from conversion of production forests (deforestation). Because the area of deforestation for oil palm plantations is much less than the area of reforestation for oil palm plantations, in net terms, the expansion of Indonesian oil palm plantations to reach 10.4 million ha in 2013 is a form of reforestation and not deforestation. This means that the expansion of Indonesian oil palm plantations to 10.4 million ha in 2013 on a net basis is to increase land carbon stock or reforestation [15]. However, the conversion of forest land which was converted into oil palm plantations in 2019 has reached 14.6 million ha, so that deforestation cannot be avoided. This is what causes a huge source of CO_2 emissions that actually triggers climate change.

3. The opportunities for mitigating and adapting to climate change in Indonesia

3.1 Mitigation and adaptation opportunities through the REDD+ Program

The remaining forest area in Indonesia in 2019 is 94.1 million ha or 50.1% of the total land area [16]. These forests play an important role in climate change mitigation and adaptation, so various strategies are needed and identification of opportunities to strengthen the results for both. a logical step. Therefore, the existence of the REDD+ Program will be very useful to support various steps that will help reduce the vulnerability of forest communities to the impacts of climate change. Reducing Emissions from Deforestation and Forest Degaradation (REDD+) is an effort to reduce emissions from deforestation and forest degradation, the role of conservation, sustainable forest management and increasing forest carbon stocks using a national approach and sub-national implementation. In its implementation, mitigation-adaptation synergy is needed which aims to find ways to take advantage of the synergy between REDD+ and climate change adaptation. Thus there is certainty that REDD+ will have impacts that go beyond mitigation and are sustainable in a climate that changes over time [17].

3.2 Climate change financing opportunities

Indonesia still dominantly uses fossil energy sources that are not environmentally friendly and contribute to the increase in GHG which has been scientifically

proven to change climate patterns with the emergence of global warming. Climate change will affect the duration of the dry and rainy seasons. This will certainly affect the yields in the agricultural-plantation sector and also the results of fishing in the sea. Therefore, people whose income depends on these two livelihoods will definitely be affected directly. To overcome this, it is necessary to implement climate change mitigation and adaptation programs. Here there are funding opportunities to carry out climate change mitigation and adaptation sourced from (1) public funds through the State Budget (APBN), (2) funds from abroad in the form of grants or loans (3) Funds from the private sector through Corporate Social Responsibility (CSR) and Green Bond [18].

3.3 Opportunities for providing climate information

The selection of the types of adaptation that can be carried out in various regions is basically a follow-up to the National Action Plan - Climate Change Adaptation (RAN-API). Understanding the impacts of climate change varies depending on location or region. In this condition, an assessment of the impacts and vulnerability of climate change specific to the economic sector in a location or region is required as a first step in selecting climate change adaptation options. Furthermore, an evaluation of adaptation options is carried out considering that the implementation of climate change adaptation requires additional costs [19]. One of the important elements needed in conducting a climate change impact and vulnerability assessment is climate information. This climate information plays a vital role in identifying the impact of global climate change on climate conditions in a region. The trend of climatic elements such as rainfall and air temperature observations is the earliest stage to see the effects of climate change in an area. Climate information is needed to (1) undergo impact models, for example: crop simulation models to assess the impact of climate variability in a region on the agricultural sector, (2) validate climate model outputs for projecting future climate conditions, compiling climate change scenarios. The uncertainty of future climate change is often approached by using more than one climate model or emission scenario. To understand the capabilities of climate models, validation of climate model outputs for the current period (control) is carried out using observational climate information. Compiling climate change scenarios also requires observational climate information, for example by changing (adjusting) observational climate information with differences between future climate projections and control periods [20].

4. The challenges to mitigating and adapting to climate change in Indonesia

4.1 A policy framework and implementation of climate change control have not yet gone hand in hand

Indonesia is the fourth largest country with GHG emissions in the world but does not make climate change a national priority agenda. At the international level, Indonesia has ratified the PARIS Agreement and has committed to reduce GHG emissions without conditions by 29% under a business as usual scenario in 2030 and up to 41% with international assistance. The government has established a policy framework such as RAN GRK SINCE 2011 and RAN API in 2014. These policies must be broken down to sub-national levels in the form of RAD GRK and RAD API. However, in practice, the policy framework and implementation often do not go hand in hand because local governments do not fully implement the policies set by

the central government [21]. Addressing this challenge requires a strong synergy between the central government and local governments.

4.2 The rights of indigenous peoples to the REDD+ program

For indigenous community activists, fighting for community rights to support the implementation of REDD+ is very important. This is because the role of indigenous peoples is very real in protecting the forest and its environment. Those with local wisdom have the knowledge to protect and protect their territory with customary laws, customary institutions and tenure systems that are different from the Western system. In general, they apply communal ownership and do not understand property rights [22]. Tenure issues cannot be eliminated in forestry management in Indonesia. This is due to overlapping control of forest areas because there are claims of state blasphemy over customary forests which are controlled by customary law communities. State forest claims provide room for the State's unilateral control over the forest through the various companies it owns or granting permits on it with the authority of the regional government. This has resulted in legislation and policies that are not clearly formulated, uncoordinated granting of permits and denial of recognition of indigenous peoples and other local forest users [23]. Indigenous peoples have a special role in REDD+, especially from the policy context, namely their participatory role. They have long lived in the forest and are able to care for and protect the forest for their survival from generation to generation. In addition, their cultural and spiritual relationship with the land and forest where they live is very deep [24]. Actually, the existence of this tenurial conflict has been eliminated somewhat by the implementation of the Social Forestry Program. In general, indigenous peoples have been given access to be able to carry out activities and manage in State forests. Tenure conflicts do not only occur on land already owned by companies that have forest concession permits but also in forest areas that have implemented the REDD+ program. So this is a challenge that must be resolved in the future.

4.3 Uncertainty in the implementation of the REDD+ program

Before REDD+ is fully implemented, a Demonstration Activity (DA) is carried out in the early stages. The implementation of DA is based on international guidelines from COP's decision in the form of International Guidance for DA. The aim is to find out progress, evaluate the implementation of activities and lessons learned related to DA REDD+. In the implementation of DA REDD+, various activities carried out refer to the methodology issued by the IPCC but the mechanisms mostly follow the schemes issued by the Voluntary Standard such as VCS, CCBS and Plan Vivo. The implementation of REDD+ provides benefits and provides opportunities because it is in accordance with the principles of forest sustainability and provides benefits to the community and biodiversity preservation. The current conditions for DA REDD+ are various, many lessons learned have ended and are also results-based with varying progress which still needs further guidance [25]. A crucial implementation stage is the implementation of the Measuring, Reporting and Verifying (MRV) System. Developing country governments at the COP 16 meeting in Cancun 2010 were encouraged to carry out various mitigation activities, including: reducing emissions from deforestation and forest degradation, conserving forest carbon stocks, sustainable forest management, and increasing carbon stocks (FCCC/CP/2010/7/Add.1/C/Par. 70). In connection with these activities, a suitable and transparent measurement and reporting system needs to be established (FCCC/CP/2010/7/Add.1/C/Par.71). Specifically for activities funded by international or

domestic sources, verification must be carried out based on the conventions/ guidelines that will be developed (FCCC/CP/2010/7/Add.1/C/Par.71; FCCC/ CP/2010/7/Add 1/B/Par. 61 and 62). During its development, the Monitoring, Reporting and Verification system was changed to Measurement, Reporting and Verification (MRV) at the Subsidiary Body for Scientific and Technological Advice (SBSTA) 36 in Bonn, 2012. MRV system is the basic and main requirement of implementing the REDD+ program using the principles incentives that are assessed based on performance or pay for performance [26].

MRV activities include measuring and reporting the effectiveness of GHG reduction or absorption quantitatively using methods and procedures that are reliable, transparent and accountable. MRV is part of a monitoring system where measurement methods and results are conveyed using standard and consistent sci- entific principles. These activities will serve as the basis for payment for the perfor- mance of reducing emissions. Each MRV activity must be in line with the reporting principles of the IPCC (Intergovernmental Panel on Climate Change), which must be transparent, accurate, consistent, complete, comparable and have minimal uncertainty. The MRV system implementer is an independent body but still coordi- nates with the REDD+ Agency as a governing council. The UN-REDD Program has recommended a set of key considerations for the development of a national MRV system. As a system, MRV can be applied to several scales, namely national, sub- national (province, district) and projects. The MRV system can also be reported to certain agencies and verified or validated by certain agencies or associations related to carbon. The use of MRV at the local and national levels is highly recommended. At the international level, reporting to the UNFCCC is a must or a requirement. Because the MRV system reporting must be based on scientific principles, this is a challenge for scientists and foresters in implementing the MRV system [27]. This is very important because the MRV principle is applied to collect data on each type of forest, forest cover and the amount of carbon content contained therein. Forest conditions in Indonesia are very diverse and categorized as mega-biodiversity. Of course, there will be many difficulties in implementing MRV. The challenge that is often faced is the calculation of the biomass present in each forest type. Ideally, biomass calculations are carried out by developing an allometric equation for each tree species which is very expensive. If this is done per tree type in each forest type, it certainly requires a large biomass measurement fund. The REDD+ program is known for leakage, additionality and uncertainity. In REDD+ activities, forest land which is designated as the location for REDD+ implementation according to the stipulated time period must be able to prevent leakage from occurring [28]. Here it is necessary to take intensive care for the location of the implementation of REDDD + so that there is no leakage originating from the work area and the sur- rounding area. Thus, year after year additionality must be guaranteed. Given the prevalence of forest conversion to non-forest, unresolved tenurial conflicts and illegal logging, etc., it will definitely be difficult to avoid uncertainty.

5. Conclusion

Global warming has caused climate change around the world. The impact of climate change is very large which affects the joints of life from an economic, eco- logical, and social perspective. The main cause is deforestation and forest degrada- tion which releases CO_2 emissions into the atmosphere. Thus, if deforestation and forest degradation cannot be controlled, the earth's temperature will get warmer. The warming of the earth's temperature is also triggered by the use of fossil energy which is not environmentally friendly. Nowadays there is awareness from each

country to start replacing fossil energy with biofuels that are more environmentally friendly. Indonesia has planned the production of biofuels to be independent of national energy that is environmentally friendly. One of them is by converting forest land for expansion of oil palm plantations and of course it will cause deforestation. So on the one hand developing environmentally friendly energy but on the other hand, sacrificing the area of the forest so that it becomes a contributor to CO_2 emissions that trigger climate change. Therefore, it requires a strong determination from the Government to be able to find the best way that can benefit both of them in controlling climate change. In every program that is executed, there are always opportunities and challenges that must be faced. One of them is the implementation of climate change mitigation and adaptation programs, such as opportunities for implementing the REDD+ program, financing climate change management, and the availability of climate information. There are also challenges faced, such as the lack of synergy in the policy framework and implementation of climate change control, recognition of indigenous peoples' rights, and uncertainty in the implementation of the REDD+ program.

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