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Guardians of the green: An essay on the impacts of climate change on forest ecosystems and mitigation

Larizza Faith N. DEL SOCORRO

BS Biology Student, Faculty of Agriculture and Life Sciences, Davao Oriental State University, Mati City, Davao Oriental. ORCID Larizza Faith N. Del Socorro: https://orcid.org/0009-0007-0396-5253

**Corresponding author: larizzafaithdelsocorro@gmail.com*

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ABSTRACT. The Philippines, recognized as a biodiversity hotspot, grapples with the escalating crisis of climate change, evident in rising temperatures, shifting rainfall patterns, and the increased frequency of extreme weather events. This essay explores the profound yet often overlooked impacts of climate change on the country's forest ecosystems, emphasizing the interconnectedness of environmental, societal, and economic consequences. Despite forests being perceived as a solution to climate change, they face disruption in composition, structure, and biogeography, endangering biodiversity and essential ecosystem services. Addressing this crisis demands a multifaceted approach. Scientifically grounded strategies, such as conservation, reforestation, and reduced-impact logging, are crucial for mitigating climate change's impact on forests. The study underscores the pivotal role of technology, policy interventions, and sustainable practices, stressing the importance of a diverse strategy. Legal frameworks, like the National Integrated Protected Area System, need reassessment and strict enforcement. Human activities, identified as primary contributors to climate change, necessitate a shift toward sustainable practices, embracing eco-friendly technologies, and responsible consumption. Furthermore, the essay advocates for global cooperation, technology sharing, and financial support to combat climate change collectively. International collaboration is essential to set common goals, share resources, and address the global impacts of climate change. The urgency of this matter calls for immediate, concerted efforts at individual, national, and international levels to safeguard the Philippines' forests and mitigate broader climate change impacts. The responsibility to act is clear—it is a necessity for a sustainable planet.

Keywords: *Conservation, climate change, biodiversity, biogeography, human activities*

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The Philippines, an archipelago renowned as one of the biodiversity "hotspots" and "megadiversity areas" of the world, has been and is continuously facing an existential threat commonly experienced by most countries globally: the relentless force of climate change.

Climate change has emerged as one of the most defining challenges of our time, affecting every corner of the planet. In the Philippines, this escalating global crisis is evidenced by changes in the environment that cannot be solely attributed to natural variations and fluctuations (PAGASA, 2011). For instance, records show that our country has experienced an increase in yearly average temperature, with the rate of change increasing over time. A report by PAGASA (2018) shows that the annual mean temperature in the Philippines over the past 65 years (1951–2015) has risen by 0.68°C, an average rate of increase of about 0.1°C per decade. Changes in rainfall patterns, characterized by changes in monsoon performance, was also noted, with evident rise in sea levels and an increased frequency of extreme weather events (PAGASA, 2018; Lindwall, 2022). This evidence of climate change is undeniable, and its impacts are extensive.

More often than not, people tend to think that forest ecosystems are the solution to the deteriorating effects of climate change (Sax and Nesbitt, 2020). While this may already be an established truth, it is an underlying fact that these forests also suffer from the complex web of ecological destruction caused by climate change. With continuous change in climate and heating of our environment, the estimated 7.01 million ha of remaining forested areas in the Philippines are at great risk of disruption, particularly in terms of their composition, structure, and biogeography (Allen et al., 2010), which can then ultimately lead to their destruction as well as those who depend on them for survival. This predicted adverse impacts include the increased occurrence of forest fires, which will push these forests to the precipice of destruction, and the release of enormous amounts of carbon dioxide into the atmosphere, which contributes to a vicious cycle of further warming, ultimately setting fire to more deteriorating effects of climate change (Singh, 2022). It stimulates the increase in the occurrence of diseases and pests (IPCC, 2007), wherein invasive species can threaten the integrity of native species, prompting the loss of hundreds or maybe even thousands of the 13,000 valuable species of flora, which comprises 5% of the world's total plant species, and an estimated ±38,000 species of vertebrates and invertebrates (Catibog-Shinha and Heaney, 2006, as cited by Berba and Matias, 2022), which are essential, particularly in diversity and maintaining balance within the ecosystem. Climate change is affecting the forest and its ability to deliver its environmental services. Ecosystem services such as biodiversity, water, carbon, climate regulation, soil, and water projection or purification, as well as the recreational, cultural, and spiritual beliefs provided by the forests, may all be terminated (Lasco et al., 2008). The impacts of climate change are undeniably interconnected and interdependent, demonstrating that no single aspect of our environment operates in isolation. One thing leads to another, and another, until the planet we came to know will eventually turn into a battle ground that forces us to either adapt or disappear.

Reflecting on the long list of possibilities for the future of forest ecosystems reveals a sobering truth: the country's forests and everything else that comes with them are under siege, with climate change posing a grave threat to these vital ecosystems. The fate of these forests' ecosystems is intertwined with humanity's collective future, hence, it is not a choice, but a responsibility to take immediate action and invest in climate-resilient practices.

To combat climate change in general, we must adopt a variety of strategies that do not only satisfy human innovation but are also anchored on scientific knowledge and research. The study of the IPCC, (2007) revealed that forests are crucial in the combat against climate change for three primary reasons: they serve as sinks, sources, and reservoirs of carbon; they provide wood products that can lengthen the storage period of carbon; and they can act as a direct or indirect substitute for fossil fuels, as liquid or solid biofuel substitutes, or as replacements for fossil fuel-intensive products, respectively (as cited in Villamor et al, 2023). According to the study of Lasco et al., (2008), forests, particularly tropical forests like those found in many areas of the Philippines, have immense potential to mitigate climate change through the conservation of existing carbon pools (e.g., reduced impact logging), expansion of carbon sinks (e.g., reforestation, agroforestry), and substitution of wood products for fossil fuels.

Ostrom (2009) emphasizes the importance of diverse strategies, highlighting the need for a combination of technological advancements, policy interventions, and sustainable practices to effectively mitigate and adapt to climate change. The crucial role of technology is something that should not be overlooked, as it offers innovative solutions across various sectors. For instance, renewable energy technologies, such as solar and wind power, are key contributors to reducing carbon emissions, which are major triggering factors of climate change. The transition to electric vehicles powered by clean energy is another technological progress fostering sustainability, wherein we are not only given the ability to mitigate climate change but also get the most out of its effects on the planet by using it to power these technologies.

Additionally, existing laws and regulations relating to the issue of climate change should be reassessed and updated to give more emphasis not only on how we will be able to mitigate climate change but also on how we will reduce its impacts, particularly on our forests, and how we can effectively manage these forests to mitigate climate change while making sure that these laws adhered to and are enforced religiously. In the Philippines, the National Integrated Protected Area System was implemented in 1992 as a step towards biodiversity conservation, giving a stronger legal basis for the establishment and management of 290 recognized protected areas in the country (DENR, 1997). However, this law was deemed ineffective because many of the areas were protected merely on paper, and only five protected areas have been formally established through congressional actions even after 10 years of the NIPAS (Ong, 2022), due to reasons including lack of resources and externalities such as patterns of resource use, societal value, or patronage systems existing within the context of poverty, insurgency, and state-sponsored resource extraction (Ploeg and Mesipiqueña, 2005). If the government decides to turn a blind eye to these kinds of shortcomings, our individual efforts will never be enough to mitigate the impacts of climate change. Higher-risk areas should be assessed and given stronger conservation and management strategies. Native ecosystems should be maintained and restored, ecosystem services should be protected and enhanced, habitats of endangered species should be managed, and a wider area of interest should be taken into account.

Moreover, it is revealed that human activities are the primary contributors to the worsening climate change, with Huber and Knutti (2011) observing that around 74% of global warming is caused by human activities such as transportation, deforestation, water overuse, fossil fuels, and electricity overuse, among others (Driga and Drigas, 2019). If this remained unchanged, all efforts to mitigate and adapt to climate change would be in vain. Thus, a shift towards sustainable

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practices is deemed necessary. This shift involves embracing environmentally friendly technologies, promoting responsible consumption, and reevaluating industrial processes. Very simple actions like reducing energy consumption, implementing efficient waste management and recycling initiatives, practicing sustainable agricultural practices, and raising public awareness and education can already have a big impact and make a difference. It is a holistic approach that goes beyond mere compliance with regulations; rather, it represents a conscientious effort to redefine our relationship with the planet.

Further, the battle against climate change is a global imperative that transcends borders and boundaries. The Philippines alone cannot combat climate change and protect its forests in isolation. International cooperation, technology sharing, and financial support are essential for building resilience and implementing mitigation strategies. Climate change is a problem that cannot be attributed to a single nation, as we are all both culprits and victims of this phenomenon. And it is in this context that international cooperation becomes crucial, allowing countries to work together in setting common goals such as emission redution targets and sharing resources, expertise, and scientific data to address the global impacts of climate change. Additionally, sharing break throughs in technology, for instance, renewable energy, carbon capture technologies, and sustainable agricultural practices, allows countries to collectively transition to low-carbon economies and reduce overall greenhouse gas emissions. Furthermore, financial support in the form of grants, loans, or investments can help countries build resilience against climate-related challenges and implement strategies to reduce their carbon footprint, helping them both mitigate and adapt to the effects of climate change.

The dire threat that climate change poses to the Philippines' diverse and invaluable forest ecosystems demands urgent and collective action. To combat climate change, a multifaceted approach is imperative. Scientifically grounded strategies, including conservation efforts, reforestation, and reduced-impact logging, are crucial for mitigating climate change's impact on forest ecosystems. Diverse strategies encompassing technological advancements, policy interventions, and sustainable practices are essential, and human activities, identified as the primary contributors to climate change, necessitate a shift towards sustainable practices, embracing eco-friendly technologies, responsible consumption, and reevaluating industrial processes. Climate change challenges us to redefine our relationship with nature and to recognize that the health of our forests is not a choice but a necessity in creating a sustainable planet. In the face of this existential threat, the call to action is clear: immediate, concerted efforts are required at individual, national, and international levels to safeguard the Philippines" forests and mitigate the broader impacts of limate change. It is a responsibility we cannot afford to ignore.

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