

# Juridical construction of socio-ecological security: Indonesia's vulnerability to climate change

*Diah Apriani Atika Sari*<sup>1,3\*</sup>, *Marsudi Triatmodjo*<sup>2</sup>, and *Harry Purwanto*<sup>2</sup>

<sup>1</sup>PhD Student, Faculty of Law, Gadjah Mada University, Indonesia

<sup>2</sup>Faculty of Law, Gadjah Mada University, Indonesia

<sup>3</sup>Faculty of Law, Universitas Sebelas Maret, Indonesia

**Abstract.** As an archipelagic state, Indonesia is very vulnerable to losing part of its land and islands due to climate change. Climate change causes atmospheric instability and sea level rise. Sea level rise that causes land loss, ecosystem damage, infrastructure damage, and even massive population displacement, are the impacts of climate change that affect environmental security. At the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, the goal was to stabilize greenhouse gas concentrations to prevent harmful anthropogenic disturbances to the climate system. Therefore, as a response to overcoming the problem of the effectiveness of international environmental law, the idea of juridical construction in the protection of socio-ecological security is needed. Initiatives that can be undertaken by the government include the development of resilient infrastructure systems and land-use planning, as well as the restructuring of spatial planning, particularly for coastal areas and sensitive ecosystems. This research is a normative study that examines the legal framework of socio-ecological security concerning Indonesia's vulnerability as an archipelagic nation due to the impacts of climate change. This research adopted a normative methodology with legislative and conceptual approaches.

## 1 Introduction

Indonesia is an archipelagic state with a total of about 17,504 islands, covering a marine area of approximately 5.87 million km<sup>2</sup> and a coastline of around 81 thousand km. As an archipelagic state, Indonesia is highly vulnerable to the impacts of climate change. Coastal areas and small islands are particularly susceptible to climate-related disasters due to sea level rise caused by climate change. Climate change also leads to land loss, ecosystem degradation, and population migration, posing threats to socio-ecological security in coastal regions. [1]

Naturally, the Earth's climate is dynamic and has always changed over time. However, in recent decades, the climate has been shifting toward a more constant trend, characterized by a rise in global temperatures. The average global temperature has increased by 1.1°C compared to the pre-industrial period and is projected to exceed 1.5°C by the early 2030s.

---

\* Corresponding author: [atika\\_sari@staff.uns.ac.id](mailto:atika_sari@staff.uns.ac.id)

The United Nations Framework Convention on Climate Change states that the maximum tolerable limit for global temperature rise is only 1.5°C. [2] The main factor influencing the increase in Earth's temperature is Anthropocene activities, where humans are the primary actors in climate change. Carbon emissions in Indonesia came from the utilization of resources that produce high carbon concentrations. The use of fossil fuels, [3] the reduction of green spaces, and the effects of industrialization contribute to increasing waste gases, which further add to the greenhouse effect on Earth.

A report from the Intergovernmental Panel on Climate Change [4] indicates that from 1850–1899 to 2001–2005, the global average temperature increased by approximately 0.76°C. During the period from 1961 to 2003, sea levels rise at an average rate of 1.8 mm per year. By 2080, it is estimated that the rate of sea level rise will increase to about 4.2 mm per year.

In Indonesia, the rate of sea level rise is higher than the global average. The rate of sea level rise up to 3.9±0.4 mm/year between 1992 and 2020. The highest sea level in the Pacific Ocean in the north of Papua, which reached 10–12 mm/year and the lowest in the south of Java, west of Sumatra, south of Nusa Tenggara, and the Karimata Strait, which only ranged 2–4 mm/year. [5] Therefore, low-lying islands are at risk of sinking due to rising sea levels. According to the Roadmap NDC for Adaptation, the Ministry of Environment and Forestry of Indonesia detected Climate change hotspots Areas with a maximum temperature of 35 °C and a temperature increase of >1.5 °C are identified in North Sumatra, West Sumatra, South Sumatra, Bengkulu, the western part of Java, the southern part of Central Kalimantan, and Papua. Aceh, Lampung, South Sumatra, West Sumatra, and West Java are detected as the area with a maximum temperature of 38 °C and a temperature increase of >1.5 °C. [6]

This research is a normative study that examines the legal framework of socio-ecological security concerning Indonesia's vulnerability as an archipelagic state due to the impacts of climate change. This study utilizes secondary data and employs a legislative approach based on relevant legal materials.

## **2 Discussion**

### **2.1 Vulnerability of Indonesia as an Archipelagic Nation Due to Climate Change**

Climate change leads to atmospheric instability in the lower layers, particularly near the Earth's surface. Meanwhile, in marine and coastal areas, marine ecosystems and coastal communities bear the greatest burden from climate change. Identifiable impacts of climate change include sea level rise, warmer sea surface temperatures, higher waves, and extreme weather. Here are some vulnerabilities of Indonesia as an archipelagic state to the impacts of climate change :

- a. The loss of all or part of the land is a significant concern. Coastal areas and small islands with elevations below 2 meters are at risk of disappearing. If we assume a one-meter rise in sea level with an average coastal slope of 2% over 100 years, this means that coastal land, including Indonesia's small islands, could submerge approximately 4,050 hectares per year [7]. Various studies may yield differing results, as there is still no definitive figure regarding the rate of sea level rise. However, it is clear that the rise in sea level due to climate change, as highlighted by multiple reports from researchers, currently poses a real threat to coastal areas. Coastal regions are geographic units that consist of land and marine ecosystems that are intrinsically interconnected in terms of climate, geology, chemistry, and biology [8].

- b. Ecologically, land and small islands are highly vulnerable to global warming, hurricanes, and tsunami waves. Sea level rise will cause the coastline to retreat further inland, leading to the loss of land, either in whole or in part.
- c. Climate change also has the potential to cause damage to coastal and marine ecosystems. The degradation of marine ecosystems poses a threat to coastal areas and the ocean.
  - Coral bleaching. Corals typically thrive in sea temperatures ranging from 28 to 31°C. When sea temperatures exceed 31°C, coral damage becomes unavoidable. Coral reefs serve as habitats and spawning grounds for many fish species, as well as safe havens for marine biodiversity. The rising sea temperatures and ocean acidification will threaten coral life in approximately 39% of Indonesia's waters. [9]
  - Loss of mangrove forests. Indonesia has lost a significant area of mangroves since the 1980s. The 2022 Coastal and Marine Resource Statistics report indicates that the area of mangrove forests in Indonesia is no more than 3 million hectares [10]. This decline is due to a lack of government commitment to providing protection within its marine spatial planning.
- d. The dimension of socio-ecological security has become a significant issue and a threat due to climate change. Climate change has a substantial impact on the livelihoods of coastal communities, particularly considering Indonesia's characteristics as an archipelagic state. Ecologically, climate change poses a threat not only to the state but also to all forms of life, especially humanity. Climate change has the potential to damage infrastructure and lead to the loss of livelihoods for coastal communities, the majority of whom are fishermen. The climate crisis affects fish catches because fishing activities are highly dependent on current weather conditions. Climate change prevents fishermen from predicting the weather, which they typically do based on local knowledge and wisdom passed down through generations. On a macro level, Indonesia's economy is also affected. Economic losses due to climate change are projected to reach 112.2 trillion rupiah by 2023 [11].
- e. Threat of loss and damage. Loss and damage represent a serious potential threat due to the impacts of climate change, particularly for national security. The concept of loss and damage refers to the unavoidable nature of extreme weather events and slow onset events. In general, the measures that can be taken to address climate change issues are based on two main actions: mitigation and adaptation. However, even if these two actions are implemented optimally, extreme weather events and slow onset events cannot be avoided or reduced.

## 2.2 Juridical Construction of Socio-Ecological

International negotiations on climate change under the United Nations Framework Convention on Climate Change (UNFCCC) seek solutions to resist and reduce the impacts of climate change through efforts in mitigation and adaptation. Currently, sea levels are rising at a rate of 1-3 mm per year in the coastal regions of Asian countries, and it is projected that this rate will accelerate to about 5 mm per year in the future [12]. Indonesia, as the fourth most populous state in the world and a significant greenhouse gas emitter, contributes 85% of its emissions due to deforestation and land-use degradation. The combination of high population density, Indonesia's geographical shape as an archipelagic state, and its rich biodiversity makes Indonesia one of the states most vulnerable to the impacts of climate change. The Indonesian economy heavily relies on natural ecosystems and available natural resources; however, climate change poses a threat to the sustainability of these ecosystems.

At the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, the goal was to stabilize greenhouse gas concentrations to prevent harmful anthropogenic disturbances to the climate system. Research conducted by experts indicates that mitigation

efforts alone are insufficient to avoid all impacts of climate change; thus, the UNFCCC process also focuses on adaptation efforts at the national level.

While the overall surface air temperatures observed in Asia have increased by about 1-3°C over the past century, the Intergovernmental Panel on Climate Change (IPCC) states that data related to the temperature rise history in Indonesia is not available. However, it has been found that Indonesia has become warmer since 1900, with the annual average temperature rising by approximately 0.3°C [12].

The impacts of climate change are already being felt in Indonesia, and this situation is likely to worsen due to human activities (anthropogenic). Increasing concentrations of greenhouse gases will raise both the Earth's surface temperature and sea surface temperatures, alter rainfall patterns, and contribute to rising sea levels. Climate change will also lead to more frequent occurrences of extreme weather events that are highly intense.

Indonesia, with its geographical characteristics as the largest archipelagic state in the world, faces significant challenges from the impacts of climate change, particularly the vulnerability of land areas and even Indonesian islands to submersion. With a population of 238 million, approximately 42 million of whom live in low-lying areas less than 10 meters above average sea level, this population is highly susceptible to the impacts of climate change. Climate change has significant effects on both the physical and socio-economic aspects of the population in Indonesia, including infrastructure industries and fertile agricultural land concentrated in coastal regions. Around 60% of Indonesia's population resides in coastal and low-lying areas.

Initiatives that can be undertaken by the government include the development of resilient infrastructure systems and land-use planning, as well as the restructuring of spatial planning, particularly for coastal areas and sensitive ecosystems. In general, most of Indonesia's islands, especially small islands, are directly threatened and have low resilience to the impacts of climate change.

In addition, to reduce vulnerability, impacts, and risks, there are four priority sectors for building climate resilience: marine and coastal resilience, water, agriculture, and health. These four sectors are expected to contribute significantly to the GDP [11]. One of the national development priority agendas is Climate Resilience Development (CRD), which represents a joint effort between the central and regional governments, focusing on achieving the national climate resilience development agenda in these four priority sectors. The CRD aims to strengthen the nation's resilience in facing climate change. It is a commitment by the government to support the sustainability of the Paris Agreement to address climate change. Some policy directions and strategies to reduce the impacts of climate change implemented by the Government include: [13]

1. The implementation of climate resilience actions focused on improving coastal settlements and cultivation areas;
2. strengthening the stability of coastal communities through comprehensive and holistic support in the form of capacity building and capabilities for reducing the impacts of climate-related disasters;
3. Strengthening effective and efficient disaster management regulations;
4. Enhancing the integration of regional and national policies based on the needs of coastal communities;
5. Strengthening investments in disaster risk management in accordance with projections and location priorities;
6. Strengthening governance for adaptive climate change adaptation and disaster mitigation;
7. Building ecological, economic, and social resilience, particularly in high-risk areas.

Meanwhile, to ensure the sustainability of fishery resources and the welfare of traditional fishermen, a policy transformation is needed through the implementation of Government Regulation No. 11/2023 on Measured Fish Catching. This policy is one of the regulations under the 5 (five) priority programs based on the Blue Economy in 2024, aimed at ensuring the sustainability of fish resources, increasing productivity and the welfare of fishermen, as well as realizing an advanced and sustainable capture fishery industry.

### 3 Conclusion

As an archipelagic nation, Indonesia faces high vulnerability due to climate change. Identifying several impacts of climate change includes: rising sea levels, increasing sea temperatures, high waves, extreme weather, coral damage and bleaching, loss of mangrove ecosystems, and population migration are socio-ecological security issues that require efforts to address them. Generally, efforts to prevent the pace of climate change involve mitigation and adaptation strategies. A legal approach to socio-ecological security is one way to address Indonesia's vulnerability as an archipelagic nation facing the threats of climate change. Indonesia's participation in the Paris Agreement serves as evidence of its commitment to contributing to the global climate change issue, including through its Climate Resilience Development policy. The CRD aims to strengthen the nation's resilience in facing climate change. Meanwhile, to ensure the sustainability of fishery resources and the welfare of traditional fishermen, a policy transformation is needed through the implementation of Government Regulation No. 11/2023 on Measured Fish Catching.

Authors received the award: Diah Apriani Atika Sari, Funder: Universitas Sebelas Maret Grant Contract number 194.2/UN27.22/PT.01.03/2024.

### References

- [1] Nguyen, Trung. T, et.al., "Security risks from climate change and environmental degradation: implications for sustainable land use transformation in the Global South", *Environmental Sustainability*, Vol. **63**:101322 (2023)
- [2] The United Nations Framework Convention on Climate Change, *United Nations Climate Change Annual Report 2021*, (UNCC, 2022)
- [3] Prawoto, N., and Basuki, Agus. T., "Factors Influencing Carbon Emissions in Indonesia: Dynamic Model Approach", *Jurnal Mantik*, Vol. 7, Number 1 (2023)
- [4] Pachauri, R.K and Reisinger, A.(eds.), *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, (IPCC, Geneva, Switzerland, 2007)
- [5] Triana, Karlina and Wahyudi, A. Johan, "Sea Level Rise in Indonesia: The Drivers and the Combined Impacts from Land Subsidence", *ASEAN Journal on Science & Technology for Development* Vol. 37, No. 3 (2020)
- [6] The Ministry of Environment and Forestry of Indonesia, *Indonesia's Adaptation Communication: A Report to the United Nations Framework Convention on Climate Change*, (Directorate General of Climate Change, Ministry of Environment and Forestry, Republic of Indonesia, Jakarta, 2022)
- [7] Marine Research and Observation Center, *Application of Coastal, Marine, and Small Island Observation Technology*, 2008.

- [8] Gao, Lehua., et.al., "The Mutual Influence of Land-Sea Ecological Security and Its Coordinated Governance in the Guangdong-Hong Kong-Macao Greater Bay Area", *Ecological Indicator*, Vol. 156 (2023)
- [9] Asian Development Bank, *Climate Risk Country Profile: Indonesia* (World Bank Group, Asian Development Bank, 2021)
- [10] Exwar, Asmar., et.al., *Fact Brief: Seruan Jaring Nusa Kepada Pemerintah Indonesia Dalam Momentum Konferensi Tingkat Tinggi Perubahan Iklim Atau COP Ke-28: Masyarakat Pesisir di Kawasan Timur Indonesia Suarakan Keadilan Iklim*, (Jaring Nusa Kawasan Timur Indonesia, 2021)
- [11] Kementerian PPN/Bappenas, *Executive Summary: Climate Resilience Development Policy 2020-2045*, (Jakarta, 2021)
- [12] Case, Michael. J., et.al, "Climate Change in Indonesia: Implications for Humans and Nature", *World Wide Fund for Nature* (2007)
- [13] <https://lcdi-indonesia.id/2022/08/29/loss-and-damage-akibat-dampak-perubahan-iklim-di-sektor-pesisir/>