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MORALITY BEFORE KNOWLEDGE

Indonesia's economic and environmental resilience in the face of climate change: Analysis and implementation strategies

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ABSTRACT

Background: Climate change is a significant threat to Indonesia, an archipelago that is vulnerable to the negative impacts of this phenomenon. This study aims to identify the effects of climate change in Indonesia and evaluate mitigation and adaptation strategies needed to improve economic and environmental resilience. Based on climate change projections, increases in surface temperature, changes in rainfall patterns, sea level rise, and changes in water salinity have negative impacts on various sectors such as agriculture, fisheries, infrastructure, and public health. **Method:** The research method includes secondary data analysis from various official sources and a study of relevant literature, with an analytical descriptive approach to identify critical challenges and necessary strategies. **Findings:** The results show that limited fiscal space and the need for budgetary reform are significant challenges that need to be addressed through the introduction of a carbon tax, budgetary incentives for green technologies, and the removal of fossil fuel subsidies. In addition, mobilization of non-budget funding sources is needed to support green projects, with strategies such as the development of public-private partnerships, access to international funds, and technical capacity building. **Conclusion:** In conclusion, implementation of the recommended mitigation and adaptation strategies can increase Indonesia's resilience to climate change, reduce its risks and negative impacts, and ensure the sustainability of economic and social development. **Novelty/Originality of this study:** This research provides practical guidance for policymakers to develop effective strategies to deal with climate change.

KEYWORDS: climate change; mitigation; adaptation; fiscal strategy; fiscal reform.

1. Introduction

Climate change impacts many aspects of human life, including the environment, economy, and health. Indonesia, an archipelago of more than 17,000 islands, is particularly vulnerable to climate change, such as rising sea levels, increasing temperatures, and changing rainfall patterns. According to BAPPENAS (2019), Indonesia's economic and social growth is hampered by climate change, which also jeopardizes environmental sustainability. Surface temperatures in Indonesia's major cities are expected to increase by 3°C by the end of the 21st century, according to the Meteorology, Climatology and Geophysics Agency (BMKG, 2017). In addition, it is expected that rainfall will be higher in the dry season and lower in the wet season, which could lead to more severe floods and droughts (BMKG, 2017). Communities living near the coast and coastal ecosystems are in danger due to the 0.25°C per year rise in sea surface temperature and 0.6-1.2 cm per year rise in sea level. (Fig. 1).

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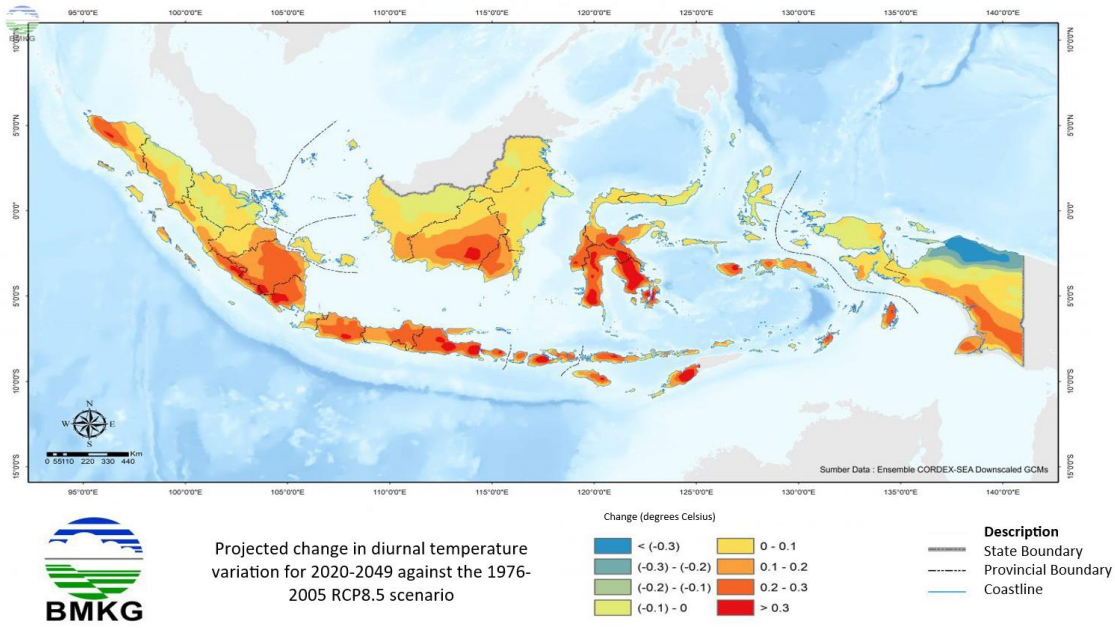

Fig. 1. The phenomenon of climate change in Indonesia (BMKG, 2019)

All over the world, the impacts of climate change are being felt. Some straightforward indications of this phenomenon include increased global temperatures, changes in rainfall patterns, and increased frequency of natural disasters. The effect of climate change on rice production in Indonesia (Ruminta et al., 2018), dengue fever cases in West Java (Raksanagara et al., 2016), climate suitability of nutmeg plants in Seram Island (Laimeheriwa et al., 2020), rainfall distribution in Central Sulawesi Province (Alfiandy & Permana, 2020), and productivity of crops in Jember Regency are some examples of climate change impacts. In addition, farmers in Wain Village, Southeast Maluku Regency, experienced a decrease in income and productivity of cassava as a result of climate change (Wokanubun et al., 2020), as well as the Juanda Surabaya climate disaster. Other studies show that climate change can impact the distribution of rainfall in Lampung (Manik et al., 2016), Serang, and changes in the beginning of the dry and wet seasons in Kupang City, East Nusa Tenggara.

The urgency of climate change is increasingly clear, as its impacts are increasingly widespread and felt around the world. Rising global temperatures, changing rainfall patterns, and increasing levels of natural disasters are clear evidence of this phenomenon. Global climate change, caused by increasing concentrations of greenhouse gases in the atmosphere, is expected to have a significant impact on the tourism industry. It will affect tourists' preferences for destinations and change the attractiveness of destinations, which in turn will lead to changes in tourism destination management (Perdinan, 2020). Climate change has led to very high rainfall, which has increased the rate of flash floods, landslides, and disasters due to natural dams (Azmeri et al., 2015). In disaster-prone areas such as Mount Merapi, there have been changes in communication. These changes impact the way communication is used, the sources of information used to make evacuation decisions, sources of information about volcanic activity, and priorities during emergency response and post-disaster recovery (Wardyaningrum, 2014). In addition, an analysis of the impact of climate change on the welfare of fishermen in Sungai Kakap Village, Kubu Raya Regency, emphasized adaptation strategies, such as the application of multiple income patterns through activities that are not related to fishing (Kartini, 2013).

Concerns about climate and weather risks are increasing due to reduced catchment areas, projected increases in extreme weather intensity, and increased flood frequency as a result of climate change (Syarifuddin, 2023). Social assistance is essential for flood and landslide victims, as thousands of people were evacuated as their homes were washed away

by the Cidurian River (Prihhartini et al., 2021). In Bukit Lawang Nature Park, Bahorok District, Langkat Regency, North Sumatra Province, disaster awareness education through physical activities through mobile applications has been carried out through socialization preparation, assessment, program planning, action plans, and evaluation (Nurkadri et al., 2022).

A spatial study looking at spatial planning that considers disaster risk in Kudus District, Central Java Province, emphasized the importance of community participation in improving the quality of spatial planning and reducing the likelihood of disasters (Suryanta & Nahib, 2016). Villages such as Destana Patra in Sungai Kupah Village, West Kalimantan, were built to accelerate recovery, reduce the negative impacts of disasters, and encourage economic growth and tourism (Wibisono et al., 2023). Adaptation strategies of coastal communities in the Kei Besar Islands, Southeast Maluku, to the impacts of climate change are essential to cope with climate disasters over the past forty years. These disasters have caused significant losses to individuals and their livelihoods, economic damage, social infrastructure damage, and environmental degradation (Far & Tuhumury, 2022).

To understand the impact of climate change on rice productivity in rice-producing areas in Indonesia, the sensitivity of rice production to climate change has been analyzed using four different climate variables from 1974 to 2015 (Nurhayanti & Nugroho, 2016). To achieve education goals, evaluating the quality of primary education infrastructure in West Java Province, Indonesia, based on a multi-hazard and accessibility model, is essential (Rahadianto et al., 2021). Given that Indonesia is one of the most vulnerable countries to natural disasters, students need to understand how to mitigate landslides (Nurjanah & Mursalin, 2021).

To reduce disaster risk, it is crucial to anticipate the negative impacts of natural disasters through disaster mitigation. One example is instilling earthquake disaster response awareness in children in elementary school (Yulistiya & Yuniawatika, 2022). To improve students' understanding of disaster risk and preparedness, innovative learning programs such as Web-Tana are used as a disaster risk reduction strategy in the digital era (Rachmadian et al., 2021). A study of health crisis management in Indonesia in 2016 emphasized that qualitative studies utilizing electronic information sources and literature are essential for improving health crisis management programs (Pane et al., 2018).

In hundreds of sub-districts in ten districts/cities with different levels of disaster vulnerability, the development of interactive multimedia teaching materials for disaster preparedness is essential (Raibowo et al., 2021). Web-based and Android-based disaster management applications are examples of advances in information technology, such as mobile technology, that play an essential role in disaster management (Ardianto, 2022). To develop disaster-resilient tourism, collaborative governance, which is based on community-based disaster preparedness, is necessary (Demartoto, 2019).

The achievement of poverty alleviation in sustainable development and its relation to disaster in Central Java can be seen from the decline in target achievement in 2020 compared to 2019, with most indicators remaining in the red (Purwaningsih, 2022). For successful disaster risk reduction and sustainable development efforts, it is crucial to work together with various stakeholders in collaborative governance. Raksanagara et al. (2016) looked at the effects of climate change on dengue fever cases in West Java, where temperature, humidity, and rainfall increased, increasing public health risks. Sunarti & Apriliasari (2015) found the effects of climate change on coastal residents in Demaan Village, Jepara Regency, such as rising temperatures, tides, flooding, and rob. Salampessy et al. (2018) investigated the capacity of wet-rice farmers to adapt in Pasuruan District, East Java. The study showed that farmers' views on climate change influenced their level of support for mitigative and adaptive actions.

Previous researcher talked about the availability and access to information on climate change, government duties, and community participation in implementing climate change adaptation in Indonesia. The study conducted by Utomo & Sitorus (2016) shows changes in the way forest land is used in Katingan District, Central Kalimantan, indicating spatial synergies in REDD+ implementation. As an effort to reduce the risk of climate change

impacts, Zukmadini & Rohman (2023) showed that education about climate change mitigation and adaptation is critical. Wahyudin et al. (2020) examined environmental law policies for climate crisis mitigation in Indonesia; Yuliantoro & Wahyuni (2019) investigated how coastal communities perceive and adapt to climate change in Sarawet Village, North Minahasa Regency; and Adiyoga & Lukman (2018) investigated how vegetable farmers in South Sulawesi perceive and adapt to climate change. To understand how climate change impacts various areas, such as the environment, health, and agriculture. This study provides valuable knowledge on how to make appropriate policies and actions to deal with problems caused by climate change. To reduce the risks posed by climate change, it is crucial to understand how it impacts essential sectors such as agriculture, health, and the environment. Mitigation and adaptation must be strengthened.

Indonesia's infrastructure, agriculture, and fisheries are greatly affected by climate change (Wijaya et al., 2017; Syaukat, 2018). For example, changes in rainfall patterns have led to decreased agricultural productivity and increased incidence of hydrometeorological disasters (Syaukat, 2018). However, there has not been a thorough evaluation of mitigation and adaptation methods that can improve economic and environmental resilience in Indonesia. As a result, it is crucial to understand the impacts of climate change and undertake appropriate mitigation and adaptation efforts to face the challenges generated by climate change. The purpose of this study is to discover the effects of climate change in Indonesia and evaluate the mitigation and adaptation methods needed to improve economic and environmental resilience so as to provide concrete and implementable policy recommendations.

2. Methods

This research uses an analytical descriptive approach to provide a complete picture of the critical issues facing Indonesia related to climate change. This method allows researchers to thoroughly describe phenomena and analyze data to find relevant patterns and relationships. In doing so, the study was able to discover specific issues faced in the mitigation and adaptation process, such as limited fiscal space, reliance on environmentally unfriendly revenue sources, and the complexity of the current tax system.

This study utilizes secondary data analysis from various official sources, including the Meteorology, Climatology and Geophysics Agency (BMKG) and the National Development Planning Agency (BAPPENAS), as well as relevant literature research. These data sources were chosen because they provide up-to-date and accurate information on the Indonesian government's policies on climate conditions, adaptation, and mitigation.

The analysis includes an evaluation of carbon tax policies, fiscal incentives for green technologies, and fossil fuel subsidy removal strategies. It also evaluates the effectiveness of fiscal policies that have been implemented to support climate change mitigation and adaptation efforts. In addition, the research examines various public-private collaboration initiatives, the ability to secure international funding, and efforts to improve the technical capabilities needed to optimize non-budgetary funding sources.

The results of this analysis are expected to provide an overview of the strengths and weaknesses of existing policies, as well as prospects and obstacles in the mobility of non-budgetary funding sources. This research is expected to help Indonesian policymakers create more sustainable and efficient mitigation and adaptation strategies.

3. Results and Discussion

The following is a histogram representation of the data provided in the table, showing the budget ("Ceiling") versus realization ("Realization") for 2023 and 2024 for the categories "Climate Change Mitigation" and "Climate Change Adaptation" as well as the total. The left side of the graph shows data for 2023, and the right side shows data for 2024.

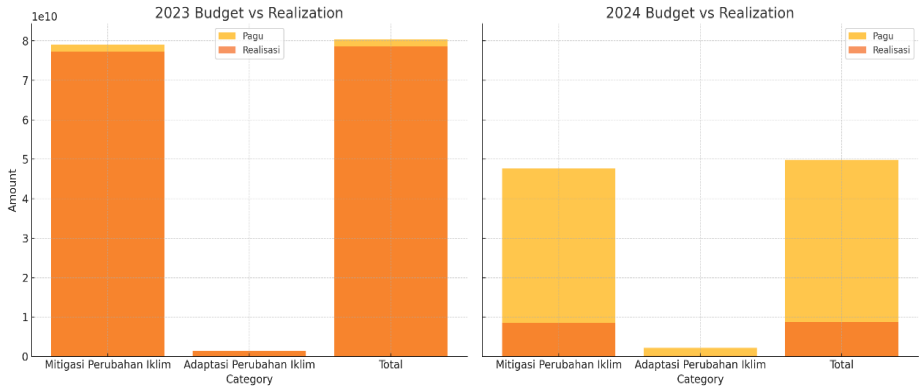

Fig. 2 The budgets for climate change mitigation and adaptation programs in the West Papua Region

The histograms in Fig 2. showing how the budgets for climate change mitigation and adaptation programs in the West Papua Region in fiscal years 2023 and 2024 were allocated and used show some critical points. The budgets for climate change mitigation and adaptation of 79,051,495,000 and 1,334,377,000, respectively, were realized almost entirely, with a percentage of 97.78% in 2023, indicating that climate change budget management was very efficient and effective. However, the budget realization was very low from April to April 2024, with 17.93% mitigation of the budget ceiling. However, it is essential to ensure that the budget for 2024 is realized according to the target so that climate change mitigation and adaptation goals can be fully achieved. It is expected that climate change mitigation and adaptation efforts in West Papua will yield significant and sustainable results with sound budget management. This is due to the fact that the tagging budget, also known as the climate change tagging budget, becomes an important tool to find and ensure that the funds provided are actually used for related areas such as agriculture, forestry, energy, transportation, as well as water, marine and food security.

In Indonesia, various climate change projections and threats need to be considered. Surface temperatures in major cities will increase by 3 degrees Celsius by the end of the 21st century. Projections show that while the application of green technologies and development adaptation can help, this increase in temperature can cause heat stress in humans and animals, as well as accelerate the melting of ice on mountains, threatening the balance of ecosystems and public health.

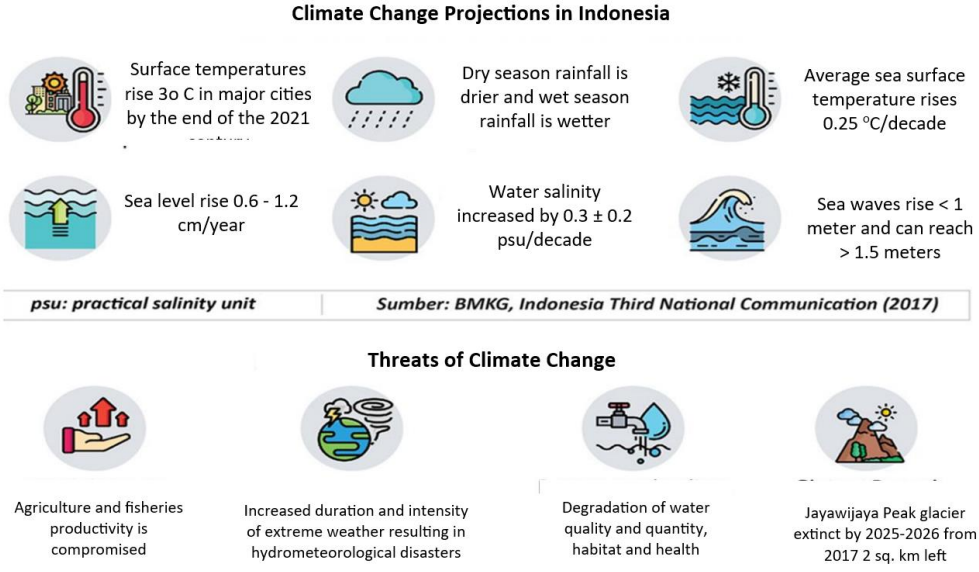

Fig 3. Climate change projections in Indonesia

With drier dry seasons and wetter wet seasons, increasingly erratic rainfall can help water management become better, but it can also disrupt agricultural patterns and increase the risk of natural disasters such as floods and landslides. With sea levels rising by 0.6-1.2 cm every year, changes are needed by building dykes and coastal infrastructure. However, coastal erosion and land loss in coastal areas are still significant hazards.

Increases in seawater salinity of 0.3 to 0.2 PSU (practical salinity unit) per year can be controlled through water quality monitoring but can affect marine life and threaten the availability of freshwater and fisheries resources. In addition, to protect coastal infrastructure from ocean waves that are predicted to rise less than 1 meter and may reach 1.5 meters, the development of breakwater technology is needed. However, there is still a risk of damage to infrastructure and the safety of fishermen.

Reduced agricultural and fisheries productivity is a real threat from climate change, negatively impacting food security and the economies of communities that depend on these sectors. With the increasing duration and severity of extreme weather, improved early warning systems and disaster preparedness are needed, but they still cause infrastructure damage and economic losses. To address declining water quality and quantity, which impacts habitat and health, water treatment and conservation technologies are needed, but the water crisis is still a threat to public health.

Jayawijaya Peak Glacier is predicted to be extinct by 2025-2026, signaling the loss of a primary water source and significant ecosystem changes. While research and documentation can improve understanding and mitigation efforts, the loss of glaciers will have substantial environmental impacts. As a result, to deal with these multiple impacts of climate change, planned and sustainable adaptation and mitigation actions are essential.

3.1 Impact of climate change on the agriculture sector

Decreased Crop Productivity: If temperatures increase, the process of evapotranspiration occurs faster, which in turn can lead to lower crop yields. According to research, an increase in temperature led to a decrease of up to 20% in South African maize yields. The evapotranspiration process accelerates when temperatures increase. This can result in reduced yields (Amin et al., 2015). Studies have shown that climate change affects the harvested area and yields of major food crops in some countries, such as Sudan and Bangladesh (Uddin et al., 2023; Osman et al., 2021). In addition, weather conditions have been a concern of research on mesta cultivation in India (Rao et al., 2013). Moreover, it has been observed that climate variations impact crop yields in different places around the world. This shows how necessary knowledge of climate cues is for agriculture (Holopainen et al., 2012; Llano et al., 2011).

In addition, many studies have been conducted on the relationship between climatic factors and crop yields. Examples include the effect of water stress on soybean development (Pereira et al., 2019), the impact of climate change on maize productivity (Gurusamy & Rudrasamy, 2020), and the effect of climate variables on rice yield in the Philippines (Enovejas et al., 2020). These studies emphasize that climate variability in agricultural systems is critical for optimizing productivity. As shown by studies on wheat cultivation in Germany and Brassica Juncea L Bharat et al. (2022), planting time has been identified as an essential component that affects crop yield (Liu & Hou, 2017). Many studies have shown that evapotranspiration plays a critical role in agricultural water consumption and demonstrates how vital irrigation treatments are (Hashem, 2015). In addition, research has examined the use of agrometeorological indices to improve yield predictions with crop models; this suggests that complex factors influence accurate yield calculations (Lalic et al., 2014). A synthesis of these references shows how climate change, temperature variation, evapotranspiration, and crop productivity relate to each other. It is critical to understand these interactions to develop sustainable agricultural practices that can prevent the negative impacts of climate change on crop yields.

3.2 Impacts of climate change on the fisheries and marine sector

Changes in the Geographic Distribution of Fish can be caused by increased seawater temperatures, resulting in many species shifting to calmer waters. The study conducted by Park Williams et al. (2017) showed that in the last twenty years, cod populations in the North Atlantic have moved northward by 200 km. Climate change can alter the distribution of fish species by increasing sea surface temperatures. Many fish behaviors can be affected by these increased temperatures. These include reproduction, early life stages, and migration patterns. Studies have shown that temperature affects fish reproduction, larval survival, and size at hatching (Pankhurst & Munday, 2011).

In addition, adult fish can migrate early due to temperature changes, which can alter their habitat choices and place them in different environmental conditions (Quinn et al., 2016). In addition, sea surface temperature is a critical climate component in the timing of fish migration; these factors also influence when fish return to their freshwater habitat (Hodgson et al., 2005). Studies on salmon species have emphasized the influence of temperature on habitat use and fish migration routes. These studies also emphasize the ability of fish to adjust to changes in the marine environment (Kristensen et al., 2019; Goertler et al., 2021).

It is critical to understand the relationship between temperature variation and fish migration to predict how climate change may affect the geographic distribution of fish populations. By studying the influence of temperature on fish behavior and migration patterns, researchers can gain insight into how fish species respond to changing environmental conditions, including shifts in sea surface temperature.

3.3 Impacts of climate change on the tourism industry

Increased storm frequency and rising sea levels can cause damage to beaches and tourist sites. According to a 2019 World Tourism Organization report, hurricane damage to Caribbean beaches has increased by 30% in the last five years. Increased storm frequency and sea level rise due to climate change can indeed have a detrimental impact on coastlines and tourist destinations. Numerous studies have investigated the effects of extreme weather events and sea level rise on coastal areas, highlighting the vulnerability of these areas to hazards caused by climate change.

An increasing number of storms and sea level rise jeopardize beaches and coastal tourist attractions (García-Romero et al., 2023; Hoogendoorn & Fitchett, 2018; Widura & Mardiatno, 2022) These environmental changes lead to severe coastal flooding, coastal erosion, and erosive processes. This impacts the infrastructure and attractiveness of tourist destinations. Studies show an increase in storms since the 1990s. They predict extreme sea levels will increase by up to 60% by 2100. When sea level rise, ocean surges and storms combine, they cause significant coastal erosion and coastal flooding. This threatens tourism infrastructure and requires remediation plans. The goal of the cooperation between the research institute and the environmental program is to ensure the sustainability and resilience of coastal tourism destinations through the application of climate change data in coastal management.

Research has shown that intensification of storms can lead to increased coastal erosion, waterlogging, and infrastructure damage along coastlines. In addition, sea level rise exacerbates the impacts of storms by amplifying coastal flooding and erosion, posing significant risks to coastal communities and tourist sites. The research also emphasizes the importance of coastal management strategies, such as beach nourishment and dune restoration, in reducing the adverse impacts of storm surges and sea level rise in coastal areas.

In addition, the economic implications of coastal hazards on tourism have been explored, with findings indicating potential revenue losses and infrastructure damage from storm events and sea level rise. The tourism sector's reliance on coastal attractions

underscores the need for adaptation measures to protect these valuable assets from the impacts of climate change. Understanding the interactions between storm frequency, sea level rise, coastal erosion, and tourism vulnerability is critical to developing effective adaptation and resilience strategies for coastal areas and tourist destinations.

3.4 Climate change impacts on infrastructure

Physical Damage to Infrastructure: Natural disasters such as floods, storms, and heat waves can cause damage to roads, bridges, and buildings. A study conducted by research, shows that infrastructure damage caused by flooding in Southeast Asia amounts to $2 billion per year. Natural disasters such as floods, storms, and heatwaves can severely affect physical infrastructure such as roads, bridges, and buildings. These accidents can cause significant damage, disrupt vital services, and challenge recovery (Cavallo et al., 2010). Natural disasters often cause damage to infrastructure and medical facilities, which hinders the provision of health services for acute and chronic illnesses (Hugelius et al., 2019). Infrastructure rehabilitation is necessary after disasters to ensure the continuity of essential services and assist affected communities (Reinhardt et al., 2011).

In areas prone to climatic disasters such as floods, landslides, and earthquakes, infrastructure, particularly railway systems, faces significant challenges. The effects of such disasters on railway infrastructure can be severe, affecting operations and requiring robust strategies for resilience and recovery (Roy et al., 2023). Implementing decentralized energy and water networks can increase community resilience to natural disasters by ensuring continued access to vital resources during and after disasters (Joshi & Mohagheghi, 2022). To reduce risks and accelerate post-disaster recovery, it is considered essential to incorporate a disaster risk reduction philosophy into infrastructure projects (Palliyaguru et al., 2012).

Geographic information systems (GIS) and artificial intelligence can work together to improve disaster management by enabling effective resource allocation and organized rescue operations (Emami, 2023). It is critical to have a robust prediction and mitigation strategy as severe weather conditions associated with natural disasters damage power infrastructure and impact millions of users (Ali et al., 2022). Using software-defined satellite networks, evacuating data from centers in disaster-affected areas can help maintain connectivity and data access during a crisis (Lourenco et al., 2019).

To build cities and communities that are resilient to natural hazards such as floods, volcanic eruptions, earthquakes, and hurricanes, it is crucial to incorporate psychological preparedness into disaster risk reduction policies (Palupi, 2022). To create successful resilience strategies and response plans, evaluation of the vulnerability of critical infrastructure, related industries, and communities during extreme events is essential. Sand and dust storms, often considered underestimated natural hazards, have significant impacts on a wide range of environments, confirming the importance of a thorough disaster preparedness plan (Middleton et al., 2018).

Building resilience to natural disasters requires a multi-faceted approach involving stakeholders from different sectors to improve warning systems, social engagement, disaster planning, and physical infrastructure (Chaudhary & Piracha, 2021). After major natural disasters, assistance from other countries is essential to aid recovery and reconstruction in the affected areas (Becerra & Cavallo, 2014). To maintain community functionality during disasters and improve overall resilience, protecting vital infrastructure is essential (Cvetković & Kezunović, 2021). Civil engineers are necessary for dealing with natural disasters such as floods and hurricanes, and they also contribute to disaster response and infrastructure recovery (Ha, 2017).

To understand the financial implications and challenges associated with rebuilding damaged infrastructure, it is imperative to conduct cost-performance indicator analysis in post-disaster reconstruction projects (Safapour et al., 2020). The implementation of post-disaster learning models based on local wisdom can help the recovery of educational infrastructure and human resources in affected communities (Warsihna et al., 2020). A

critical component of disaster resilience is mental health preparedness, which requires robust social, economic, cultural, and political infrastructure to support effective emergency response and recovery (Sadeghi & Ahmadi, 2007).

Thus, comprehensive strategies are needed for resilience, recovery, and reconstruction, as natural disasters pose significant challenges to physical infrastructure. Communities can improve their preparedness and emergency response capabilities to reduce the impact of natural disasters on infrastructure and ensure sustainable development in the face of environmental hazards by combining disaster risk reduction philosophies, technological advances, and interdisciplinary cooperation.

3.5. Interlinkages between Sectors

Climate change impacts affect multiple and interconnected sectors, which increases the importance of inter-sector collaboration for mitigation and adaptation. The relationship between the agriculture and tourism sectors is close; in this case, the growth of the agriculture sector drives the growth of the tourism sector, especially through agrotourism and produce-based festivals. If the agriculture sector experiences a decline in productivity due to drought or flooding, local food availability will be compromised, resulting in rural and coastal tourist attractions losing their appeal. In addition, damage to ecosystems such as rice fields or coffee plantations due to changes in weather patterns will reduce the quality of natural attractions. Conversely, disruptions caused by tourism, such as a decrease in tourist visits, affect the local economy, especially those who depend on tourism as part of the agricultural economy.

Fiscal policies supporting climate change mitigation are essential to deal with these issues. The use of renewable energy is encouraged by the removal of fossil fuel subsidies and the implementation of a carbon tax. This assists the agriculture and tourism industries and sectors in adopting sustainable practices. For example, funds obtained from carbon taxes can be used to build green infrastructure or more efficient irrigation technologies. In addition, fiscal policies can enable cooperation between the private sector and the government to develop green initiatives such as ecotourism and organic farming. Fiscal incentives help local communities adopt new technologies and strengthen their defenses against natural disasters and extreme weather.

For mitigation policies and strategies to be effective and impactful, cross-sector integration is essential. To tackle climate change, governments must ensure that policies work with the energy, transportation, agriculture, and tourism industries. For example, to prevent coastal erosion, dykes are built to protect coastal infrastructure and sustain tourism and agricultural activities. Early warning systems for extreme weather can also help local communities prevent disasters and reduce economic losses in the transportation and tourism sectors.

Education plays an important role in disaster preparedness and climate adaptation. By providing disaster education in schools and community-based training, communities can be better prepared for climate risks. Education on climate change mitigation increases people's awareness and encourages them to actively participate in adaptation strategies, such as environmentally friendly agriculture. In today's digital era, social media applications and mobile phone apps further facilitate training and information dissemination, ensuring that communities have relevant skills and knowledge.

A resilient ecosystem in the face of climate change is shaped by appropriate fiscal policies, cross-sector collaboration, and a strong role for education. Indonesia can improve economic and environmental resilience through cooperation between the public and private sectors. Through the adoption of sustainable technologies and the improvement of people's skills, the agriculture, tourism, and infrastructure sectors will be better prepared for the impacts of climate change. Ultimately, this sustainable and integrated approach can ensure inclusive development aligned with climate mitigation goals, resulting in a more sustainable and secure future for everyone.

4. Conclusions

Limited fiscal space and the need for budgetary reform are significant challenges that need to be addressed through the introduction of carbon taxes, fiscal incentives for green technologies, and the removal of fossil fuel subsidies. In addition, mobilization of non-budget funding sources is needed to support green projects, with strategies such as the development of public-private partnerships, access to international funds, and technical capacity building. Implementation of recommended mitigation and adaptation strategies can increase Indonesia's resilience to climate change, reduce its risks and negative impacts, and ensure the sustainability of economic and social development.

Climate change can have a significant impact on various sectors of the regional economy. The agriculture, fisheries, tourism, and energy sectors are the most vulnerable to the effects of climate change. Implementation of mitigation and adaptation strategies can increase Indonesia's resilience to climate change, reduce its risks and negative impacts, and ensure the sustainability of economic and social development.

In addition to the four main sectors mentioned earlier, several other sectors could be affected by climate change, but indirectly. 1. Public Health Sector: Climate change may increase the risk of infectious diseases such as dengue fever, malaria, and chikungunya, and an increase in the frequency and intensity of heat waves may cause health problems. 2. Transportation Sector: Sea level rise and extreme flooding can damage transportation infrastructure, such as roads, bridges, and ports, disrupting the mobility and distribution of goods. Extreme weather, like storms and strong winds, can disrupt air, land, and sea transportation operations. 3. Industry Sector: Water and electricity supply disruptions due to climate change can hamper production processes in the industrial sector. Infrastructure. Decreased revenue, increased costs, and supply chain disruptions are some of the significant economic risks for the region.

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Author Contribution

This paper is prepared as part of the author's responsibility as a regional expert from the Ministry of Finance of the Republic of Indonesia for the Papua and Maluku regions, as well as a regional expert from the West Papua Provincial Treasury Office. These contributions are as follows: providing the overall policy framework and analysis for the study, responsible for collecting and analyzing data from national sources, evaluating the effectiveness of fiscal policies, and providing recommendations to mitigate and adapt to climate change.

Funding

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Ethical Review Board Statement

The Ministry of Finance of the Republic of Indonesia established ethical standards and guidelines for this study. This research does not require ethical review as it involves secondary data analysis and does not involve human or animal subjects. The data sources, which include reports from BMKG, BAPPENAS, and other relevant literature, are publicly available and can be used in accordance with applicable regulations. All procedures conducted in the research involving these data were in accordance with the ethical

standards of the institutional and national research committees. The West Papua Provincial Treasury Office funded this research.

Informed Consent Statement

This study did not involve human subjects.

Data Availability Statement

Data supporting the results of this study were obtained from publicly available sources, including reports from the Meteorology, Climatology, and Geophysics Agency (BMKG) and the National Development Planning Agency (BAPPENAS). These sources are publicly accessible and can be found through their respective websites, as well as data published in the West Papua Provincial Treasury Office ALCO document. No new data was created in this study. The data used in this study is available from the following sources: BMKG: www.bmkg.go.id, BAPPENAS: www.bappenas.go.id, and Asset Liabilities Committee (ALCo). For more information on the datasets used in this study, please contact the corresponding author.

Conflicts of Interest

The authors declare no conflicts of interest. The funders had no role in the design of the study, in the collection, analysis, or interpretation of the data, in the writing of the manuscript, or in the decision to publish the results.

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References

Adiyoga, W. and Lukman, L. (2018). Persepsi dan adaptasi petani sayuran terhadap perubahan iklim di sulawesi selatan. *Jurnal Hortikultura, 27*(2), 279. https://doi.org/10.21082/jhort.v27n2.2017.p279-296

Alfiandy, S., & Permana, D. S. (2020). Tren Curah Hujan Berbasis Data Sinoptik BMKG dan Reanalisis MERRA-2 NASA di Provinsi Sulawesi Tengah. *Jurnal Sains & Teknologi Modifikasi Cuaca*, *21*(2), 63-72.

Ali, R., Khosa, I., Armghan, A., Arshad, J., Rabbani, S., Alsharabi, N., … & Hamam, H. (2022). Financial hazard prediction due to power outages associated with severe weather-related natural disaster categories. *Energies, 15*(24), 9292. https://doi.org/10.3390/en15249292

Amin, M., Zhang, J., & Yang, M. (2015). Effects of climate change on the yield and cropping area of major food crops: a case of Bangladesh. *Sustainability, 7*(1), 898–915. https://doi.org/10.3390/su7010898

Ardianto, E. (2022). Pengembangan aplikasi penanggulangan bencana ship, handle & drive berbasis android dan web. *Jatisi (Jurnal Teknik Informatika Dan Sistem Informasi), 9*(3), 1973-1987. https://doi.org/10.35957/jatisi.v9i3.2352

Azmeri, A., Yulianur, A., & Listia, V. (2015). Analysis of Flash Flood Behavior Due to the Collapse of Natural Dams in the Krueng Teungku River Basin, Aceh Province. *Jurnal Teknik Sipil, 22*(3). https://doi.org/10.5614/jts.2015.22.3.5

BAPPENAS. (2019). *Indonesia's Third National Communication under the UNFCCC*. Ministry of National Development Planning. https://perpustakaan.bappenas.go.id/e-library/file_upload/koleksi/migrasi-data-publikasi/file/Policy_Paper/synthesis-roadmap__20110217190358__0.pdf

Becerra, Ó. and Cavallo, E. (2014). Foreign aid in the aftermath of large natural disasters. *Review of Development Economics, 18*(3), 445-460. https://doi.org/10.1111/rode.12095

Bharat, R., Gupta, V., Gupta, M., & Rai, S. (2022). Effects of different sowing schedules and planting geometry on yield and productivity of brassica juncea el. *Bangladesh Journal of Botany, 51*(3), 631–635. https://doi.org/10.3329/bjb.v51i3.62011

BMKG. (2017). *Indonesia Climate Change Sectoral Roadmap*. Badan Meteorologi, Klimatologi, dan Geofisika. https://cdn.bmkg.go.id/Web/RENCANA-STRATEGIS-BMKG-TAHUN-2020-2024.pdf

Cavallo, E., Galiani, S., Noy, I., & Pantano, J. (2010). Catastrophic natural disasters and economic growth. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1817292

Chaudhary, M. & Piracha, A. (2021). Natural disasters—origins, impacts, management. *Encyclopedia, 1*(4), 1101–1131. https://doi.org/10.3390/encyclopedia1040084

Cvetković, V. and Kezunović, A. (2021). Security aspects of critical infrastructure protection in anthropogenic disasters: a case study of Belgrade. https://doi.org/10.21203/rs.3.rs-927528/v2

Demartoto, A. (2019). Kajian refleksivitas masyarakat risiko dalam pengembangan pariwisata siaga bencana berbasis collaborative governance. *Talenta Conference Series Local Wisdom Social and Arts (Lwsa), 2*(1), 1-7. https://doi.org/10.32734/lwsa.v2i1.586

Emami, P. (2023). The synergy of artificial intelligence (AI) and geographic information systems (gis) for enhanced disaster management: opportunities and challenges. *Disaster Medicine and Public Health Preparedness*, p. 17. https://doi.org/10.1017/dmp.2023.174

Enovejas, A., Maldia, S., Komarudin, N., Vergara, D., Hilmi, Y., & Sevilla-Nastor, J. (2020). Effect of climate variables on rice yield in Nueva Ecija, Philippines. *Asia Pacific Journal of Sustainable Agriculture Food and Energy, 9*(1), 29-44. https://doi.org/10.36782/apjsafe.v9i1.77

Far, R. and Tuhumury, S. (2022). Strategi adaptasi masyarakat pesisir terhadap dampak perubahan iklim di kepulauan kei besar maluku tenggara. *Jurnal Akuatiklestari, 6*(1), 53-61. https://doi.org/10.31629/akuatiklestari.v6i1.4903

García-Romero, L., Carreira-Galbán, T., Rodríguez-Báez, J. Á., Máyer-Suárez, P., Hernández-Calvento, L., & Yánes-Luque, A. (2023). Mapping environmental impacts on coastal tourist áreas of oceanic islands (Gran Canaria, Canary Islands): A current and future scenarios assessment. *Remote Sensing, 15*(6), 1586. https://doi.org/10.3390/rs15061586

Goertler, P., Mahardja, B., & Sommer, T. (2021). Striped bass (morone saxatilis) migration timing driven by estuary outflow and sea surface temperature in the san francisco bay-delta, california. *Scientific Reports, 11*(1). https://doi.org/10.1038/s41598-020-80517-5

Gurusamy, P. and Rudrasamy, B. (2020). Effect of climate change on maize productivity: panel data analysis. *Advances in Research*, 41-45. https://doi.org/10.9734/air/2020/v21i1230280

Ha, K. (2017). Korean civil engineers: handling of natural disaster management and its implication. *Water and Environment Journal, 32*(1), 34-42. https://doi.org/10.1111/wej.12287

Hashem, A. (2015). Performance evaluation and development of daily reference evapotranspiration model. *Irrigation & Drainage Systems Engineering, 05*(01). https://doi.org/10.4172/2168-9768.1000157

Hodgson, S., Quinn, T., Hilborn, R., Francis, R., & Rogers, D. (2005). Marine and freshwater climatic factors affecting interannual variation in the timing of return migration to the freshwater of sockeye salmon (Oncorhynchus nerka). *Fisheries Oceanography, 15*(1), 1-24. https://doi.org/10.1111/j.1365-2419.2005.00354.x

Holopainen, J., Rickard, I., & Helama, S. (2012). Climatic signatures in crops and grain prices in 19th-century Sweden. *The Holocene, 22*(8), 939-945. https://doi.org/10.1177/0959683611434220

Hoogendoorn, G., & Fitchett, J. M. (2018). Tourism and climate change: A review of threats and adaptation strategies for Africa. *Current Issues in Tourism, 21*(7), 742-759. https://doi.org/10.1080/13683500.2016.1188893

Hugelius, K., Adams, M., & Romo-Murphy, E. (2019). The power of radio to promote health and resilience in natural disasters: a review. *International Journal of Environmental Research and Public Health, 16*(14), 2526. https://doi.org/10.3390/ijerph16142526

Joshi, G. and Mohagheghi, S. (2022). Decentralized energy and water networks for community resilience against natural disasters. *European Journal of Energy Research, 2*(4), 39-48. https://doi.org/10.24018/ejenergy.2022.2.4.76

Kartini, E. (2013). Analisis dampak perubahan iklim terhadap tingkat kesejahteraan nelayan di desa sungai kakap kabupaten kubu raya. *Jurnal Teknologi Lingkungan Lahan Basah, 1*(1). https://doi.org/10.26418/jtllb.v1i1.3216

Kristensen, M., Pedersen, M., Thygesen, U., Villar-Guerra, D., Baktoft, H., & Aarestrup, K. (2019). Migration routes and habitat use of a highly adaptable salmonid (sea trout, salmo trutta) in a complex marine area. *Animal Biotelemetry, 7*(1). https://doi.org/10.1186/s40317-019-0185-3

Lalic, B., Eitzinger, J., Thaler, S., Vučetić, V., Nejedlik, P., Eckersten, H., … & Nikolic-Djoric, E. (2014). Can agrometeorological indices of adverse weather conditions help to improve yield prediction by crop models?. *Atmosphere, 5*(4), 1020-1041. https://doi.org/10.3390/atmos5041020

Liu, Z. and Hou, Y. (2017). The influence of climate factors on the yield of winter wheat in Germany based on the lintul 2 models. https://doi.org/10.2991/bep-16.2017.83

Llano, M., Vargas, W., & Naumann, G. (2011). Climate variability in areas of the world with high production of soya beans and corn: its relationship to crop yields. *Meteorological Applications, 19*(4), 385-396. https://doi.org/10.1002/met.270

Lourenco, R., Figueiredo, G., Tornatore, M., & Mukherjee, B. (2019). Data evacuation from data centers in disaster-affected regions through software-defined satellite networks. *Computer Networks, 148*, 88-100. https://doi.org/10.1016/j.comnet.2018.10.019

Manik, T. K., Rosadi, B., & Nurhayati, E. (2016). Study of climate change impact to local rainfall distribution in lampung provinces. In *Forum Geografi* (Vol. 28, No. 1). https://doi.org/10.23917/forgeo.v28i1.439

Middleton, N., Tozer, P., & Tozer, B. (2018). Sand and dust storms: underrated natural hazards. *Disasters, 43*(2), 390-409. https://doi.org/10.1111/disa.12320

Nurhayanti, Y. and Nugroho, M. (2016). Sensitivitas produksi padi terhadap perubahan iklim di indonesia tahun 1974-2015. *Agro Ekonomi, 27*(2), 183. https://doi.org/10.22146/jae.23038

Nurjanah, S. and Mursalin, E. (2021). Pentingya mitigasi bencana alam longsor lahan: studi persepsi mahasiswa. *Jurnal Basicedu, 6*(1), 515-523. https://doi.org/10.31004/basicedu.v6i1.1937

Nurkadri, N., Silwan, A., Andriani, R., Furqoni, M., & Gunri, R. (2022). Edukasi sadar bencana melalui physical activity berbasis mobile application wisata alam bukit lawang kecamatan bahorok kabupaten langkat provinsi sumatera utara. *Jurnal Pengabdian Kepada Masyarakat Bina Darma, 2*(3), 254-262. https://doi.org/10.33557/pengabdian.v2i3.2044

Osman, M., Onono, J., Olaka, L., Elhag, M., & Abdel-Rahman, E. (2021). Climate variability and change affect crop yield under rainfed conditions: a case study in Gedaref state, Sudan. *Agronomy, 11*(9), 1680. https://doi.org/10.3390/agronomy11091680

Palliyaguru, R., Amaratunga, D., & Haigh, R. (2012). Impact of integrating disaster risk reduction philosophies into infrastructure reconstruction projects in Sri Lanka. *Journal of Civil Engineering and Management, 18*(5), 685-700. https://doi.org/10.3846/13923730.2012.723322

Palupi, L. S. (2022). Towards sustainable cities and communities: Is psychological preparedness include in the disaster risk reduction policy framework in Indonesia. In *E3S Web of Conferences* (Vol. 340, p. 03009). EDP Sciences. https://doi.org/10.1051/e3sconf/202234003009

Pane, M., Isturini, I., & Wahidin, M. (2018). Penanggulangan krisis kesehatan di indonesia tahun 2016. *Media Penelitian Dan Pengembangan Kesehatan, 28*(3), 147-156. https://doi.org/10.22435/mpk.v28i3.115

Pankhurst, N. and Munday, P. (2011). Effects of climate change on fish reproduction and early life history stages. *Marine and Freshwater Research, 62*(9), 1015. https://doi.org/10.1071/mf10269

Park Williams, A., Cook, B. I., Smerdon, J. E., Bishop, D. A., Seager, R., & Mankin, J. S. (2017). The 2016 southeastern US drought: An extreme departure from centennial wetting and cooling. *Journal of Geophysical Research: Atmospheres*, *122*(20), 10-888. https://doi.org/10.1002/2017JD027523

Perdinan, P. (2014). Perubahan iklim dan demokrasi: Ketersediaan dan akses informasi iklim, peranan pemerintah, dan partisipasi masyarakat dalam mendukung implementasi adaptasi perubahan iklim di Indonesia. *Jurnal Hukum Lingkungan Indonesia*, *1*(1), 109-132. https://doi.org/10.38011/jhli.v1i1.87

Pereira, P., Daros, R., Silva, A., Campos, A., Bianchini, A., Júnior, J., … & Pallaoro, D. (2019). Effect of water stress on the development of soybean crop. *Journal of Experimental Agriculture International*, 1-8. https://doi.org/10.9734/jeai/2019/v39i230330

Prihhartini, S., Adara, R., & Khadijah, S. (2021). Pelaksanaan pemberian bantuan sosial kepada korban bencana banjir dan longsor. *Journal of Empowerment, 2*(1), 76. https://doi.org/10.35194/je.v2i1.1253

Purwaningsih, M. (2022). Capaian penanggulangan kemiskinan dalam pembangunan berkelanjutan serta keterkaitannya dengan bencana di jawa tengah. *Jurnal Ekobistek*, 206-214. https://doi.org/10.35134/ekobistek.v11i3.344

Quinn, T., McGinnity, P., & Reed, T. (2016). The paradox of "premature migration" by adult anadromous salmonid fishes: patterns and hypotheses. *Canadian Journal of Fisheries and Aquatic Sciences, 73*(7), 1015–1030. https://doi.org/10.1139/cjfas-2015-0345

Rachmadian, R., Khairunisa, T., Sofiana, E., & Putra, A. (2021). Web-tana: inovasi pembelajaran sebagai aksi pengurangan risiko bencana bagi siswa di era digital 4.0. *Jurnal Integrasi Dan Harmoni Inovatif Ilmu-Ilmu Sosial (Jihi3s), 1*(7), 803-814. https://doi.org/10.17977/um063v1i7p803-814

Rahadianto, M., Sakti, A., & Wikantika, K. (2021). Evaluasi kualitas infrastruktur fasilitas pendidikan dasar di provinsi jawa barat indonesia menggunakan pendekatan berbasis model multi-hazard dan aksesibilitas. *Seminar Nasional Geomatika*, 125. https://doi.org/10.24895/sng.2020.0-0.1127

Raibowo, S., Nopiyanto, Y., Sutisyana, A., & Prabowo, A. (2021). Workshop pembuatan bahan ajar kesiapsiagaan bencana alam dalam bentuk multimedia interaktif bagi guru pendidikan jasmani. *Gervasi Jurnal Pengabdian Kepada Masyarakat, 5*(2), 217-229. https://doi.org/10.31571/gervasi.v5i2.2180

Raksanagara, A., Arisanti, N., & Rinawan, F. (2016). Dampak perubahan iklim terhadap kejadian demam berdarah di jawa-barat. *Jurnal Sistem Kesehatan, 1*(1). https://doi.org/10.24198/jsk.v1i1.10339

Rao, B. B., Triveni, U., Harisatyanarayana, N., Latha, P., Rao, N. V., & Rao, V. U. M. (2013). Influence of weather on the fibre yield of mesta (Hibiscus sabdariffa) in the north coastal zone of Andhra Pradesh, India. *Archives of Agronomy and Soil Science*, *59*(7), 989-999. https://doi.org/10.1080/03650340.2012.699675

Reinhardt, J., Li, J., Gosney, J., Rathore, F., Haig, A., Marx, M., … & DeLisa, J. (2011). Disability and health-related rehabilitation in international disaster relief. *Global Health Action, 4*(1), 7191. https://doi.org/10.3402/gha.v4i0.7191

Roy, S., Debnath, P., & Mitra, S. (2023). Impact of climate disasters on railway infrastructure: a case study of northeast India. *Acadlore Transactions on Geosciences, 2*(1), 33-45. https://doi.org/10.56578/atg020104

Ruminta, R., Handoko, H., & Nurmala, T. (2018). Indikasi perubahan iklim dan dampaknya terhadap produksi padi di indonesia (studi kasus : sumatera selatan dan malang raya). *Jurnal Agro, 5*(1), 48-60. https://doi.org/10.15575/1607

Sadeghi, N. and Ahmadi, M. (2007). Mental health preparedness for natural disasters in Iran. *Natural Hazards, 44*(2), 243-252. https://doi.org/10.1007/s11069-007-9150-1

Safapour, E., Kermanshachi, S., & Thahomina, J. (2020). Analysis of cost performance indicators in reconstruction projects: a comparative study of low vs high-level damages.. https://doi.org/10.3311/ccc2020-049

Salampessy, Y., Lubis, D., Amien, I., & Suhardjito, D. (2018). Menakar kapasitas adaptasi perubahan iklim petani padi sawah (kasus kabupaten pasuruan jawa timur). *Jurnal Ilmu Lingkungan, 16*(1), 25. https://doi.org/10.14710/jil.16.1.25-34

Sunarti, S. and Apriliasari, N. (2015). Dampak perubahan iklim terhadap permukiman pesisir di kelurahan demaan kabupaten jepara. *Jurnal Tataloka, 17*(4), 248. https://doi.org/10.14710/tataloka.17.4.248-256

Suryanta, J., & Nahib, I. (2016). Kajian Spasial Evaluasi Rencana Tata Ruang Berbasis Kebencanaan Di Kabupaten Kudus Provinsi Jawa Tengah. *Majalah Ilmiah Globe*, *18*(1), 33-42. https://doi.org/10.24895/mig.2016.18-1.392

Syarifuddin, M. (2023). Prediksi hujan untuk manajemen bencana dan risiko pertanian. https://doi.org/10.31219/osf.io/bp2qf

Syaukat, Y. (2018). Climate Change and its Impact on Indonesian Agriculture. *Journal of the Indonesian Tropical Agriculture*, 42(1), 1-12.

Uddin, G., Mishu, M., Hasan, M., & Choudhury, D. (2023). Crop production amid climate change and river water level fluctuation at northeastern region of Bangladesh: a time series analysis. *International Journal of Agricultural Research Innovation and Technology, 12*(2), 18-26. https://doi.org/10.3329/ijarit.v12i2.64023

Utomo, N. A., & Sitorus, S. R. (2016). Sinergi tata ruang terhadap pelaksanaan redd+: studi kasus di kabupaten katingan, kalimantan tengah. *Jurnal Penelitian Sosial Dan Ekonomi Kehutanan, 13*(3), 165-176. https://doi.org/10.20886/jpsek.2016.13.3.165-176

Wahyudin, W., Sampara, S., & Baharuddin, H. (2020). Kebijakan hukum lingkungan terhadap penanggulangan krisis iklim di indonesia. *Kalabbirang Law Journal, 2*(2), 91-100. https://doi.org/10.35877/454ri.kalabbirang122

Wardyaningrum, D. (2014). Perubahan komunikasi masyarakat dalam inovasi mitigasi bencana di wilayah rawan bencana gunung merapi. *Jurnal Aspikom, 2*(3), 179. https://doi.org/10.24329/aspikom.v2i3.69

Warsihna, J., Anwas, E. O. M., Anas, Z., Kosasih, F. R., & Ramdani, Z. (2020). Post-Disaster Learning Model: Design of Distance Learning Based on Local Wisdom Perspective. *International Association for Development of the Information Society*. https://doi.org/10.33965/celda2020_202014l039

Wibisono, H., Arkeman, Y., Djohar, S., & Maulida, M. (2023). Green Competitive Advantage in The Tourism Industry. *Journal of Scientific Research, Education, and Technology (JSRET)*, *2*(4), 1727-1740. https://doi.org/10.58526/jsret.v2i4.289

Widura, E., & Mardiatno, D. (2022, February). Assessment of the Coastal Vulnerability Index (CVI) for disaster mitigation strategies in some coastal tourism areas in Gunungkidul, Yogyakarta-Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. 989, No. 1, p. 012014). IOP Publishing. https://doi.org/10.1088/1755-1315/989/1/012014

Wijaya, A., Juliane, R., & Firmansyah, R. (2017). The Impact of Climate Change on Indonesia's Agriculture Sector. *International Journal of Climate Change Strategies and Management, 9*(3), 349-365.

Wokanubun, A., Ririhena, R. E., & Wattimena, A. Y. (2020). Potensi Dampak Perubahan Iklim Terhadap Produksi Ubi Kayu (Manihot esculenta Crantz) dan Pendapatan Petani di Desa Wain, Kecamatan Kei Kecil Timur, Kabupaten Maluku Tenggara. *Jurnal Budidaya Pertanian*, *16*(2), 206-214. https://doi.org/10.30598/jbdp.2020.16.2.206

Yuliantoro, I. and Wahyuni, N. (2019). Perception and adaptation of coastal community toward climate change at Sarawet village of north Minahasa Regency. *Jurnal Wasian, 6*(2), 89-99. https://doi.org/10.20886/jwas.v6i2.4728

Yulistiya, D. and Yuniawatika, Y. (2022). Sosialisasi tanggap bencana gempa bumi untuk anak sekolah dasar. *Abdimas Pedagogi Jurnal Ilmiah Pengabdian Kepada Masyarakat, 5*(2), 65. https://doi.org/10.17977/um050v5i2p65-71

Zukmadini, A. and Rohman, F. (2023). Edukasi mitigasi dan adaptasi perubahan iklim menggunakan film dokumenter. *Kumawula Jurnal Pengabdian Kepada Masyarakat, 6*(1), 191. https://doi.org/10.24198/kumawula.v6i1.39503

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