

FACING CLIMATE CHANGE CHALLENGES: ADAPTATION AND MITIGATION POLICIES FOR A BETTER FUTURE

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Abstract

Climate change is a global problem and has become an urgent issue in this modern era. In recent decades, we have witnessed the serious impacts of climate change, such as rising global temperatures, increasing intensity of extreme weather, and decreasing environmental quality. All of this poses a big challenge for the sustainability of our environment. The challenges faced by the environment due to climate change are very complex and require serious attention. To effectively adapt and manage these diverse difficulties, Indonesia and the rest of the world must take proactive, preemptive measures. Climate change poses a significant problem that necessitates taking concrete steps to mitigate greenhouse gas emissions and adapt to current and future effects. By taking small steps to lower greenhouse gas emissions, such as limiting the use of motorized vehicles, beginning to use public transportation, conserving water and electricity, cutting back on the use of plastic waste, and planting trees in the surrounding area, the community can contribute to mitigation. This study conducted an exploratory evaluation of the literature using a qualitative descriptive approach. This research discusses adaptation in the context of climate change, preventive and responsive adaptation, mitigation in the context of climate change, and general mitigation policies such as reducing greenhouse gas emissions and developing renewable energy.

Keywords: Climate change, adaptation and mitigation policies

INTRODUCTION

The increase in global warming beyond the threshold of 1.5 Celsius within one year is not surprising. January was recorded as the eighth hottest

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month in a row. In fact, Berkeley Earth, a science organization in the US, said temperatures in the 2023 calendar year will exceed 1.5 Celsius above pre-industrialization levels. Meanwhile other science agencies, such as NASA, put the level for the last 12 months at slightly below 1.5 celsius (Hotaling et al., 2017).

These small differences occur because of the way global temperatures were estimated in the late 1800s, when measurements were still rare. Despite the differences, all major figures agree that the recent increase in global warming is the highest since modern methods were used. This increase is also estimated to last longer. The world's sea surface was also recorded at its highest average temperature, showing how wide the scope of climate records is. In 2023, global temperatures were recorded to be around 1.48 C warmer than the average temperature of the pre-industrial era of 1850-1900, said the European Union's climate agency. Almost every day since July there has been the highest increase in global air temperature so far this year, based on BBC analysis. Last year's sea surface temperature also broke the previous record (Nalau, J., & Verrall, B. 2021).

Based on data from 116 BMKG observation stations, Basukiet al. (2022) conducted study in Indonesia and found that the average air temperature in 2023 was 27.2 C. This means that there was a 0.5 C anomaly in 2023's average air temperature when compared to the average air temperature for the period 1991-2020. With an anomaly value of 0.6 C, 2016 was the hottest year in Indonesia during the observation period from 1981 to 2023. The second-hottest year on record was 2023, with an anomaly value of 0.5 C.

These worldwide records bring the globe one step closer to failing to meet important international climate goals. The fact that the warmth of 2023 has been felt practically everywhere in the world is another noteworthy aspect of it. Nearly the whole Earth was warmer between 1991 and 2020 than it was recently, as the map below illustrates. This time was nearly 0.9 C warmer than it was prior to humans starting to burn huge amounts of fossil fuels in the late 1800s. Revolution Industriale (A. N. Khaira, & M. A. Ranti, 2024).

It is difficult to say for sure, but 2024 might be warmer than 2023 since part of the record ocean surface heat escapes into the atmosphere due to the present El Niño's "strange" behavior. According to the UK Meteorological Service, this suggests that 2024 may even surpass the cutoff point for a temperature increase of 1.5 C over a calendar year. In order to mitigate the worst effects of global warming, nearly 200 nations decided in Paris in 2015 to attempt to keep temperature to this level (Rasendriya, R. D., 2024).

Field, C. B., & Barros, V. R. (2014) stated that climate change is a global problem and has become an urgent issue in this modern era. The impacts of climate change are not only felt in a few areas, but have spread throughout the world. In recent decades, we have witnessed the serious impacts of climate change, such as rising global temperatures, increasing intensity of extreme weather, and decreasing environmental quality. All of this poses a big challenge for the sustainability of our environment.

One of the main impacts of climate change is rising sea levels. Through global warming, ice at the North and South Poles is melting rapidly, causing an alarming rise in sea levels. This threatens small islands and coasts, and causes the risk of more frequent and severe flooding in coastal areas. In addition, climate change also contributes to an increase in extreme weather. Stronger hurricanes, more severe droughts, and hotter summers are all direct results of climate change. This threatens agricultural sustainability, water sustainability, and causes significant economic losses (Pecl et al., 2017).

The challenges faced by the environment due to climate change are very complex and require serious attention. One aspect that needs to be considered is maintaining the sustainability of natural resources so that they do not experience a significant decline. This is related to habitat loss, species extinction, and ecosystem damage which is increasingly becoming a real threat to our lives (Wu et al., 2016). Therefore, immediate action is needed to overcome these problems. Apart from that, climate change also has a significant impact on the agricultural sector, biodiversity and the availability of clean water. Changes in weather patterns and increasing temperatures can affect crop yields and crop quality. Biodiversity is also threatened by climate change, where some species may not be able to survive in the new conditions that are created. Not only that, climate change also has the potential to disrupt the availability of clean water, which is a basic need for human life. Changes in rainfall patterns and increased evaporation could result in a serious water crisis, especially in areas already experiencing drought.

To effectively adapt and manage these diverse difficulties, Indonesia and the rest of the world must take proactive, preemptive measures. Climate change poses a significant problem that necessitates taking concrete steps to mitigate greenhouse gas emissions and adapt to current and future effects. By taking small steps to lower greenhouse gas emissions, such as limiting the use of motorized vehicles, beginning to use public transportation, conserving water and electricity, cutting back on the use of plastic waste, and planting trees in the surrounding area, the community can contribute to mitigation. To combat

climate change, however, a social engineering or social innovation strategy is also required (Abbass et al., 2022).

For instance, in order to adjust the time, patterns, and types of crops that must be planted in order to produce the best food commodity products even when hit by various weather disturbances, farmers need to be knowledgeable about climate change and weather prediction techniques. By making this adaptation, farmers can also choose when to plant and harvest in order to minimize adverse weather conditions and climatic disruptions.

RESEARCH METHOD

This study uses a qualitative descriptive approach by conducting an exploratory review of the literature. The data collection technique uses library study techniques. Literature study is an activity of collecting data from various sources or literature needed in research.

The author looks for reliable sources such as scientific journals, reference books, and websites related to facing the challenge of climate change: adaptation and mitigation policies for a better future. The sources selected are sources that have the authority to adapt and mitigate policies for a better future. After collecting relevant sources, data and information from these sources are analyzed systematically.

RESULT AND DISCUSSION

Climate Change Theory

Lucarini et al. (2017) claim that climate change is currently one of the world's most dangerous issues. A number of indications have brought the topic of climate change to the attention of the general public, including the rise in air temperature of up to 1.1 degrees Celsius during the past 130 years. Alongside this, there have been significant polar ice loss, rising ocean temperatures, and severe climate shifts in a number of areas. The sustainability of many aspects of Indonesians' life is disrupted by climate change, especially the balance of the ecosystem.

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as any change caused either directly or indirectly by human activities. As such, it has the ability to modify naturally existing climate variability and the composition of the Earth's atmosphere over similar time periods (Baxi, 2016).

Climate change is defined as any alteration in the climate that is caused by human activity, whether directly or indirectly, as per Law No. 31 of 2009,

which governs meteorology, climatology, and geophysics. Human activity is responsible for both the natural climate variability seen over comparable time periods and the variations in the composition of the global atmosphere.

According to the Directorate General of Climate Change Control, climate change is a substantial alteration in air temperature, rainfall, and climate that can last anywhere from a few decades to millions of years. Growing atmospheric quantities of carbon dioxide and other gases, which produce the greenhouse gas effect, may be the source of this climate change.

According to the World Wildlife Fund (WWF), the use of fossil fuels has resulted in an increase in greenhouse gas concentrations in the atmosphere since the Industrial Revolution, which has altered regional or worldwide climate patterns. NASA defines climate change as a shift in a location's typical weather patterns. For instance, the amount of rainy weather varies throughout the year. The earth's climate is changing due to climate change as well. Take variations in the planet's temperature, for instance (Shapiro, 2016).

Climate change is the long-term modification of specific weather patterns in an area. As a result, there is often a connection between climate change and the phenomena of global warming. Climate change refers to long-term changes in weather patterns and temperature. This shift occurs naturally, for instance, due to modifications in the solar cycle (Iler et al., 2021).

However, human activity has been the main cause of climate change since the 1800s. mostly as a result of using fossil fuels like coal, oil, and gas, as was previously indicated. Another word for climate change in general is global warming. where the atmospheric concentration of greenhouse gasses momentarily increases.

The causes of climate change and global warming consist of various different factors, apart from that the resulting impacts will also be different. Various studies have concluded that the main cause of climate change is none other than human activity. Human activities give rise to green house gas (GHG) which causes the earth to warm much faster in the last 2,000 years (Zhang et al., 2020). The average temperature of the earth is currently increasing by 1.1 degrees Celsius compared to the 18th century at the beginning of the industrial revolution. The last decade (2011-2020) was also confirmed as a record for the highest temperature conditions on earth. The main greenhouse gas substances that cause climate change, such as carbon dioxide and methane, are generated mainly from the industrial sector. The use of fossil energy such as coal, oil and gas for various purposes from various global sectors, the use of motorized vehicles using fossil energy as fuel, and deforestation which inhibits the process

of re-absorbing carbon dioxide by plants also trigger climate change in the world. The Intergovernmental Panel on Climate Change in 2022 said that a significant increase in GHG in the atmosphere came from CO₂ from industry and fossil fuels (64%), methane (18%), CO₂ from land and forest conversion (11%), N₂O (4%), fluorinated gases/ F-gases (2%).

World GHG emission production continues to increase every year. Starting from the industrial sector, transportation, to individual activities. Referring to data from Our World In Data, total world CO₂ emissions in 2020 reached 34 billion tonnes. When viewed from the country's income level. Countries with High Income contribute 12 Billion Tons of CO₂ or 35%, countries with Upper-Middle Income contribute the most GHG emissions, namely 16 Billion Tons of CO₂ or 47% while countries with Lower-Middle Income contribute 6 Billion Tons of CO₂ or 17% and lastly, countries with Lower Income only contributing 0.16 Billion Tons of CO₂ or less than 1%. If these data are analyzed, it is found that the country with the highest emissions refers to a larger human population factor.

When divided and viewed sectorally, there are five impacts that can be directly felt from climate change. The first is the scarcity of clean water due to hot conditions in the earth which causes drought or high rainfall which causes floods. Next is damage to natural ecosystems due to drought or land or forest fires where forest fires will increase greenhouse gas emissions into the atmosphere and damage ecosystems and biodiversity. Then climate change causes damage to ocean ecosystems due to greenhouse gases which cause an increase in carbon dioxide levels in the sea, which can accelerate the bleaching process of coral reefs and disrupt the ocean ecosystem. Apart from that, global warming can also cause sea levels to rise. Climate change also has an impact on reducing the quality of human health (Dunlap, R. E., & Brulle, R. J, 2015).

From the health sector, climate change can have an impact on global public health directly or indirectly. Reporting from the journal "The Lancet", climate change is the biggest health challenge experienced globally in the 21st century. Various studies say that extreme heat conditions cause disorders such as cardiovascular disease (Uscinski, J. E., Douglas, K., & Lewandowsky, 2017). This is because in extreme conditions, the body sweats and releases more body fluids so that the body system lacks salt. This causes the fluid in the blood to decrease and the blood to become thicker, making the heart work harder.

According to Kai Chen, assistant professor at the Yale School of Public Health and Research Director of the Yale Center on Climate Change and Health, hot conditions also cause inflammation which is bad for the heart. Furthermore,

climate change which causes changes in weather patterns triggers an increase in the risk of infectious disease transmission due to geographic expansion by vectors that spread infectious diseases. Climate change, which causes forest fires, releases particles which, when inhaled by the lungs, have a long-term effect on human cognitive abilities, thereby increasing the risk of dementia. Research also says that heat stress causes chronic kidney disorders such as urinary tract infections and kidney stones. This disease is at high risk for workers outside environments with high heat and humidity conditions. Air changes have had an impact on current air pollution which exceeds the limits set by WHO, this causes respiratory problems such as pneumonia, Chronic Obstructive Pulmonary Disease, and lung cancer.

Adaptation Policy

According to Eriksen, S. H., Nightingale, A. J., & Eakin, H. (2015), adaptation is the process of altering natural or artificial systems in response to present or anticipated climatic stimuli or impacts in order to reduce risks or create opportunities. prosperous. Efforts made by humans or by nature to adapt in order to lessen the effects of potential or actual climate change are also known as adaptation. The commitment to adapt to climate change is predicated on Indonesia's standing in the international community to lessen the adverse effects of climate change on a range of economic sectors, which may lead to a drop in the world's gross domestic product (GDP). Putting climate change adaption (API) into practice is relatively complex considering Indonesia's geographical position in the tropical region, topographic variations, and the vast land and sea areas. A comprehensive and comprehensive approach is needed in planning adaptation actions in order to fulfill the basic needs of society, namely food, water, energy and health. Planned climate change adaptation steps need to pay attention to connectivity between action programs to fulfill these basic needs, so that mal-adaptation does not occur, namely actions that have a negative impact on fulfilling one of the basic needs. For example, irrigation to meet food needs can trigger an increase in the need for fossil-based energy, so it is necessary to think about alternative energy (Wise et al., 2014). Thus, adaptation actions need to have basic principles of efficiency and effectiveness in the use of ecosystem services resources in a sustainable manner.

Together with mitigation activities, adaptation initiatives must be coordinated and complementary. Integrating mitigation strategies with adaptation tactics will make them more sustainable. Incorporating adaptation

and mitigation strategies can help boost local community interest in and acceptance of climate change mainstreaming initiatives. While mitigation offers more long-term benefits for the entire world, adaptation is more focused on the urgent needs of local populations.

Referring to the typology of adaptation developed by Matthews, T., Lo, A. Y., & Byrne, J. A. (2015), there are two types of adaptation activities, namely those that are independent (autonomous-responsive/reactive) and those that are planned (planned-anticipatory). Independent adaptation because it is autonomous and responsive can be carried out, both by the community and the government, as a response to the conditions experienced. Independent adaptation can actually take place without being linked to climate change, that is, as long as there are efforts to change water management conditions and habits for the better, such as avoiding water crises, droughts and floods. In addition, as a response, independent adaptation does not require vulnerability studies which sometimes contain studies of projected climate conditions and water stock conditions. This is different from planned and anticipatory adaptation. This type of adaptation activity will usually require vulnerability studies and also studies related to climate change scenarios as a scientific basis for determining the required adaptation options.

In order to minimize the negative effects of climate change and, if feasible, to maximize its positive effects, adaptation efforts in Indonesia are focused on two main areas: (1) adjusting strategies, policies, management, technology, and attitudes; and (2) reducing the direct, indirect, continuous, discontinuous, permanent, and impact-level effects of climate change (Ministry of National Development Planning/Bappenas, 2014).

The form of adaptation can be in the form of local wisdom or technology that is still traditional in a community. Local wisdom and traditional technology are the local knowledge of a community which of course has different backgrounds and methods or techniques and arrangements from one community to another. Adaptation has the characteristics of a community in relation to facing or responding to natural phenomena, including the impact of climate change. Some of the main components of climate change adaptation activities include attribution of climate change components to socio-economic and biosphere activities, impact assessments and studies, vulnerability to climate change, adaptive capacity, and studies of resilience to climate change (Merilä, J., & Hendry, 2014).

Mitigation Policy

The definition of mitigation is all efforts and activities carried out to reduce and minimize the consequences caused by climate change, which includes preparedness and preparation of physical readiness, vigilance and mobilization capabilities (Edenhofer, 2015).

Mitigation efforts aim to reduce greenhouse gas emissions by switching to renewable energy, reducing fossil fuel consumption, and preserving forests. Efforts to mitigate or reduce the effects of greenhouse gases can be done by saving energy, not being consumptive, managing waste and efficient use of transportation.

Following are several mitigation efforts that can be carried out according to Mi, Z., Guan et al., (2019) as follows:

1. **Switch to Renewable Energy:** such as solar, wind and hydro power to reduce carbon dioxide emissions from power plants.
2. **Energy Efficiency:** Improving energy efficiency in homes, industry, and the use of sustainable transportation can also reduce energy consumption and CO₂ emissions.
3. **Reforestation and Forest Conservation:** Protecting forests and carrying out reforestation is very important because forests can absorb natural carbon.
4. **Sustainable Agriculture:** Sustainable agricultural practices such as livestock waste management and reduced use of fertilizers can also help reduce methane and nitrogen oxide emissions.
5. **Climate Education and Awareness:** Increasing public awareness is essential in reducing emissions and adopting a sustainable lifestyle.

Long-term changes in Earth's temperature are referred to as "climate change," particularly when those changes are brought on by human activity such as greenhouse gas emissions from burning fossil fuels. The atmosphere will become more heated as a result of these released gasses, which will have detrimental effects on the economy, the environment, and human health. Natural disasters including storms, droughts, and floods are brought on by some of the negative effects of climate change and can result in fatalities as well as property damage. Because of altered weather patterns that make it more difficult to raise animals and cultivate crops, climate change also has an impact on agricultural output and food security. Additionally, this may lead to the spread of illness and pose a risk to human populations (Lundmark et al., 2014).

Emissions of greenhouse gases, particularly carbon dioxide, must be decreased in order to lessen the adverse effects of climate change. This can be accomplished in a number of ways, including by encouraging the use of renewable energy sources, raising energy efficiency levels, and lowering deforestation. It is imperative to address climate change by allocating resources towards resilient infrastructure and enacting measures to safeguard marginalized communities.

According to Epple, C et al., (2016) to reduce carbon emissions, there are several efforts that can be made, including:

1. **Increasing Energy Efficiency:** Increasing energy efficiency can help reduce energy use needed in daily activities, such as reducing electricity consumption at home and offices, as well as optimizing the use of vehicles with more efficient technology.
2. **Forest Planting:** Forest planting can help absorb carbon in the atmosphere and reduce carbon emissions from deforestation and forest encroachment.
3. **Use of Renewable Energy:** In the long term, the use of renewable energy can reduce dependence on fossil fuels and reduce carbon emissions.
4. **Sustainable Transportation:** Support and promotion for the use of sustainable transportation such as public transportation and bicycles can reduce carbon emissions from private vehicles.
5. **Environmental Education and Awareness:** Environmental education and awareness are important to promote the reduction of carbon emissions. The government can carry out educational campaigns about the impact of climate change and the importance of reducing carbon emissions to the community.

Today, climate change is increasingly in global focus, with increasingly pressing challenges to reduce greenhouse gas emissions and limit global temperature rise. However, amidst these challenges, there are also optimistic stories about positive developments in climate change mitigation efforts. The latest trends in climate change mitigation efforts that are promising and what they mean for the future of our planet according to Wood, E.

1. **Road Transport: Driving to a Green Future.** Significantly increasing sales of electric vehicles in China and the European Union are a key driver in limiting the growth of emissions from the road transport sector. New policies and incentives for consumers and manufacturers of electric vehicles in the United States are also expected to increase the adoption of

environmentally friendly vehicles. This trend marks a shift towards cleaner and more sustainable mobility.

2. **Industrial Sector: Deep Energy Transformation.** Industrial sectors, such as chemicals, iron and steel, and electricity, are experiencing sharp changes in their emissions trajectories. The increasing use of renewable energy, especially in China, is key to reducing industrial sector emissions. This is an important step towards a more environmentally friendly and sustainable industrial system.
3. **Buildings: Reducing the Carbon Footprint in Cities.** Energy demand for heating and cooling from developing countries is increasing, but accompanied by increased efficiency and electrification in developed countries. It marks a transformation in the way we build and manage urban infrastructure, with a focus on reducing our carbon footprint and adapting to climate change.
4. **Aviation and Maritime Sector: Challenges Towards Decarbonization.** Despite progress in several sectors, emissions from the aviation and maritime sectors continue to increase as global demand continues to grow. The challenge of decarbonization remains strong in this sector, with the need for technological innovation and stronger policies to address this challenge.
5. **China's Role: Leading Change Towards a Sustainable Future.** China is a key driver in reducing emissions post-2025, with ambitious renewable energy policies and declining coal use. This transformation highlights the importance of global leadership in climate change mitigation efforts and provides inspiration for other countries to follow in its footsteps.

These patterns give us fresh hope for attempts to mitigate climate change. Still, a lot of work needs to be done. Climate change is a worldwide issue that calls for cooperation from all stakeholders, including businesses, governments, and individuals. We live in a pivotal moment in history where the things we do now will determine the course of our planet's destiny. Although the challenges of climate change mitigation can feel great, we have the tools and knowledge necessary to make positive changes.

With hard work, innovation and global cooperation, we can achieve our climate change mitigation goals and pass on a cleaner, more sustainable world to future generations. Every small step we take, from adopting electric vehicles to reducing our carbon footprint at home and work, has a real impact. Let's make these changes part of our lifestyle and encourage political and business

leaders to take strong action to confront the climate change crisis. With a spirit of collaboration and shared commitment, we can make the vision of a green and sustainable future a reality. It's time to unite and move forward towards a better future for our planet and all the creatures that inhabit it (Nielsen et al., 2024).

CONCLUSION

Climate change is a global problem and has become an urgent issue in this modern era. The impacts of climate change are not only felt in a few areas, but have spread throughout the world. In recent decades, we have witnessed the serious impacts of climate change, such as rising global temperatures, increasing intensity of extreme weather, and decreasing environmental quality. All of this poses a big challenge for the sustainability of our environment.

The challenges faced by the environment due to climate change are very complex and require serious attention. To effectively adapt and manage these diverse difficulties, Indonesia and the rest of the world must take proactive, preemptive measures. Climate change poses a significant problem that necessitates taking concrete steps to mitigate greenhouse gas emissions and adapt to current and future effects. The community can help mitigate greenhouse gas emissions by adopting small actions like reducing the use of motorized vehicles, starting to use public transportation, conserving water and electricity, using less plastic waste, and planting trees in the neighborhood.

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