



Indonesian Government Mitigation Efforts towards Climate Change in the Marine and Fisheries Sector

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Authors' contributions

This work was carried out in collaboration among all authors. Author DA designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft on the manuscript and analyses of the study. Authors EPP and ATF managed the literature search and analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study aims to determine the Indonesian Government's mitigation efforts in dealing with climate change, especially in the marine and fisheries sector.

Study Design: Literature study model.

Place and Duration of Study: Yogyakarta, Indonesia; 2020-2021.

Methodology: This study method utilized a qualitative approach with a literature study model. Sixty scientific national and international journals, online mass media, and legislations were collected. Data sources were used to explain the mitigation policy analysis of climate change in the marine and fisheries sector. The study stages started from article searching, theme classification, literature mapping based on discussions of various scientific journals, books, and online mass media with different orientations, data analysis, interpretation, and data presentation.

Results: The results of the study reveal that the impact of climate change on the marine and fisheries sector is very significant so that the Indonesian government establishes various policies, undertakes mitigation efforts to strengthen its identity as a maritime country, eradicates illegal, unreported, unregulated (IUU) fishing, imposes a moratorium on ex-foreign ships, accelerates the growth of national economy, enhance food sovereignty and promote the development of maritime

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and marine economies. However, there are still problems in implementing policies, so it is necessary to improve the management system for climate change countermeasures in the marine and fisheries sector in Indonesia.

Conclusion: Mitigation strategies in the marine and fisheries sector in Indonesia that can be implemented include applying sustainable aquaculture management practices suitable for carrying capacity and developing an integrated cultivation system. Various climate change mitigation policies in the marine and fisheries sector of the Government of Indonesia are commendable given many recognized successes, but there are still many problems with policy implementation. Ineffective application of policies is due to the government's focus on tackling climate change based on forestry and energy sectors, weak application of laws, and other problems. There is still a need for improvement in the management system for climate change countermeasures in Indonesia's marine and fisheries sector.

Keywords: Climate change; mitigation; marine and fisheries.

1. INTRODUCTION

Changes in the Earth's climate in each region have long been observed by researchers and found many changes in climate that have not occurred before in thousands, even hundreds of thousands of years, and some changes have already begun to occur today. Not only changes in temperature, climate change brings several different changes in different regions including changes in wet and dry, wind, snow and ice, coastal areas and oceans (ipcc.ch, 2021). This climate change occurs in the span of decades, and even centuries, without considering the possible impacts. Climate change is being the primary problem to be handled rapidly because it poses major social and economic impacts without proper handling; Southeast Asia, including Indonesia, is particularly vulnerable to the harsh impacts of climate change. Southeast Asia is a region that is projected to become warmer during this century so it is necessary to take urgent action to adapt to climate change, build resilience, and explore affordable and cost-effective mitigation measures [1].

Indonesia is a tropical country with many islands that may get affected by climate change [2]. Indonesia experiences significant impacts from climate change in various sectors during the last few years. Due to an increase in the earth's temperature, water cycle changes and environmental disasters – such as flood, drought, fire, and others – several life sectors are affected, one of which is the marine and fisheries sector. Flood in land or coastal areas will create inundated coastal wetlands, changes in tidal range, and coral reef sinkage [3]. Tidal flood may submerge fields and ponds and unite them with the sea. It also damages ponds so that shrimp and milkfish cultivations washed away in the

water [4]. Meanwhile, drought may influence the cultivation pattern of reservoir farmers [5]. There is a strong indication in Indonesia by the presence of forest and peat fires in Kalimantan that emit CO₂, affecting the air-sea CO₂ exchange in the Java Sea surface and decreasing the global ocean pH [6].

Climate change in the marine and fisheries sector has various adverse effects, e.g., changes in the sea level temperature, rising waves, extreme weather, changes in rainfall, brackish water runoff triggered by El-Nino and La-Nina, changes in sea cycle pattern, decreasing salinity, increasing coastal and ocean sedimentation, and decreasing oxygen level [7,3,8,9]. The high surface temperature causes seawater molecules to expand and melts snow in mountains that adds the seawater volume [5]. Impacts on sea biota are the death of coral reefs and phytoplanktons, changes in physiology, behavior, growth, reproduction ability, death rate, and productivity of fishery cultivation [10,2]. Uneven fish distribution and changing fish migration pattern [11] decrease fish-catching potential in Indonesia by 15-30 percent [12]. Based on the annual report of the Ministry of Marine and Fisheries in 2019, Indonesia fishery production from 2015-2019 increased, although sometimes missing the KKP performance target. Data are presented in Table 1. The following is fishery production achievement.

There was a problem of percentage decline in fishery export target achievement for several period. It is presented in Table 2 as follows.

Furthermore, climate change impacts also influence the coastal community life, particularly on the socioeconomic level [14]. Difficulties to earn income occur because the fish catch

decreases due to changes in sea breeze movements in the fish catching area [11]. This affects the coastal community food service and their future life quality [15,8,4]. Impacts on the fisher residential area are disturbances in clean water sources and the potential of tornado events [11]. The coastal area is a vital ecosystem in aquatic human and animal lives as a natural resource supplier; for instance, coral reefs as the house and food source of coral fish with high economic value, e.g., brown-marbled groupers, leopard coral groupers, humphead wrasses, mangrove species, and sea biota associated to the coastal ecosystem [10]. Climate change will affect the coastal ecosystem, influencing the fishery life. Climate change effects on the coastal area can be observed in Fig. 1.

Table 1. Indonesian fishery production achievement (Million ton unit) from 2015-2019

| Year | Target | Achievement |
|------|--------|-------------|
| 2015 | 24.12 | 22.31 |
| 2016 | 23.43 | 22.58 |
| 2017 | 29.46 | 23.01 |
| 2018 | 33.53 | 23.13 |
| 2019 | 38.30 | 23.86 |

Source: (Kementerian Kelautan dan Perikanan Republik Indonesia, 2019)

It can be concluded that climate change effects regarding the marine and fisheries sector in Indonesia are relatively extensive. The magnitude and area of climate change impacts force disaster prevention measures, one of which is a mitigation measure to reduce and minimize disaster threats [14,16]. If a mitigation program is absent, it is estimated that Indonesia may lose around 2,000 islands in 2030 [10], several seaside cities in Java in 2050, thus posing negative impacts on its million residents [17]. An island as a coastal ecosystem is crucial for sea biota lives. Mitigation is best applied on the similar ratio with the personal, family, population, and national stages, either on local, national, or international levels. It can be performed by determining the action plan in the short, middle, and long period (Satria, 2011).

Studies regarding climate change mitigation in the fishery sector have been extensive; however, they generally focused on various possible mitigation methods or strategies [18,19,20,21], the effectiveness of mitigation implementation in certain areas [20,22,21,23,24], (Siagian, 2016), and mitigation system related to technology [25,16]. Nevertheless, the discussion regarding Indonesian mitigation policy in the marine and fisheries sector remains unavailable.

Table 2. Comparison of Indonesian fishery export value target with the actual (million dollar unit) from 2015-2017

| | 2015 | 2016 | 2017 |
|----------------------|-------|------------|------------|
| Target | 5.68 | 6.82 | 7.62 |
| Actual | 3.95 | 3.78-4.17 | 3.17-4.09 |
| % target achievement | 67.4% | 55.4-61.1% | 41.6-53.7% |

Source: [13]

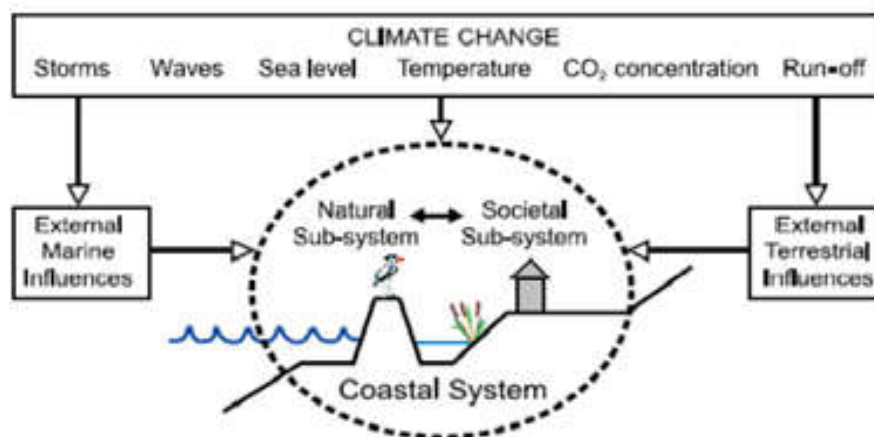


Fig. 1. Climate change effects on the Coastal area

Source: [10]

Various scientific findings proved that the sea is critical to maintain the earth's sustainability because the majority of earth consists of oceans. The fishery sector is an essential contributor to national food security and labor absorption in Indonesia. A latest study measured dependence on fish as animal protein, placing Indonesia as a country with the eighth highest fish dependence globally (CEA, 2018). Therefore, climate change mitigation should prioritize ocean functions and roles. Nonetheless, based on several policies, the majority of countries focus more on the land climate change [17]. Indonesian Constitution states that land, water, and air in the country are authorized by the nation and used for people's welfare, where the government is obliged to maintain resource quality by various efforts, such as the applied policy [26].

This study aims to discover mitigation measures by the Indonesian government to handle climate change, particularly in the marine and fisheries sector. A qualitative approach employed in the study was expected to be a reference for the Indonesian government, primarily in the fisheries sector to formulate sustainable fisheries policies. It can also be utilized as a reference for future studies regarding climate change mitigation in the marine and fisheries sector.

2. METHODS

This study utilized a qualitative approach with a literature study model. The literature study model can completely identify a topic, determine the extent of trend or pattern interpreted by predecessor studies, generate new frameworks and theories, and identify topic or question requiring further examination [27].

Several articles were collected from various sources themed climate change on Indonesian marine and fishery condition. Sixty scientific national and international journals, online mass media, and legislations were collected. The data collection in this qualitative descriptive study with the literature analysis method was carried out by extracting evidence and knowledge [28] by searching scientific journals, books, online mass media, and legislations. Data sources were used to explain the mitigation policy analysis of climate change in the marine and fisheries sector.

The study stages started from article searching, theme classification, literature mapping based on discussions of various scientific journals, books, and online mass media with different

orientations, data analysis, interpretation, and data presentation.

3. RESULTS AND DISCUSSION

All articles regarding climate change on Indonesian marine and fishery condition were classified into three major themes: climate change impacts; climate change mitigation strategies; and mitigation policies. Most climate change articles focused on the analysis of different applied policies; however, they were mostly articles in mass media. This section will discuss the three major themes based on literature study from the collected articles.

3.1 Climate Change Impacts in Indonesia

Gas collected and entrapped in the atmosphere as a result of anthropogenic activities such as vehicle or plant pollutions causing global warming (greenhouse effect) is the initial stage of climate change occurring in many parts of the world [29,30,31,32,2]. Based on the data, Asia becomes the primary region exposed to the worst climate physical risk than other regions if no action is taken to mitigate disasters [33]. It also applies to Indonesia, which is an archipelago with an area of water greater than that of the plains, placing Indonesia as a susceptible area to climate change impacts [25,2]. Climate change impacts that have occurred in Indonesia include extreme temperature and land humidity rising, extreme rainfall rising, and season shift [15,33].

In the marine sector, climate change impacts cause physical changes on the earth's atmosphere, such as temperature rising and uncertain rainfall distribution, melting polar ice, causing an increase in sea-level temperature, rising waves, extreme weather, changes in rainfall, brackish water runoff triggered by El-Nino and La-Nina, changes in sea-cycle pattern, decreasing salinity, increasing coastal and ocean sedimentation, and decreasing oxygen level [5,25,7,3,8,9]. Climate change impacts affect marine-based businesses, such as fish catching, mariculture (marine-based cultivation system), and coral reef tourism [34]. The marine sector is closely related to fisheries.

In the fishery sector, climate change also affect aquatic life, e.g., increasing coral reef and phytoplankton death, changes in physiology, behavior, growth, reproduction ability, and death rate of cultivated fish [18,10,2]. Uneven fish

distribution and changing fish migration pattern [11] decrease fish-catching potential in Indonesia by 15-30 percent [12].

Climate change not only impacts marine and fishery physical environments but also the coastal community's life, particularly in the socioeconomic condition [14]. Climate change causes difficulties to catch fish due to changes in sea breeze movements in the fish catching area [11]. Food security and the coastal community's future life quality depend on sea products [15,8,4]. Problems emerged due to climate change are complex and directly and indirectly affect other related sectors [35].

Managing climate change impacts should be performed immediately to avoid the continuous occurrence of environmental damage. The cause of climate change is humans; hence, humans must make efforts to handle it [36]. If climate change is allowed to be prolonged and not handled immediately, then the Earth's temperature will continue to rise, exacerbating global warming and affecting human life and all living things on Earth [37]. Specific policies and strategies are required to regulate and limit actions harming nature and the climate [38]. A climate mitigation strategy remains the proper action to minimize potential impacts [18].

3.2 Mitigation Strategies of Climate Change

Mitigation is an effort to reduce the risk of adverse effects of climate change and prevent sustainable damages or disasters [39]. Climate change should be encountered with various mitigation strategies requiring the integration of various related parties, including the government, private sector/industry, and the community. It should be conducted by education on climate change comprehension and accompanied by actual actions [18].

Mitigation strategies in the marine and fisheries sector in Indonesia are influenced by the management of climate change impacts in the plains sector. Such a management can be implemented by: replacing fossil energy sources with cleaner, energy-efficient and environmentally friendly fuels; increasing the green open space area; encouraging green land (forest) conservation actions; improving the plant rehabilitation system [18,40] and taking measures to slow or contain additional greenhouse gas emissions, or sequestering them to forests or other carbon sinks (Siagian, 2016).

The community's role is vital in any implemented mitigation strategy. Therefore, strengthening the capacity of the society as a whole, and especially the coastal communities in Indonesia in facing the impacts of climate change, is important. This can be done through various counseling, education and training which can be carried out to establish community independence in terms of mitigation [5,18]. Raising awareness about the adverse impacts of climate change, preparing resource development plans, infrastructure development, maintaining natural ecosystems in coastal areas, as well as introducing coastal communities to potential climate change disasters and early warning system equipment [5,41]. The use of Quantum GIS (Geographic Information System) technology, which is a map application for disaster-prone areas in Indonesia, can help reduce disaster risk [16].

Academics should contribute various scientific studies regarding the ever-changing development of climate change [29] and provide climate change learning materials at the formal education level for the younger generation [31]. It is crucial because, to date, the climate change material provision remains lacking [42]. Therefore, it is essential to raise awareness from an early age on the sustainability of the earth's preservation. It is advisable to introduce it from the basic level of education [32,43]. The materials are sustainable development, environmental conservation, natural resources, and effective involvement of all parties [37]. Knowledge of climate change literacy related to economic, social, and environmental components is also critical [44]. It should include as well children from the coastal community directly involved in the marine and fisheries sector in Indonesia.

Mitigation strategies in the marine and fisheries sector in Indonesia also include applying sustainable aquaculture management practices suitable for carrying capacity and developing an integrated cultivation system (Satria, 2011). Fishery management with the potential to adapt to climate change will be able to withstand any changing conditions [34]. As stated above, the climate change on rising sea surface temperatures will lead to changes in catch locations, shifting of fish locations, and reducing fish species and numbers. Thus, to help overcome the negative impacts of climate change on local fish stocks, development or expansion of the mariculture sector (sea water-based cultivation system) can be carried out [34].

Another action to be implemented is related to the concept of blue carbon (carbon stored in marine and coastal ecosystems). In this perspective, mangrove conservation efforts will help reduce gas emissions and increase carbon storage (carbon benefits) while providing benefits for community welfare (non-carbon benefit) [19,45,20,6,46]. Therefore, actions should focus on conducting conservation of mangrove forests, tidal swamps, and seagrass beds (nurseries for coral reef fish species and as sediment retainers), as well as increasing the sustainability and productivity of coral reefs [34].

Mitigation strategies are not only in operational field practices but also in stakeholder policy strategies. The government's role is significant in determining policies regarding, for example, the problem of fishing areas. The climate change impacts change the migration pattern of fish from one area to shift to the territorial waters of other territories and even other countries. A strategy is needed to build cooperation agreements in the field of fisheries, cooperation in handling risks due to climate change at the regional, national, and international levels [34]. It is necessary to understand the risks and anticipate the impacts of climate change that occur and plan policies that can improve the sustainability of ecosystems.

The existence of Corporate Social Responsibility (CSR) activities for the surrounding environment should be appropriately utilized by the government and society. CSR is a mandatory activity carried out by each company as a form of accountability to the society, economy, and environment. CSR can be more directed at mitigating climate change impacts besides improving the economy and social well-being [36].

Various climate change mitigation strategies in the marine and fisheries sector can be endorsed in the government's policies. However, problems remain present in the implementation process.

3.3 Indonesian Climate Mitigation Policy in the Marine and Fisheries Sector

The Indonesian government's policy regarding climate change impacts on the marine and fisheries sector begins with the active participation in various leading international negotiations on climate change, especially the Conference of Parties (COPs) to the United Nations Framework Convention on Climate

Change (UNFCCC) [47] and other fora such as the G-20. Such a participation indicates the vital role Indonesia plays in the world's first steps against climate change impacts [2].

The climate negotiations outcomes require that participating countries be committed to dealing with climate change impacts in their respective regions. This commitment encourages the Indonesian government to establish various policies, laws, and regulations in dealing with the impacts of climate change. One of them is the mitigation policy. Climate change mitigation in Indonesia includes a diversification program of energy sources (Presidential Decree No. 5/2006), a national emission reduction of 26% with self-efforts, and 41% if receiving assistance from abroad until 2020 [5]. Policies for reducing greenhouse gas emissions through the Indonesia Climate Change Trust Fund (ICCTF) and preparation of the Indonesia Climate Change Sectoral Roadmap (ICCSR) are contained in PERPRES 61/2011 concerning RAN GRK [48,49,24]. Efforts to mitigate climate change impacts are contained in the National Action Plan for Climate Change Adaptation (RAN API). Nationally, RAN-API is under the Adaptation Working Group, Coordinating Team for Handling Climate Change [47]. The marine sector is one of the primary sectors in the Adaptation Climate Change RAN (RAN API) [50] in the Government Working Plan (RKP) 2008 that facilitates the cooperation of the regional marine sector. The Coral Triangle Initiative (CTI) has been echoed since 2005 (supported by RKP 2006) and is stated in RKP 2007, 2008, 2009, and 2010 [48].

The Ministry of Marine Affairs and Fisheries (KKP) outlined a policy in a work plan that contains strengthening identity as a maritime country, eradicating illegal, unreported, unregulated (IUU) fishing, imposing a moratorium on ex-foreign ships, accelerating national economic growth, food sovereignty, and maritime and marine economic development [51,52,13]. The KKP has made various efforts in mitigating climate change. Application of environmentally friendly technologies, such as the use of clean energy (i.e. biofuel) as a substitute for fossil fuels, planting coastal vegetation, and other mitigation measures [53]. Application of aquaculture technology with integrated multitrophic aquaculture (IMTA) biofloc technology, Minapadi, recirculating aquaculture system (RAS), which can increase productivity up to 100 times, increase the efficiency of water and land use, and increase the development of local fish farming [54].

Efforts to improve the management of fish resources and preserve their environment are supported by establishing a Marine Conservation Area in the Minister of Marine Affairs and Fisheries Regulation Number Per.30/MEN/2010, i.e., protected water areas managed by a zoning system [55]. Coastal areas are also essential to take into account to reduce carbon gas emissions according to the UNFCCC and Intergovernmental Panel on Climate Change (IPCC) reports; the government states a commitment to protecting coastal ecosystems, namely mangroves and seagrass beds that play a significant role in carbon storage or blue carbon [51].

Government policies also include human resources where the KKP has made a protection policy for fishermen. The stipulation of Law on Protection and Empowerment of Fishermen, Fish Cultivators, and Salt Farmers: Law no. 7/2016, Article 1 paragraph (4) Protection and empowerment of fishers, fish cultivators, and salt farmers, KKP prioritizes the provision of fishermen's insurance, as well as increasing the capacity of the community, especially coastal communities in Indonesia, with various counseling, education and training that can be carried out to establish the independence of coastal communities [56] such as Proklam (Climate Village Program) socialization to support aquatic environment preservation and carbon emission reduction [57].

The marine and fisheries sector's mitigation policy involves other agencies besides KKP. The National Development Planning Agency (BAPPENAS) makes policies on sustainable fisheries management strategies, including

stipulating policies for licensing and landing tuna processes that must be carried out in an integrated manner. It aims to reduce the rate of exploitation and add value (added value) to tuna species with a value lower [53]. This policy can ensure the maximization of profits for the fishing country and the management of processed fish products.

Various climate change mitigation policies in the marine and fisheries sector that have been established by the Government of Indonesia are commendable. A successful policy implementation takes an example in the Bantul Regency Government which succeeded in implementing the concept of sustainable development, maintaining environmental resilience by protecting local flora and fauna, breeding animals, conserving turtles, and maintaining mangrove ecosystems utilizing conservation [38]. However, the policy implementation process is still suffering from many problems.

There are indications that Government policies tend to be influenced by external/foreign pressure [39]. The influence of outside parties makes the implementation of policies ineffective. For example, there is no policy regarding technical regulations in mangrove management, provision of information or data on mangrove areas and land use, and there is no good mangrove management strategy [23]. This may have a potential impact on reducing uncontrolled mangrove areas. Fig. 2 shows the extent of mangrove areas in Indonesia that have been lost, even though Indonesia has the largest mangrove area, around 28 percent of all mangrove areas globally.

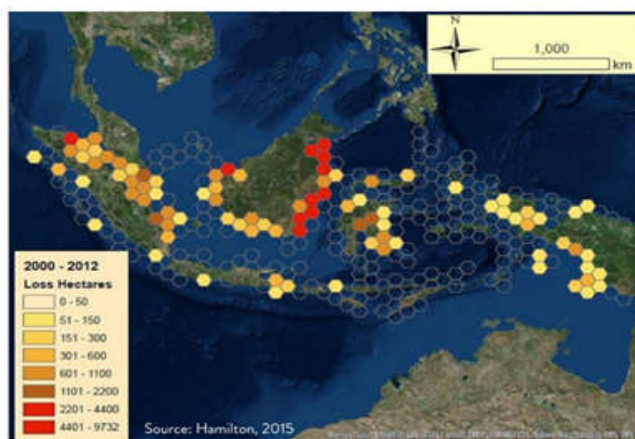


Fig. 2. Lost mangrove areas in Indonesia
Source: [13]

Mangroves are related to the management of coastal areas. Indonesia's small outer islands' management is also perceived to be not optimal, and border legal problems with neighboring countries are predicted to be more real in the future. Therefore, amendments (revisions) to the national regulations of the Law of the Republic of Indonesia Number 27 of 2007 on the Management of Coastal Areas and Small Islands are necessary [24]. Management of coastal areas, especially the small outermost islands in Indonesia, is essential to withstand climate change. As a policymaker, the local government is still considered very minimal in assisting the community in dealing with climate change impacts. For example, there are research results that show the lack of facilities and infrastructure for Acehese fishers due to the lack of attention from the Aceh Government, as well as information related to the impacts of climate change; Qanun Policy No.7 of 2010 on Fisheries, has not been able to have a significant impact on the fishery sector in Aceh Besar in general [22].

Another policy problem is that climate change focuses too much on land areas that only cover 30% of the Earth's surface, absorbs only 10% of heat, and recycles only 7% of CO₂ in the atmosphere. It is shown in the UNFCCC has not given adequate attention to discussing the role of the sea in climate change [17]. The same thing can also be observed in the Indonesian government, which has not massively considered the marine and fisheries sector. Data on the use of state's funds for climate change countermeasures shows that the forestry and energy sectors have the most significant funding requirements [47]. The mitigation of climate change in the marine sector planned by related Ministers such as KKP, Ministry of Environment and Forestry, Coordinating Ministry for Maritime Affairs, Bappenas, and others has no clear direction. Climate change has not become a major concern [17].

Government agencies related to climate change countermeasures have paid less attention to policy functions and their implementation. There is a problem of overlapping policies in the same location; the example is the changes in the policy of Article 30 of Law no. 1 of 2014 and the Ministry of Maritime Affairs and Fisheries Regulation No. 3 of 2018. Such changes allow activities in the conservation area, in contradiction with Law no. 27 of 2007 and Law No. 1 of 2014, as well as other regulations regarding conservation areas, which stipulate

that the core zone is designated for habitat protection and is limited to research activities [58]. It raises legal issues and environmental problems because it is considered to potentially damage the environment in the core zone, resulting in pollution and/or damage to the marine ecosystem.

Another problem is the migration of foreign fishing vessels and the operation of vessels with destructive fishing gear in fishing activities in several Indonesian Fisheries Management Areas (WPP). Problems related to the natural conditions of the sea where the conditions of seagrass beds, mangroves, and many damaged coral reefs. This is exacerbated by efforts to prevent and enforce laws against environmental destroyers which are still fragile, as well as the practice of illegal, unregulated and unreported fishing (IUU fishing) which has so far been ineffective [59].

In addition, climate change mitigation activities in the lowlands also have an impact on the marine and fisheries sector. Among other things, the reforestation program as a mitigation strategy, carried out so far, still has many shortcomings: such a reforestation program is implemented at the wrong time; the selection of inappropriate plant species does not pay attention to local climatic conditions (altitude and temperature); and spontaneous program activities are carried out without evident sustainability [40]. Mitigation activities of reforestation, afforestation, community forestry, agroforestry, enrichment, reduced impact logging, and bioelectricity are not going well [39]. The Community-Based Forest Management (CBFM) forest conservation program policies in Indonesia are still controversial regarding land and natural resources' political and legal foundations [26]. The Green Open Space Policy (RTH) regulated in Law Number 26 of 2007 concerning Spatial Planning is also difficult to materialize because many interests interfere with management [60].

Based on the above discussion, there is still a need for improvement in the management system for climate change countermeasures in Indonesia's marine and fisheries sector. All parties carry out mitigation at an appropriate scale, namely the government and the community, both local, national and global, with the full awareness that climate change must be tackled quickly with various efforts to prevent more damage.

4. CONCLUSION

Indonesia is one of the countries experiencing significant impacts of climate change in various sectors in recent years. It is a tropical country with many islands, which are influenced by such impacts. Climate change is adversely effecting the marine and fisheries sector causes through changes in the sea-level temperature, rising waves, extreme weather, changes in rainfall, brackish water runoff, changes in sea-cycle pattern, decreasing salinity and oxygen level, increasing coastal and ocean sedimentation, and other damages. Moreover, climate change harms aquatic life such as fisheries, coral reefs, and phytoplankton and affects coastal communities' lives, especially socio-economic conditions.

It can be said that climate change impacts related to the marine and fisheries sector in Indonesia are quite widespread. Hence, further disaster prevention measures are needed. One of them is mitigation measures that can reduce and minimize the threat of disasters. Mitigation strategies in the marine and fisheries sector in Indonesia that can be implemented include sustainable aquaculture management practices suitable for maintaining the carrying capacity and developing an integrated cultivation system. Existing mitigation policies in Indonesia are commendable given the existence of recognized successes, but the policy implementation process is still suffering from many problems. Ineffective application of policies is due to the government's focus on tackling climate change based on the forestry and energy sectors, weak application of laws, and other problems. Based on the above discussion, there is still a need for improvement in the management system for climate change countermeasures in Indonesia's marine and fisheries sector.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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