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Drivers of Climate Vulnerability to Tropical Storms: A Comparative Analysis of Adaptive Capacities in Haiti and Dominican Republic

Factores de la vulnerabilidad climática ante tormentas tropicales: análisis comparativo de las capacidades de adaptación en Haití y la República Dominicana

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ABSTRACT: The impacts of potential climate change threats are far-reaching and intrinsically diverse, while the adaptive capacities in both nations to cope with hazards are uneven. In this study, the drivers of climate vulnerability of two island nations were analysed: Haiti and the Dominican Republic, with a specific focus on tropical storms. While the countries generally experience the same level of exposure to storms, their vulnerabilities and adaptive capacities were found to be dissimilar. In the 2020 Global Climate Risk Index the Dominican Republic was ranked as the 50th country with the highest disaster risk index, while Haiti ranked in the top 3 countries. The analysis of adaptive capacity in both countries involved a review of secondary literature generated by evaluations of USAID, WBG, and UN agencies, as well as reading government reports and policy plans. It was found that the main drivers of divergent levels of vulnerability are the different historical, social and political processes experienced between the two countries. Factors such as the use of natural resources, dependency on economic sectors, trust in governance and awareness of storm threats all contribute to this disparity in preparedness and vulnerability. What this study has confirmed is that hazards become disasters when they impact on populations in precarious conditions built or developed by the failure or neglect of governments or those in power.

KEYWORDS: climate vulnerability; climate change adaptation; adaptive capacity; exposure to storms; climate resilience.

RESUMEN: Los impactos de las posibles amenazas del cambio climático son de gran alcance e intrínsecamente diversos, mientras que las capacidades de adaptación de ambas naciones para hacer frente a los peligros son desiguales. En este estudio, se analizaron los factores de vulnerabilidad climática de dos naciones insulares: Haití y República Dominicana, con un enfoque específico en las tormentas tropicales. Si bien los países generalmente experimentan el mismo nivel de exposición a las tormentas, se encontró que sus vulnerabilidades y capacidades de adaptación eran diferentes. En el Índice de Riesgo Climático Global de 2020, República Dominicana se ubicó como el país número 50 con mayor índice de riesgo de desastres, mientras que Haití se ubicó entre los 3 primeros países. El análisis de la capacidad de adaptación en ambos países implicó una revisión de la literatura secundaria generada por evaluaciones de USAID, el GBM y agencias de la ONU, así como la lectura de informes gubernamentales y planes de políticas. Se encontró que los principales impulsores de los niveles divergentes de vulnerabilidad son los diferentes procesos históricos, sociales y políticos experimentados entre los dos países. Factores como el uso de los recursos naturales, la dependencia de los sectores económicos, la confianza en la gobernanza y la conciencia sobre las amenazas de tormentas contribuyen a esta disparidad en la preparación y la vulnerabilidad. Lo que este estudio ha confirmado es que las amenazas se convierten en desastres cuando impactan en poblaciones en condiciones precarias construidas o desarrolladas por el fracaso o la negligencia de los gobiernos o aquellos en el poder.

PALABRAS CLAVE: vulnerabilidad climática; adaptación al cambio climático; capacidad de adaptarse; exposición a tormentas; resiliencia climática.

Climate change represents one of the most fundamental challenges to continued international development and sustainable global progress. The impacts of potential hazards are far-reaching and inherently uneven, while the tools individual nations have at their disposal to combat these threats are equally uneven. In this study, the adaptive capacities of two island nations will be analysed. The Caribbean island of Hispaniola, shared by Haiti and the Dominican Republic, is one of the most impacted islands in terms of natural hazards, and especially tropical storms. Due to its geographical position, this bi-national island is exposed to the annual recurrence of tropical storms (Klose, 2011). Borth countries have a long history of exposure to tropical storms, and this is likely to continue in the future under current climate change predictions (Vosper et al., 2020; World Bank, 2022a).

Although both nations face similar levels of exposure to storms, the way in which these hazards are experienced and addressed differs significantly. As will be demonstrated and analysed in this research, their vulnerability to hazards, potentially worsened by climate change, is not similar. In the 2020 Global Climate Risk Index the Dominican Republic was ranked as the 50th country with the highest disaster risk index, while Haiti ranked in the top 3 countries (Eckstein et al., 2019). In 2004, for example, Hurricane Jeanne hit as hard in Haiti as it did in the Dominican Republic, but resulted in the loss of 3,000 lives in Haiti and 19 in the Dominican Republic (Park, 2016). It seems clear that Haiti and the Dominican Republic have divergent levels of vulnerability, in spite of their similar exposure to hazards bounded by their geographic position, yet why is Haiti so vulnerable to storms compared to the Dominican Republic? How can Haiti's adaptive capacity be strengthened?

With similar storm exposure but uneven risk and vulnerability, the case of this Caribbean binational island facilitates the analysis on the determinants of such unequal levels of vulnerability. The case provides an opportunity to conduct research on the extent to which adaptive capacities to climate change could enable better response and preparedness to future climate-induced hazards. This paper seeks to discuss the reasons for the different levels of vulnerability between the two countries and the connection with the development of adaptive capacity to storm-related disasters. It seeks to show the predictability of vulnerabilities in both countries, with a special focus on Haiti, in a way that provides useful information for the effective formulation and implementation of improved climate change adaptation policies that help reduce the adverse impacts of storm-related disasters while strengthening livelihoods and adaptive capacities to cope with future events.

The studies analysed in this line have often been restricted to comparing the levels of exposure to climate hazards or individually analysing the social and political context of each country as well as their risk reduction initiatives. However, few comparative studies of the two countries were found in which, in addition to analysing contrasts in the impacts of climate hazards, a study of climate change adaptation and capacity building is also proposed. If progress can be made to highlight the most notable factors which contribute to climate vulnerability and uneven adaptive capacity in this region, then progress can surely be made to root out these

issues and build long-term solutions for the betterment of the people who live in these regions. As climate change worsens, this question will only become more and more pressing.

For the purposes of this research question the data has been prepared and presented by secondary resources such as the climate change knowledge portal, World Bank and UN agencies. The analysis of adaptive capacity in both countries involved a review of secondary literature generated by evaluations of international organisations such as USAID, as well as reading government reports and policy plans.

Literature review

Exposure to hazards and disasters

There is extensive literature on the relationship of climate change towards shifts in the frequency and severity of hazards. Hazards, according to the UNISDR (2009), are defined as dangerous events, conditions or human activities that lead to adverse impacts on people's health or loss of life, as well as damage to property and livelihoods. Climate models suggest that the severity and even the occurrence of weather hazards such as storms will increase by 2030. (Shepherd et al., 2013). For example, the return period of severe 100-year event storms in the Caribbean is expected to decrease with increasing global temperatures (Vosper et al., 2020). Hazards will lead to a variety of potential impacts; including increased disease prevalence, injury, death, disruption of livelihoods, loss of livelihoods, loss of assets, displacement of people and many more. But there is also the potential for the creation of unique patterns of vulnerability and disadvantage as impacts will be experienced differently depending on location and conditions (Schlosberg, 2012). Therefore, the livelihoods of the poorest in developing countries are under threat. Climate change threatens to roll back all the gains made in international development, as well as hinder the implementation of future poverty reduction efforts.

Disasters, on the other hand, are usually associated with «the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences» (UNISDR, 2009, p. 9). Exposure to hazards is thus one of the building blocks of disasters. However, exposure, understood as the magnitude and duration of a hazard to which a system or individual is susceptible, is still a widely debated conecept to justify vulnerability risk (Gallopín, 2006; Adger, 2006; Kasperson et al., 2005). The *naturalness* of hazards has been challenged by a number of other scholars who argue that disasters are not caused by natural events alone (Cannon, 2008; Wisner et al., 2004). The climate change impacts narrative is being used in many countries and political spaces to justify the cause of many problems today, as if it is the climate change situation that needs to be addressed and not the existing problems that have been present for a long time (Cannon, 2008). In addition, Wisner et al. (2004) comment on the terminology used in the news or media when referring to the power of nature as the cause of widespread disaster impact. Hazards become disasters when they impact populations in precarious conditions built or developed by the negligence or failure of governments and those in power (Cannon, 2008; Wisner et al*.,* 2004; Shepherd et al., 2013).

Climate change vulnerability

In the extensive literature on disasters, words such as vulnerability, adaptive capacity and resilience appear constantly. However, the conceptualisation of each term varies greatly and some authors have noted this inconsistent terminology in the climate change impacts literature. The concept of vulnerability has evolved over time but there is still no definite consensus on the term. By the 1970s, it was perceived merely in relation to exposure to disasters or natural hazards (Adger, 2006). Vulnerability was often associated with people's marginalisation, poverty and exposure to hazards. In the late twentieth and even early twenty-first centuries, the term vulnerability was associated with the absence of resilience to recover from shocks (Briguglio, 2008; Manyena, 2006). Concepts such as exposure or insecurity to risks also prevailed (Wratten, 1994). And other authors, such as Moser (1996), focused on the negative effects on households' well-being to explain their vulnerability to hazards. Fragility, exposure and marginalisation were commonly accepted to explain people's vulnerability to disasters (Gallopín, 2006). But this type of approach was very limited in explaining the factors that lead a person to become vulnerable.

The literature on the drivers or components of vulnerability clearly states that exposure to hazards is only an additional factor of risk within a much broader spectrum of conditions that lead to vulnerability. Exposure is understood as the presence of households, livelihoods, infrastructure and/or ecosystems in locations or conditions that could be affected because of climate catastrophes (IPCC, 2022). But the degree of vulnerability to climate shocks is not determined solely by exposure to climate shocks. The risk of impoverishment or vulnerability is influenced by factors such as lack of access to assets or capital, including forms of insurance to improve the ability to adapt or recover from disasters (Shepherd et al., 2013). The combination of exposure and limited access to safety nets leads to increased risk from hazards.

A broad range of experts argue that disasters are a social construct. More critics claim that people become vulnerable through a series of socio-political processes that lead to their vulnerability (Cannon, 2008; Shepherd et al., 2013; Wisner et al., 2004; Adger et al., 2009). These processes make it possible to determine and predict who is most at risk from hazards. Cannon (2008), for example, proposes a list of five components of vulnerability to understand the factors that make some people more at risk to hazards than others. The building blocks of vulnerability are (1) livelihoods and resilience, (2) baseline status or well-being, (3) self-protection, (3) social protection, and (4) governance mechanisms (see Figure 1)

Source: Cannon (2008).

Figure 1. Five components of vulnerability.

Building adaptive capacity

Adaptation to climate change was first defined as an adjustment in social, economic and ecological systems to respond to the effects of climate change with the aim of reducing adverse impacts (IPCC, 2001). Many authors define adaptation as a series of processes in which humans adjust to changes in climate. In the latest IPCC assessment report (2022, p. 134), adaptation is further elaborated as the process of adjusting to the actual or expected effects of climate change, which often integrates risk management actions. However, there is no standard «one fits all» adaptation process (Schlosberg, 2012). Strategies are needed to probe for context-specific adaptation needs. Rural populations in developing countries are at the frontline because of their climate-dependent livelihoods, for example. The challenge then becomes one of reaching populations that have already been left behind by «development» and poverty reduction interventions.

Consequently, the discussion on the adaptation to climate change and reduction of people's vulnerability started to integrate a focus on adaptive capacities that can be built or developed. The purpose of this approach is to avoid the idea that people are defenceless victims and that skills can be developed to cope with risks and build resilience (Cannon, 2008). The increase in the number and scale of disasters, as well as the worrying estimates of human, economic and development losses from disasters (IPCC, 2014), suggests an urgency to developing adaptive capacities. The literature review on the fundamental characteristics of adaptive capacities starts with the definition in biology that refers to a function or behaviour of organisms to ensure *adaptness* (Dobzhansky, 1968, in Gallopin, 2003). Recently in the field of climate change, adaptive capacity began to integrate the ability to react to and anticipate hazards. An example of this is the IPCC (2001) definition that described adaptive capacity as the ability of a system to moderate the

expected damages from global warming and take advantage of opportunities to respond to and prepare for hazards (IPCC, 2001). The term has thus come to involve both strategies for responding to impacts as well as preparation for future adverse effects.

Analysis

Although both countries generally face the same natural catastrophes given their geographical conditions, the populations in them experience and respond to the impacts of these events unequally (Pichler & Striessnig, 2013). According to the Global Climate Risk Index (2020), Haiti ranked among the top 3 countries in the world with the highest risk of disasters between 1999 and 2018, unlike the Dominican Republic which was placed in the 50th position (Eckstein et al., 2019). Previous studies have already shown how the Dominican Republic is moving towards climate adaptation. In Haiti, on the other hand, there are still significant delays towards climate resilience (Sheller & León, 2016).

The comparative analysis in this paper begins with a discussion of the exposure of both Haiti and the Dominican Republic to climate change hazards, specifically storms. Subsequently, the differing levels of vulnerability in both countries are evaluated, as well as the components that lead to a higher vulnerability to storms. Finally, an analysis will be made regarding the adaptive capacity and responsiveness to threats between the two countries, as well as their determinants.

Haiti and Dominican Republic: Exposure to climate-related hazards

The Hispaniola island

The island of Hispaniola, the second largest island of the Antilles, is shared by Haiti in the west and the Dominican Republic in the east (see Figure 2). The island lies in the northern fringe of the Caribbean Sea and is made up of alternating mountain ranges, lowlands and valleys. It has a surface land area of 76,192 km^2 and is distinguished by geographical contrasts, from peaks of more than 2,600 meters above sea level, such as Mount Selle in Haiti, to the lowest parts such as Lake Enriquillo in Haiti, whose surface is 45 meters below sea level (Herrera et al., 2021). It is the most populated island in the Caribbean with a total of 21 million people, of which 11.1 million live in Haiti (UNDESA, 2022). Hispaniola island is particularly exposed to natural hazards such as hydro-meteorological events, and especially severe storms due to its geographical position in the «hurricane belt».

The island is also part of the Small Island Developing States (SIDS), named after the Economic Commission for Latin America and the Caribbean (ECLAC). The SIDS are a group of 38 island nations around the world and are characterised by their small size, weak diversification of economic activities, and high pressure on resources (UNWTO, 2014), which make them particularly vulnerable to the impacts of climate change.

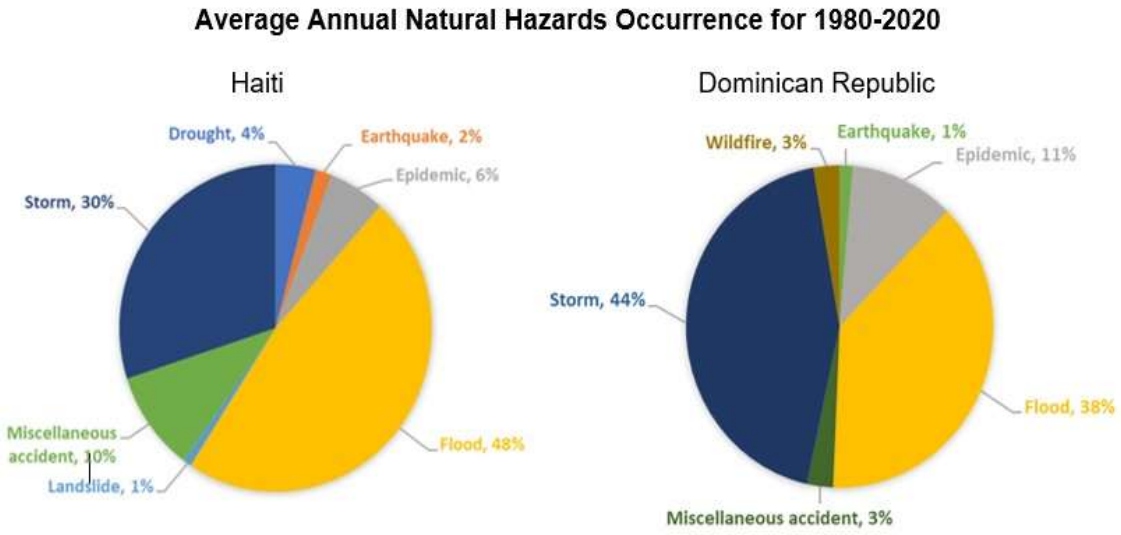
Source: The Limited Times (2021).

Figure 2. The Hispaniola Island.

Storms frequency and intensity

For purposes of the comparative analysis on the exposure to climate change hazards in both countries, the research analysis will focus on storms and hurricanes. The similar levels of exposure in terms of frequency and intensity of storms in both Haiti and the Dominican Republic will be compared. Subsequently, there will be a review of the unequal social and economic impacts that these events have left for each nation, and the factors that make one country more vulnerable than the other.

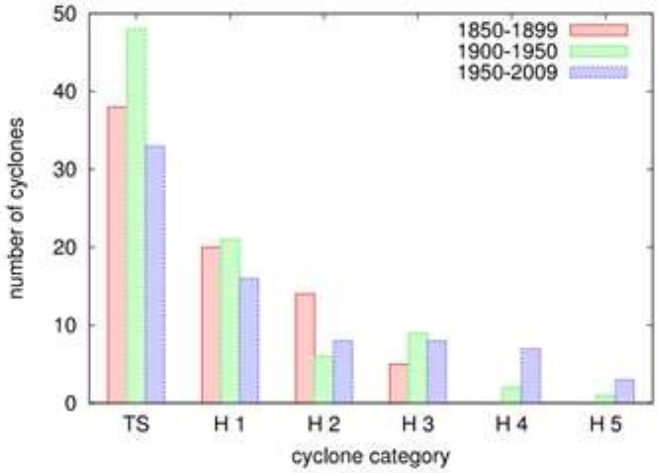
Both Haiti and the Dominican Republic have a long history of exposure to tropical storms. For the Caribbean region as a whole, it has been estimated that since 1960, 95 % of all of the total damage from natural disasters has been caused by extreme storm events (Burgess et al., 2018). In absolute numbers, Haiti only surpasses its neighbour with 4 more storms out of a total of 32 storms recorded by the Dominican Republic between 1980 and 2020 (World Bank, 2022a). Yet the proportions of total hazards that affect each country differ. Approximately 30 % of all natural hazards impacting Haiti corresponds to storms. In the Dominican Republic, storms represent 44 % of all natural hazards that affect the country (see Figure 3)



Source: Climate Change Knowledge Portal, World Bank.

Figure 3. Comparison of the share of occurrence of natural hazards in Haiti and the Dominican Republic.

As Figure 4 shows, between 1850 and 2009, Hispaniola Island was hit by 72 significant storms. Not all made direct landfall, however their proximity and intensity were still able to often cause a significant impact. Anecdotally, it appears as though hurricane intensity has been increasing in recent decades, however, Klose (2011) states that it is difficult to conclude this from the data that is available as it is not a statistically significant inference. While it is likely that climate change is leading to an increase in the intensity of severe storms in most regions of the globe, the changes to the number of storms that will occur each year is still not yet clear (Walsh et al., 2015). Significant uncertainties remain in modelling climate change induced changes on storm frequency and intensity. For the Hispaniola Island, Vosper et al. (2020) modelled the projected return period for extreme hurricanes under different climate change scenarios. They showed that a global surface temperature increase of 2^{O}C above pre-industrial levels would lead to a 100-year hurricane event becoming a 30-year event in the Dominican Republic and a 57-year event in Haiti (Vosper et al., 2020).

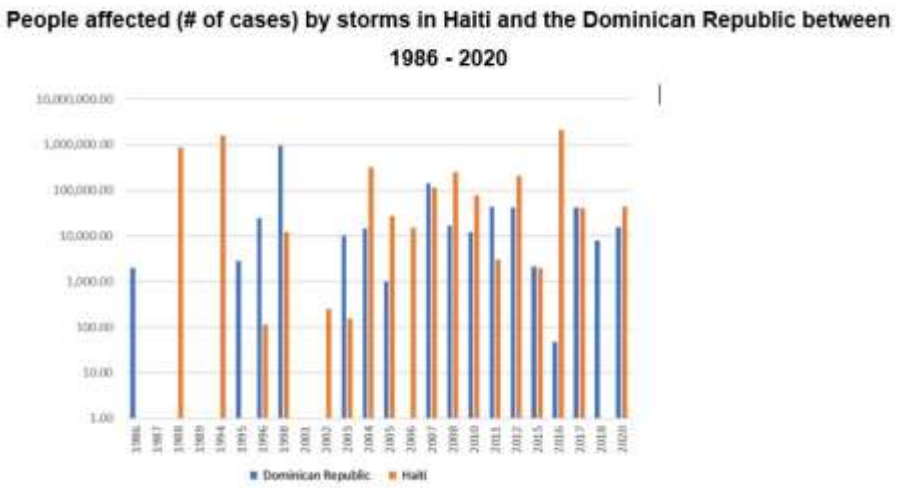


Source: Klose (2011; data compiled from the US National Oceanic and Atmospheric Administration).

Figure 4: The frequency of tropical storms (TS) and hurricanes (H) that came close to the Hispaniola Island from 1850-2009; grouped into multi-decadal periods.

Analysing differential vulnerabilities

The fact that Haiti and the Dominican Republic are exposed to a relatively similar frequency and intensity of storms does not however imply that they are affected to a similar degree. Populations in neighbouring countries often experience and respond to the impacts of these events in an unequal manner (Pichler & Striessnig, 2013). For instance, according to data presented by the Climate Change Knowledge Portal in Figure 5, a total of approximately 1.3 million people in the Dominican Republic, and 5.6 million in Haiti have been affected by storms in the period from 1980-2020 (World Bank, 2022a). The difference is most noticeable in 2016 when Hurricane Matthew (Category 4 storm) struck both countries. More than 2 million people were affected in Haiti compared to 42,000 people in the Dominican Republic (World Bank, 2022a). In 2021 alone, there were 220,000 cases of internally displaced persons who were forced to flee their homes due to natural disasters in Haiti. In the same year, the Dominican Republic only quantified 10,000 cases (World Bank, 2022a). Haiti has the highest vulnerability index to cyclones compared to the rest of the island states in the region with 96 % of its population living at risk (World Bank, 2021). Despite sharing the same island and facing common hazards, evidence reflects the divergent impacts of natural disasters such as storms in both countries.



Source: Climate Change Knowledge Portal (World Bank, 2022a).

Figure 5. Comparison of the number of people affected by storms in Haiti and the Dominican Republic between 1986 and 2020.

Storms impacts in Haiti and Dominican Republic

The most significant impacts of climate change-induced storm variations and intensity for both Caribbean countries range from floods, droughts, landslides as well as erosion from heavy rains (USAID, 2013a). In the most vulnerable countries, it is clear that the poorest will be ones who are affected the most. Factors such as a lack of access to economic stability and savings, their education facilities and access to healthcare is more vulnerable, and they often need more time to recover from shocks all contribute to this. Furthermore, in rural areas, the livelihoods of the poorest are often based on assets that depend on predictable and/or stable weather conditions.

Agriculture

As annual rainfall and intense storms become more unpredictable and frequent, agricultural productivity in both countries will likely be affected. A study by Sheller and León (2016) revealed the effects of flooding in both countries. Residents near two border lakes between Haiti and the Dominican Republic reported significant losses in economic activities, including the direct loss of livestock and arable crops, as well as impacts on access to water from springs that were flooded. Reduced annual rainfall in combination with the occurrence of increasingly intense storms, is expected to cause a weakening of rice and potato production in Haiti; staple crops which are essential to feed a large proportion of the population, as well as increased cases of climate-sensitive diseases such as dengue fever and malaria in the country (World Bank, 2021). Due to the steep rocky hillsides that typify Haiti's geography in combination with its weakened soils resulting from deforestation, only 28 % of the land in Haiti is considered cultivable (Cohen & Singh, 2014). In 2018 Haiti had access to approximately 18,400km2 of agricultural land, compared to over

24,000km2 for the Dominican Republic, while having a slightly larger population (The Global Economy, 2022). In scenarios where storms increasingly damage more of the country's available agricultural land, those that do not have «buffers» of excess land to utilise when hazards strike will likely be impacted more.

Food security

The deterioration in agricultural production in combination with a number of other factors has left the Haitian population suffering from high levels of food insecurity and malnutrition. When the country's lack of access to cultivable land and low economic development are combined, it is easy to understand why Haiti is highly dependent on food imports. Given the adverse effects of climate change on global crop yields, the country now faces an increase in global food prices that are expected to rise up to 120-180 % by 2030 (Cohen & Singh, 2014). As its agricultural capacity is limited by flooding resulting from storms, the country is now also facing the consequences of rainfall fluctuations and changes in the intensity of hydro-meteorological events in other producer countries. By 2020, 42 % of the population is likely to be acutely food insecure (World Bank, 2021). The increased frequency and intensity of climate shocks are negatively affecting the agricultural sector, both in terms of infrastructure and production. Secondary effects will be present in the long term, if not already happening, in relation to dietary diversity and health indicators. In addition, storms also pose obstacles to the processing of imported goods. Storm damage to port infrastructure, road networks, warehouses, etc., hampers food supply during emergency conditions such as the during and after the occurrence of storms and hurricanes. In the Dominican Republic it has been shown that there has been significant underinvestment in key port infrastructure of Rio Haina to prepare for the increased risk of severe storms (Rosa & Lohmann, 2015).

The drivers of storms vulnerability

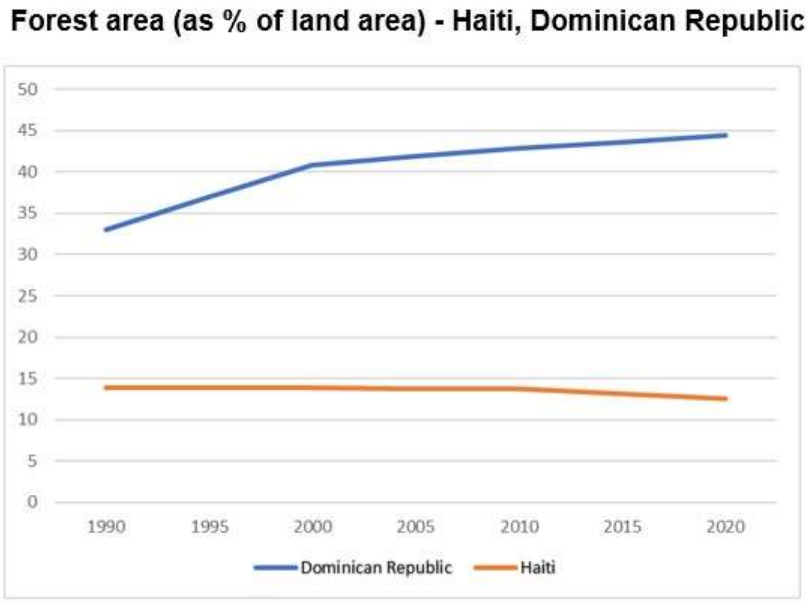
Dependence on agriculture

Agriculture accounts for 21.5 % of Haiti's total Gross Domestic Product (GDP), as opposed to 4 % in the Dominican Republic (USAID, 2017a, 2017b). Agriculture, forestry and fisheries are the largest contributors to Haiti's GDP, only second to the services sector. About 40 % of Haitians rely on sectors such as fisheries and crops as their main source of income, in addition to self-consumption agriculture (USAID, 2017a). In addition, half of the economically active population in Haiti is engaged in agriculture as opposed to only 9 % of the economically active population in the Dominican Republic (IFAD, 2022a, 2022b). Fewer households in the Dominican Republic are dependent on agricultural income.

Heavy reliance on weather conditions for these types of economic activities only makes households more vulnerable to the impacts of climate-induced changes in storm intensity. However, while Haitians rely largely on agricultural livelihoods, the government has not invested sufficiently in technological innovation (Cohen % Singh, 2014). This limits their possibilities to cope with the reduction or interruption of agricultural production and prevents them from seeking alternative sources of income from other diversified productive activities. Strategies are needed to diversify Haitian households' livelihoods.

Deforestation

Deforestation has marked a contrasting landscape between Haiti and the Dominican Republic. However, Haiti remains one of the most deforested countries in the world, with less than 15 % of its territory covered by forest in 2021 (see Figure 6), compared to the Dominican Republic with 45 % of forest area (World Bank, 2022b). Such high deforestation rates in Haiti, which are explained by the country's colonising history in the following section, cause soil erosion, desertification and more flooding, as well as shortages in water resources. For instance, there is a deficit in soil quality to support tree roots and inadequate moisture for crops during the dry season in Haiti (Cohen & Singh, 2014). Widespread land renting in the country also does not provide incentives for farmers to invest in agroforestry or afforestation (Cohen & Singh, 2014). Crucially, forests function as an additional buffer mechanism against the adverse effects of storms. Coastal forests, and especially mangrove forests, have been shown to greatly decrease the coastal impact that severe winds and their associated flooding effects (Koh et al., 2018). A country such as Haiti, with a high dependence on agriculture, should arguably establish national environmental policies to safeguard the remaining forest areas and foster the implementation of forestry programs in order to protect agricultural land from the effects of storms.

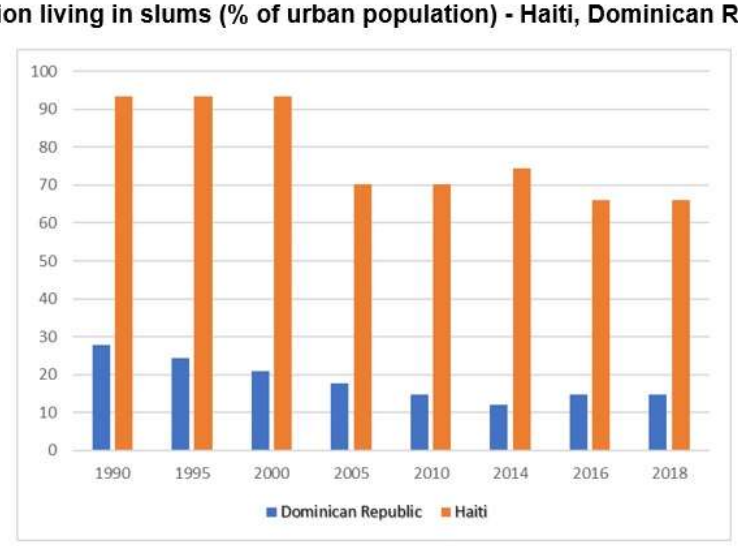


Source: World Development Indicators (World Bank, 2022b).

Figure 6. Forest area (as % of total land area) in Haiti and the Dominican Republic between 1990 and 2021.

Urban population density and urbanisation

Haiti is currently the most densely populated and poorest country in the Americas (World Bank, 2021). Its high population density is concentrated in urban areas. For instance, between 1887 and 2009, the population density in the capital Port-au-Prince increased 17 times (Klose, 2011). This increase in population concentration in urban areas is another symptom of coastal or mountainous communities migrating to the cities, as they have been impacted from the adverse effects of climate change on their economic activities. The majority of the poor in Haiti are in rural areas and their livelihoods such as agriculture are highly exposed to the impacts of climate change. Due to the high population density in urban areas, people living in the capital Port-au-Prince are two to four times more vulnerable to the impacts of tropical storms compared to the rest of Haitians (Cohen & Singh, 2014). Additionally, Figure 7 shows the disparate concentration of slum dwellers in Haiti compared to the Dominican Republic. A slum household is characterised by limited access to water and sanitation, as well as rudimentary infrastructure. According to data from the World Bank (2022b), in 2018 alone, 66 % of the urban population in Haiti was estimated to live in slum households. In contrast, the Dominican Republic quantifies only 15 % of its urban population living in the same conditions.



Source: World Development Indicators (World Bank, 2022b).

Figure 7. People living in slums in Haití and Dominican Republic from 1990 to 2021.

Social and political context

According to World Bank reports, Haiti is the poorest country in Latin America and the Caribbean. The country's GDP per capita in 2021 was US$3,127, compared to the Dominican Republic's US$20,769 in the same year. GDP per capita contracted by 0.8 % from 2015 to 2021; in contrast, the Dominican Republic has seen GDP growth of 5.4 % over the same period (World Bank, 2022b). But poverty in Haiti particularly

affects vulnerable groups such as children and those with underlying health issues. Poverty levels among children are 12 % higher than among adults (World Bank, 2014). Similarly, Haiti's human capital index lags behind the Dominican Republic. By 2018, the HCI of Haiti was 0.4 against 0.5 for the Dominican Republic. This only reflects the consequences of the low quality of service provision such as health, education or nutrition. In addition, there is low trust in the government due to a long history of corruption scandals. For example, in 2019, anti-government demonstrations took place after corruption cases involving the use of the Petro-Caribe fund were revealed (World Bank, 2021). Political tensions have become stronger since the change of presidential power in 2011 and the presence of armed groups has increased, especially in the capital (World Bank, 2021).

Uneven adaptive capacities

Adaptive capacity, according to USAID, is the ability of livelihoods and communities to buffer shocks from natural disasters (USAID, 2013b). Climate resilience will depend on the set of strategies and assets available to increase that adaptive capacity. Despite comparable exposure to climate change hazards such as storm intensity and increased hurricane recurrence, unequal capacities to prevent risks prevail when comparing Haiti with the Dominican Republic (Sheller & León, 2016; Pichler & Striessnig, 2013).

Community-driven, social actions

Specific social actions in the Dominican Republic: there is a greater sense of the practical responses needed from the communities itself (Sheller & León, 2016). For example, it has been shown in a previous study that communities in the Yaque del Sur region have implemented community irrigation initiatives through the establishment of irrigation committees to cope with climate risk (UNDP, 2013). On the other hand, a study of lake flooding in both countries provides indications of weak civic engagement in Haiti, as none of the Haitian respondents could identify civic institutions that were responding to the impacts of flooding (Sheller & León, 2016).

Effectiveness

Haitian participants in a study on climate impacts and adaptive capacities in both countries stated that in the face of flooding caused by the rise in the level of a lake on the border with the Dominican Republic, they had not received any assistance and the little government assistance they received was distributed among the government's political supporters (Sheller & León, 2016), while in the Dominican Republic a third of those interviewed said they had received some type of assistance from an organisation or the government. It was also noted that in the affected areas, the Dominican government had carried out works to clear some of the land and prepare higher ground for the construction of new communities.

Governance

On the other hand, in this same study, a marked difference was noted in the blaming of responsibilities in proposing solutions to flooding problems. In Haiti, all respondents branded the government as incapable and not taking responsibility. In contrast, Dominicans also proposed a list of local actions that could be taken such as the creation of local associations or

committees, marches, meetings, and although some Haitians agreed on the need for collaboration, they did not express specific actions to achieve this (Sheller & León, 2016). People's willingness to cooperate with Haitian aid institutions is very low (Pichler & Striessnig, 2013). About 75 % of people in Haiti stated that they do not believe that State institutions are prepared to respond to natural disasters. However, even when interventions by the government of the Dominican Republic are carried out jointly with international organisations such as the United Nations Environment Programme or Oxfam, adaptation programmes do not offer strategies for long-term adaptive capacity building (Sheller & León, 2016). According to the study by Pichler and Striessnig (2013), there is a lack of interest and/or knowledge about long-term preventive interventions by the government of the Dominican Republic.

Access to information

In 2009, both Haiti and the Dominican Republic signed the Barahona Declaration to reduce the impact of damage to the lakes. This declaration includes bi-national cooperation actions such as a reforestation plan, public information campaigns, agricultural development plan, reforestation, among others. In the study conducted with people living in areas affected by climate change in Haiti and the DR, none of those interviewed claimed to be aware of these initiatives (Sheller & León, 2016). However, Haiti has a weak capacity to adapt to the impacts of climate change and this is reflected in the poor development of disaster risk management plans in areas vulnerable to hurricanes. Although the government is in charge of managing flood early warning systems, in an assessment of the adaptive capacity of the state of Haiti, it was found that the system does not provide relevant and real-time information (Cohen & Singh, 2014).

Factors of the uneven capacities

In this study climate adaptive capacity was assessed with «Villagers» perceived causes and solutions, access to assistance, mobilisation capacity, international collaboration, and visions of responsibility. It was concluded that Haiti still faces major challenges in institutional and financial capacity to cope with the threats of climate change. The study argues that differences in the adaptive capacities of both countries are marked by historical dependencies, local institutional contexts and international linkages (Sheller & León, 2016). In addition, authors such as Cohen and Singh (2014) have argued that weak state capacity prevails due to a lack of awareness of climate change scares, inadequate technical knowledge and unsustainable financial allocation.

Historical dependencies / colonisation

The Caribbean islands were the main focus of the Spanish colonisation agenda. Plantation economies left the soils of these islands particularly vulnerable to climate change. This inequality is unevenly distributed among the nations of this region. Sheller and León (2016) draw this differentiation in soil condition to historical events that have marked land use until the present. While Haiti focused its nineteenth-century economy on coffee, timber and sugar production, the Dominican Republic was mainly dedicated to cattle ranching (Sheller & León, 2016). Then, in the early 20th century, the US occupied Haiti and the Dominican Republic and

had control over the economies of these countries. Even at the end of the occupation, much of the territory of both countries came under the domination of private companies that made decisions on land use. About 25 % of the Dominican Republic belonged to sugar companies, and in the case of Haiti, 790,000 hectares were given to American agricultural associations (Sheller & León, 2016).

Institutional context and resource dependencies

Haiti's current extensive deforestation, for example, is blamed on the country's peasant culture. However, it is ignored that many of these land-use practices were shaped by political-ecological facts. According to Diamond (2006), the reason why only two % of Haiti's territory is currently covered by forest is mainly due to governmental decisions. In contrast, the Dominican Republic implemented forest protection policies during the dictatorship of Rafel Trujillo. This makes the Dominican Republic a country with an economy that industrialises while conserving the environment.

Conclusion

It is evident that the two cases proposed in this research, with very similar exposure to climate hazards but divergent adaptive capacities, served to reveal the causal factors of vulnerability in both Haiti and the Dominican Republic. Firstly, one of the reasons why Haiti and the Dominican Republic have divergent levels of vulnerability is the different historical, social and political processes experienced between the two countries. These socio-political processes have led to disasters that are reflected in the numbers adverse effects on food security and agricultural production. What this study has confirmed is that hazards become disasters when they impact on populations in precarious conditions built or developed by the failure or neglect of governments or those in power through historical processes dating back to colonisation.

Such structural factors must be identified for the implementation of climate change adaptation strategies. However, and against the initial hypothesis, this paper has demonstrated that although the differences in the levels of adaptive capacity between the two countries, it has also shown how the spatial/ environmental/ geographical variety of conditions that distinguish each country is also a relevant factor in the analysis of differentiated vulnerabilities. Income-generating activities take place in areas, which due to their geographic and climatic conditions, provide both opportunities and threats.

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Conflict of interests

The author declares that there is no conflict of interest.