

Biodiversity and environmental policy challenges in Central America towards natural resource governance

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Introduction

Central America harbors the lowest human development indexes but at the same time is the second most biodiverse region in the whole continent after the Amazon¹. The region natural landscape and biodiversity have been shaped by the democratic shifts of the last century. Central America is facing significant impacts from climate change and environmental vulnerabilities^{2,3}. In recent decades, the area and its inhabitants have been greatly impacted by tropical storms, hurricanes, and other natural phenomena. This can be attributed, in part, to inadequate laws addressing issues such as territorial planning, extractive industries, intensive agriculture, conservation of biodiversity, and infrastructure development⁴. When comparing natural resource governance, climate policy efficiency and science production in Central America, there is a noticeable gap from the deficient governmental system from the Northern countries (Guatemala, El Salvador, Honduras, and Nicaragua) versus those from the South (Costa Rica and Panama)⁵. These countries feature

different levels of institutional maturity and policy success.

Distinguishing between the direct and indirect effects of the democratic transitions to the natural resource management of Central America is still a challenge. The direct effects refer to how natural resource and biodiversity are managed and its environmental consequences, which are described in Hagen *et al.* (2022)², although the authors conceive the whole Central American region as homogenous without taking in consideration the development discrepancies of the region. On the other hand, the indirect effects relate to the institutional, science production, and policy responses to the Anthropocene environmental risks. These responses could encompass the socio-economic impact of containment and mitigation measures, which can have varying implications among vulnerable social classes and groups, as discussed in Morales-Marroquín & Solis (2022)⁵.

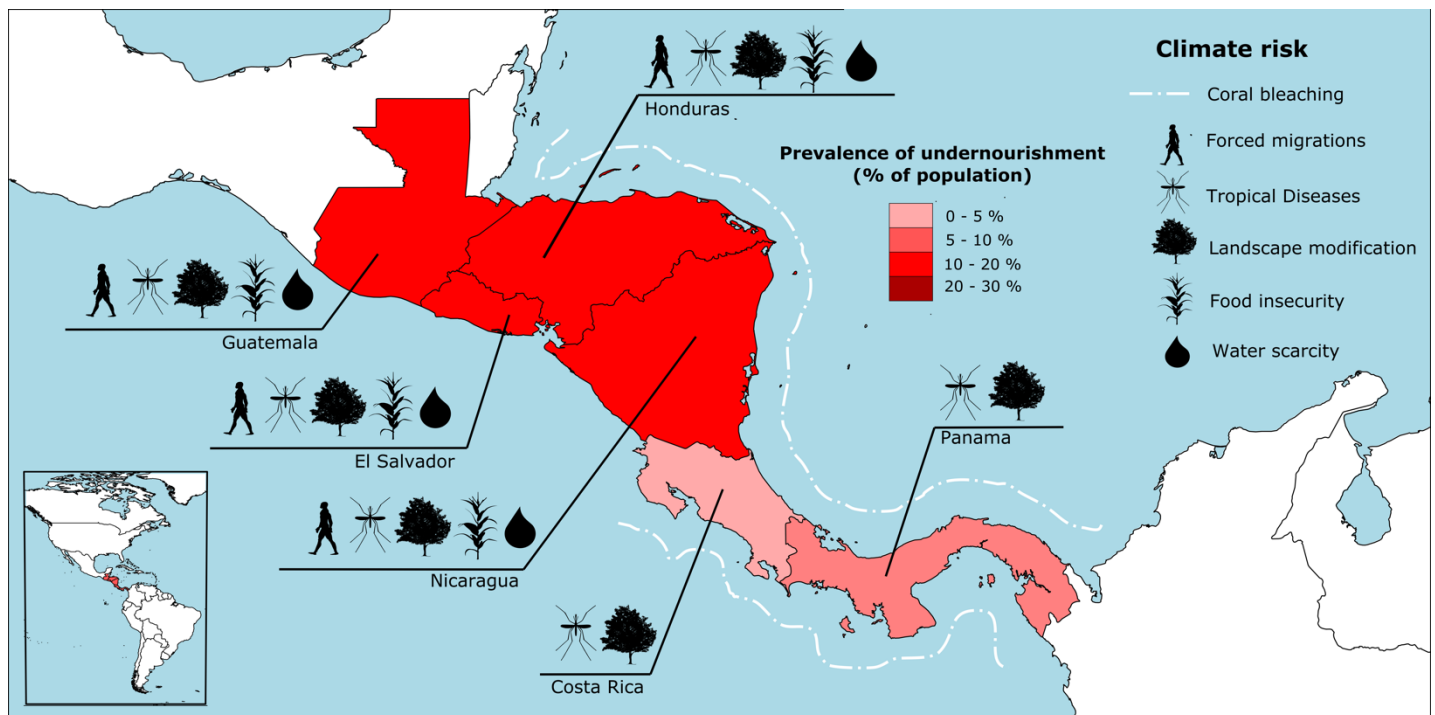


Figure 1. Distribution of severe climate-related risks in the Central America for the 21st century, based in Hagen et al 2022.

In order to address the challenges brought by the climate risks (Fig. 1), there are primary actions we must take. The first is to establish effective monitoring systems to gathering and evaluating data on climate risks, while investing in scientific research and education. The second action involves promoting institutional strengthening through a sense of cultural historical congruence within society for combating the state capture phenomenon. In Central America, particularly in the Northern countries, there is a pressing need for robust and autonomous institutions. To address this issue, we propose 8 axes dimensions in which climate policy must be reinforced to achieve effective management of natural resources.

Axes for natural resource governance in Central America

Axis 1: Mining and energetic management

Central American governments, are continuously advocating for the growth of extractive industries and regional integration. In doing so, they prioritize national objectives above the needs and concerns of local communities, and have been known to exert both rhetorical and tangible pressure to advance this policy agenda, with authoritarian tendencies in the Northern countries⁶. Furthermore, the inclusion of practices such as revolving doors and lobbying is integrated and enhance the state capture phenomenon⁷.

Especial attention should be pay on the open-pit mining policies in Guatemala, Nicaragua and Panama. The overall revenue generated by the mining process in the country should also be subject to scrutiny, for example, only 5% of the profit is retained by Guatemala.

Axis 2: Agroindustry and forestry management

Costa Rica has shown three areas in which efforts to tackle deforestation are being made: domestic public policies, financial mechanisms under the international REDD+ program, and sustainable supply chain initiatives. Enhancing governance can lead to a reduction in tropical deforestation⁸. However, there is no one-size-fits-all approach to resolving this issue, and governments must take into account factors such as the causes of deforestation, their own political determination, and institutional capabilities before implementing successful methods from other countries. Food governance and supply chains should also be discuss.

The objective of forest and food governance is to develop a well-planned, synchronized strategy that integrates various interventions in a purposeful manner to achieve maximum synergies between local communities and mid-large scale farming. Also, the implementation of MRV (Measuring, Reporting, and Verification) systems has the potential to facilitate the expansion of climate action in Central America and unlock climate finance.

Axis 3: Water and basin management and governance

The risk of water scarcity is significantly amplified by the effects of climate change. Several regions in the Central American dry corridor (Guatemala, El Salvador, Honduras and Nicaragua) are already experiencing increased aridity, severe droughts, and consequential impacts on agriculture, also forced migrations^{2,4,5}. The dry region possess the highest prevalence of undernourishment in the continent.

Enhance water governance is essential, which encompasses activities such as water storage, harvesting, irrigation, and equitable distribution. The absence of strong water policies increases the rate of biome shifting caused by extractive industries and exacerbates the lack of urban and territorial planning, this can have direct implication with epidemics. Water treatment, solid treatment and technology for better public water systems in Central America is a must.

Axis 4: Genetic resources management and conservation paradigm

Governance of global biodiversity has shifted from a preservation-focused paradigm to a sustainable-use paradigm, this is mainly perceived in Costa Rica^{8,9}. This approach acknowledges the instrumental value of nature in facilitating sustainable human resource management, and promoting well-being. Monitoring and understanding how communities and the private sector incorporate biodiversity into their economic activities is necessary.

The agrobiodiversity is one of the most important cultural assets of the region^{10,11}. Native crops should be included in national strategies, and genetic prospecting should be carried out in conjunction with the technification of smallholder farmers. Universities and other stakeholders are key actors in the knowledge networks. Genomic editing techniques like CRISPR-Cas9 should be discuss for genetic resource conservation¹².

Axis 5: Land management

Is necessary to facilitate land access to smallholders by utilizing market assisted mechanisms, regularizing land tenure, modernizing property and cadastre registries, and enhancing municipal capacities. The agribusiness market's lack of competitiveness is due to the increasing dominance of capital and land-intensive agriculture.

Protected areas continue to be a fundamental aspect of biodiversity policy⁹ in Central America, functioning as land control instruments that impose restrictions on activities within their boundaries. Harmony between the protected area and the surrounding communities is necessary in the new conservation paradigm^{13,14}.

Land governance is a complex topic in the Northern countries. The primary cause of forced migration is disaster displacement, with populations living in vulnerable ecosystems or conflict zones exposed to hostile or violent groups such as maras or drug cartels.

Axis 6: Indigenous territory and local knowledge integration

Efforts to preserve indigenous lands through conservation policies must prioritize local support and align with the indigenous people governance systems, and capacities. This underscores the significance of taking 'bottom-up' approaches to designing environmental policies and investments¹³⁻¹⁵.

It is essential to complement these efforts with locally-driven, context-specific agreements that are led by Indigenous communities themselves. This mutual trust approach should prioritize collaboration between conservation efforts and indigenous peoples' needs and aspirations¹⁶. Access to health, education and resource should be guaranteed in a decolonialized approach.

Axis 7: Research funding and tracking scientific mobility

Honduras and Guatemala have the lowest number of researchers per million people, which is exacerbated by the fact that the institutions in these countries receive only a small percentage of the national GDP allocated for research and development. Increasing science investment from various stakeholders is necessary for the development of congruent environmental policies⁵.

Alternatively, mapping, characterizing, and comprehending the Central American scientific diaspora can facilitate capacity building and networking

among local actors¹⁷. South-South cooperation for technology transfer capacity should be prioritize.

Axis 8: From public health to One Health

The distribution and magnitude of vector-borne diseases can be affected by climate change and biome shift. To mitigate the risk of neglected tropical diseases, it is essential to make investments in well-equipped public health facilities that should be distributed equitably, particularly in regions with low socio-economic status².

Strengthening surveillance and vaccination systems is also critical. Furthermore, conducting educating campaigns and investing time and resources in developing respectful participatory process can establish mutual trust on the public health system in rural areas and indigenous communities¹⁶. The One Health approach should be consider.

Final considerations

The establishment of an effective policy system for natural resource governance faces four major challenges in countries where state capture is prevalent. (1) uncertainty regarding the legal status of relevant policies and regulations, especially in the Northern Central American countries, (2) inadequate consistency and fiscalization in accounting and reporting guidelines, (3) unclear specifications for the content of monitoring plans, and (4) insufficient information technology.

References

1. Cano, Á. *et al.* Recent and local diversification of Central American understory palms. *Glob. Ecol. Biogeogr.* (2022). doi:10.1111/GEB.13521
2. Hagen, I. *et al.* Climate change-related risks and adaptation potential in Central and South America during the 21st century. *Environ. Res. Lett.* **17**, 033002 (2022).
3. Barlow, J. *et al.* The future of hyperdiverse tropical ecosystems. *Nat.* **2018 5597715 559**, 517–526 (2018).
4. Magrin, G. O. *et al.* 27 Central and South America Coordinating Lead Authors: Lead Authors: Contributing Authors: Review Editors: to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
5. Morales-Marroquín, J. A., Solis Miranda, R., Baldin Pinheiro, J. & Zucchi, M. I. Biodiversity Research in Central America: A Regional Comparison in Scientific Production Using Bibliometrics and Democracy Indicators. *Front. Res. Metrics Anal.* **7**, 44 (2022).

6. Urkidi, L. The Defence of Community in the Anti-Mining Movement of Guatemala. *J. Agrar. Chang.* **11**, 556–580 (2011).
7. Hellman, J. & Kaufmann, D. Confronting the Challenge of State Capture in Transition Economies. *Financ. Dev.* **38**, 25–41 (2001).
8. Furumo, P. R. & Lambin, E. F. Policy sequencing to reduce tropical deforestation. *Glob. Sustain.* **4**, e24 (2021).
9. Echeverri, A. *et al.* Colombian biodiversity is governed by a rich and diverse policy mix. *Nat. Ecol. Evol.* **2023** 7, 382–392 (2023).
10. Wright, A. Agriculture and Biodiversity in Latin America in Historical Perspective. *Oxford Res. Encycl. Lat. Am. Hist.* (2021). doi:10.1093/ACREFORE/9780199366439.013.991
11. Clement, C. R. 1492 and the loss of amazonian crop genetic resources. II. crop Biogeography at contact. *Econ. Bot.* **53**, 203–216 (1999).
12. Camacho, A. E. In the Anthropocene: adaptive law, ecological health, and biotechnologies. (2023). doi:10.1080/17579961.2023.2184133
13. Cámara-Leret, R., Fortuna, M. A. & Bascompte, J. Indigenous knowledge networks in the face of global change. *Proc. Natl. Acad. Sci.* (2019). doi:10.1073/pnas.1821843116
14. Garnett, S. T. *et al.* A spatial overview of the global importance of Indigenous lands for conservation. *Nat. Sustain.* **2018** 17 **1**, 369–374 (2018).
15. Cámara-Leret, R. *et al.* Ecological community traits and traditional knowledge shape palm ecosystem services in northwestern South America. (2014). doi:10.1016/j.foreco.2014.08.019
16. Berger-Gonzalez, M. *et al.* Green Health in Guatemala: How can we build mutual trust and partnerships to develop an evidence-base for local medicines and realize their potential? *Botany* **100**, 109–126+– (2022).
17. Bonilla, K. *et al.* Engaging the Guatemala Scientific Diaspora: The Power of Networking and Shared Learning. *Front. Res. Metrics Anal.* **7**, 30 (2022).