To What Extent Does Being Colonised Influence Climate Vulnerability?

Chad Patrick Osorio,* Amihan Manuel,† Ciaran Irwin‡

* Adjunct Assistant Professor, School of Environmental Science and Management, University of the Philippines; PhD Candidate, Environmental Economics and Law, Wageningen University and Research, the Netherlands

† Associate Scientist, Centre for Remote Imaging, Sensing and Processing, National University of Singapore

‡ MA Researcher, Digital Democracies Institute, Simon Fraser University, Canada

KEYWORDS

climate change, vulnerability, colonisation

ABSTRACT

The legacy of colonisation intertwines historical injustices with contemporary geosocial vulnerabilities, affecting climate change impacts. However, quantitative evidence for this link is very limited. We examine the premise that former colonies, particularly in the Global South, bear a disproportionate burden of climate change effects due to historical patterns of exploitation and neglect by colonising countries. Using the Country Index of the Notre Dame Global Adaptation Initiative and University of Zurich's Colonial Transformation Dataset, we find that colonised countries are more climate vulnerable than non-colonised countries. However, we find no significant relationship between the duration of colonisation, period of independence, and intensity of political domination on heightened climate vulnerability. These results indicate that regardless of the characteristics of the period of colonisation, being colonised is an important factor related to the vulnerability of countries to climate change.

CC BY SA

I. Introduction

It is well-established that the impacts of climate change are uneven.[1] This differential vulnerability can be attributed to geography and varying exposure to climate-related and environmental hazards, as well as social, economic and political circumstances.[2] This is why some socioeconomic groups are far more vulnerable than others.[3] Social factors include

[1] Thomas, Kimberley, et al. "Explaining Differential Vulnerability to Climate Change: A Social Science Review." *WIREs Climate Change*, vol. 10, no. 2, 2019, e565.

[2] ibid.

[3] Birkmann, Joern, et al. "Understanding Human Vulnerability to Climate Change: A Global Perspective on Index Validation for Adaptation Planning." *Science of the Total Environment,* vol. 803, 2022, 150065; Djoudi, Houria, et al. "Beyond Dichotomies: Gender and Intersecting Inequalities in Climate Change Studies." *Ambio*, vol. 35, no. 3, 2016, pp. 248-262; Thomas, Kimberley Anh, and Benjamin Warner. "Weaponizing Vulnerability to Climate Change." *Global Environmental Change,* vol. 57, 2019, 101928; Tsosie, Rebecca.

levels of education and access to healthcare; economic factors relate to wealth and employment opportunities; and political factors involve issues of governance and access to power, among others. These various factors combine to influence how different communities and nations can prepare for, respond to, and recover from climate-related hazards.[4] Understanding these human aspects of climate vulnerability can help to address associated risks.

Over the past two decades, climate scholars have developed increasingly nuanced understandings of climate vulnerability, integrating these social, economic, and political dimensions into climate models. Tools such as the ND-GAIN Index,[5] the Climate Risk Index,[6] and the IPCC Vulnerability and Risk Assessments[7] offer valuable insights, yet have been critiqued for insufficiently capturing historical and structural drivers of vulnerability.[8] Many of these indices emphasise exposure and adaptive capacity, but often treat nations as temporally static units,[9] without properly accounting for the historical injustices that shape contemporary susceptibility to climate shocks.

Critical development and postcolonial scholars have long argued that colonial legacies—such as extractivist economies, repressive governance structures, and racialised labour systems—have contributed to enduring structural inequalities.[10] These inequalities manifest in weaker infrastructure, fragmented institutions, ecological degradation, and economic dependence in formerly colonised countries, all of which compound climate risk. These scholars have proposed and revisited various mechanisms to explain how these colonial histories continue to affect current vulnerabilities. Benjamin traces the various interconnections of colonialism and climate vulnerability in Commonwealth countries by analysing climate policy and litigation efforts.[11] Bordner, Ferguson and Ortolano highlight how climate vulnerability arises from engrained colonial dynamics.[12] Carmona discusses how forestry extractivism and policies fostering dependence on welfare have impacted the climate vulnerability of Indigenous Peoples.[13] In their article discussing the human right to climate adaptation, Bordner, Barnett and Waters also point to colonial violence as a direct cause of climate vulnerability.[14] Goubert proposes that stratification also contributes to creating more climate marginalised groups in colonised nations.[15] From these discussions, it is apparent that the extraction of natural resources and the transfer of wealth from the colonised to the coloniser, as well as the

"Indigenous People and Environmental Justice: The Impact of Climate Change." *University of Colorado Law Review*, vol. 78, no. 4, 2007, pp. 1625-1678; Winsemius, Hessel, et al. "Disaster Risk, Climate Change, and Poverty: Assessing the Global Exposure of Poor People to Floods and Droughts." *Environment and Development Economics*, vol. 23, no. 3, 2018, pp. 328-348.

[4] Kuran, Christian Henrik Alexander, et al. "Vulnerability and Vulnerable Groups from an Intersectionality Perspective." *International Journal of Disaster Risk Reduction*, vol. 50, 2020, 101826.

[5] Notre Dame Research. *Global Adaptation Initiative Index*. University of Notre Dame, 2024.

[6] GermanWatch. *Climate Risk Index*. 2025.

[7] *see* Estoque, Ronald, et al. "Has the IPCC's Revised Vulnerability Concept Been Well Adopted?" *Ambio*, vol. 52, 2022, pp. 376-389.

[8] Birkmann et al. (n 3) *supra*.

[9] De Ruiter, Marleen, and Anne van Loon. "The Challenges of Dynamic Vulnerability and How to Assess It." *iScience*, vol. 25, no. 8, 2022, 104720.

[10] Benjamin, Lisa. "Racial Capitalism and Climate Change: Colonialism and Climate Law and Policy in the Commonwealth." *Wisconsin International Law Journal*, vol. 4, no. 41, 2024, pp. 577-612; Bordner, Autumn, et al. "Colonial Dynamics Limit Climate Adaptation in Oceania: Perspectives from the Marshall Islands." *Global Environmental Change*, vol. 61, 2020, 102504; Bordner, Autumn, et al. "The Human Right to Climate Adaptation." *npj Climate Action*, vol. 2, 2023, 43; Carmona, Rosario. "The Colonial Roots of Climate Vulnerability: Analysing the Case of the Mapuche-Pehuenche People in Southern Chile." *Routledge Handbook of Climate Change Impacts on Indigenous Peoples and Local Communities*, edited by Victoria Reyes-García, Routledge, 2023, pp. 196-208; Goubert, Anais. "Slavery, Colonialism, and Ecological Imperialism: Insights from Stratification Economics." *American Journal of Economics and Sociology*, vol. 81, no. 3, 2022, pp. 537-579.

[11] Benjamin (n 10) *supra*.

[12] Bordner et al. (n 10 2020) *supra*.

[13] Carmona (n 10) *supra*.

[14] Bordner et al. (n 10 2023) supra.

[15] Goubert (n 10) *supra*.

sociopolitical policies that colonial governments established, have resulted in a massive inequality in climate impacts.

This assertion has gained traction in global policy discussions. International organisations like the Intergovernmental Panel on Climate Change (IPCC) have begun to recognise colonialism as a key contributor to the vulnerability of a social group to climate change. In its 2022 Assessment Report, the IPCC highlighted "historical and ongoing patterns of inequity, including colonialism" as contributing to climate vulnerability.[16] However, while there has been much discussion in qualitative literature on the impact of historical colonialism on a climate vulnerability, to our knowledge, quantitative evidence to support these claims is limited. Existing efforts often rely on qualitative case studies or focus on ecological outcomes rather than integrated vulnerability metrics. For example, Mariani et al. provide evidence, through pollen records, of how pre-colonial Aboriginal cultural burning to manage wildfires being phased out by European settlement have resulted in more fire-prone regions.[17] The Decolonial Atlas project attempts to model environmental and geographic conditions prior to and after colonialism, which can contribute to an understanding of climate vulnerabilities. Táíwò, Cuenca, and Tsoi provide some preliminary analysis on colonialism and climate vulnerability, adopting the ICOW colonial history dataset[18] and creating their own climate vulnerability index.[19] However, their study does not take into account various factors related to colonialism, such as the intensity of the political duration of the period of colonisation, the length of period of independence, and differing levels of political domination. This gap in the research limits our understanding of the extent to which structural historical processes like colonialism shape present-day climate risks. It highlights the need for a deeper examination of how past injustices through colonial mechanisms might still be shaping contemporary outcomes in the face of global climate challenges and could potentially strengthen the empirical foundations for claims of climate justice and reparative adaptation finance.

In this article, we aim to provide empirical evidence to address a crucial question: to what extent does a history of being under colonial rule influence the climate vulnerability of colonised countries? Furthermore, how do factors such as the duration and intensity of political domination, as well as the temporal proximity of the period of colonisation, influence their current susceptibility to climate effects? By exploring these questions, we seek to bridge the gap between qualitative insights and quantitative analysis, offering a more comprehensive understanding of the long-term impacts of colonialism on climate vulnerability. This research is particularly important as it could inform policy decisions and international climate justice initiatives, helping to ensure that those who are most vulnerable receive the support they need to adapt to a changing climate.

II. **Data Sources, Methods, and Scope**

For this exploratory study, we use the University of Zurich's Colonial Transformation Dataset[20] and the Country Index of the Notre Dame Global Adaptation Initiative (ND-GAIN).[21] Essentially, we adopt their respective definitions of colonialism and climate vulnerability.

Colonialism is characterised by a "significant reduction [in] the level of political sovereignty"[22] with an increasing intensity of political domination. Each observation in the

[16] Intergovernmental Panel on Climate Change. *IPCC Sixth Assessment Report*. 2022.
[17] Mariani, Michela, et al. "Disruption of Cultural Burning Promotes Shrub Encroachment and Unprecedented Wildfires." *Frontiers in Ecology and the Environment,* vol. 20, no. 5, 2022, pp. 292-300.
[18] Hensel, Paul. *ICOW Colonial History Data*. 2018.
[19] Táíwò, Olúfémi. *Reconsidering Reparations*. Oxford University Press, 2022.
[20] Ziltener, Patrick, et al. "Research Note: Measuring the Impacts of Colonialism: A New Data Set for the Countries of Africa and Asia." *Journal of World-Systems Research,* vol. 23, no. 1, 2017, pp. 156-190.
[21] Notre Dame Research (n 5) *supra*.
[22] The definition given in Ziltener et al. (n 20) *supra*.

dataset contains data on colonial duration, as well as the level of intensity and social, economic, political, and colonial transformation experienced during the period. We can infer, based on this data, the number of years that these countries have formally had their independence recognised. In particular, the dataset excludes countries where colonisation occurred primarily through the settlement of people from the colonising country without establishing a structured colonial administration. In such cases, the traditional mechanisms of colonial exploitation and its impacts on climate vulnerability might be less relevant.

Climate vulnerability, defined as the "propensity or predisposition of human societies to be negatively impacted by climate hazards", is an aggregate of six sectors: food, water, health, ecosystem services, human habitat and infrastructure.[23] For each of these sectors, the ND-GAIN Index takes into account its duration of exposure to the climate hazard, its extent of sensitivity, and its adaptive capacity. Figure 1, below, shows the development of the climate vulnerability index over time across the world.

We use analysis of variance (ANOVA) and independent t-tests to map out the relationship between colonised countries and their level of climate vulnerability. First, we apply the t-test to compare the mean ND-GAIN vulnerability scores between two groups: colonised and non-colonised countries. This helps us test whether having a history of colonisation is associated with systematically higher climate vulnerability. Second, within the subset of colonised countries, we use ANOVA to examine whether multiple categorical factors related to colonial experience—such as the duration of colonisation, number of years since independence, and intensity of political domination—are associated with differences in climate vulnerability. ANOVA allows us to assess whether there are statistically significant differences between the means of three or more groups defined by these colonial characteristics. This step enables us to explore not just whether colonialism matters, but whether different forms or trajectories of colonial rule might lead to varying levels of susceptibility to climate change. These methods help identify broad patterns and associations, serving as a first step toward understanding the historical dimensions of contemporary climate vulnerability. The correlation matrix in Figure 2, below, provides an overview of the different relationships between various variables that we examined.

Prior to the presentation of our results, we would like to highlight that this study is exploratory and correlational in nature. While we seek to identify statistically significant associations between aspects of colonial history and present-day climate vulnerability, we caution against interpreting this as a definitive causal relationship. Climate vulnerability is shaped by a wide range of interacting factors—both structural and environmental—including geography, pre-colonial institutional resilience, post-independence governance quality, international trade relationships, and access to financial or technological resources. These potential confounding variables may mediate or moderate the observed patterns. Due to data limitations and the scope of this study, we do not explicitly control for all such variables; instead, our aim is to identify broad historical patterns and raise questions for further, more causally robust research. As such, this work should be read as a first step toward quantifying how colonial legacies might shape present vulnerability landscapes, rather than as a comprehensive explanatory model.

III. **Results and Discussion**

In this Section, we discuss two main questions. First, is a history of being under colonial rule correlated with a country's climate vulnerability? If so, what are the potential mechanisms behind this relationship? Second, do various aspects of colonial rule (duration, intensity of political

[23] The country index in Notre Dame Research (n 5) *supra*.

domination, temporal proximity of the period of colonisation) influence current susceptibilities to climate change? Our answer to the first question is yes, while our answer to the second question is more nuanced.

A. *Colonialism and Climate Vulnerability*

Colonialism has been a major force in shaping the modern world. Key aspects of colonisation include territorial acquisition, economic exploitation, cultural domination and assimilation, political and administrative control, and social and racial hierarchies. There is no exhaustive, universally accepted list of all countries that have been colonised, as colonisation has varied in form, duration, and impact across different regions and time periods. However, a vast majority of countries in the world, particularly those from the Global South, have experienced colonisation or have been part of an empire at some point in their history.[24]

The effects of colonisation are deeply embedded in the socio-economic, cultural, and political frameworks of former colonies and continue to influence their development trajectories and international relations. The process of later decolonisation led to the emergence of new nation-states and a reconfiguration of global power dynamics, though the legacy of colonialism remains a contentious and influential aspect of contemporary global affairs. To determine the relationship between colonisation and vulnerability, we group countries according to their colonial status (binary: colonised vs. non-colonised) and calculate the mean vulnerability score for each group. The data is visualised using a boxplot to display central tendency, variability, and potential outliers. They help highlight statistically meaningful differences in climate vulnerability. Our results, as illustrated in Figure 3, below, show that the effects of colonialism on climate vulnerability are significant.

This finding is supported by the preliminary analysis of Táíwò, Cuenca, and Tsoi using a different dataset,[25] as well as general literature. There are a number of mechanisms which can explain this. From the environmental perspective, extractivism is a premier example.[26] Colonialism often involved the exploitation of natural resources for the benefit of the colonising powers, with little regard for the long-term environmental sustainability of the colonised regions. In many cases where colonial settlers faced high mortality rates, their administrations frequently prioritised extractive industries, such as mining, logging, and monoculture farming, to maximise profits.[27] This has led to deforestation, soil degradation, and biodiversity loss in the colonised countries, which in turn impacts climate vulnerability to this day. For instance, in British-controlled India, vast areas of oak and deodar forests were cleared and replaced with pine plantations for resin extraction, resulting in increased vulnerability to wildfires and ecosystem disruption.[28] Similarly, in many African and Latin American colonies, intensive cash crop production exhausted the soil and reduced agricultural diversity, making these regions more susceptible to climate shocks like droughts and floods.[29] The environmental degradation that began during colonialism

[24] Fisher, Max. "Map: European Colonialism Conquered Every Country in the World but these Five." *Vox*, 24 Feb. 2015.

[25] Táíwò (n 19) *supra* at 215.

[26] Sultana, Farhana. "The Unbearable Heaviness of Climate Coloniality." *Political Geography,* vol. 99, 2022, 102638.

[27] Acemoglu, Daron, et al. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review*, vol. 91, no. 5, 2001, pp. 1369-1401.

[28] Parashar, Amit, and Sas Biswas. "The Impact of Forest Fire on Forest Biodiversity in the Indian Himalayas (Uttaranchal)." *XII World Forestry Congress*, 2003, 358 B-1; Govindarajulu, Dhanapal. "India was a Tree Planting Laboratory for 200 Years: Here are the Results." *The Conversation,* 10 Aug. 2023.

[29] Papaioannoua, Kostadis, and Michiel de Haas. "Weather Shocks and Agricultural Commercialization in Colonial Tropical Africa: Did Cash Crops Alleviate Social Distress?" *World Development,* vol. 94, 2017, pp. 346-365; Diepart, John Christophe, and Laura Schoenberger. "Governing Profits, Extending State Power and Enclosing Resources from the Colonial Era to the Present." *The Handbook of Contemporary Cambodia*, edited by Katherine Brickell and Simon Springer, Routledge, 2016, pp. 157-168; Rulli, Maria Cristina, et al. "Global Land and

continues to impact these countries today, reducing their resilience to climate change. Degraded ecosystems are less able to provide essential services such as water purification, flood control, and carbon sequestration.[30] This legacy of environmental harm is compounded by climate change, as weakened ecosystems are less capable of adapting to rising temperatures, changing precipitation patterns, and more frequent extreme weather events. For many former colonies, the environmental scars of colonialism have become pathways for greater climate vulnerability.

Colonialism not only altered the environmental landscapes of colonised countries but also entrenched economic dependencies and structural inequalities that persist to this day.[31] Colonial economies were typically designed to serve the needs of the imperial powers, focusing on the extraction of raw materials and the export of cash crops rather than the development of diversified, self-sustaining economies.[32] This economic model created a dependency on global markets and left many former colonies with limited industrial bases and weak infrastructure. In the context of climate change, economic dependency limits the ability of these countries to adapt.[33] Many of these nations rely heavily on agriculture, which is highly sensitive to climate variability.[34] Climate shocks such as droughts, floods, and storms can devastate agricultural production, leading to food insecurity and economic instability. Moreover, the global trade systems that were established during colonial times continue to prioritise the needs of wealthier countries, leaving former colonies with little leverage to negotiate for fairer trade terms or access to climate adaptation resources.

These economic vulnerabilities are compounded by debt.[35] Many former colonies face significant financial constraints due to external debt incurred during and after colonial rule.[36] Servicing this debt often takes precedence over investing in climate resilience, leaving these countries ill-prepared to cope with the impacts of climate change. The structural inequality embedded in the global financial system means that former colonies are more likely to bear the brunt of climate-related disasters without sufficient resources to mitigate or recover from their impacts. Figure 4, below, plots countries' log GDP per capita against their ND-GAIN vulnerability scores, with points coloured depending on their colonial status. This scatterplot visualises the relationship between economic development and climate vulnerability while indicating whether countries had a colonial past. It was constructed by merging GDP data with colonial history and climate vulnerability scores, illustrating both the economic and historical dimensions in climate susceptibility.

Water Grabbing." *Proceedings of the National Academy of Sciences,* vol. 110, no. 3, 2013, pp. 892–897.

[30] Sekercioglu, Cagan. "Ecosystem Functions and Services." *Conservation Biology for All,* edited by Navjot Sodhi and Paul Ehrlich, Oxford University Press, 2010, pp. 45-72; Smith, Pete, et al. "Review: The Role of Ecosystems and their Management in Regulating Climate, and Soil, Water and Air Quality." *Journal of Applied Ecology,* vol. 50, no. 4, 2013, pp. 812-829.

[31] Myrdal, Gunnar. "The Economic Impact of Colonialism." *Developing the Underdeveloped Countries,* edited by Alan Mountjoy, Springer, 1971, pp. 52-57.

[32] Bridge, Gavin. "Exploiting." *Companion Encyclopedia of Geography,* edited by Ian Douglas et al., Taylor and Francis, 2007, pp. 861-882.

[33] Barnett, Jon et al. "From Barriers to Limits to Climate Change Adaptation: Path Dependency and the Speed of Change" *Ecology and Society,* vol. 20, no. 3, 2015, p. 5.

[34] Ortiz-Bobea, Ariel, et al. "Anthropogenic Climate Change Has Slowed Global Agricultural Productivity Growth." *Nature Climate Change,* vol. 11, 2021, pp. 306-312.

[35] Koh, Wee Chian. "Debt and Financial Crises: From Euphoria to Distress." *Global Waves of Debt: Causes and Consequences,* edited by M Ayhan Kose et al., The World Bank, 2019, pp. 131-159.

[36] Bernards, Nick. "Poverty Finance and the Durable Contradictions of Colonial Capitalism: Placing 'Financial Inclusion' in the Long Run in Ghana." *Geoforum,* vol. 123, 2021, pp. 89-98; Hossen, M Anwar, et al. "Donor Climate Coloniality, Ecological Debt and Vulnerabilities in Coastal Bangladesh: Redesigning Institutions for Recognition Justice." *Environmental Management*, 2025; Bannan, Natasha Lycia Ora. "Puerto Rico's Odious Debt: The Economic Crisis of Colonialism." *City University of New York Law Review,* vol. 19, no. 2, 2016, pp. 287-311; Perry, Keston. "From the Plantation to the Deep Blue Sea: Naturalising Debt, Ordinary Disasters, and Postplantation Ecologies in the Caribbean." *Geographical Journal,* vol. 189, no. 4, 2023, pp. 562-574.

Most of the countries with lower GDPs, which can be a function of being former colonies, are also more climate vulnerable. These ecological impacts align with the 'resource curse' literature, where colonial-era resource exploitation undermines long-term adaptive capacities.[37]

Additionally, colonialism frequently disrupted or dismantled pre-existing governance structures, replacing them with systems that were often authoritarian, extractive and externally imposed. One significant aspect of this imposition was legal transplantation—the introduction of foreign legal systems that often overrode Indigenous laws and customary governance, particularly those related to land stewardship and environmental management. These transplanted legal frameworks tended to prioritise extractive land use, private property regimes, and resource commodification over the well-being of local populations, creating a legacy of weak, corrupt, and unstable governance in many former colonies.[38] Following independence, many former colonies inherited these externally imposed legal systems, which were often ill-suited to local contexts and lacked public legitimacy. This legal mismatch compounded the difficulties of establishing stable, inclusive political institutions. Colonial borders, drawn with little regard for ethnic, cultural, and linguistic realities, created further internal conflicts and social fragmentation.[39] These weak governance systems exacerbate climate vulnerability in several ways. Effective climate adaptation requires strong institutions capable of planning, coordinating, and implementing complex policies across multiple sectors. In countries with fragile political systems, the capacity to respond to climate threats is often limited.[40] The culture of corruption often present in these systems can divert resources intended for climate adaptation, while political instability can prevent long-term planning and undermine the implementation of climate policies.[41]

Examples of these poor governance mechanisms resulting from colonialism are clearly seen in the built environment.[42] Built environments, as critical determinants of climate resilience, are also shaped by colonial priorities. Infrastructure during colonial periods was typically constructed to facilitate resource extraction and administrative control, not to serve the adaptive needs of local populations. Railroads, roads, and ports were often designed to export goods rather than connect communities or distribute resources equitably. Housing, water systems, and public utilities were usually segregated and underdeveloped for local use. This legacy has left many former colonies with vulnerable infrastructures, poorly suited to withstand climate extremes such as floods, heatwaves, and storms. In many urban centres, colonial-era planning decisions continue to shape spatial inequalities today, concentrating risks among the most marginalised populations.

Moreover, in countries recovering from the legacies of colonialism, climate change can act

[37] Frankel, Jeffrey. "The Natural Resource Curse: A Survey of Diagnoses and Some Prescriptions." CID Working Paper No. 233, 2012.

[38] Angeles, Luis, and Kyriakos Neanidis. "The Persistent Effect of Colonialism on Corruption." *Economica,* vol. 82, no. 326, 2015, pp. 319-349; Ali, Merima, et al. "European Colonization and the Corruption of Local Elites: The Case of Chiefs in Africa." *Journal of Economic Behavior & Organization*, vol. 179, 2020, pp. 80-100.

[39] Bernhard, Michael, et al. "The Legacy of Western Overseas Colonialism on Democratic Survival." *International Studies Quarterly,* vol. 48, no. 1, 2004, pp. 225-250; Rice, Jennifer, et al. "Against Climate Apartheid: Confronting the Persistent Legacies of Expendability for Climate Justice." *Environment and Planning E: Nature and Space,* vol. 5, no. 2, 2021, pp. 625-645.

[40] Signé, Landry, and Ahmadou Aly Mbaye. "Renewing Global Climate Change Action for Fragile and Developing Countries." Brookings Institute Working Paper No. 179, 2022; Grayson, Catherine-Lune, and Amir Khouzam. "Climate Action in Conflict and Fragile Settings: Closing the Implementation Gap." *Humanitarian Law and Policy,* 12 Nov. 2024.

[41] Adebayo, Tomiwa Sunday, et al. "Does Political Stability Contribute to Environmental Sustainability? Evidence from the Most Politically Stable Economies." *Heliyon*, vol. 8, no. 12, 2022, e12479.

[42] Mahony, Martin, and Georgina Endfield. "Climate and Colonialism." *WIREs Climate Change*, vol. 9, no. 2, 2018, e510; Mercer, Harriet, and Thomas Simpson. "Imperialism, Colonialism, and Climate Change Science." *WIREs Climate Change,* vol. 14, no. 6, 2023, e851.

as a threat multiplier, exacerbating existing social tensions and conflicts.[43] For example, competition over scarce resources like water and arable land, intensified by climate change, can lead to violence and displacement, further destabilising these regions. In Africa, the Lake Chad Basin, spanning Nigeria, Niger, Chad, and Cameroon, illustrates how environmental degradation can deepen existing tensions. Once one of Africa's largest freshwater lakes, Lake Chad has lost approximately 90% of its water volume since the 1960s due to climate change, unsustainable water use, and population growth. This decline has intensified competition between farmers, herders, and fishers, creating fertile ground for violent groups like Boko Haram to exploit local grievances, contributing to regional instability.[44] In Central Asia, the border region between Kyrgyzstan and Tajikistan has experienced repeated clashes over access to water and arable land.[45] The same thing is true in the Andean highlands of Peru and Bolivia, where Spanish colonial powers seized communal lands and controlled water for mining and export agriculture. Indigenous communities, still facing political exclusion, struggle with the retreat of glaciers that once supplied their water.[46] In turn, these manifestations of political instability, rooted in colonialism, contribute significantly to the climate vulnerability of these nations in an ever-vicious cycle.

Before colonisation, many societies had developed sophisticated systems of environmental management based not only in Indigenous knowledge and practices, but also in distinct legal ontologies—comprehensive frameworks governing relationships between people, land, and ecological system. These epistemic systems, often cultivated over centuries, were well-adapted to local climates and ecosystems, enabling communities to live sustainably and mitigate the effects of climate variability. However, colonialism often undermined or destroyed these knowledge systems, imposing European models of land use and conservation that were ill-suited to local conditions.[47] This legal displacement delegitimised Indigenous authority structures and erased sustainable practices that had long served as climate resilience mechanisms. In Australia, for example, Indigenous fire management practices that promoted biodiversity and reduced the risk of catastrophic wildfires were banned by colonial authorities, leading to an increase in destructive fires in areas where these practices were no longer allowed.[48] Similarly, in many parts of Africa and the Americas, colonial policies replaced traditional agricultural systems with monoculture plantations, reducing resilience to climate shocks.[49] In parallel, colonialism also entrenched scientific exclusion, positioning colonised territories as sites of resource extraction rather than knowledge production. Scientific institutions, funding structures, and research agendas were largely centred in the imperial metropoles, marginalising local knowledge systems and depriving colonised regions of investment in scientific infrastructure. This legacy persists today through differential access to funding, limited participation in global research networks, and

[43] Huntjens, Patrick, and Katharina Nachbar. "Climate Change as a Threat Multiplier for Human Disaster and Conflict." The Hague Institute for Global Justice Working Paper No. 9, 2015.

[44] Petrocelli, Tobi, et al. "Climate Change and Peacebuilding in the Sahel." *Peace Review,* vol. 25, no. 4, 2013, pp. 546-551; Carlesi, Camilla. "Understanding the Relationship between Terrorism and Climate Change: The Case of Boko Haram Activities and the Environmental Degradation of the Lake Chad Basin." Growing Thought Leadership Award Winning Paper, 2022.

[45] Human Rights Watch. "Kyrgyzstan / Tajikistan: Apparent War Crimes in Border Conflict." 2 May 2023.

[46] Ferguson, Rebecca. "Shrinking Andean Glaciers Threaten Water Supply of 90 Million People, Global Policy Makers Warned." *University of Sheffield News*, 21 Mar. 2025; Vidal, John. "As Water Scarcity Deepens across Latin America, Political Instability Grows." *The Guardian,* 1 Mar. 2017.

[47] Sultana (n 26) *supra*.

[48] Fletcher, Michael-Shawn, et al. "Catastrophic Bushfires, Indigenous Fire Knowledge and Reframing Science in Southeast Australia." *Fire,* vol. 4, no. 3, 2021, 61.

[49] Reyes, Jameela Joy. "Greener on the Other Side? Perspectives on Green Colonialism." *Heinrich-Böll-Stiftung Southeast Asia Articles*, 11 Nov. 2024; Garver, Geoffrey, and Cristiane Derani. "Moving From Monocultures to Resilience." *Ecological Integrity and International Law*, edited by Klaus Bosselmann et al., Taylor and Francis, 2025, pp. 165-179.

the ongoing 'brain drain' of scientific talent to the Global North. As a result, many former colonies face structural limitations in generating context-specific climate data, designing adaptive technologies, and influencing international climate policy. The disruption of Indigenous knowledge systems has long-term consequences for climate adaptation. Many former colonies now rely on Western models of environmental management, which may not be as effective in the context of their unique ecosystems and climate challenges.[50] Restoring and integrating Indigenous knowledge into modern climate adaptation strategies could help reduce vulnerability, but this requires overcoming the colonial legacy of marginalising Indigenous voices and practices.

In this subsection, we illustrated how the heightened climate vulnerability of former colonised countries is a direct consequence of the historical and structural legacies of colonialism. Environmental degradation, economic dependency, political instability, and the disruption of Indigenous knowledge systems have all contributed to the increased susceptibility of these nations to the impacts of climate change. Addressing this vulnerability requires a deep understanding of the ways in which colonialism has shaped these countries' current conditions.

B. *Colonial Period Characteristics and Climate Vulnerability*

As highlighted by previous studies, context matters when understanding climate vulnerability and its intersections with colonialism.[51] This why we wanted to explore the different aspects of the colonial period and how much they could affect climate vulnerability. In particular, we analysed three factors: the level of political domination, the duration of colonisation, and the number of years of political independence. Our results indicate that the quantitative features of countries' respective colonial periods do not correlate with their degree of climate vulnerability.

In Figure 5, below, we used the form of colonisation as assigned by the Colonial Transformation Dataset. In the dataset, the form of colonisation corresponds to the levels of colonial control, starting with no colonialism (level 0), semi-colonialism (level 1), then progressing to indirect rule with minimal interference in internal affairs (level 2), followed by indirect rule with significant interference in internal affairs (level 3), and finally reaching direct rule (level 4). We find that the level of political domination during colonisation correlates little with climate vulnerability. This could be because post-colonial development paths can differ greatly even among countries with similar colonial histories. For example, India and Nigeria both experienced British colonisation, but India has made significant strides in economic growth and infrastructure development, while Nigeria struggles with governance and economic challenges, leading to varying climate vulnerabilities.[52] The type of colonial rule (direct versus indirect) does not uniformly affect climate resilience; rather, post-colonial governance, policy, and international support can play larger roles.

For the duration of colonisation, we set the cut-off period at 200 years, based on the bimodal distribution observed in the histogram of colonised countries. The two distinct peaks in the histogram suggest the presence of two clusters, which guided our choice of threshold. Based on Figure 6, below, we find that this also weakly correlates with climate vulnerability, and this could be because different countries have had diverse post-colonial experiences regardless of how long they were colonised. For example, Singapore was a British colony for 144 years,

[50] Dominguez, Lara and Colin Luoma. "Decolonising Conservation Policy: How Colonial Land and Conservation Ideologies Persist and Perpetuate Indigenous Injustices at the Expense of the Environment." *Land,* vol. 9, no. 3, 2020, p. 65.

[51] Sultana (n 26) *supra*.

[52] Cohn, Caroline. "India and Nigeria: Similar Colonial Legacies, Vastly Different Trajectories: An Examination of the Differing Fates of Two Former British Colonies." *Cornell International Affairs Review,* vol. 7, no. 1, 2013, pp. 18-30.

yet today it is one of the most climate-resilient countries due to its efficient governance and economic strength.[53] In contrast, countries with a shorter period of colonisation continue to struggle with high climate vulnerability due to weaker infrastructure and economic instability. This shows that factors like governance quality, economic policies, and international cooperation, among other factors, can outweigh the length of colonial rule when it comes to climate vulnerability.

Lastly, we analysed the number of years since a country gained independence and its effect on climate vulnerability. We used the period of 70 years because the histogram showed a natural break around that point, suggesting two clusters of countries—those that gained independence earlier and those more recently. This cutoff also allows us to explore how different lengths of post-colonial experience might relate to current climate vulnerability. Our results, as illustrated in Figure 7, below, show weak correlation with climate vulnerability. One of the factors which could affect this is effectiveness of policies post-independence, not necessarily just the time elapsed. For instance, Haiti and Botswana both gained independence around the 1960s. However, in addition to external interference, Botswana has also invested in stable governance and development,[54] reducing its climate vulnerability, while Haiti has remained economically fragile and politically unstable,[55] making it more vulnerable to climate impacts. Thus, the length of independence does not directly determine climate resilience.

C. *Limitations and Directions for Future Research*

While we explained a number of mechanisms by which the relationship between climate vulnerability and colonialism arises, we acknowledge the limitations related to the complexity of attributing climate vulnerability solely to colonial history. In particular, as mentioned above, environmental and geographic factors complicate efforts to disentangle the effects of imperial exploitation from those of inherent climatic exposure. Many post-colonial states are located in regions already predisposed to climate extremes, making it difficult to isolate the influence of colonial governance, extraction, and underdevelopment from the biophysical realities of place. These overlapping structural and environmental conditions pose significant challenges for quantitative analysis and causal inference. We also note the potential for more discussion on the effects of different forms of political influence post-colonialism, including quasi-colonialism and neocolonialism. Lastly, while we rely on established indices, such measures may obscure important intra-country variations in vulnerability and the lived experiences of climate risk.

When it comes to the interpretation of our results, while our findings show a robust correlation between colonisation and contemporary climate vulnerability, we equally highlight that the non-significant findings of correlation in the various aspects of colonialism do not negate the relevance of colonial history to climate vulnerability. Rather, it points to the importance of examining evidence-based path-dependent trajectories and institutional legacies that mediate postcolonial development. This opens important avenues for deeper investigation.

First, regional differences may mediate this relationship. For example, tropical former colonies may face inherently greater climatic exposure than temperate ones, raising questions about whether geography and bioclimatic conditions amplify the legacy effects of colonial exploitation. A spatially disaggregated analysis could help disentangle environmental drivers from historical structural ones.

Second, although colonialism has left lasting institutional legacies, it is also important to

[53] Notre Dame Research (n 5) *supra*.
[54] Diaz-Bonilla, Carolina, et al. "Systematic Country Diagnostic Update: Botswana." World Bank, 2023.
[55] Demetriou, Spyridon, et al. "Systematic Country Diagnostic Update: Haiti." World Bank, 2022.

assess the extent to which present-day fragility of institutions can be attributed to postcolonial governance choices, conflict, or global political economy dynamics. As given in the examples above, some countries with similar colonial experiences have diverged significantly in terms of governance quality and resilience, suggesting a role for path-dependent but context-contingent developments. More empirical study on this matter, including improved quantification of the concept of fragility, should be undertaken.

Third, we acknowledge that contemporary political and economic conditions—including trade dependency, aid flows, and debt structures—likely interact with historical legacies to shape vulnerability. For instance, former colonies that remain integrated into asymmetrical trade or financial relationships may have limited fiscal space to invest in climate adaptation, reinforcing long-term vulnerability. Future research could use panel data, mediation models, or case comparisons to explore how these contemporary variables condition or compound the effects of colonial history. Further study could also explore the interactions of colonial legacy with present governance quality, civil society strength, and international aid regimes (as opposed to aid flows) and how they influence the climate vulnerability trajectories of colonised countries.

Addressing these questions is crucial for moving beyond bivariate correlations toward a more nuanced, historically grounded, and policy-relevant understanding of climate vulnerability.

IV. **Conclusion**

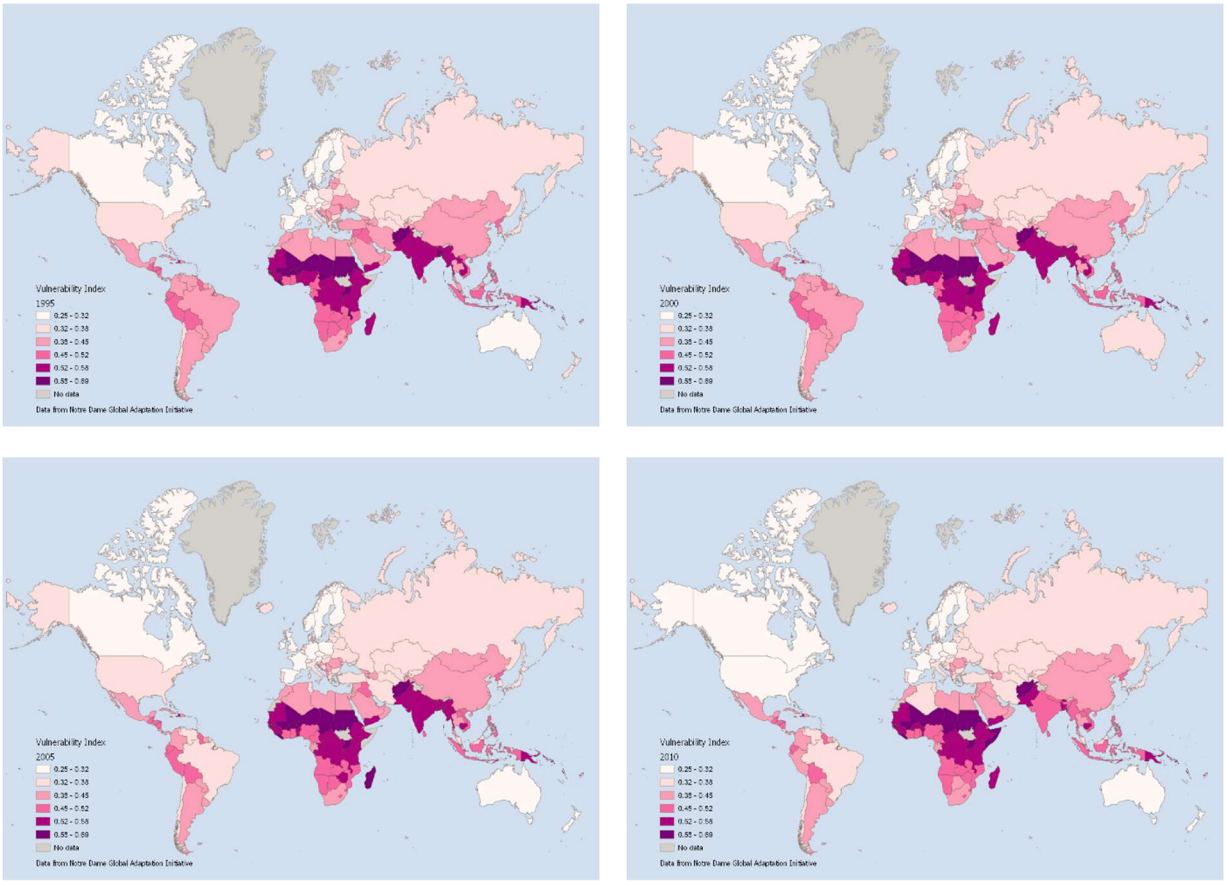
The significant correlation between colonisation and climate vulnerability likely stems from the fundamental differences in development opportunities between colonised and non-colonised nations. Colonised countries often had their resources extracted for the benefit of the colonisers, leaving them with weakened economies, degraded environments, Indigenous knowledge deprioritised, and fragile political infrastructures at independence. These disadvantages, inherited from colonial rule, have long-term consequences, making it difficult for such nations to build resilience against climate impacts. In contrast, non-colonised countries have had more autonomy over their natural resources and development trajectories, allowing them to establish stronger governance systems and infrastructure better suited to managing climate risks. This broad historical distinction has a more pronounced effect on climate vulnerability than specific variations within colonial experiences. Regardless of the duration of colonisation, period of independence, and intensity of political domination, our findings suggest that countries with a history of colonisation tend to exhibit higher levels of climate vulnerability.

It is important to note that this correlation does not imply a uniform or deterministic effect. Rather, it highlights how colonial histories often set the stage for enduring patterns of environmental degradation, economic dependency, and institutional fragility—factors that cumulatively constrain adaptive capacity and increase exposure to climate risk. It is essential to interpret this correlation with care: colonisation interacts with a web of mediating variables—geography, post-independence governance, global trade dynamics, and financial systems—which all influence climate outcomes. The legacy of colonisation is thus not a monolithic cause, but a significant structural backdrop that conditions vulnerability in complex and context-dependent ways.

In any case, our findings underscore the profound and lasting impact of colonialism on climate vulnerability. While our study shows that the characteristics of colonial rule do not directly correlate with climate vulnerability, it firmly supports the assertion that being colonised is a key structural factor shaping contemporary climate risk. Recent developments in international law highlight the increasing recognition of these historical injustices. For example, the increased calls for

climate justice[56] and the establishment of a Loss and Damage Fund at COP28,[57] aimed at supporting vulnerable countries, reflect a growing acknowledgment of the responsibility of wealthier, historically colonising nations to provide financial and technical support to those disproportionately affected by climate change. However, while these initiatives signal a rhetorical shift toward acknowledging responsibilities, the practical outcomes of international climate justice mechanisms—particularly within the COP process—have often fallen short of meeting the needs and objectives of developing countries.

Procedural delays, political compromise, and insufficient financial commitments have frequently undermined the transformative ambitions of Global South negotiators. As such, while the legal and moral imperative[58] for redress is increasingly acknowledged, realising meaningful support for former colonies requires more than recognition—it demands sustained, equitable cooperation and structural reform to ensure that vulnerable communities are truly empowered to build climate resilience and shape a more just global adaptation framework.



[56] Briggs, Helen. "Carbon: How Calls for Climate Justice Are Shaking the World." *BBC,* 3 May 2021.
[57] Jaynes, Cristen Hemingway. "COP28 Agrees to Establish Loss and Damage Fund for Vulnerable Countries." *World Economic Forum*, 1 Dec. 2023.
[58] Collste, Goran. *Global Rectificatory Justice.* Palgrave Macmillan, 2015.

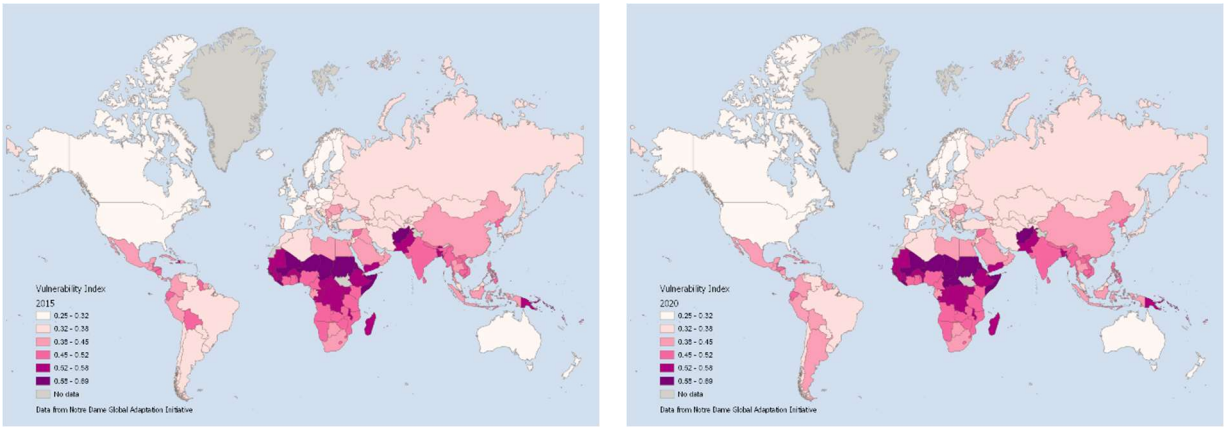


Figure 1: Climate Vulnerability Maps Over Five-Year Periods.

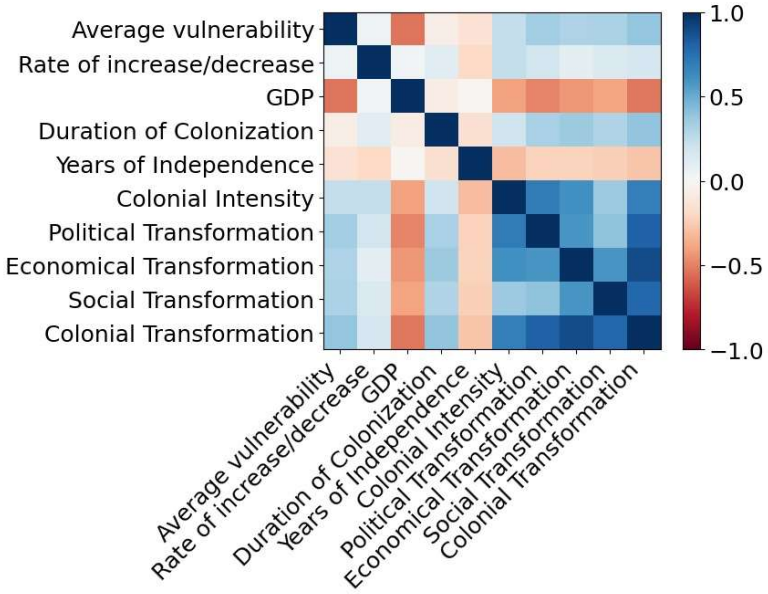


Figure 2: Correlation Matrix of Various Aspects of Colonisation and Climate Vulnerability.

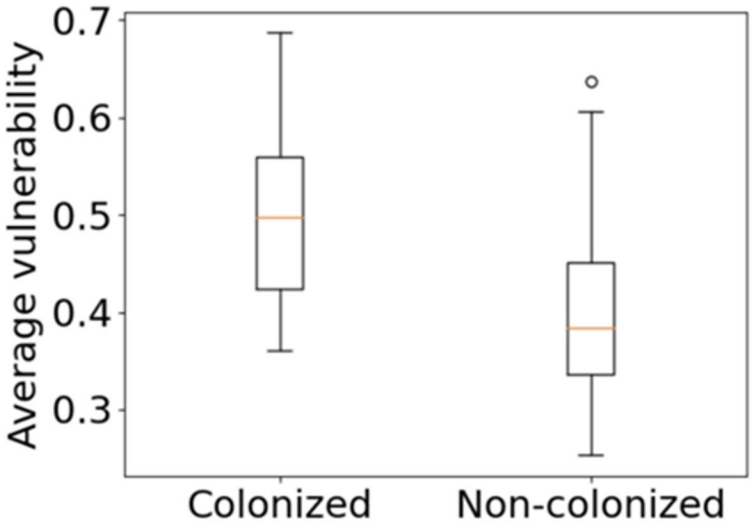


Figure 3: Colonised / Non-Colonised Countries and their Level of Climate Vulnerability.

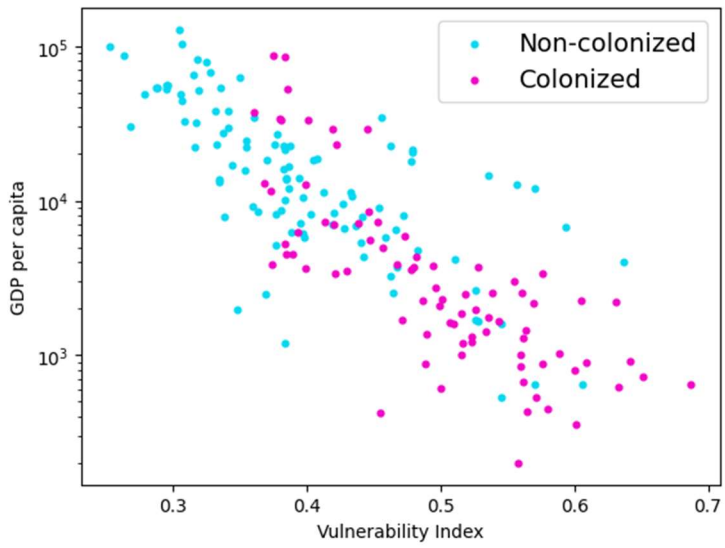


Figure 4: GDP Per Capita (USD), Colonisation, and Climate Vulnerability.

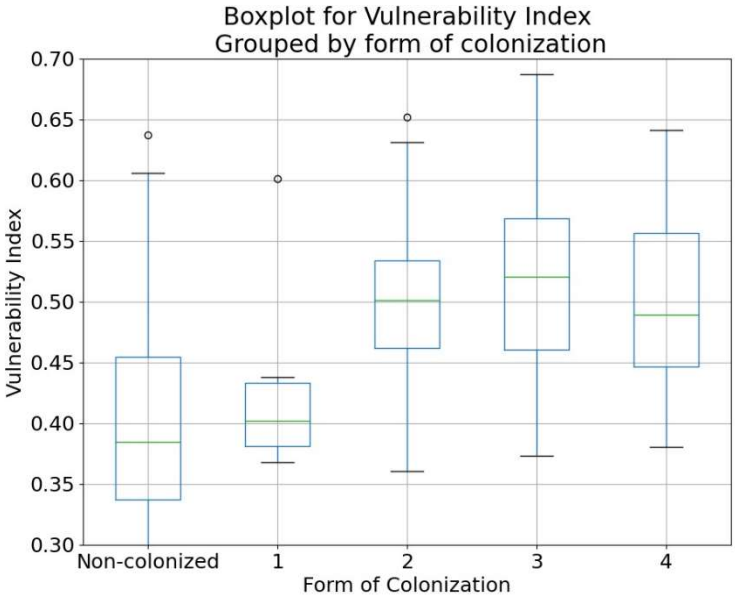


Figure 5: Political Domination and Climate Vulnerability.

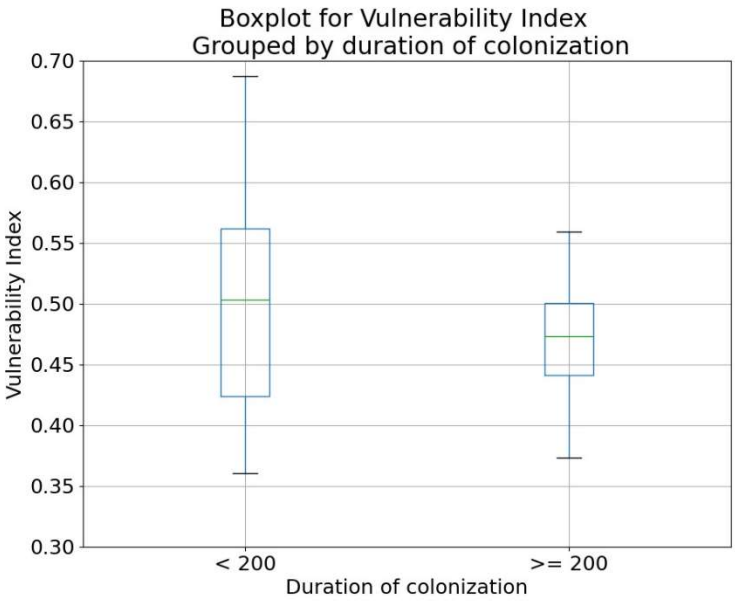


Figure 6: Duration of Colonisation and Climate Vulnerability.

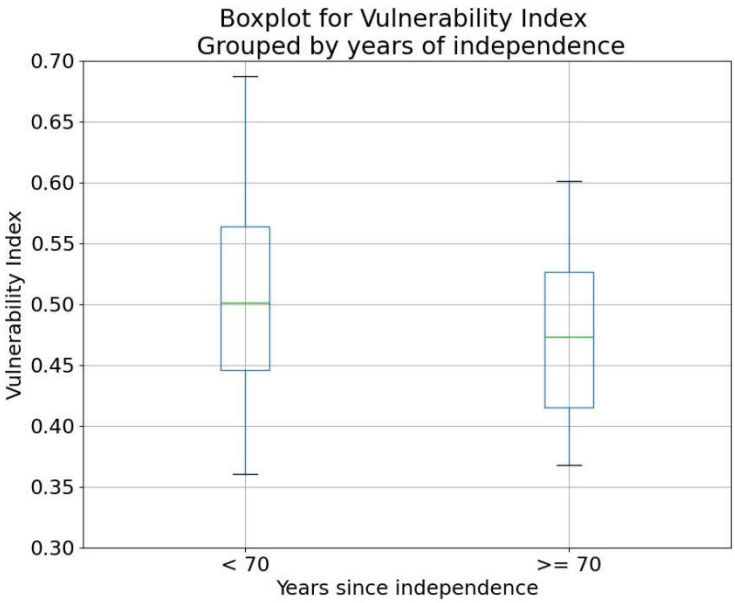


Figure 7: Years of Independence and Climate Vulnerability.