A discussion on forests' protection values against tropical cyclones on Vietnam's coast during the climate change era

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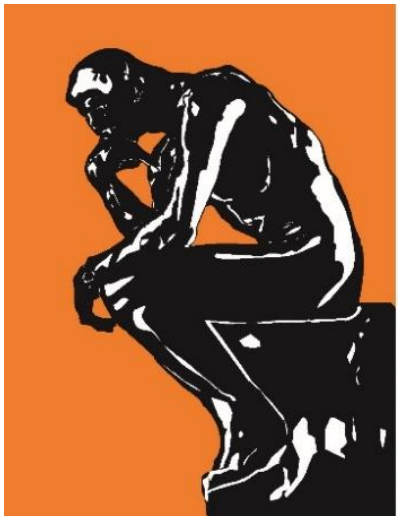

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"[…] Any gust of wind would leave the whole structure shaking as if it were falling apart.

Even more questionable is how flimsy each piece of the whistling pine tree is sewn together—and despite vehement insistent from Sparrow that the house is very much stable—all Kingfisher sees is its imminent collapse."

In "Mansion"; *Wild Wise Weird* (2024)

Abstract

Tropical cyclones and their pertinent natural hazards can cause destructive damage to people and properties. Vietnam, located in the Northwest Pacific basin, is highly vulnerable to tropical cyclones due to its geography (i.e., a long coastline and narrow width). In this paper, we discuss how the negative consequences of tropical cyclones on Vietnam can be exacerbated by climate change and how forests, either in the mountainous or in the coastal regions, play crucial roles in safeguarding the country from tropical cyclones and their pertinent hazards (e.g., landslides and flood). Despite the importance of forests, their protection values are undermined, leading to continuous deforestation of natural forests for socio-economic development. We suggest the social transitions towards eco-surplus culture through more proactive and transparent communication of the destructive outcomes of tropical cyclones and the protection roles of forests in the current climate change era.

Keywords: forests; typhoons; landslides; flood; environmental communication; eco-surplus culture

Tropical cyclones are some of the most destructive natural disasters on the planet, bringing intense winds, heavy rainfall, storm surges, and other severe weather events that profoundly affect the communities in their path. Vietnam, situated in Southeast Asia, lies within the Northwest Pacific basin—one of the most active tropical cyclone regions globally. This area alone accounts for nearly one-third of the world's tropical cyclones each year (Han et al., 2023). With a coastline of 3,260 km, Vietnam is highly vulnerable to tropical cyclones. According to data from the National Oceanic and Atmospheric Administration (NOAA), 459 tropical cyclones have hit Vietnam in 70 years since 1945, with a average of 6-7 tropical cyclones annually (Trung Tâm Phối Hợp Tìm Kiếm, n.d.). Compared with its long coastline, Vietnam has a relatively narrow width, with the narrowest point being only 50 km. As a result, that whole area can be wiped through in less than three hours by cyclones with a movement speed of around 20 km/hour (e.g., Typhoon Yagi in 2024, the largest cyclone that has ever hit Vietnam in the last 30 years).

In the era of climate change, the damages caused by tropical cyclones are projected to be significantly more severe. The rising sea surface temperature induced by anthropogenic climate change is found to increase the cyclone intensity (by 2%-11% globally) and trigger

a higher number of major cyclones in the tropical North Atlantic (Murakami et al., 2018; Walsh et al., 2016). The warmer atmosphere is associated with a higher maximum moisture content of air, with an increase of 6%–8.5% per degree of warming, which significantly increases the risk of extreme rainfall events (Van Oldenborgh et al., 2017). Exacerbated by elevated sea level rise caused by melting glaciers and ice sheets, the effects of storm surges, the abnormal rise in sea level during a storm, and heavy rainfall also make coastal flooding more severe (Strauss et al., 2021). The multi-risk assessment of Thuc implies that 100% of districts in the Mid-Central Coastal region of Vietnam are at high to very high multi-hazard risk classes caused by typhoons (Thuc et al., 2023).

Due to the mountainous topography of Vietnam, beyond the damages caused directly to coastal communities by tropical cyclones, communities in the mountainous areas also suffer from the destruction of landslides and floods triggered by heavy rainfalls brought by cyclones (Van Tien, Luong, et al., 2021; Van Tien, Trinh, et al., 2021). For instance, according to Vietnam's National Centre for Hydrometeorological Forecasting, heavy rainfall on 8th September 2024 caused by Typhoon Yagi led to heavy floods that exceeded multiple historical peaks across the Red River. Over 20 of 25 northern provinces (80%) also experienced severe flooding. The rapid report of The Department of Dyke Management and Flood Storm Control indicates that by 16th September, the number of deaths and missing persons due to Typhoon Yagi and subsequent floods in northern provinces reached 329 (291 deceased and 38 missing), with 1,922 people injured. The estimated total economic damage is over 32,787 trillion VND (approximately 1.3 billion USD) (Vietnam+, 2024). In an analysis using data from 1980 to 2017, Takagi (2019) found that the economic damages caused by typhoons had soared over the past two decades (Takagi, 2019).

Forests, either in mountainous areas or in coastal regions, can act as bio-shields to safeguard society from the negative consequences of tropical cyclones in the climate change era. It has been discovered that mangrove forests, located throughout the coast of Vietnam, can provide protection values to the coastal areas against natural hazards through attenuation of wave height and energy (Badola & Hussain, 2005; Fritz et al., 2009; Nehren et al., 2017; Veettil et al., 2019). Global evidence reveals that mangroves provide crucial protection for economic activities during tropical cyclones, mitigating damage and preventing what would otherwise be permanent economic losses. Even disturbed and fragmented mangrove ecosystems can provide attenuation effects against short waves, especially during elevated water levels associated with storm events (Lee et al.,

2021). Forests in mountain areas play crucial roles in protecting the people and infrastructure against landslides, torrential floods, and debris flows often caused by heavy and prolonged rainfall. Specifically, studies have suggested that forests can help reduce the onset probability (or frequency), propagation probability (or magnitude), and intensity of shallow landslides and mitigate the onset probability of deep-seated landslides and floods in certain situations (Moos et al., 2018).

In Vietnam, forests remain a prominent focus in political discourse, with their importance frequently emphasized. According to Resolution No. 138/NQ-CP, outlining the National Master Plan for the period 2021–2030, the government has set an objective to maintain forest cover at a stable level of 42–43% while improving forest quality (Chính phủ Nước Cộng hòa Xã hội Chủ nghĩa Việt Nam, 2022). However, when national and regional development priorities come into play, economic growth and construction projects often take precedence, relegating forest preservation to a lower priority. A discourse and thematic analysis of Vietnam's forest cover narrative—examining forestry regulations, official reports, media articles, and statements by government officials and National Assembly representatives—reveals a pattern of excluding crucial underlying ecosystems within forested areas. This discourse has evolved across four main themes: intercropped support trees, multipurpose tree species, compensatory afforestation, and a shift from "forest cover" to "tree cover." The conversion of forests to other land uses has been legitimized by framing these changes within the context of livelihood improvement and social developement (Dang, 2022).

Analyzing Vietnam's comprehensive land use and land cover data from 1990 to 2020, Phan et al. (2021) found that net forest loss (19,940 km^2) was largely due to conversion to croplands over these 30 years. Meanwhile, a threefold increase in aquaculture significantly drove wetland losses (1,914 km^2), impacting both mangrove and inland wetlands. Additionally, natural forests have been repurposed for various uses, including infrastructure development, mineral extraction, and agricultural expansion, with afforestation efforts compensating for these losses (Dang, 2022; PanNature, 2016). While afforestation and reforestation provide valuable approaches for enhancing forest cover, they cannot fully substitute the ecological benefits of primary forests, such as natural hazard protection. A meta-analysis of paleoecological records using fossil pollen as a proxy for vegetation shifts over the past 20,000 years indicates that in most tropical forest ecosystems, it takes over 200 years for forests to recover to approximately 95% of the values of their former arboreal abundance (Cole et al., 2014).

Extreme events such as tropical cyclones and the associated floods and landslides serve as momentary reminders of forests' importance. Yet, once the storms pass, deforestation resumes unabated. This issue arises from Vietnam's lack of an eco-surplus culture—a cultural value system where environmental protection and restoration are seen as prerequisites for sustainable economic and social development. The informational entropy-based notion of value, grounded in the granular worldview and principles of quantum mechanics (Hertog, 2023; Rovelli, 2018), Shannon's information theory (Shannon, 1948), and the mindsponge theory (Vuong, 2023; Vuong et al., 2022), can elaborate such a cultural value system well.

According to the informational entropy-based notion of value (Vuong & Nguyen, 2024b, 2024c), we can consider that Vietnamese society possesses a set of core values that guide its actions and decisions. Since society is made up of diverse institutions and groups of people, this set of core values encompasses a wide range of different values (Vuong et al., 2023). The greater the number of distinct values, the more chaotic and disordered society's set of core values becomes. Shannon's formula effectively captures this aspect (Shannon, 1948):

$$H(X) = -\sum_{i=1}^{n} P(x_i) \log_2 P(x_i)$$

$H(X)$ is the informational entropy (uncertainty or unpredictability) of a random variable X with possible outcomes $\{x_1, x_2, \dots, x_n\}$ and corresponding probabilities $\{P(x_1), P(x_2), \dots, P(x_n)\}$. $P(x_i)$ is the probability of the outcome x_i. Each probability $P(x_i)$ represents how likely each outcome x_i is to occur. In this context, the variable X can be seen as representing Vietnamese society's set of core values at a given time, with i number of values. Each value has a probability $P(x_i)$ of driving the directions and actions of society. According to the entropy formula, when the number of values increases without clear differentiation or prioritization, informational entropy also rises. This entropy reaches its peak when all values hold equal significance when $P(x_i) = \frac{1}{n}$. This is also the scenario where the society needs to invest significant energy (e.g., resources, labor, and capital) to maintain order in the socio-economic and political systems and achieve its objectives. Currently, economic and social development is prioritized over environmental sustainability to save energy, leading to the situation that natural forests are sacrificed for socio-economic benefits. Even when the value of forests is factored into economic calculations, it is often assessed solely in terms of financial gain through forest

exploitation and land use, overlooking the forest's other ecological values—such as protecting people and property from tropical cyclones and related hazards, especially in the era of climate change.

Transitioning to an eco-surplus culture requires society to prioritize environmental sustainability—particularly forest preservation—in its strategic directions and actions (Nguyen & Jones, 2022; Vuong & Nguyen, 2024a; Vuong, 2021). The value of forests must be proactively and effectively communicated across society to facilitate the transition (La et al., 2024). Communication efforts need to focus on raising societal awareness of the futility of years of economic growth that can be undone overnight by storms, flash floods, and landslides. Additionally, the opportunity costs associated with destroyed assets should be calculated and communicated effectively.

This effort should also include collecting and publishing comprehensive data on tropical cyclones and their pertinent hazards, shifting cyclone paths due to monsoons, the intensifying impacts of cyclones as a result of climate change, and the role of forest ecosystems in mitigating these damages. Such statistics must be transparent and frequently shared with the public through news outlets rather than limited to post-disaster updates. Currently, the National Center for Hydrometeorological Forecasting is responsible for providing forecasts and warnings on weather, climate, hydrology, water resources, and marine conditions. Although it began operations in 2003, the climate data, including tropical cyclone information on its website, still displays as "updating data."

The mountains and forests may seem apart from the ocean and coastline, yet they are intrinsically connected and share much more than meets the eye. As climate issues grow more severe, it becomes increasingly clear that these natural ecosystems, though distinct, share the same vulnerability to tropical cyclones. The value of forests must be factored into all strategic development decisions, either in the mountainous or coastal regions, with an understanding that extreme events are escalating and their impacts are exacerbated by climate change. Industrial zones submerged in floodwaters are far from sustainable. No matter how profitable economic activities may seem, they cannot compensate for the total damages wrought by extreme events. Therefore, society must cultivate an eco-surplus culture that prioritizes humanistic values and ensures that monetary and commercial decisions are aligned with environmental sustainability.

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