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Fostering Disaster Resilience through a Dual Strategy: Early Warning-Emergency Response Systems and Ecological Recovery

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Abstract

The recurrent incidence of floods and flash floods across various regions of Indonesia has incited ongoing public and scholarly discourse that attributes hydrometeorological factors and deforestation as principal contributors to hydrometeorological disasters. This perspective adds a view angle to typical cause-and-effect discussions about floods and flash floods, proposing a two-pronged approach to address their challenges. Though not entirely new, it emphasizes the importance of prioritizing disaster prevention over simply managing the aftermath.

Keywords: Disaster Resilience, Early Warning-Emergency System, Ecology Restoration

1. Introduction

Floods and flash floods represent hydrometeorological phenomena that frequently precipitate disasters, thereby endangering human life. In the last thirty years, Indonesia has seen a steady rise in disasters caused by floods and flash floods, with both their frequency and intensity growing over time. Indonesia, in the period of 2010 and 2025, experienced 51,008 disaster events, with floods and flash floods accounting for 39% of them. Tornadoes made up 23%, while landslides were responsible for 19%. Among the 38 provinces in Indonesia, the provinces of West Java, Central Java, East Java, Aceh, North Sumatra, South Sulawesi, Central Sulawesi, West Sumatra, South Sumatra, and West Nusa Tenggara rank as the ten provinces most frequently affected by floods and flash floods, each experiencing over 500 flood days during the specified period [1]. The flash flood that resulted in the most significant disaster in the last three decades transpired in November 2025, impacting the provinces of Aceh, North Sumatra, and West Sumatra, leading to the loss of over 1,000 lives and leaving numerous individuals unaccounted for. After the major flash floods in the aforementioned provinces, additional flash floods continued to occur. On December 20, 2025, flash floods affected the Guci Tourist Attraction in Tegal, followed by another incident on December 25, 2025, in the Maninjau area, Tanjung Raya District, Agam Regency, West Sumatra, and from November 28 to December 26, 2025, flash floods and extensive flooding struck villages in 83 districts across Indonesia. This data transcends mere disaster statistics, serving as an alarming signal that necessitates proactive measures; it calls for immediate action to avert future occurrences and to implement preventive strategies.

What are the underlying causes of these phenomena? High-intensity rainfall occurs in short periods, several hours, days, and extreme rainfall events, and deforestation are frequently identified as trigger factors for floods and flash floods. While this perspective is not entirely wrong, it is not comprehensive; numerous research findings substantiate this viewpoint. Research shows that when natural forest cover decreases, it can lead to increased surface runoff, which worsens erosion and triggers more landslides [3]. Furthermore, the transformation of peatlands into oil palm plantations in Trumon, South Aceh, has resulted in land subsidence, an expansion of inundated areas, and a shift in the flood regime from periodic occurrences to nearly annual events [4]. The empirical findings derived from research conducted within the Tembesi Sub-Watershed, located in the Batanghari Jambi

Watershed, indicate that the observed trend of increased frequency and duration of flooding cannot be comprehensively elucidated solely through rainfall patterns [5]. This investigation reveals that even with consistent, moderate rainfall, flooding can still occur when land use becomes dangerously unsustainable. In the context of the Tembesi Sub-Watershed, it is noted that natural forest cover is less than 35%, with a predominance of oil palm and rubber plantations that lack sufficient management practices.

Equipped with statistical insights on flood disasters as indicators of potential flood hazards, including flash floods, and informed by research on the causative factors and consequences of such disasters, it is imperative to implement strategic interventions aimed at averting loss of life, mitigating damage to socio-economic infrastructure, and restoring the optimal functionality of watersheds.

2. Opinion

2.1. Dual Strategy for Enhancing Resilience to Disasters: An Early Warning-Emergency Response System (EW-ERS) coupled with Watershed Ecosystem Rehabilitation.

Flash flood disasters in Indonesia highlight a troubling developmental paradox that calls for urgent action. On the one hand, substandard exploitation practices of natural resources have compromised the hydrological and socio-economic functions of the watershed. Conversely, the capacity for adaptation and responsiveness to these impacts remains markedly limited. Consequently, a dual strategy is essential, one that concurrently establishes an early warning system and a rapid emergency response while systematically, consistently, and participatively restoring the watershed's optimal functionality. When disasters happen, the top priority should be keeping people safe and making sure everyone is accounted for. While disasters can occur with little warning, they are indeed predictable. In the realm of hydrometeorological disasters, relevant hydrometeorological variables can be monitored daily employing both sophisticated and rudimentary technological means. The Indonesian Meteorology, Climatology and Geophysics Agency (BMKG) has implemented weather monitoring to forecast extreme climatic events (such as torrential rains and cyclones), with findings disseminated through digital platforms, including the BMKG website and the BMKG Info mobile application. The Center for Atmospheric Science and Technology (PSTA) LAPAN has developed the Decision Support System (DSS) for the Satellite-Based Disaster Early Warning System (SADEWA), which integrates a continuous real-time observation framework utilizing satellites along with the Automatic Weather System (AWS), in conjunction with a predictive model based on numerical weather forecasting. The resultant weather forecasts are made available online [6]. Moreover, the National Disaster Management Agency (BNPB) has advocated for a regulatory framework that fosters the establishment of disaster-resilient villages (Destana) and standardizes emergency response protocols [7]. Nevertheless, the effectiveness of the information provided by BMKG and SADEWA as a resource for early warning and emergency response initiatives, as well as the realization of Destana, warrants scrutiny. The efficacy of the EW-ERS must be prioritized in developmental agendas. The dissemination of reliable weather information to Destana is of paramount importance, particularly for communities susceptible to flood disasters, as a means to enhance adaptive and responsive capacities in the face of impacts induced by flash floods, landslides, and tornadoes.

Disaster-prone villages constitute a focal point in the implementation of "Destana." The initiative of "Destana" necessitates the establishment of an emergency response infrastructure. A critical component to facilitate "Destana" and the provision of Weather Information from BMKG-LAPAN is the deployment of a satellite-based communication network, alongside additional internet networks, designated evacuation routes and locations, rescue apparatus (inclusive of shelters), and the provision of expedited assistance. Bangladesh's Early Warning System, known for its success in reducing disaster risks, stands out as an inspiring example for others to follow. This system employs Communication and Dissemination Mechanisms through multiple channels to effectively disseminate information to a broad demographic, particularly in rural settings, utilizing media such as Radio, television, and print media, as well as community-level interventions via loudspeakers,

megaphones, and flags, in addition to SMS and Mobile Alerts. Information is shared through a network of volunteers, guided by a joint coordinating group made up of both Non-Governmental Social Institutions and government agencies [8]. Villages susceptible to disasters must cultivate human resources equipped to undertake emergency response responsibilities through training and simulations orchestrated by the National Disaster Management Agency (BPBD), Regional Disaster Management Agency (BPBD), and Community Social Institutions (NGOs), along with the formulation of Community Action Plans that serve as disaster preparedness strategies encompassing evacuation routes, shelter sites, and identification of vulnerable groups. In the context of the prevailing ecological emergency, the advancement of resilient Early Warning and Emergency Response Systems (EW-ERS) is an imperative action and should not be viewed as a substitute for environmental restoration endeavors, but rather as a parallel undertaking.

Bringing an environment back to life during an ecological crisis is challenging, but far from impossible. Historical precedents on a global scale indicate that forest restoration and optimal land utilization are processes imbued with intricate political and social dimensions. Nations that have successfully undertaken environmental restoration typically exhibit robust governance frameworks that facilitate such initiatives, maintain consistent pro-people-environmental policies, acknowledge the rights and contributions of local communities, and enforce equitable legal standards. Local and regional environmental restoration projects can serve as a practical alternative to national strategies, providing effective solutions for the short to medium term. The priorities for local-regional environmental restoration are organized as follows: 1) Recovery of impacted communities, encompassing the rehabilitation of the socio-economic infrastructure within the affected villages, 2) Mapping priority recovery locations predicated on vulnerability assessments related to surface flow, landslide susceptibility, and watershed, sub-watershed, village, and sub-district mapping units, and 3) Determining alternative recovery strategies predicated upon rainfall scenarios for recurrence intervals of 2, 5, and 10 years. These efforts should work alongside preventive measures focused on safeguarding natural forest ecosystems.

2.2. Program Funding

Given the current state of the compromised landscape, the aspiration to revert it to a natural forest within the constraints of time and budget is largely unrealistic; therefore, recovery initiatives are predominantly focused on reinstating the functions of flood control and landslide prevention in prioritized locations. Restoring it into a natural forest is an illusion in the time scale and budget it has, so that the recovery efforts are carried out more on restoring the function of flood and landslides control in priority locations. Restoring critical areas to natural forests are not prioritized, but existing natural forests need to be maintained. Such measures are instituted to ensure the efficient and effective utilization of financial resources. The sources of funding comprise allocations from pre-existing financial reserves, including Government Funds (APBN), Provincial and Regency Government funds (APBD), Village Government contributions (Village Funds), and Natural Resources Revenue Sharing Funds. Additional potential funding avenues may encompass Corporate Social Responsibility (CSR) contributions aimed at environmental rehabilitation, which includes community training programs for ecological restoration, sustainable agricultural partnerships with enterprises operating within the designated watershed, Green Bonds, Payment for Ecosystem Services (PES), Carbon Credits, among other sources. The collection and distribution of funds should be through transparent, accountable, and credible fund management institutions. The allocation of resources for environmental restoration, whether direct or indirect, is prioritized through Cash for Work initiatives aimed at environmental recovery, transforming social assistance into incentives for collective action in the development of green infrastructure, thus providing immediate income opportunities for the community engaged in environmental restoration activities. Furthermore, there is an imperative to encourage business entities within the targeted watershed to adhere to best practices grounded in applicable laws and regulations, as well as national and international standards, such as the implementation of RKL-RPL ANDAL, Indonesian Sustainable Palm Oil (ISPO), Roundtable on Sustainable Palm Oil (RSPO) standards, the International Finance Corporation (IFC) Standards, and the Environmental, Social and Governance (ESG)

Framework and Standards, with ISPO being executed substantively, rather than merely administratively, under the oversight of the community.

3. Conclusions

The establishment of disaster resilience constitutes a political endeavor and a collective effort aimed at prioritizing the safeguarding of lives and environmental integrity over transient interests. The efficacy of developing Early Warning - Emergency Response Systems and Environmental Restoration initiatives will be contingent upon the political commitment of all stakeholders to honor the lives of individuals and the environment, manifested through governmental policies and local governance that foster the protection of human beings and their surroundings, equitable law enforcement, and the active engagement of community constituents. Prioritizing finding alternative solutions is more important than finding black camps.

Conflicts of interest

There are no conflicts to declare.

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