



ENVIRONMENTAL
CHANGE Initiative



UNIVERSITY OF
NOTRE DAME

RESEARCH

Identifying Constructs and Metrics for Adaptive Capacity

Lessons from Guatemala, Honduras, Nicaragua,
Colombia, and Haiti



ND-GAIN

Notre Dame Global
Adaptation Initiative



AUTHORS

Danielle Wood, Ph.D.

Director, Notre Dame Global Adaptation Initiative

Thomas Mustillo, Ph.D.

Associate Professor of Global Affairs, University of Notre Dame

Eduardo Pages Jimenez

Research Associate, Notre Dame Global Adaptation Initiative

Mikaela Bona

Research Assistant, Notre Dame Global Adaptation Initiative

Brian Wanbaugh

Project Manager, Notre Dame Global Adaptation Initiative

Mohammad Farrae

Research Assistant, Notre Dame Global Adaptation Initiative

CITATION

Wood, D., Mustillo, T., Jimenez, E., Bona, M., Wanbaugh, B., Farrae, M. (2023), Identifying Constructs and Metrics for Adaptive Capacity: Lessons from Guatemala, Honduras, Nicaragua, Colombia, and Haiti; ND-GAIN Technical Report



Table of Contents

Summary	4
1 About	6
2 Overview of Approach	6
3 Stage One	12
4 Stage Two – Meta Analysis of Constructs to Inform Metrics	27
5 Selected Key Constructs – Preconditions and Drivers	37
6 Precondition: Inequality (Economic, Gender, Racial)	45
7 Precondition: Absence of Violence	46
8 Precondition: Absence of Weak State	47
9 Precondition: Natural Capital	48
10 Precondition: Absence of Corruption	49
11 Driver: Income (Assets)	50
12 Driver: Occupational Flexibility (Flexibility)	51
13 Driver: Social-Ecological Management Networks (Organization)	52
14 Driver: Infrastructure (Assets)	53
15 Driver: Access to Capital (Assets)	54
16 Driver: Wealth/Savings (assets)	55
17 Driver: Geographic Flexibility (Flexibility)	56
18 Driver: Access to Land (Assets)	57
19 Driver: Bureaucratic Capacity (Organization)	58
20 Driver: Community Empowerment (Empowerment)	59
21 Driver: Climate and Disaster Planning (Organization)	60
22 Driver: Learning (Access to and Capacity for)	61
23 Discussion	62
24 Appendix 1: ND-GAIN Key	65
25 Appendix 2: Codebook of Indicators	66
26 Appendix 3: Benchmarking Preconditions	72
27 Appendix 4: Category Sources	78
28 Citations	87



SUMMARY

The Notre Dame Global Adaptation Initiative (ND-GAIN) at the University of Notre Dame explored and identified factors affecting adaptive capacity and potential corresponding metrics. This work extends a prior examination of factors associated with disruption, as measured by ND-GAIN's country indicators. It examines Guatemala, Honduras, Nicaragua, Colombia, and Haiti in two stages.

In Stage One, the team identified and catalogued historical climate disruptions for each of the five countries and then examined ND-GAIN Country Index indicators to determine whether they captured adverse change in vulnerability or readiness for selected years or with reasonable lag. This was, in part, to understand the sensitivity of country-level metrics, such as those used by ND-GAIN, to capture expected change due to major disruptions, highlighted through qualitative information such as relief reports. In this area, ND-GAIN shows fairly consistent adverse impacts in the governance content area, except in Colombia. It demonstrates a frequent co-occurrence between climate events and declines in stability, control of corruption, rule of law, and regulatory quality. Concurrent adverse changes also showed up in health indicators, particularly the metrics on slum population and health services dependency. Otherwise, the lack of response in many ND-GAIN country indicators for the climate events, combined with the observation of a low baseline in the metrics for several of the countries, encouraged the team to incorporate the distinction between preconditions and critical drivers for adaptive capacity into Stage Two.

***Key takeaway:** The national level metrics for ND-GAIN capture some of the impact of extreme events in governance and health but are not sensitive in other domains; pre-disruption low baseline and/or scale of the measure may obscure impacts.*

The focus of Stage Two is to identify key factors of adaptive capacity and measurement for those factors. To do so, Stage Two provides an overview of the adaptive capacity framing, sourced information, and existing measures. One purpose of first identifying the qualities of adaptive and resilient communities, regardless of whether appropriate measures yet exist, is that it enables us to highlight measurement gaps. Next, Stage Two provides information on the analysis and selection of identified preconditions and critical drivers for adaptive capacity, culminating in a summary sheet for each that provides a definition, rationale, relevant existing indicators, and potential measures that may address gaps or measurement limitations. *Assets* and *Organization* are the most prominent factors for adaptive capacity across the different countries and different types of sourced information. This is consistent with the state of knowledge: assets provide a buffer during times



Key takeaways:

- 1) *Assets and organization capacity are consistently important to adaptive capacity. Assets provide a buffer to disruption while organizational capacity affects readiness for disruption or ability to respond.*
 - 2) *Low performance on a precondition (e.g., inequality, insecurity/violence, etc.) acts as a barrier to progress on adaptive capacity drivers.*
 - 3) *Interventions that provide stabilizing income such as Payment for Environmental Services (PES) or access to capital for wealth-building are strongly correlated with positive outcomes.*
 - 4) *Community empowerment strategies consistently emerged as a driver of the long-term sustainability of programmatic investments.*
-

of disruption, and many of the organization subconstructs relate to readiness for disruption or capacity to respond. Our analysis also underscored the generalizability of the findings across the different countries. For each critical driver, we provide a distillation of key findings, including high-impact practices, such as Payment for Environmental Services (PES) and community capacity building. We also provide an approach for examining metrics for preconditions. Rather than distinct thresholds or a focus on the point estimate, we look at the trend for the construct and consider the overall level by examining where the country falls as compared with other countries

when it comes to preconditions (e.g., Haiti is in the bottom decile for several measures).

The Discussion section outlines the strengths and limitations of the approach as well as opportunities for investment. In it, we highlight implementation challenges within what we understand about high-impact practices, including the differences in context for a type of intervention. For example, while we may understand the importance of a general subconstruct (e.g., “access to capital”) within the construct “Assets,” interventions will need nuanced

Key takeaways:

- 1) *This study begins with characterizing key qualities/constructs of adaptive capacity, which allows for evolving, more precise measurement of the constructs.*
 - 2) *Implementing the key findings will require fitting implementation to the particular context.*
 - 3) *Core investments may rely on building or supporting enabling infrastructure with local intermediaries, such as cooperatives.*
-

implementation models to fit the particular context (i.e., address particular barriers to access, etc.). Many of the constructs, particularly preconditions, represent systemic challenges. Nonetheless, strategic investment in interventions that can deliver multiple benefits may help to build a virtuous cycle in targeted areas. *Community-based organizations*, such as cooperatives, could potentially serve a multitude of functions across several adaptive capacity areas – particularly serving as a hub for building assets (income and wealth), socio-ecological networks for management and learning, data collection, and community empowerment.



1 ABOUT

The Notre Dame Global Adaptation Initiative (ND-GAIN) at the University of Notre Dame explored and identified factors affecting adaptive capacity and corresponding metrics for five countries in Central America and the Caribbean. ND-GAIN is a part of the Notre Dame Environmental Change initiative; it gathers more than 20 years of data on over 45 core indicators to measure vulnerability to climate challenges and disruptions and readiness to leverage investment for adaptation for over 180 UN countries. This analysis extends the approach of the ND-GAIN Country Index and informs our understanding of potential metrics actionable at the subnational level.

2 OVERVIEW OF APPROACH

This examination focuses on Guatemala, Honduras, Nicaragua, Colombia, and Haiti. The analysis follows a two-stage approach. Stage One begins with an inventory of major climate events for each of the five countries and an examination of the ND-GAIN Country Index data across the same time period, then provides initial indications of key climate challenges and the sensitivity of national metrics to these challenges. Stage Two provides a conceptual framework for adaptive capacity and critical outcome domains, and examines findings across different source

document types to inform drivers of adaptation to climate. The examination for either stage is not comprehensive of the potential areas of exploration, but rather an extension of our previous efforts highlighting potential drivers of climate resilience and extending to a broader evidence base for better understanding and measuring these drivers.

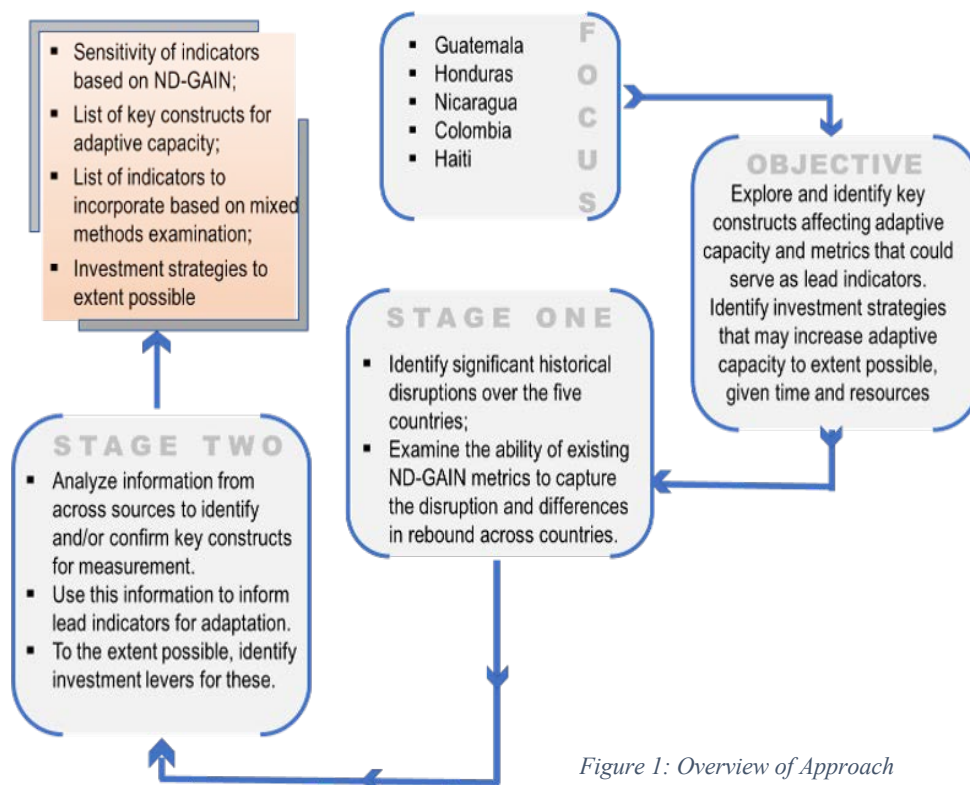


Figure 1: Overview of Approach



2.1 Overview of Countries

2.1.1 Guatemala

Guatemala is the most populous country in Central America, with 17.1 million people [16]. Throughout the 19th century, Guatemala was governed by a string of dictators, with economic development dominated by bananas and the American United Fruit Company [17]. In 1944, a pro-democracy coup successfully overthrew dictator Jorge Ubico, and, for decades to follow, the country underwent a series of socio-economic changes. In 1954, a US-backed military coup installed a new dictatorship [18]. Guatemala was then plunged into a violent civil war for 36 years between 1960 to 1996. Estimates put civilian deaths from that period at between 140,000 and 200,000, the overwhelming majority affecting Mayans. Since the peace agreement was signed in 1996, Guatemala has seen considerable economic recovery and relatively peaceful elections, but it remains among the lowest-ranking in terms of human development in the region [19].

Life expectancy in Guatemala is 74.3 years, with the adolescent birth rate (births per 1,000 women ages 15-19) relatively high, at 71%. The average years of schooling are 6.6, with female and male education attainment similar [16]. However, female participation in parliament is relatively low, at 19.4%. Currently 26% of Guatemalans experience food insecurity, a situation recently affected in part by Russia's invasion of Ukraine and the resulting shocks to global food supply chains [20]. Although services dominate more than 60% of its economy, it remains vulnerable to climate events common to countries located in the Central American Dry Corridor (Dry Corridor)[21].

Guatemala			Average Annual Hazard Occurrence (1980-2020)	Incidents
Capital	Guatemala City		Drought	7
Region	Central America		Earthquake	12
Official Language	Spanish		Epidemic	9
ND-GAIN Ranking (2020)	119th out 181 countries		Extreme temperature	4
Country Metrics	Number	Data Year	Flood	31
			Landslide	11
Population growth (annual %)	1.48	2021	Mass movement (dry)	2
Population density (people per sq. km of land area)	159.67	2021	Miscellaneous accident	4
Population, total	17,109,746	2021	Storm	19
Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population)	8.80	2014	Volcanic activity	11
Population living in slums (% of urban population)	31.00	2018	Wildfire	2
Urban population (% of total population)	52.25	2021	Total	112
Net official development assistance received (constant 2020 US\$)	472,359,985	2020	Climate Disaster Management Agency	
Net ODA received (% of GNI)	0.62	2020	Guatemalan Coordinating Agency for Disaster Reduction or <i>Coordinadora Nacional para la Reducción de Desastres</i>	
Net migration	-46,073	2017		
Number of internally displaced individuals due to climate-related disasters	720,211	2008-2020	Data from: World Bank Group (WBG), Data Overview (2022). WBG, Climate Change Knowledge Portal (2022). UNDP, Country Insights – Human Development Insights (2022)	



2.1.2 Honduras

Honduras is a Central American state with an estimated 10.1 million people [22]. Like other former colonial states, Honduras has undergone numerous political transitions. After the 1963 military coup, Honduras was governed by various authoritarian military governments until 1983 [23]. Political instability ensued in 2017, following a close election that triggered protests. Honduras is also located in the Dry Corridor and experiences several vulnerabilities brought about by climate change [24]. It is bordered by Guatemala, El Salvador, and Nicaragua, which are also particularly vulnerable as part of the Dry Corridor. With an economy reliant on agriculture, Honduras is especially vulnerable.

Life expectancy in Honduras is 75 years, with the adolescent birth rate at 72.9%. The mean years of schooling is equal to Guatemala, at 6.6 years [22]. Women occupy 21% of parliamentary seats, and have higher secondary educational attainment compared to men by 3%, at 32%. While services dominate half of the economy, approximately 14% is dedicated to agriculture [22]. It ranks quite low in terms of adaptive capacity, with mid-level human development [19].

Honduras			Average Annual Hazard Occurrence (1980-2020)	Incidents
Capital	Tegucigalpa		Drought	10
Region	Central America		Earthquake	3
Official Language	Spanish		Epidemic	8
ND-GAIN Ranking (2020)	136th out of 181 countries		Flood	35
Human Development Index Ranking (2020)	132nd out of countries		Mass movement (dry)	1
Gender Inequality Index Ranking (2020)	100th out of 191 countries		Total	57
Country Metrics	Number	Data Year	Climate Disaster Management Agency	
Population growth (annual %)	1.59	2021	Permanent Contingency Commission of Honduras or Comisión Permanente de Contingencias (COPECO)	
Population density (people per sq. km of land area)	89.94	2021		
Population, total	10,062,994	2021		
Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population)	14.80	2019	Data from: World Bank Group (WBG), Data Overview (2022). WBG, Climate Change Knowledge Portal (2022). UNDP, Country Insights – Human Development Insights (2022)	
Population living in slums (% of urban population)	38.60	2018		
Urban population (% of total population)	58.98	2021		
Net official development assistance received (constant 2020 US\$)	1,432,630,005	2020		
Net ODA received (% of GNI)	6.46	2020		
Net migration	-34,000	2017		
Number of internally displaced individuals due to climate-related disasters	1,053,105	2008-2020		



2.1.3 Nicaragua

With a population of 6.7 million people, Nicaragua has the smallest population of the Central American countries examined, despite having the largest land area[25]. The country gained independence from Spain in 1821, but has experienced several dictatorships and political violence in the intervening centuries. Between 1961 and 1990, the Nicaraguan Revolution and the Contra War, stimulated by Sandinista National Liberation Front's (FSLN) opposition to the Somoza family dictatorship, caused an estimated 30,000 fatalities [26]. Nicaragua was also involved in a series of proxy wars during the Cold War. Peace accords were signed in 1989, and the FSLN was demobilized [26]. While no widespread political violence has occurred since, Nicaragua remains a fledgling democracy with contested elections.

Life expectancy in Nicaragua is 74.5 years, with adolescent birth rate at 72.8% [25]. Similar to other countries in our study, mean years of schooling is under 7 years, at 6.9, with women 3 percentage points higher than men in terms of secondary educational attainment (32.2%). Women occupy 21.1% of the parliamentary seats. Services comprise 60% of the Nicaraguan economy, while agriculture employs 15.5% of the labor force [25]. Nicaragua is considered the least developed country in the region and relies heavily on migrant remittances [27]. In terms of environment, the country is home to the second largest rainforest in the Americas, the Bosawás Biosphere Reserve [28]. It remains vulnerable to climate change and has a low mid-level score both in terms of adaptive capacity and human development [19].

Nicaragua			Average Annual Hazard Occurrence (1980-2020)	Incidents
Capital	Managua		Drought	6
Region	Central America		Earthquake	5
Official Language	Spanish		Epidemic	11
ND-GAIN Ranking (2020)	132nd out of 181 countries		Flood	18
Human Development Index Ranking (2020)	128nd out of 191 countries		Landslide	1
Gender Inequality Index Ranking (2020)	101st out of 191 countries		Miscellaneous accident	1
Country Metrics			Storm	23
	Number	Data Year	Volcanic activity	4
Population growth (annual %)	1.17	2021	Wildfire	3
Population density (people per sq. km of land area)	55.70	2021	Total	72
Population, total	6,702,379	2021	Climate Disaster Management Agency National System for Disaster Prevention, Mitigation and Response or <i>Sistema Nacional Para La Prevencion (SINAPRED)</i>	
Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population)	3.40	2014		
Population living in slums (% of urban population)	42.20	2018		
Urban population (% of total population)	59.28	2021		
Net official development assistance received (constant 2020 US\$)	599,909,973	2020		
Net ODA received (% of GNI)	5.10	2020		
Net migration	-106,360	2017		
Number of internally displaced individuals due to climate-related disasters	404,043	2008-2020	Data from: World Bank Group (WBG), Data Overview (2022). WBG, Climate Change Knowledge Portal (2022). UNDP, Country Insights – Human Development Insights (2022)	



2.1.4 Colombia

Colombia, the only country examined that is located in South America and ranked high in the human development index (HDI), has a population of 51.2 million people [19]. Life expectancy is 77.3 years, while the average years of schooling is 14.4 years [29]. In terms of gender inequality, however, Colombia resembles the other countries examined with mid-level HDI (Guatemala, Honduras, Nicaragua) [30]. The adolescent birth rate is 66.7%, and women occupy around 20% of parliamentary seats [30]. More women have some secondary educational attainment by almost 3 percentage points compared to men. It is also worth noting that Colombia has the highest secondary educational attainment for both sexes among the study countries, at 55.7% overall [29].

While Colombia has the third-largest economy in the region and experiences stable economic growth, an active, low-intensity conflict has been ongoing since the 1960s between the government and the Revolutionary Armed Forces of Colombia (FARC) [31]. In terms of environment, Colombia is one of the most biodiverse countries in the world. 62% of its economy is in services, but a substantial part still relies on agriculture (17%) and remains vulnerable to climate shocks [32]. Colombia ranks in the middle in terms of adaptive capacity [33].

Colombia			Average Annual Hazard Occurrence (1980-2020)	Incidents
Capital	Bogotá		Drought	2
Region	South America		Earthquake	17
Official Language	Spanish		Epidemic	6
ND-GAIN Ranking (2020)	91st out of 181 countries		Flood	77
Human Development Index Ranking (2020)	83rd out of 191 countries		Landslide	32
Gender Inequality Index Ranking (2020)	101st out of 191 countries		Mass movement (dry)	3
Country Metrics			Miscellaneous accident	9
	Number	Data Year	Storm	10
Population growth (annual %)	0.75	2021	Volcanic activity	10
Population density (people per sq. km of land area)	46.21	2021	Wildfire	4
Population, total	51,265,841	2021	Total	170
Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population)	10.30	2020	Climate Disaster Management Agency	
Population living in slums (% of urban population)	27.80	2018	National Unit for Disaster Risk Management or Unidad Nacional para la Gestión del Riesgo de Desastres (UNGRD)	
Urban population (% of total population)	81.74	2021		
Net official development assistance received (constant 2020 US\$)	1,868,719,971	2020		
Net ODA received (% of GNI)	0.70	2020		
Net migration	1,023,981	2017	Data from: World Bank Group (WBG), Data Overview (2022). WBG, Climate Change Knowledge Portal (2022). UNDP, Country Insights – Human Development Insights (2022)	
Number of internally displaced individuals due to climate-related disasters	3,549,683	2008-2020		



2.1.5 Haiti

Haiti is located in the west part of Hispaniola Island, with a population of 11.5 million people [34]. The only state established by a slave revolt, Haiti was also the first country to gain independence in Latin America and the Caribbean and the first to abolish slavery [35]. Today the country grapples with several problems rooted in its complex history of political instability and economic insecurity. Haiti has the highest level of net out-migration among all study countries, and continues to experience systemic poverty, widespread violence, and health vulnerabilities from shocks such as the COVID-19 pandemic and natural disasters. The July 2021 assassination of the President ushered in a particularly unstable period of increasing insecurity.

Life expectancy in Haiti is only 64 years, while average years of schooling equals 5.6 years [34]. In terms of gender equality, women only occupy 2.7% of seats in parliament, the adolescent birth rate is 51.7%, and the female population with at least some secondary education is 27%, 13 percentage points lower than the male population's average [19]. While Haiti's economy is structured similarly to other countries, its agriculture and other sectors are more heavily devastated by climate shocks due to its weak state [36]. It ranks lowest both in terms of adaptive capacity and human development [19].

Haiti			Average Annual Hazard Occurrence (1980-2020)	Incidents
Capital	Port-au-Prince		Drought	5
Region	Caribbean		Earthquake	2
Official Language	French, Haitian Creole		Epidemic	7
ND-GAIN Ranking (2020)	168th out of 181 countries		Flood	57
Human Development Index Ranking (2020)	170th out of 191 countries		Landslide	1
Gender Inequality Index Ranking (2020)	152nd out of 191 countries		Miscellaneous accident	12
Country Metrics	Number	Data Year	Storm	36
			Total	120
Population growth (annual %)	1.21	2021	Climate Disaster Management Agency	
Population density (people per sq. km of land area)	418.78	2021	Directorate for Civil Protection (DPC)	
Population, total	11,541,683	2021		
Poverty headcount ratio at \$1.90 a day (2011 PPP) (% of population)	24.50	2012	Data from: World Bank Group (WBG), Data Overview (2022). WBG, Climate Change Knowledge Portal (2022). UNDP, Country Insights – Human Development Insights (2022)	
Population living in slums (% of urban population)	65.90	2018		
Urban population (% of total population)	57.96	2021		
Net official development assistance received (constant 2020 US\$)	886,849,976	2020		
Net ODA received (% of GNI)	6.10	2020		
Net migration	-175,000	-175000		
Number of internally displaced individuals due to climate-related disasters	2,034,844	2008-2020		



3 STAGE ONE

Stage One provides an initial screening to determine national-level metrics that are responsive to climate-based disruption. By first identifying and cataloging the last 20 years of climate events across the five countries and the accompanying relief reports, researchers identified a sample set of years to examine. Implicit in this approach is that researchers use humanitarian assistance/relief as a proxy for insufficient resilience or adaptive capacity; the inability to withstand the climate event, or a lack of recovery afterward implies the degree of insufficient adaptive capacity. Researchers identified three critical years for each country, defining a critical year as one in which there was: 1) a major climate event *and* 2) the absence of a preceding or subsequent climate event, to the greatest extent possible. This window provided sufficient time for researchers to observe a measurement response to the climate event.

Using ND-GAIN Country Index indicator data, researchers looked for “event capture” in the indicators for the selected climate event critical years, and for several years afterward, to account for different lag effects across sectors and metrics. The researchers recognized the following limitations to using this approach: 1) ND-GAIN source data publishes at different intervals and, therefore, may not capture the impact of a disruption in a way that is comprehensible or with timing obviously attributable to the disruption; 2) the indicator may not be a sensitive outcome measure for the sector/construct of interest; and 3) the indicator may not be at the appropriate scale for sensitivity to the construct of interest. Those indicators with responses that are correlated with climate disruption can be used as a first pass for defining causal pathways for critical outcome domains.

3.1 Historical Climate Disruptions/Weather Hazards

Researchers used the United Nations Office for the Coordination of Humanitarian Affairs (Reliefweb) website to identify and catalog climate events. This site was also used as the main source of reports on humanitarian aid. It lists nearly all major climate/weather related disasters for our target time period (1998-2020) for each of the countries, providing the information for the primary database for this step. Each climate/weather event listed for each country also represented an instance in which external aid was provided to mitigate post-event impacts. These events varied in scale, from small floods or mudslides to Category 5 hurricanes like Hurricane Mitch. Although researchers sourced most reports from Reliefweb, additional reports were identified for some of the climate/weather events. Researchers compiled additional source documentation from NGOs, news organizations, and U.S. government agencies. The final database provided climate events, organized chronologically, with the month and year of the event, severity (e.g., hurricane category), damage description, aid efforts, sectors/domains affected, and primary department/subnational area affected for each country. Following completion, researchers selected the three critical years for each country, representing an extreme event isolated from other events to the greatest extent possible. The critical years for each country are as follows: Colombia - 2004, 2010, 2015. Guatemala - 1998, 2010, 2017. Haiti - 1998, 2005, 2016. Honduras - 1998, 2005, 2017. Nicaragua - 1998, 2010, 2015.



Table 1: Illustrative of Historical Climate Events/Disaster Inventory

Year	Month(s)	Hazard Event	Damage Description	Source	Rate of Response/Aid Given
2021	Mar - Nov	Heavy Rains, Floods and Landslides	Heavy rainfall during the rainy season, many ar	https://reliefweb.int	Colombia National Unit for Disaster
2021-2011		Drought in La Guajira		Story	
2020	Feb - Mar	Drought	Drought conditions reported in Colombia.	Report	
2020	Nov	Dengue Outbreak due to Hurricanes			
2020	Nov	Hurricane Iota	Landfall as Cat 4 (Nicaragua) on November 17th	Final Report Report	COVID -19 complicated relief respor
2020	Nov	Hurricane Eta	Heavy impacts on San Andreas island in the Ca	Report	
2019	Jun	Dengue Outbreak		Report	
2019	Feb - Jun	Heavy Rains, Floods and Landslides	Heavy rainfall leads to flooding of the Rivers Sa	Report	Pan American Health Org
2018	Apr & May	Heavy Rains and Flooding	Magui and Cauca Rivers' flood causing damage	Impact Report	
2017	Oct	Tropical Storm Nate	Little to no effects.		
2017	Jun & Jul	Heavy Rains and Flooding	The Sinú and San Jorge rivers were affected by	Report	
2017	March 31st	Heavy Rains and Mudslide	On the night of 31 March 2017, increased rainf	Report Story First	Gov (UNGRD); ACT Alliance (NGO)
2016-2017	Dec - Jan	Heavy Rains, Floods and Landslides	Strong rain and winds created flooding in the n	Report	Gov; UN-OCHA; Red Cross, Red Cres
2016	Nov	Hurricane Otto	Little to no effects.		
2016	Nov	Flooding and Landslides	Main events were related to flooding and land	Report	UN-OCHA; gov response
2016	Oct	Heavy Rains	Around 20,4093 families were affected in 20 d	Report	UNGRD and CMGRD
2016	Sep	Hurricane Matthew	Skimmed the coast of Colombia as a major hur	Report	
2016	Jun	Heavy Rain and Flooding	As of June 2016, some 13,741 families have be	Report	
2014-2017		Drought	On 30 Dec, the Colombian President declared	Relief Web Graphic	USAID, WFP, other int'l aid
2015		Forest Fires	As a result of the drought, 3,421 forest fires ha	Report NASA Repor	Gov/Dept response; calls for aid fro
2015	May	Storm Surge	Between 2-4 May 2015, an unusual phenome	Report	Int'l Red Cross/Red Crescent
2015	Apr	Flooding, Windstorms and Landslides	Flooding, windstorms and landslides affected r	Report	US\$38,319,028 in 2015 humanitaria
2015	May	Heavy Rains and Flooding	On 18 May, heavy rains caused the overflowing	Report	Given the limited response capacit

The highest frequency of aid, based on data from the Humanitarian Response Plan Monitoring in the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) and the United States Agency for International Development (USAID), are as follows:

- Colombia: Departments that registered the most humanitarian emergencies include those that share a border with Venezuela (La Guajira, César, Norte de Santander, Arauca, Vichada, and Guainía) and the Pacific coast departments (Chocó, Valle de Cauca, Cauca and Nariño).
- Guatemala: The departments of Alta Verapaz, Quiche, Huehuetenango, Chiquimula and San Marcos registered the most humanitarian emergencies and aid. These departments are mostly in the Dry Corridor.
- Haiti: UN OCHA reporting did not specify frequency of particular areas, but the departments for Port au Prince (Artibonite, Sud, Grand'Anse and Ouest) are likely most impacted. In 2021, 40% of the population needed emergency aid (4.4 million people).
- Honduras: The departments of Cortes, El Paraíso, Francisco Morazan, Lempira, and Santa Barbara registered the most humanitarian emergencies and aid. These departments are also mostly in the Dry Corridor.
- Nicaragua: Departments that registered the most humanitarian emergencies and aid include Jinotega, Matagalpa, Nueva Segovia, the Northern Autonomous Region, Leon and Managua.

3.2 Data Visualization with ND-GAIN

We plotted a time series of the 45 ND-GAIN Country Index indicators for each country. The 45 indicators are organized into two general categories: 36 vulnerability indicators and nine readiness indicators (see Appendix 1). To reduce visual clutter, researchers used indicator codes on plots; see Table 1: *Adverse Changes in ND-GAIN Country Index* for full indicator names. Vulnerability indicators are grouped into six sets: health, food, ecosystems, habitat, water, and infrastructure, with each set containing six indicators. Readiness indicators are grouped into three sets: social, economic, and governance, with social and governance constructs having four indicators each, and the economic construct with one index (Doing Business). See Figure 2 for a schematic of the way the indicators are grouped.

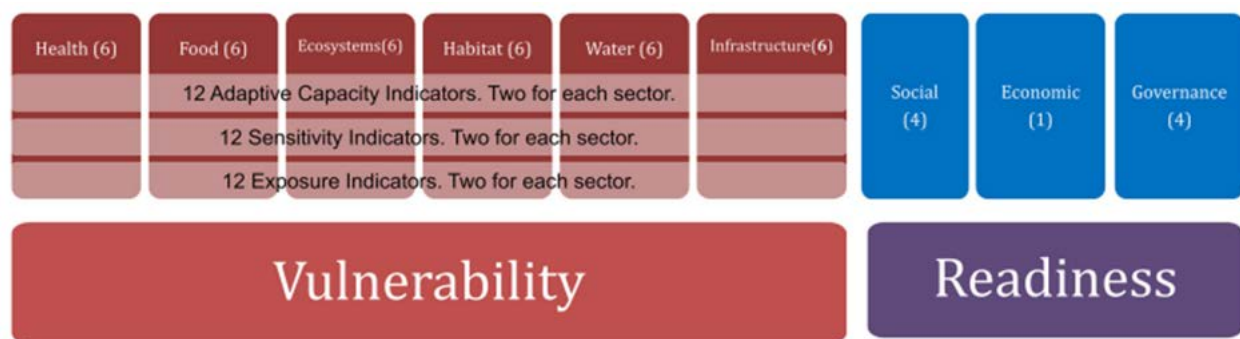


Figure 2: ND-GAIN Country Index indicators

All of the following plots (Figures 3-12) are for the range from 1995 to 2019, with year measured along the horizontal dimension. ND-GAIN Country Index indicators vary between zero and one, where one represents “more vulnerable” or “more ready.” Indicators are measured along the vertical dimension.

Each of the plots contains red vertical lines to indicate the three selected critical years identified in the *Historical Climate Disruptions/Weather Hazards* section above. Researchers then examined each of the ND-GAIN Country Index indicators to determine whether it captured adverse change in vulnerability or readiness within a five-year window. That is, we looked for climate events to show a negative change in the slope of the trend. An adverse trend includes those arising when a climate event halts or reverses a favorable trend, or accelerates the rate of deterioration in a negative trend. See Table 1: *Adverse Changes in ND-GAIN Country Index* for a summary of results. Note that this analysis identifies adverse *change* in the indicator, without regard to whether the baseline value is high or low prior to the disruption.



3.2.1 Guatemala

Figure 3: Guatemala, Readiness Indicators

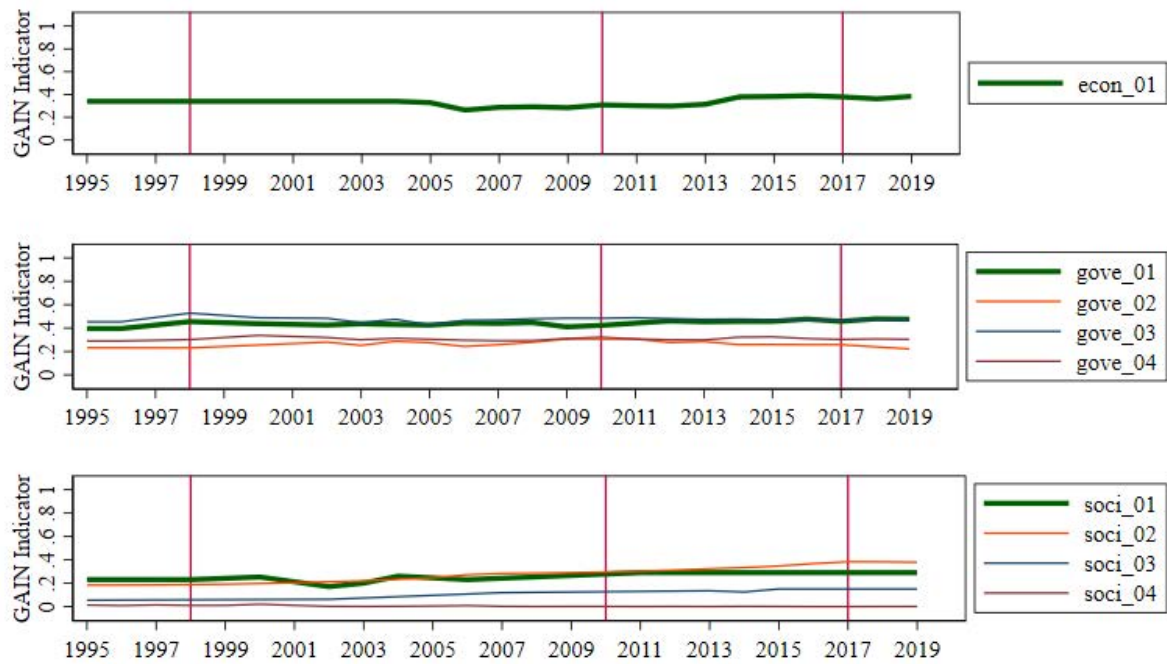
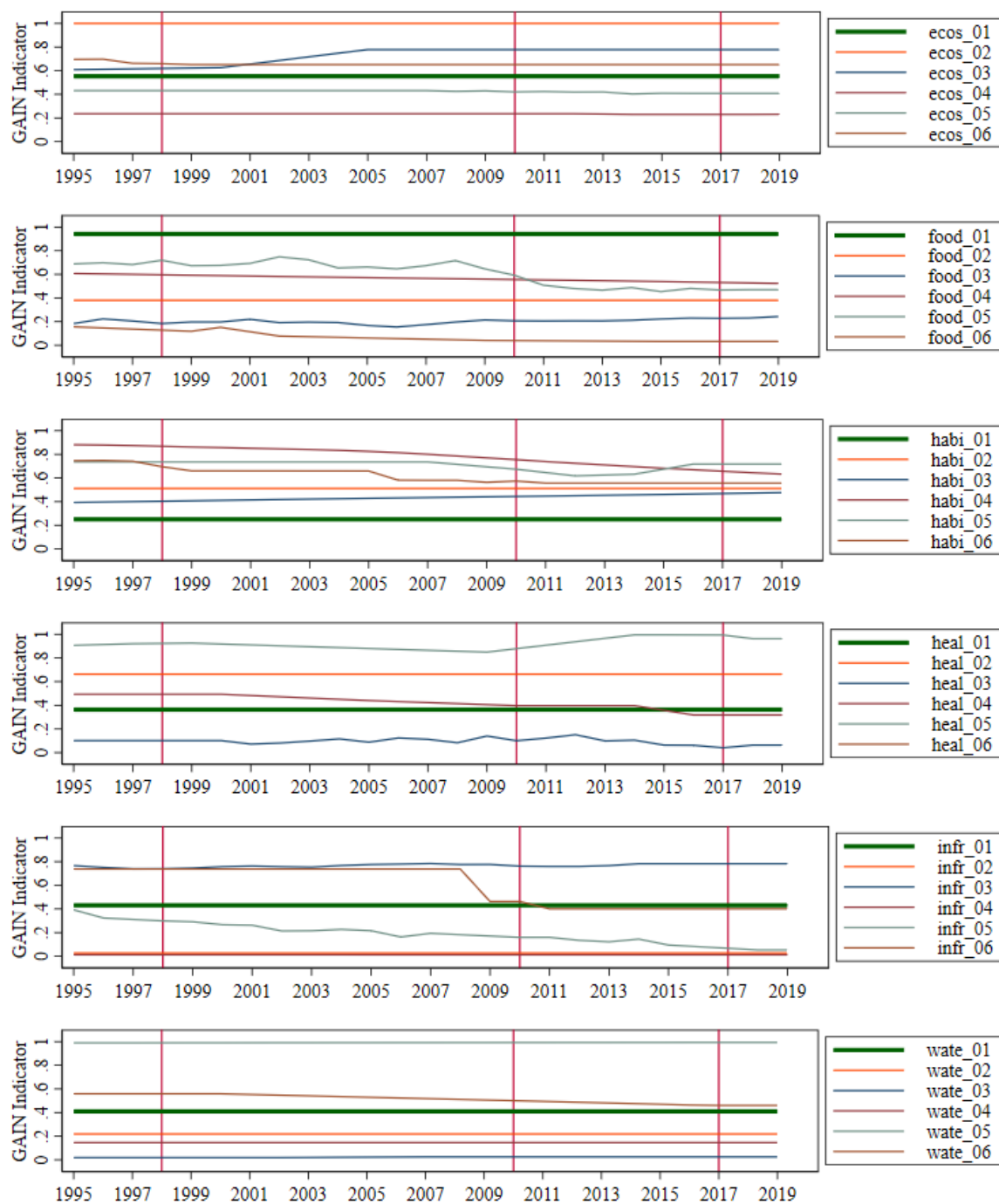




Figure 4: Guatemala, Vulnerability Indicators





3.2.2 Honduras

Figure 5: Honduras, Readiness Indicators

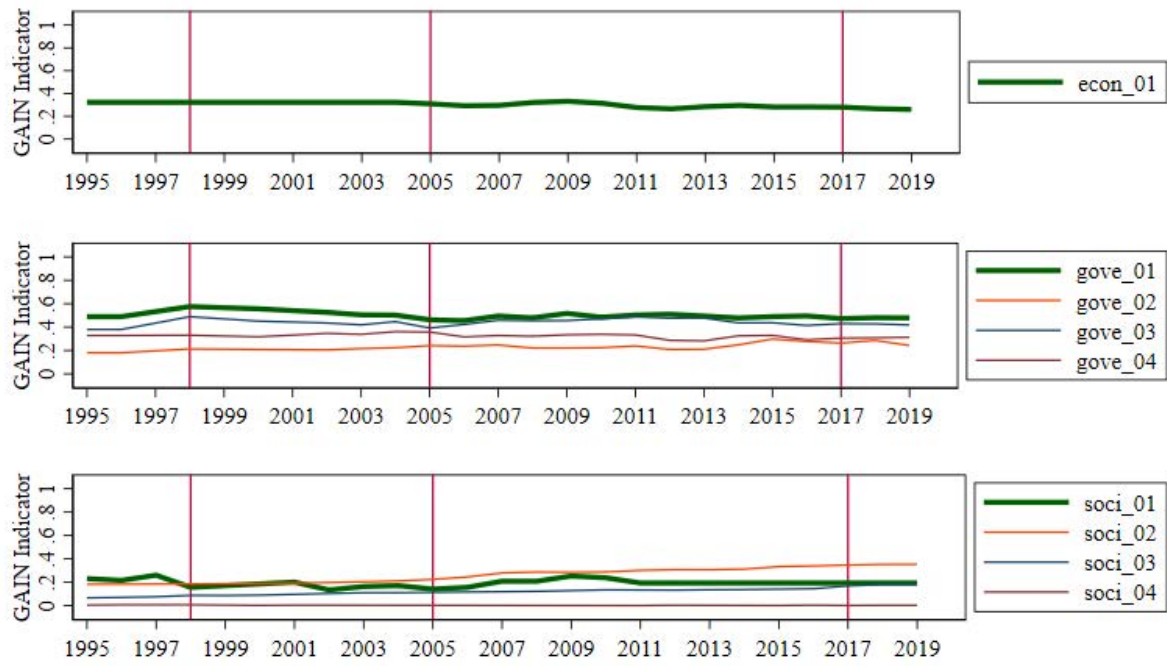
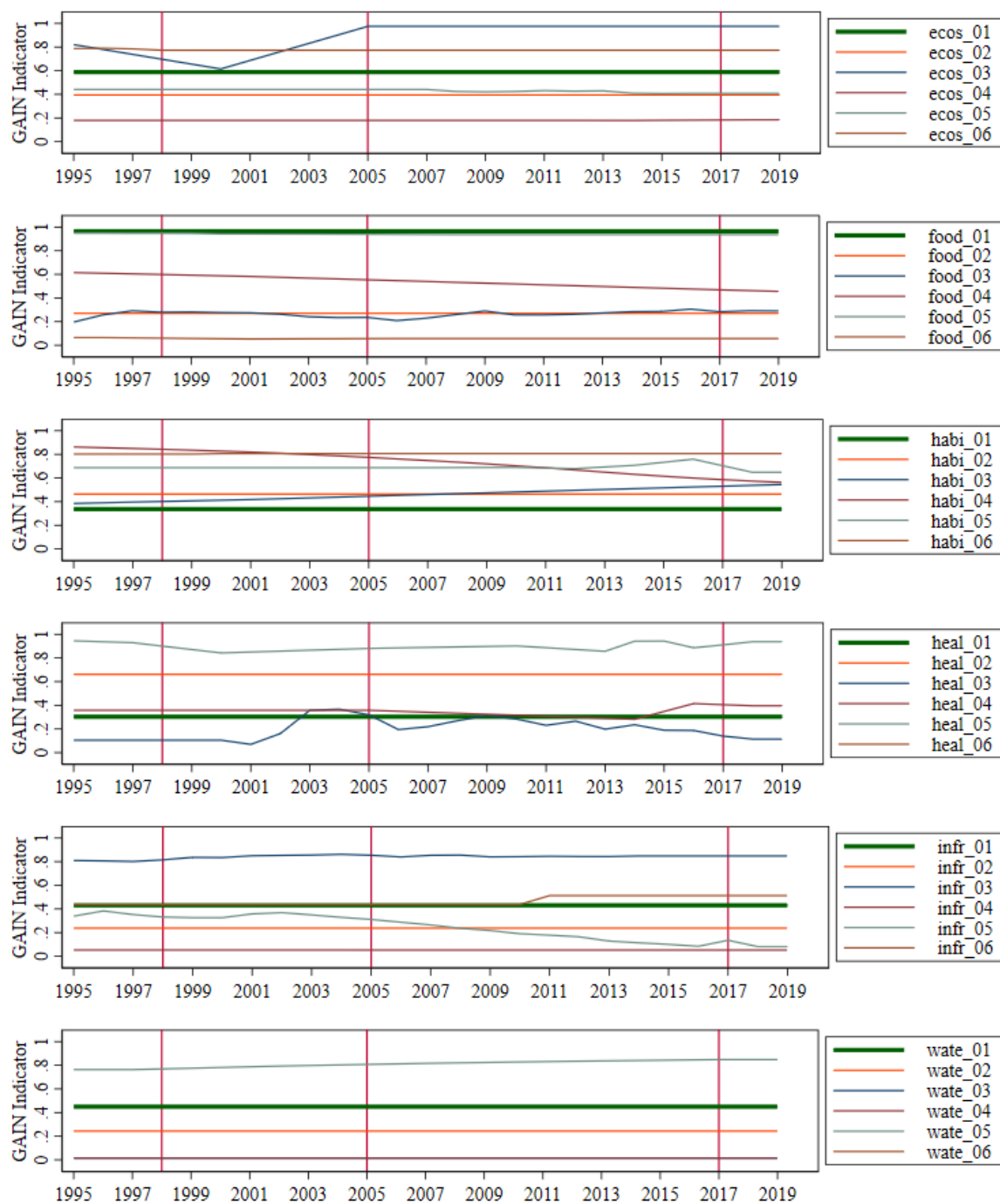




Figure 6: Honduras, Vulnerability Indicators





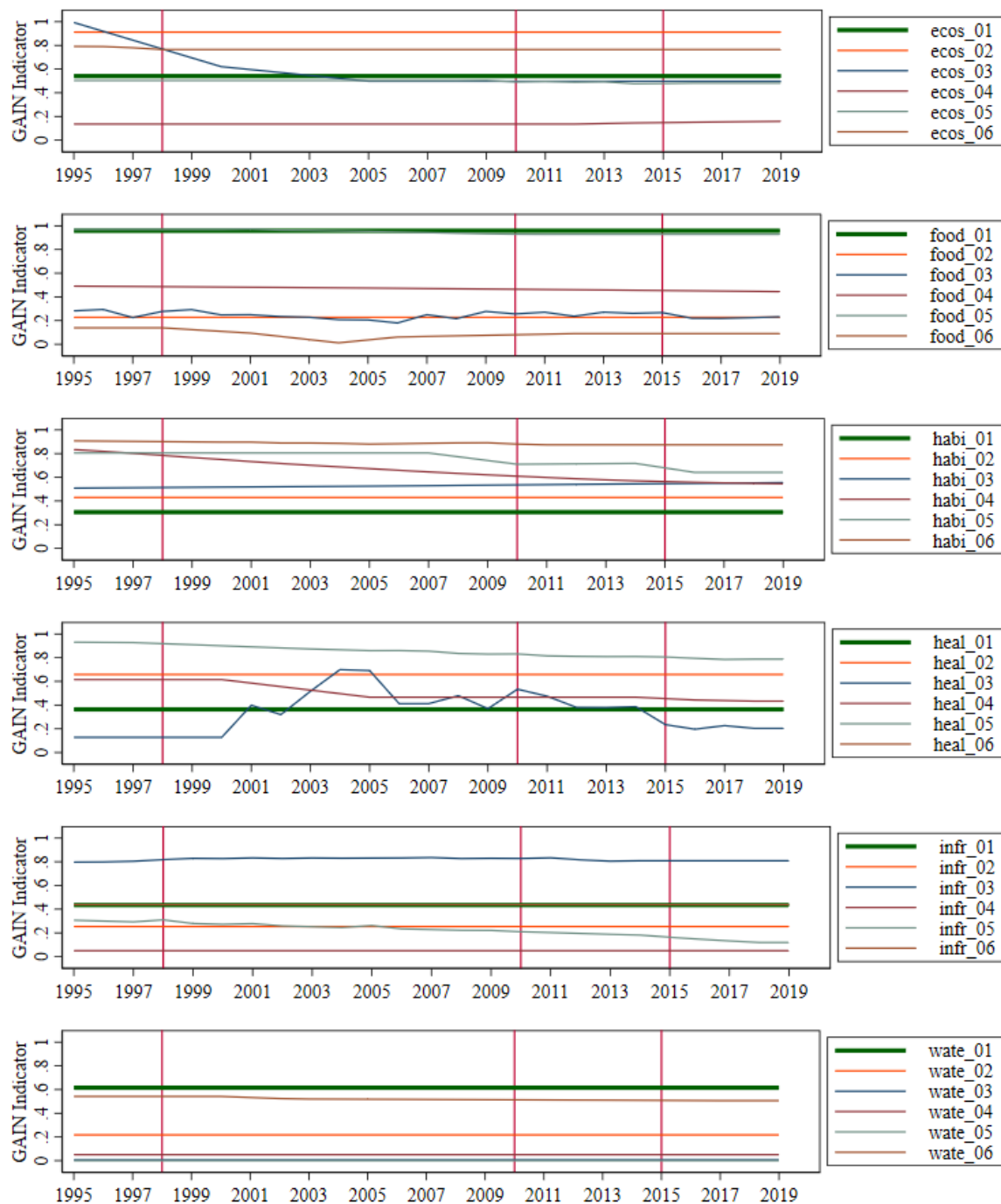
3.2.3 Nicaragua

Figure 7: Nicaragua, Readiness Indicators





Figure 8: Nicaragua, Vulnerability Indicators





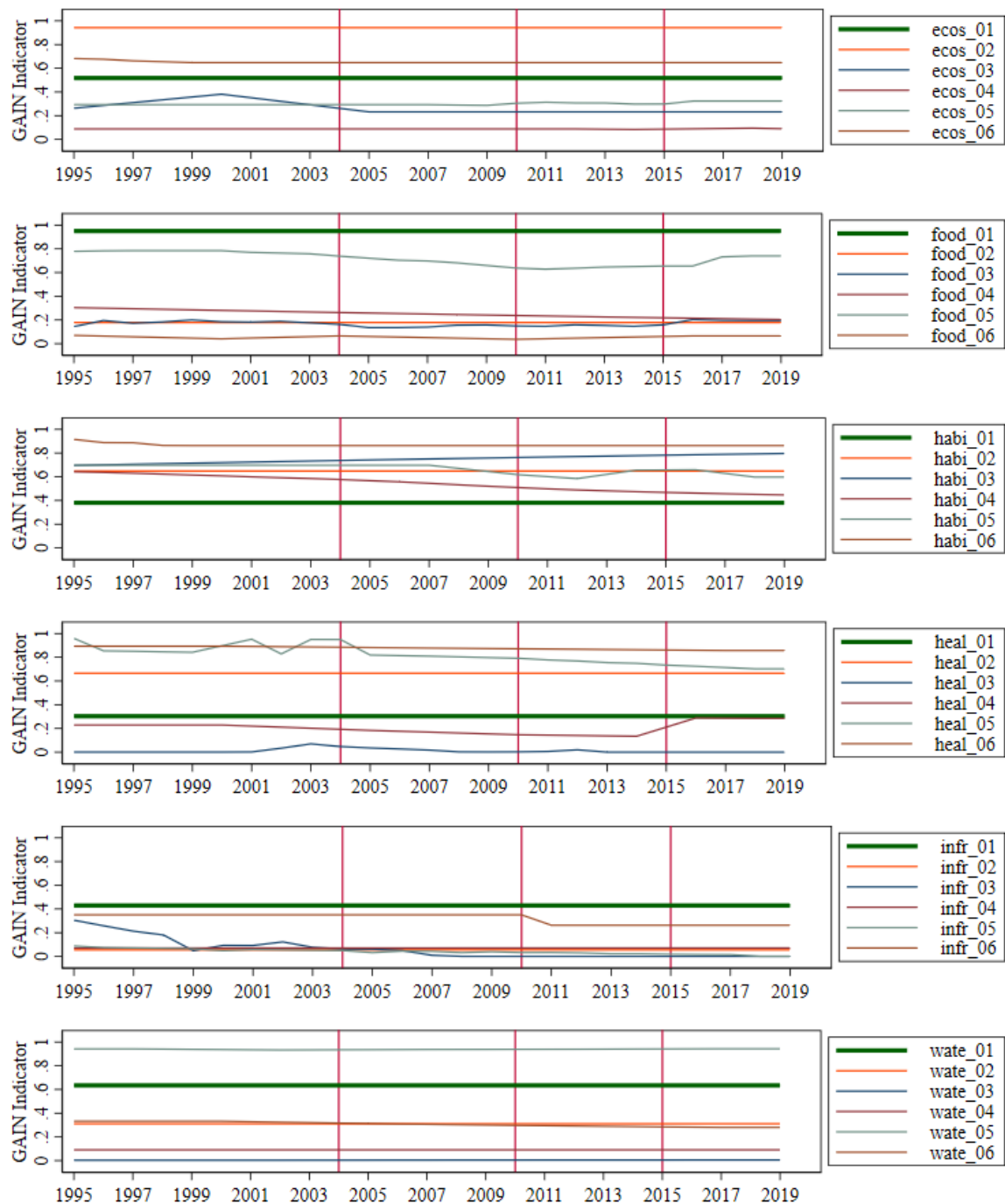
3.2.4 Colombia

Figure 9: Colombia, Readiness Indicators





Figure 10: Colombia Vulnerability Indicators





3.2.5 Haiti

Figure 11: Haiti, Readiness Indicators

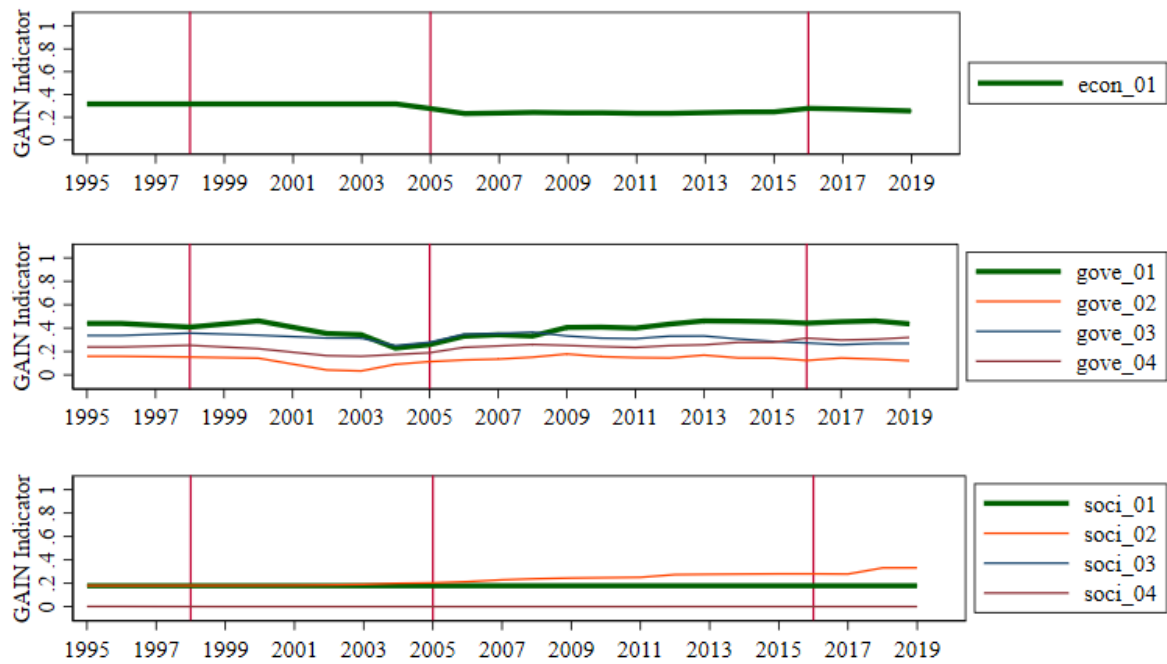




Figure 12: Haiti, Vulnerability Indicators

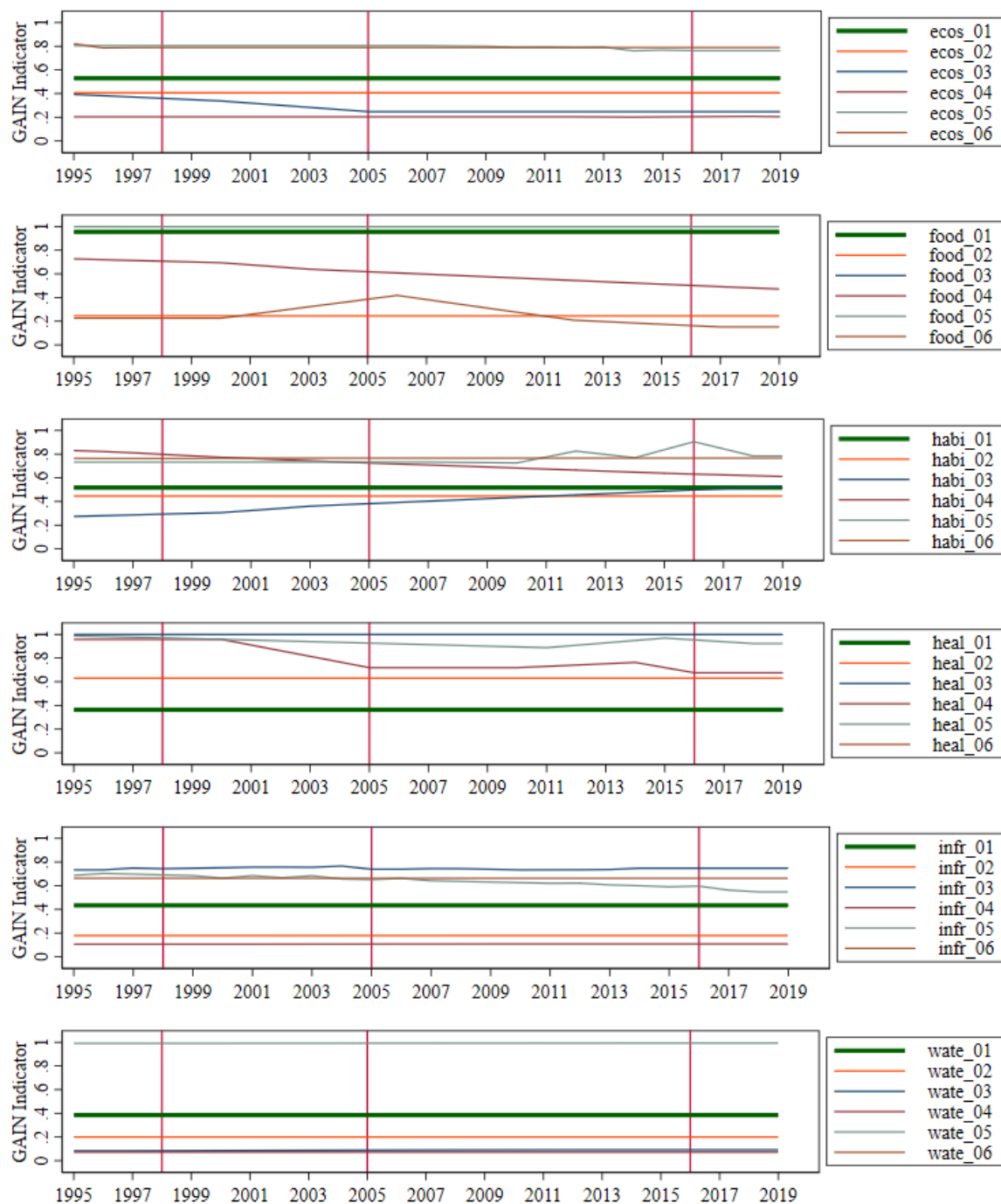




Table 2: Adverse Changes in ND-GAIN

Indicator	Brief Description	Guatemala			Honduras			Nicaragua			Colombia			Haiti		
		1998	2010	2017	1998	2005	2017	1998	2010	2015	2004	2010	2015	1998	2005	2016
Vulnerability Indicators																
ecos_01	Δ of biome distribution															
ecos_02	Δ of marine biodiversity															
ecos_03	natural capital dependency	++			+++			+			+				+	
ecos_04	ecological footprint															
ecos_05	protected biome											+	+			
ecos_06	int'l environmental conventions															
food_01	Δ in cereal yields															
food_02	population Δ															
food_03	food import dependency				+			+			+		+			
food_04	rural population															
food_05	agriculture capacity			+								+	+			
food_06	child malnutrition														++	
habi_01	Δ of warm periods															
habi_02	Δ of flood hazard															
habi_03	urban concentration														+	+
habi_04	age dependency ratio															
habi_05	trade and transport infrastructure		+						+	+		+				
habi_06	paved roads															
heal_01	Δ deaths, climate induced diseases															
heal_02	Δ in vector-borne diseases															
heal_03	health services dependency				++	+		+++								
heal_04	slum population												++		++	++
heal_05	medical staff		++				+									
heal_06	access to improved sanitation															
infr_01	Δ of hydropower capacity															
infr_02	sea level rise impacts															
infr_03	dependency on imported energy															
infr_04	population <5m above sea level															
infr_05	electricity access						+	+								
infr_06	disaster preparedness															
wate_01	Δ of annual runoff															
wate_02	Δ of annual groundwater recharge															
wate_03	fresh water withdrawal rate															
wate_04	water dependency ratio															
wate_05	dam capacity															
wate_06	access to reliable drinking water															
Readiness Indicators																
econ_01	doing business										++		+		+	
gove_01	political stability and non-violence				+					+++				++		
gove_02	control of corruption		+	+			+	+		+				++		
gove_03	regulatory quality	+			+	+		+		+				+		
gove_04	rule of law					+		+		++				+		
soci_01	social inequality	+			++	+					++					
soci_02	ict infrastructure															
soci_03	education															
soci_04	innovation															

Note: +, ++, and +++ represent small, medium, and large adverse changes.

For additional detail on ND-GAIN country indicators and sources, please visit gain.nd.edu.



3.3 Discussion from Stage One

Summarizing across cases and indicators, with the exception of Colombia, climate events during critical years show fairly consistent adverse impacts in the area of governance. There was a frequent co-occurrence between climate events and declines in stability, control of corruption, rule of law, and regulatory quality. The adverse changes to the governance domain during the 2015 drought and flooding in Nicaragua and the 1998 Hurricane Georges in Haiti were particularly large and comprehensive. Of course, there were other types of events operating at the same time. In the former case, 2015 was the same period during which President Ortega was extending his control over national politics [37]; in the latter, 1998 was a year marked by high instability and political contestation involving former President Aristide [38]. Health was another domain of notably large, concurrent adverse changes. Slum populations in Colombia and Haiti increased at moderate rates during and following several critical years, and health services dependency impacts arose after Hurricane Mitch in Honduras and Nicaragua in 1998.

A key purpose of stage one is to highlight areas represented by the ND-GAIN Country Index that did not show change, despite expectation of change due to major disruptions based on storm documentation and relief reports. This lack of response by the ND-GAIN country indicators can occur for one or more of the following reasons: 1) a particular content area was not affected (e.g., energy security); 2) the content area was affected, but ND-GAIN data cycles for that indicator did not adequately reflect it; 3) the content areas were affected, but already operated at low level of performance at baseline (e.g., Haiti is in the bottom quartile of all countries measured for gove_04, the rule of law, making it unlikely that a climate event will further diminish its score on this indicator); or 4) the content area was affected, but ND-GAIN outcome metrics at the national level are not sensitive enough to capture the impact (e.g., a particular subnational geography/department may be badly hit and affected, but it is not easily illustrated in aggregated national-level metrics).

The lack of detectable change in many ND-GAIN country indicators led the researchers to several conclusions that influenced the Stage Two research design. First, in most content areas, metrics at a subnational scale appropriate to the issues are needed. The inventory and documentation of weather events and their impact through humanitarian assistance/relief reports reveal that particular regions of countries, at least, were heavily impacted. For measurement and metrics to be useful for the intended purpose – in this case potential investment in adaptive capacity – they must be attuned to the level of interest [39-43]

Second, the apparent lack of impact of climate events on changes in ND-GAIN country indicators, combined with the observation that several country cases measure low at baseline, suggests a distinction between what we are referring to as “preconditions” for adaptive capacity and “critical drivers” of adaptive capacity. The team explored this distinction for our framework for Stage Two and included an analysis of select ND-GAIN country indicator *levels* to show that several countries lack the preconditions for impactful investments in adaptive capacity.

4 STAGE TWO – META ANALYSIS OF CONSTRUCTS TO INFORM METRICS

As outlined in the *Overview of the Approach*, Stage Two moves from the exploration of general information in Stage One to the examination of factors affecting the key constructs of adaptive capacity as related to critical outcome categories, such as food or water security. As part of this process, as we have noted, researchers considered whether adaptive capacity investments necessitate certain preconditions in order to realize the desired impact. While researchers cannot determine threshold levels of any of these “precondition” factors at the subnational level within the scope of this project, we were able to identify them as consistently-mentioned barriers to enabling adaptive capacity. Both the critical drivers and the factors that seem to serve as a foundation or precondition for developing adaptive capacity displayed different qualities in different contexts. Nonetheless, they appeared to be important across contexts. Given the focus for this analysis, the critical drivers and preconditions were matched to existing and potential metrics.

4.1 Process

Adaptive capacity is a multidimensional, interconnected concept that is both dynamic and process-oriented [43, 44]. Current literature focusing on core, interrelated constructs of flexibility, organization, learning, agency, assets, and socio-cognitive factors [1, 2, 44] captures many ideas and indicators identified in previous work examining the intersection of vulnerability and resilience



Figure 13: Key Dimensions of Adaptive Capacity [1, 2]

[43, 45]. Guided by and modifying the key constructs of adaptive capacity framed in this literature (see Figure 13), researchers explored cases, reports, and analytical documents to identify and verify key leverage points in outcome pathways. For this framework, the original dimensions were defined from the household scale [1, 2, 44]. Nonetheless, the constructs are generally relevant at the community and regional levels [46], bearing in mind that the socio-cognitive factors move from individual (risk attitudes, cognitive biases, etc.) [1, 2, 44] to the community level [47] (social norms, polarization, etc.) [2, 46]. In light of this, researchers have modified the scale for the purposes of this analysis (Figure 15).

The process for Stage Two was more overlapping than strictly linear and had four components (Figure 14). Together, they informed our selection of subconstructs representing adaptive capacity and the measurement for each. By focusing on adaptive capacity key constructs and subconstructs prior to selecting measurement, our approach allows for the identification of better metrics as new data becomes available. The process also yielded information regarding application nuances from the case documentation.

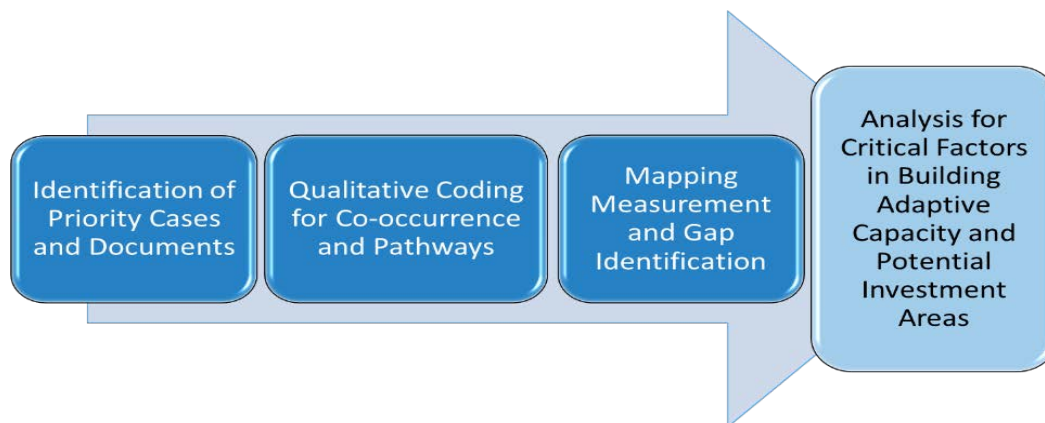


Figure 14: Stage Two Process

Using the modified framework, the process began with the identification and prioritization of documents for coding that informed our selection of adaptive capacity upstream key performance indicators related to climate impacts. Researchers used ATLAS.ti, which is a qualitative coding software with a broad functionality for analysis that includes queries, frequency, and co-occurrence, to begin coding documents to provide an evidence base for the selection and prioritization of the constructs of focus. Concurrently, researchers identified existing metrics from reliable sources (e.g., World Bank, the Food and Agriculture Organization of the United Nations, etc.) under the broad constructs, which provided a menu of known, available data for assembly. In the final step, researchers matched the refined construct/subconstructs with the measurement in the Construct pages, and identified gaps in existing measurements with regard to areas likely to be important to adaptive capacity.

4.1.1 Sourced information: Identification and Prioritization

The documents chosen as our sampling frame are critical, as they provided the evidence base for this analysis. Researchers first assembled the humanitarian relief documentation for each of the target countries from Stage One, including ones related to outcome categories that are exacerbated by climate disruptions (e.g., food and water security). Next, we assembled analytical and case documents from government and academic institutions that are related to the outcomes for the specific regions, as well as others, in the growing collection of intervention documentation for “what works,” regardless of region. Researchers first prioritized these documents by relevance and then selected the documents to be coded in the next step.

Researchers tracked the document types to ensure that none of the source types were drawn on too heavily; these included analytical-academic, analytical-government, analytical-non-government, news articles, and relief/intervention reports. This process included both screened documents and those selected for coding (see Tables 2 - 6) and supported the ability of researchers to better ensure representation of factors with potential to influence the findings from the qualitative coding of the cases. Factors such as the geography, outcome type, or purpose of a report could skew findings if



substantially overrepresented in the document samples. For example, if researchers relied only on relief reports to inform the key constructs, then the coded information could more heavily represent factors impacting response and humanitarian assistance rather than critical investment areas that support shock absorption or building adaptive capacity. Tracking documents in this way also allowed for later assessments of the distribution of the occurrences and potential generalizability of the findings. Each of the source summary tables below represent reports identified in Stage One and those added throughout the screening and coding process of Stage Two.

Table 2: Guatemala Report Summary

SUMMARY GUATEMALA				
Type	Total Reports Sourced	%	Total Reports Coded	%
Relief/intervention	26	60.5	8	53.3
Analytical-Govt Report	5	11.6	3	20.0
News Article	4	9.3	1	6.7
Analytical-Academic	4	9.3	2	13.3
Analytical-Non-Academic	4	9.3	1	6.7
	43		15	

Guatemala included a total of 43 sourced reports, with the distribution of reports that were identified and coded shown in Table 2.

Table 3: Honduras Report Summary

SUMMARY HONDURAS				
Type	Total Reports Sourced	%	Total Reports Coded	%
Relief/intervention	9	37.5	2	20.0
Analytical-Govt Report	2	8.3	2	20.0
News Article	9	37.5	2	20.0
Analytical-Academic	1	4.2	1	10.0
Analytical-Non-Academic	3	12.5	3	30.0
	24		10	

Honduras included a total of 24 sourced reports, with the distribution of reports that were identified and coded shown in Table 3.

Table 4: Nicaragua Report Summary

SUMMARY NICARAGUA				
Type	Total Reports Sourced	%	Total Reports Coded	%
Relief/intervention	24	57.1	4	40.0
Analytical-Govt Report	10	23.8	4	40.0
News Article	4	9.5	0	0.0
Analytical-Academic	3	7.1	2	20.0
Analytical-Non-Academic	1	2.4	0	0.0
	42		10	

Nicaragua included a total of 42 sourced reports, with the distribution of reports that were identified and coded shown in Table 4.

Table 5: Colombia Report Summary

SUMMARY COLOMBIA				
Type	Total Reports Sourced	%	Total Reports Coded	%
Relief/intervention	18	52.9	2	20.0
Analytical-Govt Report	8	23.5	4	40.0
News Article	2	5.9	1	10.0
Analytical-Academic	3	8.8	1	10.0
Analytical-Non-Academic	3	8.8	2	20.0
	34		10	

Colombia included a total of 34 sourced reports, with the distribution of reports that were identified and coded shown in Table 5.

Table 6: Haiti Report Summary

SUMMARY HAITI				
Type	Total Reports Sourced	%	Total Reports Coded	%
Relief/intervention	11	50.0	9	60.0
Analytical-Govt Report	3	13.6	1	6.7
News Article	3	13.6	1	6.7
Analytical-Academic	3	13.6	3	20.0
Analytical-Non-Academic	2	9.1	1	6.7
	22		15	

Haiti included a total of 22 sourced reports, with the distribution of reports that were identified and coded shown in Table 6.

4.1.2 Framework for Qualitative Coding

As noted, researchers modified a conceptual framework for adaptive capacity [1, 2, 44] to apply the framework at the scale of community, rather than household. Other studies examining adaptive capacity informed these adaptations. Specifically, *community empowerment* [46, 48] replaced *agency* as a community-level proxy for the dimension, and *contextual influence* [46, 47] replaced the *socio-cognitive* dimension (see Figure 15).

Beginning with these dimensions for adaptive capacity and core outcome categories (e.g., Food Security, Water Security), researchers identified subconstructs for each (see Table 7 for the original list). These were drawn from a combination of the framing literature and existing



measurements for parallel constructs inside of ND-GAIN. Additional codes were added to capture scale, presence/absence, type of influence (positive/negative), and temporal precedence, which allowed researchers to identify stronger evidence for pathways beyond correlation relationships. Together, these served as the framework for the qualitative coding process. Researchers imported this initial framework into ATLAS.ti. During this process, researchers iteratively refined the coding subconstructs (see Appendix 2 for the codebook).

Figure 15: Modified Framework for Adaptive Capacity



Table 7: Original Construct & Subconstruct List

Assets	Access to Credit	Organization	Socio-Ecological Ties
	Energy Security		Access to Markets
	ICT Infrastructure		Climate/Adaptive Capacity Planning
	Income		Corruption
	Infrastructure		Cross-Scale Assistance/Technical Assistance
	Insurance		Cross-Scale Coherence/Vertical Integration
	Land title		Disaster Management Body (MC)
	Natural Capital		Enforcement
	Paved Roads		Federalism
	Quality of Trade and Transport Infrastructure		Idea Exposure
	Social/Health Investments		Intersectoral Coherence/Horizontal Coordination
	Technology		Leadership within/from an organization or agency
	Urban Concentration		Political Stability
	Wealth/Savings		Professional Bureaucracy
	Youth		Racial/Ethnic Inequality
	Other (8)		Regulatory Quality/Government Effectiveness
Flexibility	Geographic Flexibility	Contextual Experience	Research and Development Expenditure
	Occupational Options		Sexual and Gender Inequality
	Policy and Regulatory Flexibility		Social Inequality/Income/Wealth Inequality
	Technological Diversity		Social-ecological Management Networks
Ecosystem Services	Biodiversity Protection		Trust in institutions
	Deforestation		Veto Points
	Ecological Footprint		Violence
	Natural Capital Dependency		Weak State
	Soil Degradation		Compliance
	Other		Past Experience
Community Empowerment	Chooses/Active in Decision-Making	Learning	Religion/Culture
	Administrative, Fiscal, Political (De)centralization		Risk Perception
	Power/Influence		Education
	Other		Experimental Knowledge
Food Security	Access to Food	Scale	Information Capacity
	Agricultural Capacity		Knowledge about Climate Change in Population
	Crop Diversification		Other
	Food Import Dependency		Community
	Producer Diversification/Facilitation		Household
	Other		Local
Health, QOL, and Human Security	Economic Opportunity	Water Security	Multiple Countries
	Internal Migration		National
	Mental Health		Subnational
	Physical Health		Drinking Water Access
	Public Services		Ground Water
	Security and Violence		Surface Water
	Public Services		Water Dependency Ratio
	Security and Violence		



After coding the documents, the ATLAS.ti software enabled researchers to quickly examine relationships between constructs and outcomes. Nonetheless, there are limitations to its capabilities. Given the sources of information and the aims of this analysis, ATLAS.ti can be used to identify the importance of the presence/absence of a factor, the direction of the relationship, and potentially the sequence from qualitative coding but not the strength of the relationship. In ATLAS.ti, the strength of the relationship is based on the prevalence of the constructs/subconstructs across documents. Since a single document might have many mentions of a construct, frequency itself is an insufficient measure for this type of examination. Although this is a limitation, the initial process is useful for identifying potential key constructs/subconstructs that can be refined using mixed methods approaches.

4.1.3 Mapping Measurement and Gap Identification

Researchers mapped relevant existing metrics within identified adaptive capacity and outcome constructs at the nation and subnational levels. Although last in the sequence, the inventory was iteratively developed as existing measurement first informed subconstructs and then highlighted measurement gaps when mapped to subconstructs identified from qualitative sources. This helped to identify gaps in the data for appropriate measurement important for climate adaptation interventions. This process provides initial metrics for the adaptive capacity KPIs, but may also confirm a key investment area – developing data capacity at the scale [47] necessary to make decisions and sound investments.

The process of metric identification began with larger agencies like the World Bank, the United Nations Food & Agriculture Organization (FAO), and the Educational Scientific and Cultural Organization (UNESCO), which have routinized data releases and data quality checks. This provided reliable sources of measurement. As time permitted, we also included data from other organizations that collect subnational or community-based information. While less consistent, researchers included these entities because they may be collecting important data of interest. Measures may include areas of operation that can be converted into binary measures of present/not present within the focus countries.

Table 8: Indicator Inventory Illustration

Domain	Sector	Indicator/Database	Source	Scale
Water	Access to reliable drinking wa	WHO/UNICEF JMP (2021). Progress on household drinking water, sanitation and hygiene	JMP - WHO and UNICEF WASH	National+Urban+Ru
Water	Access to reliable drinking wa	Population using safely managed drinking water services % (2016-2020 latest)	WHO	National+Urban+Ru
Water	Dam Capacity	AQUASTAT - FAO's Global Information System on Water and Agriculture: Dam Capacity	FAO/AQUASTAT	National
Water	Freshwater Withdrawal Rate	Total Freshwater Withdrawal	FAO/AQUASTAT	National
Water	Water Dependency Ratio	External Renewable Water Resources	FAO/AQUASTAT	National
Water	Freshwater Withdrawal Rate	% of total water withdrawal by sector (agriculture, industry and municipal)	FAO/AQUASTAT	National
Water	Surface Water	Freshwater Ecosystem Explorer	Global Surface Water Explorer	National+Departme
Food	Many	FAO Hand in Hand Data Platform	FAO	
Food	Agricultural Capacity/area equ	% of irrigation potential equipped for irrigation	FAO/AQUASTAT	National
Food	Ag Capacity	Fertilizer use on arable and permanent crop areas	FAOSTAT	National
Food	Ag Capacity	Pesticide use on arable and permanent crop areas	FAOSTAT	National
Food	Ag Capacity	Tractor use per 100 sq km of arable land	Discontinued by FAO	
Food	Rural Population	rural population as a % of total population	World Bank	National+Rural
Food	Food import dependency	Food imports (% of merchandise imports) - Colombia, Guatemala, Haiti, Honduras,	World Bank	National
Food	Food import dependency	Cereal Yield (kg per hectare)	FAO via World Bank	National
Food	Child Malnutrition	Percentage of children under 5 years of age who are stunted (modelled estimates)	FAO	National
Food	Average dietary supply adequacy	Each country's or region's average supply of calories for food consumption is normalized	FAOSTAT	National
Food	Access to Food	Prevalence of moderate to severe food insecurity in the total population	FAOSTAT	National
Food	Aquaculture	Employment in fishing and aquaculture	FAOSTAT	National



4.2 Analysis – Key Constructs and Potential Measurement

Following coding of the source information, researchers ran several analyses to confirm the co-occurrence of constructs highlighted, determine the frequency of the co-occurrences, and examine the qualitative nuances of the issues identified whether or not they had high frequency levels. Since some subconstructs may be less frequent, but nonetheless important, researchers used a mixed-methods convergent parallel design to develop a more complete understanding of the source information through comparing and triangulating results [49]. The purpose of this approach was to validate and prioritize key constructs and subconstructs from the documentation types, as well as to look for emergent factors that may have been underrepresented. By fitting the information from the measurement mapping together with the selected key constructs, researchers were able to identify existing and potential metrics. Summary information of each is provided in the Construct Pages below.

4.2.1 Co-occurrence of Constructs

As noted, ATLAS.ti allows researchers to run a variety of analyses to examine source information. For this study, we began with examining the frequency of co-occurrence between adaptive capacity constructs and outcome categories (see Table 9), such as Food Security, Water Security, Ecosystem Services, or Health and Quality of Life (QOL).

Table 9: Co-occurrence Phase One Illustration

	● Ecosystem Se... 127	● Food Security 131	● Health, QOL,... 246	● Water Security 45
● Assets 271	64	72	130	35
● Community... 42	16	7	21	6
● Contextual E... 23	5	6	16	0
● Flexibility 102	26	35	58	4
● Learning 105	28	25	30	12
● Organization 346	81	48	183	25

Table 10: Frequent Adaptive Capacity Constructs by Outcome

Ecosystem	Organization, Assets, Learning
Food Security	Assets, Organization, Flexibility
Health	Organization, Assets, Flexibility
Water Security	Assets, Organization, Learning

In this general, first pass at the source information, the three most frequent adaptive capacity constructs across each outcome category are listed in Table 10. It is noteworthy that the same four broad adaptive capacity constructs are present across all of the outcome categories. Nonetheless, at this broad level we can tell neither what the subconstructs driving the relationship are nor whether the relationship is positive or negative. Further iterations were used to refine this information.



Following this initial screening, researchers performed a series of analyses to disaggregate the broad constructs. The purpose of this was to identify the primary subconstructs driving the frequencies at the aggregated level. This step also entailed filtering for distinctions between positive and negative relationships, and for those constructs that temporally preceded an outcome. To illustrate, Table 11 shows an example of the disaggregation process for the *Assets* construct. Clearly, certain subconstructs are more frequent than others in the source information for co-occurrence with certain outcomes – *income*, *wealth*, and *access to capital* rose to the top versus *youth* or *paved roads* for this broad construct.

Table 11: Disaggregation Process Illustration

	● Ecosystem Se... (11/11) 112	● Food Security (11/11) 94	● Health, QOL,... (11/11) 226	● Water Security (11/11) 26
● Assets: Acces... (11/11) 33	5	12	20	1
● Assets: Energ... (11/11) 3	0	0	1	0
● Assets: ICT In... (11/11) 10	0	4	6	3
● Assets: Income (11/11) 82	24	9	45	2
● Assets: Infrastr... (11/11) 38	3	7	17	15
● Assets: Insura... (11/11) 0				
● Assets: Land t... (11/11) 26	15	4	9	0
● Assets: Natur... (11/11) 24	14	6	11	2
● Assets: Paved... (11/11) 7	0	2	4	0
● Assets: Qualit... (11/11) 3	0	2	2	0
● Assets: Social... (11/11) 11	0	1	7	1
● Assets: Techn... (11/11) 13	3	7	3	1
● Assets: Urban... (11/11) 7	2	0	3	0
● Assets: Wealt... (11/11) 24	0	14	15	3
● Assets: Youth (11/11) 6	0	1	5	0

Again, frequency in the co-occurrence tables is only one method by which researchers established the potential importance of a subconstruct. As mentioned, they concurrently performed a qualitative review of the evidence to identify findings from recent research and analyses. Clearly, newer findings would be less frequent in the documentation and, thus, not captured by the co-occurrence tables. These findings were used for comparison and triangulation of the ATLAS.ti analysis to provide a more complete understanding of the source information. Researchers then used this to select the subconstructs that would be applied to identify upstream adaptive capacity metrics.

To do so, researchers filtered out subconstructs that have no incidence or were coded as “other.” The latter were examined as part of the qualitative examination for comparing and triangulating



results. Researchers also removed from quantitative consideration any subconstruct that contained fewer than 10 co-occurrence instances. Finally, the number of subcodes was further reduced to a manageable number by aggregation (see Appendix 2 for the codebook). Because ATLAS.ti does not allow for tertiary coding levels, this aggregation is reflected in the selection of indicators. For the qualitative review, researchers applied two approaches. They first examined recent literature and analyses for critical issues underrepresented in the co-occurrence tables. They also performed queries of the candidate constructs inside of ATLAS.ti on the coded data, which included additional factors, such as temporal precedence. Researchers reviewed the resulting evidence to inform final selection of factors and to identify illustrative quotes. This provided information regarding constructs that were likely necessary preconditions to investing in adaptive capacity versus constructs that were critical drivers of adaptive capacity. From this reduced list of selected constructs (see Table 12), researchers matched existing and potential measurement.

Table 12: Illustration of Convergence for Final Selection

	ECOSYSTEM	FOOD	HEALTH, QOL, etc	WATER	OVERALL FREQUENCY	FREQUENCY	QUALITATIVE	PRIOR
Assets: Income Gr=82	24	9	45	2	80	X		x
Organization: Inequality	0	12	22	3	79	X		X PRECONDITION
Flexibility: Occupational Options Gr=53	12	20	37	0	69	X	X	
Organization: Social-Ecological Management Networks	21	11	21	5	58	X	X	
Organization: Violence Gr=37	6	1	39	0	46	X	X	X PRECONDITION
Assets: Infrastructure Gr=38	3	7	17	15	42	X	X (ICT)	X DRIVER
Assets: Access to Capital Gr=33	5	12	20	1	38	X		X DRIVER
Organization: Weak State Gr=24	6	3	23	3	35	X		X PRECONDITION
Assets: Natural Capital Gr=24	14	6	11	2	33	X		X PRECONDITION
Organization: Enforcement Gr=25	17	1	12	2	32	X		
Assets: Wealth/Savings Gr=24	0	14	15	3	32	X		
Learning: Education Gr=31	10	7	12	0	29	X		
Flexibility: Geographic Flexibility Gr=21	4	7	15	2	28	X	X	
Assets: Land Title Gr=26	15	4	9	0	28	X	X	
Organization: Regulatory Quality/Government Effectiveness	13	0	9	2	24	X	X	X DRIVER
Community Empowerment: Chooses/Active in Decision-Making Gr=21	11	3	10	0	24	X	X	X DRIVER
Organization: Corruption Gr=16	3	0	19	0	22	X	X	X PRECONDITION
Community Empowerment: Devolution/Administrative, Fiscal, Political (De)centralization Gr=15	1	4	13	3	21	X		X DRIVER
Learning: Information Capacity Gr=31	4	4	11	1	20	X		
Organization: Climate Planning/Adaptive Capacity Planning Gr=42	5	0	14	1	20	X	X	
Flexibility: Technological Diversity Gr=10	3	7	6	0	16	X		
Assets: Technology Gr=13	3	7	3	1	14	X		
Contextual Experience: Religion/Culture Gr=14	3	3	8	0	14	X		
Learning: Knowledge about Climate Change in Population (MP) Gr=15	4	5	2	2	13	X		
Learning: Socio-Ecological Ties Gr=15	6	4	1	0	11	X		

4.2.2 Generalizability of Constructs

Researchers performed an assessment of the distribution of the co-occurrence of adaptive capacity construct coding across countries and across document types (see Table 13). This served as a quality control to ensure representation across document types, but also informed whether constructs selected would be potentially generalizable across the different countries. Coding for the adaptive capacity constructs was not concentrated in any particular country and was generally distributed across the countries and the core document types (analytical and relief), with a few exceptions. Although there are more relief/intervention reports (24) than analytical-government reports (19), coding is heavier on the analytical-government reports (268 quotes) than



relief/intervention reports (241 quotes). Assets and Organization continued to be the most prominent factors across the different countries and document types. This is consistent with the state of knowledge: assets provide a buffer during times of disruption and many of the organization subconstructs relate to readiness for disruption or capacity to respond. From this examination, researchers determined that constructs could be applied across the different countries.

Table 13: Illustration of Coding Distribution Examination

	Colombia 7 141	Guatemala 24 103	Haiti 14 353	Honduras 10 86	Nicaragua 12 202
Assets 271	33 17.46%	39 36.45%	59 41.84%	31 41.89%	58 25.66%
Community... 42	17 8.99%	6 5.61%		2 2.70%	6 2.65%
Contextual E... 23	6 3.17%	2 1.87%	1 0.71%		11 4.87%
Flexibility 102	15 7.94%	12 11.21%	14 9.93%	5 6.76%	42 18.58%
Learning 105	16 8.47%	12 11.21%	14 9.93%	13 17.57%	27 11.95%
Organization 346	102 53.97%	36 33.64%	53 37.59%	23 31.08%	82 36.28%
Totals	189 100 %	107 100 %	141 100 %	74 100 %	226 100 %

	analytical-acade... 5 133	analytical-govt re... 19 326	analytical-non-a... 5 32	Critical Readings 6 28	news article 4 21	relief/intervention 24 372	Totals
Assets 271	43	66	16	14	5	89	233
Community... 42	9	16	4	4	1	1	35
Contextual E... 23	9	9				2	20
Flexibility 102	34	21		4	1	32	92
Learning 105	9	44	2	13	1	26	95
Organization 346	63	112	19	19	11	91	315
Totals	167	268	41	54	19	241	790

A few country-specific observations:

- *Guatemala* shows nearly equal coding in Organization and Assets.
- *Honduras* had the clearest distinction between Organization and Assets, Assets being the dominant category.
- *Nicaragua* had a high frequency for Organization and the highest number of overall codes. Since researchers selected the source documents by significance, Nicaragua case examples may help to inform understanding in the region.
- *Colombia* has over fifty percent of its coding in Organization, highlighting the importance of this domain for adaptive capacity in that country.
- *Haiti* also shows nearly equal coding in Organization and Assets. Interestingly, there were no citations coded for Community Empowerment.

While the Community Empowerment construct was highlighted as important in other documents [7, 11, 50, 51], researchers found few references in the relief reports, which tend to focus on the



impacts of an event. This more frequent identification in other types of documents and lower presence in relief reports may indicate the importance of Community Empowerment as a foundational element. For example, the implementation of the “Asset Planning for Climate Change Adaptation (APCA) Project” showed the value of bottom-up community asset adaptation planning [51] for building adaptive capacity and resilience.

5 SELECTED KEY CONSTRUCTS – PRECONDITIONS AND DRIVERS

As noted, our review of ND-GAIN country indicators, relief and analytic reports, together with extant theory and practice, suggests that we distinguish between key constructs that serve as *preconditions* for adaptive capacity, and those that are *drivers* of adaptive capacity and warrant investment. In the following pages, researchers identified the final list of key constructs for development in Table 14 and developed a **construct page** for each.

Table 14: Final List of Key Constructs

Final List	Key Constructs
Preconditions	Inequality (Economic, Gender, Racial) Violence Weak State Natural Capital Corruption
Drivers	Income Occupational Flexibility Social-Ecological Management Networks Infrastructure (Physical and Human/Social) Access to Capital Wealth/Savings Geographic Flexibility Access to Land Bureaucratic Capacity Community Empowerment Climate and Disaster Planning Learning (Access to and Capacity for)

Discussion of Preconditions

Preconditions have a special status. Preconditions at certain levels and directionality (e.g., lower corruption, higher natural capital, stronger state capacity, lower violence, lower inequality) are necessary to the development of adaptive capacity, without which other investments are unlikely to have significant impact on outcomes. In this sense, preconditions interact with other forms of investment such that they create structural barriers to improvement on the outcomes.

We identify five precondition constructs: inequality, insecurity/violence, weak state capacity, natural capital, and corruption. These constructs share three key properties. First, they tend to vary continuously (rather than discretely). This property is relevant for identifying country cases that



fail to meet the preconditions. Ideally, one would be able to identify a threshold, below which a country fails to meet the precondition. However, the complexity of social phenomena makes these thresholds very difficult to determine in any given case. Similar to how we approached other measurement efforts, we addressed this by combining information about a country-case's *rating* on a given precondition (i.e., high score on violence), with information about its *ranking* on the precondition (i.e., percentile rank). If a country has a very high score, together with a rank that places it in the top percentiles in a global sample, this low performance on the precondition serves as a substantial barrier to progress on many adaptive capacity drivers.

The second key property shared by the precondition constructs is that they are structural factors that are commonly overdetermined and resistant to change. Even if short- or medium-term interventions can stabilize a country with regard to one of these constructs—for example, if an external security mission by the UN restores security, or external aid relieves the burdens of deep inequality—domestic conditions are likely to revert to the preexisting status quo when the intervention ends. This feature has an important implication for our Stage One analysis that showed relatively few of the ND-GAIN country indicators reporting adverse changes in score following a critical climate event: climate shocks are unlikely to further undermine already poor performance on precondition constructs. This implies it is already at a floor. Our Stage Two research, thus, suggests that, in addition to looking for evidence about adaptive capacity in the *change* of scores, we must look for evidence about adaptive capacity in the *levels* of the indicators. Therefore, here we examine precondition constructs with low scores at baseline.

Third, these constructs can take many forms, and the different forms are contextually determined. Inequality can arise in the economic, political, and social life of a country or community, and across a variety of dimensions of difference, including gender, ethnic, racial, religious, or linguistic differences. Violence can arise from a weak state security apparatus or from strong criminal organizations. Security is a feature of state strength that we single out as its own precondition, following the theory and practice of other domains. However, when it comes to adaptive capacity, the state must have a minimal capacity to perform many other diverse functions, and the reach of the state must cover the territory. Natural capital is always a part of larger complex social and ecological systems; thus, depletion of a natural resource can take many forms and also cascade through to other domains, undermining adaptive capacity. Finally, corruption also takes many forms, operating within the public or private sectors and in different dimensions of political, economic, and social life. Thus, deficiencies in the desired directionality of any of these five preconditions may operate via many mechanisms to undermine a country's performance outcomes.

As an illustration of an approach to assessing preconditions, see Table 15 Precondition Performance Illustration below and Appendix 3. For Table 15, researchers used ND-GAIN country indicators that map onto identified preconditions, analyzed each country in a recent year, and validated the results with indicators from other reputable sources. The findings illustrate an approach to using precondition constructs and suites of metrics that support them. Based on this



reduced measurement of the preconditions, we offer the following summary. On security and non-violence, perhaps the most fundamental feature of a functional state, all five cases rank extremely poorly. In Colombia, insecurity is largely a carryover of the long civil war. If the recently signed peace agreement holds, with former combatants entering the political process, there is hope for improvement [52]. In Haiti, by contrast, insecurity has very recently taken a turn for the worse [53]. Concerning the other measures of state capacity, all cases are above the bottom quartile except Haiti, which is in the bottom decile. Absence of corruption and inequality are extremely low in all of the selected countries, with the exception being corruption in Colombia, which is near the median. Finally, using deforestation as one measure of natural capital depletion, all of these cases, except Haiti, have lost large shares of their forests relative to 1990 baseline levels. In Haiti, which today has only 12.6% forest coverage, the forests had rapid decline between 1950-1980 [54]. It follows that this metric may be more useful for assessing nature capital with regard to forests when combined with forest area coverage data.

Table 15: Precondition Performance Illustration

Source	Indicator	Year	N	GTM	HND	NIC	COL	HTI
Precondition: Weak State Capacity								
ND-GAIN	Regulatory quality (gove_03)	2019	186	53%	63%	73%	29%	91%
FSI	Public service	2022	179	64%	68%	61%	56%	97%
Precondition: Insecurity								
ND-GAIN	Rule of Law (gove_04)	2019	188	86%	84%	90%	59%	82%
ND-GAIN	Stability/Nonviolence (gove_01)	2019	188	73%	71%	86%	84%	79%
FSI	Security Apparatus	2022	179	73%	77%	62%	74%	70%
Precondition: Corruption								
ND-GAIN	Corruption (gove_02)	2019	186	80%	75%	87%	48%	91%
TI	Corruption	2021	179	83%	87%	91%	48%	91%
Precondition: Inequality								
ND-GAIN	Inequality (soci_01)	2019	149	87%	96%	79%	91%	98%
FSI	Inequality	2022	179	70%	68%	72%	66%	98%
Precondition: Natural Capital Depletion								
ND-GAIN	Freshwater withdrawal (wate_03)	2019	172	31%	24%	14%	9%	53%
FAO FRA	Forest Area Δ (2020-1990)	2020	180	93%	82%	99%	79%	63%

NOTE: Cell values are percentile rankings in a sample of size reported in column N; light red indicates a ranking in the bottom quartile; dark red is a ranking in the bottom decile.

Discussion of Critical Drivers

As indicated in Analysis Section 4.2.1, critical drivers of adaptive capacity are those subconstructs that were highlighted either for their frequency or for the strength of their relationship with building adaptive capacity. The following is a summary of core findings for our critical drivers.

Income refers to regular sources of income such as salary, as well as other potentially less consistent sources such as remittances or service payments. Payment for Environmental/Ecosystem Services (PES) schemes, which have had success in locations such as



Costa Rica, represent forms of income that promote positive outcomes such as reforestation and reduced soil erosion [55]. PES can provide occupational flexibility if environmental aims align with community or household aims. Income can be ambiguous for adaptation: while stable income can help to generate wealth, which offers a buffer to disasters, it oftentimes indicates only short-term coping [56]. Lack of sources of income can lead to violence, particularly in regions where rebel groups are one of the few livelihood options. Overlapping with insufficient preconditions, a weak state makes it difficult to build government resources through taxes and other revenues necessary to fund stabilizing programs [14]. Also, without oversight, and in the presence of a weak state, income can lead to negative outcomes through corruption.

Occupational flexibility refers to the ability of local economies or landscapes to provide alternative and supplemental sources of income to households. This provides redundancy that may stabilize a household during periods of disruption in one area. At the national level, flexibility is reflected in economic complexity or diversity - the national economy is more resilient if the GDP is not reliant on only a few sectors [57]. Although this is well known at the national level, it is also true at the local and household levels. In regions with economic diversity, investments in skill training opportunities can build adaptive capacity at the household level, but these opportunities are sometimes not equally accessible by gender [58].

This construct is difficult to measure for a variety of reasons. For example, some occupational flexibility is seasonal; farm work, for example, largely depends on the harvest season [51]. Also, extractive sectors such as mining, which can have long-term harmful effects to resilience, can be seen as temporarily positive for the other opportunities they provide [14]. Similarly, animal assets can be an additional source of livelihood and provide short-term positive flexibility, as when livestock is sold by a crop farmer during times of drought, but it may be maladaptive in the long-term by reducing assets [59]. Further complicating our understanding, migration is generally viewed as a failed adaptation but can also be viewed as positive occupational flexibility, as it reflects the ability to migrate for labor and send remittances home [15].

Socio-ecological networks are collaborative efforts to facilitate cooperation and social learning about shared ecological resources. Network participants, whether individuals or institutions, build relationships through shared experiences and peer-learning. These networks are important for: 1) knowledge distribution, such as sharing agro-ecological practices for agriculture, 2) support provision, such as granting access to capital in times of need, and 3) political mobilization [15]. Existing community ties/social capital is vital for mutual humanitarian support during and after extreme climate events [56]. Once in place, these networks can be leveraged to make important programs and interventions more effective, like through payments for ecosystem services [60]. When combined with the function of cooperatives, these networks can also help smaller producers compete with larger ones [15]. Large, international networks can also build information capacity between two or more countries that are facing similar challenges due to climate change (i.e., the Dry Corridor in Central America).



Examining this work through case studies, USAID shows that for REDD+ (Reduced Emissions from Deforestation and Forest Degradation) to work, networks must be built or leveraged; it requires active participation of entire communities [58]. When existing networks are damaged, such as by forced migration, communities and individuals have less adaptive capacity and will find it more difficult to survive economically. Some industries, such as mining and logging, can change the social fabric of communities as they impact socio-ecological networks [14].

Infrastructure, for our purposes, broadly refers to the set of investments, policies, facilities, and organizational structures needed to support a well-functioning society. It contains elements that support trade and transport (e.g., roads), communications (e.g., Information and Communications Technology (ICT)), water and drainage (e.g., irrigation), and health (e.g., hospitals). Investments in infrastructure broadly can build adaptive capacity. For example, ICT infrastructure is important for development but can also enable community humanitarian support and coordination during disasters [61], sometimes without government involvement [4]. Water infrastructure, such as potable water tanks, can also have a positive effect on gender dynamics due to the gendered nature of water-related tasks like gardening and washing [59]. In agricultural areas, enhanced infrastructure for irrigation is important for adaptation; for example, lack of agricultural infrastructure in the Dry Corridor was implicated multiple times for negative outcomes in the cases reviewed [62].

Access to capital includes a broad range of security and wealth-building practices, facilitation, and supports. This includes access to microlending, microgrants, and livestock, investments in agricultural inputs, insurance schemes, reducing barriers to access, and the presence of intermediaries serving lending, learning, and equipment hubs. Lack of access to capital limits investment in land, which can lead to degradation and erosion [11]. Further, because credit can be tied to land titles (disproportionately affecting women, who often cannot own land), access can often be inequitable and deepen existing disparities [59]. A lack of insurance for assets can push people into poverty following a disaster [3]. This can trigger community impacts, such as a short-term focus on human capital (e.g., increasing child labor), which can have negative long-term impacts (low education rates for children).

Wealth refers to savings accounts, land, and other assets (buildings, animals, etc.) that can be used to insulate a household from climate events. This serves as a buffer, preventing a disruption from becoming a humanitarian disaster. Livestock is a common asset in our target countries [59]. Livestock can serve as an asset that is sold in times of need, but it is more often used to create income for the owners, so selling without restocking can be maladaptive. At the community level, a community with wealth can provide resources to those in need – such as donations of food, blankets, and health products for the displaced after a specific disaster [4]. Not having wealth or savings at the household and/or community level can start a vicious cycle that leads to extreme poverty.



Geographic flexibility refers to the willingness and ability of a person or community to relocate (this may include government efforts to manage internal displacement from hazardous regions) [7]. However, people tend not to move from risky areas until they are guaranteed new places to live [63]. This means that vulnerability dramatically increases when few settlement options exist for particular groups [11]. In some countries, communities can be found located on slopes with high flood/landslide risk for lack of better available options (Haiti), whereas, in other regions, geographic flexibility is reduced by violence and conflict [64]. In building geographic flexibility, geographic variation and small climate shocks, when present, are not always negative. Variation can act as insurance when facing flooding and/or landslides, as the entire community will not be affected by those events [7]. Small climate shocks (heavy rains, tropical storms, etc.) combined with geographic flexibility can increase resilience and preparedness over time.

Access to land includes physical access for the purposes of settlement and food production, but also legal rights to land through forms of land title. The latter is vital to building resilience in communities. Land is usually rented through debt, creating a cycle of poverty when farmers cannot make payments during a bad harvest [65]. Moreover, land tenants often have little incentive to practice sustainable land management, thus leading to greater land degradation [60]. But even with land ownership, low-income farmers may over-farm to pay back debts, degrading soils, especially if they can externalize the initial costs to those downstream. Payment for Environmental Services (PES) schemes can be useful for supporting adaptive capacity aims, but land ownership is critical for PES to be successful [60]. Cooperative ownership can also facilitate this. For women, cultural norms can act as a barrier to land ownership and perpetuate vulnerability [59]. A final important land access consideration is that, when there is low/no availability of land for settlement, or people are pushed out due to economic drivers, homes are often built-in disaster-prone areas [63].

Bureaucratic capacity includes a broad range of functions and capacities within government to plan, support, and coordinate across levels and agencies in the delivery of services and the enforcement of regulations. Coordination between agencies at every level is essential, as they not only enable co-planning but also allow for co-implementation of interventions via different social networks and channels every agency possesses (e.g., the World Food Program gets access to specific schools only by working with local authorities) [70]. Since adaptive capacity happens at the local level, it is necessary for governments to create tools and capacity in those administrative bodies, enhancing cross scale coherence and technical assistance [66]. In cases where there is very little state capacity and coordination, like Haiti, knowledge gets lost, which can lead to duplication of efforts or no efforts whatsoever [67]. At the same time, too many bureaucratic procedures can be burdensome. For example, procedures to show proof of victimhood for people affected by natural disasters, which place responsibility on applicants. Certain preconditions also hamper bureaucratic effectiveness, such as cultural norms of inequality or violence. Laws, even if enforced, cannot function as intended if existing established cultural practices override them, e.g., through gender biases [59]. And when violence is present, no matter the bureaucratic effectiveness



of a state, it can destroy the networks that state and international agencies painstakingly help to build in and with specific communities [7].

Community empowerment refers to the capacity, willingness, freedom, and authority/influence of a community and its members to actively shape their future, including by managing their resources. Ensuring participatory processes and co-management of program activities are in place makes long-term program sustainability more likely [56]. Such an approach develops better understanding of the community and how to best target resources, while generating trust within the community; this also opens the possibility of future interventions [60]. In the document review, there are multiple examples of how engaging the community in shaping a project generates ownership and sustained efforts [56]. An organized community with positive leadership is key to mobilizing resources and support when a disaster hits [11]. Interventions emphasizing technical solutions without capacity building are more dependent on the top-down support of the state, but the state cannot always react in a timely manner.

Empowerment is not an unambiguous good, and who is empowered and how at the local level matters. Consultation, even at the grassroots level, does not automatically lead to successful projects [56]. For example, empowering certain constituencies can lead to insufficient taxation, hampering state capacity [68]. Sometimes the community may prioritize objectives that do not support long-term resilience. For local politicians, there are also not many electoral incentives to make investments in disaster risk prevention [7]; potentially more damaging, those involved in illegal activities such as mining can successfully bribe authorities not to enforce environmental standards [14].

Climate and disaster planning refers to when government bodies at the national, subnational and/or community levels have developed plans for managing climate adaptation and/or disaster response. An important first step in assessing this factor is to ascertain if there are any government offices/ministries focused on climate change or disaster [69], and whether they have an actionable climate, adaptation, or disaster management plan. In addition, funding needs to be allocated for the execution of the plan or to finish planning, if incomplete [7].

The full framework for climate and disaster planning is complex. It is critical that plans at different levels of government are coordinated with each other and that relevant organizations are in communication to enable knowledge flows. This requires community engagement in the co-creation of climate/disaster plans to improve quality and effectiveness [66], including those most vulnerable, as these groups are often left out of planning. Useful tools exist for successful development, such as the Sendai Framework for Disaster Risk Reduction (DRR), an internationally recognized platform that can create buy-in from community leaders [7]. Corruption, however, can render the DRR approach ineffective. In particular, agencies involved in the execution of the plan should build public trust or risk being ineffective.



Learning reflects the capacity of people and/or communities to recognize change, attribute this change to causal factors, and assess potential response strategies. Learning is necessary to increase flexibility, whether for individuals, communities, or institutions. Peer-learning networks (such as socio-ecological networks) can enhance learning at multiple scales, even among states at the international level [70]. At the local level, it can provide a structure for sharing strategies for better agricultural practices or resource use or for disseminating technical training provided by an intermediary organization such as a local cooperative [71]. Learning is enabled by information, and insufficient information capacity is often a barrier to progress, especially at the local scale [70]. Without information capacity, an institution or local government cannot understand, predict, or respond well to change. Technical assistance from higher levels of government to other agencies or organizations can enhance learning by providing local monitoring tools or approaches to change management. Learning is connected to community empowerment because it increases the capacity of locals to be aware of issues and use information. ICT infrastructure can facilitate learning: it can provide capacity for information access, as well as for data collection/analysis and enhanced technical assistance [70].



Definition: Inequality broadly refers to the unequal distribution of resources, power, and economic opportunity among different groups of people. Social inequality refers to income and wealth, as well as in the access to public services and resources. Sex/Gender and racial inequality refers to social, political, and economic inequality on the basis of sex/gender or race. In many cases, people experience more than one form of inequality.

Rationale: Extreme inequality affects both internal displacement and external migration, as well as inhibits progress with regard to many of the drivers. Persistent inequality underscores challenges with the organization construct at the national level and, like natural capital, can take on dysfunctional system patterns that are reinforcing.

Literature Highlight:

“As with most other existing vulnerabilities, the pandemic and 2020 Atlantic hurricane season created deeper gender inequalities in El Salvador, Guatemala and Honduras and disproportionately affected women, girls and members of the LGBTIQ+ community.” [12]

6 PRECONDITION: INEQUALITY (ECONOMIC, GENDER, RACIAL)

Existing Indicators

Below is a list of existing indicators that support measurement of inequality.

- Uneven economic development
- Income distribution inequality based on Gini coefficient in Latin America as of 2018, by country
- Gini coefficient
- Gender Inequality index
- Unpaid Working Time of the Population for ages 20 to 59 by Own Income and Sex
- Racial Inequality
- Select indicators for racial, ethnic, and gender inequalities - focus on Indigenous and Afro-descendant peoples
- Human Development Index

Limitations of existing measurement

Although measures for gender and income inequality are generally robust, information on racial, ethnic, or other discrimination-based (e.g., Indigenous) inequality measures remain sparse. While racial politics differs from country to country, colonial legacies have real consequences for marginalized groups. As with other constructs, information at the regional/subnational level is necessary for decision-making and monitoring investments at the scale of impact.

Potential Measures

Below is a list of suggested metrics that support measurement of inequality:

- Regional/subnational data on the above measures
- Data on geographic inequality and its relationship to racial inequality
- National data on the access to public services for Indigenous and Afro-descendant groups
- National data on the distribution of income to Indigenous and Afro-descendant groups



Definition: The prevalence of violent acts that are state-sponsored, non-state sponsored, and/or domestic based that are perpetrated upon people based on geographic location (gang activity), gender/ethnic identity, income level and/or occupation type, or some other affiliation. Violent acts include homicide, assault, and terrorism.

Rationale: The presence of violence, either state sponsored, non-state sponsored, and/or domestic based is a main driver of internal and external migration in the five target countries. Violence also precludes or complicates national and international aid efforts.

Literature Highlight:

“... large numbers of conflict- displaced people (an estimated 15% of the country’s population is internally displaced) are highly vulnerable, with scant protection against the devastating effects of disasters. Colombia’s conflict-affected poor are forced to live in locations that increase their exposure to natural hazards.” [7]

7 PRECONDITION: ABSENCE OF VIOLENCE

Existing Indicators

Below is a list of existing indicators that support measurement of violence.

- FSI Security Apparatus
- Political Stability and Absence of Violence/Terrorism
- CPJ Global Impunity Index
- UN Femicide metric
- Intentional homicide
- WJP Rule of Law Project
- Organized Crime Index

Limitations of existing measurement

Some existing measures are based upon reported instances of violence within the target countries; since not all violent acts will be reported to authorities due to fear of retaliation, these numbers may be underestimated. In addition, data is mostly provided at the national level, which does not allow for understanding subnational inequities, impacting adaptation efforts.

Potential Measures

Below is a list of suggested metrics that support measurement of violence:

- Departmental level data on violence
- Security apparatus budgets (national and subnational)
- Violence against women metric*

*Current data for all five countries is incomplete, so metric taken from Pan American Health Organization



Definition: Weak State refers to a constrained size/presence of the government, which is manifest in ways such as the inability to tax and spend, to maintain the rule of law, or to provide essential services. This definition is expansive and encompasses limited government at both the national, subnational and local/community levels.

Rationale: For the state to enact, enforce, or facilitate efforts that build adaptive capacity in a local area, it must have a minimal degree of presence in an area (e.g., in the form of an agency and employees) and funding to implement and maintain efforts. For example, while bureaucratic capacity at the national level may ensure allocation funds to support the victims of climate events, these funds are unlikely to be properly distributed in areas historically neglected by state presence. Similarly, enacted environmental protections cannot be enforced in areas over which the state has little control.

Literature Highlight:

“...in those far-off places with weak state presence... people don’t report crimes (illegal mining), because they feel threatened.” [14]

8 PRECONDITION: ABSENCE OF WEAK STATE

Existing Indicators

Many of the indicators that represent Bureaucratic Capacity (see other construct) are also representative of the Weak State construct, since Bureaucratic Capacity is functionally nested within it. Below is a list of existing indicators that support measurement of weak state.

- Security Apparatus
- Public Services
- Uneven Economic Development
- State Control over Territory
- General Government Total Expenditure

Limitations of existing measurement

Measures for this construct are appropriately primarily at the national level. Nonetheless, disproportionality can exist in the degree to which the strength of the state is expressed in particular areas. Subnational and local measures can provide greater understanding of distribution of strength.

Potential Measures

Below is a list of suggested metrics that support measurement of weak state:

- Subnational Rule of Law statistics
- Government Spending per capita at the departmental and the municipal level



Definition: Natural capital includes assets from nature that can provide environmental services and livelihoods at the household level or inputs for economic production at the national level.

Rationale: Natural capital is the basis for ecosystem services and can be leveraged for well-being if managed for sustainability. Low levels of natural capital stocks can leave a region vulnerable and produce system patterns of reinforcing feedback loops of negative social and environmental outcomes also known as a vicious cycle. This can serve as a driver to migration.

Literature Highlight:

“(Rivers) play a fundamental role in securing their livelihoods, traditionally based on subsistence agriculture, fishing and alluvial gold mining; they are fundamental for their water supply and sanitation; and they provide the main form of transportation, which is essentially fluvial in the whole department.” [14]

9 PRECONDITION: NATURAL CAPITAL

Existing Indicators

Below is a list of existing indicators that support measurement of natural capital. Most of these indicators are at the national level and sourced from the World Bank.

- Fish species, threatened
- Plant species (higher), threatened
- Terrestrial and marine protected areas (% of total territorial area)
- Land area (sq. km)
- Land area where elevation is below 5 meters (% of total land area)
- Arable land (% of total land area)
- Agricultural land (% of total land area)
- Agricultural irrigated land (% of total agricultural land)
- Forest area (% of total land area)
- Annual tree cover loss by dominant driver
- Location of tree cover loss
- Deforestation drivers
- Agriculture, forestry, and fishing value added (% of GDP)
- Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

Limitations of existing measurement

Existing measures are not at a scale that allows those monitoring to know whether chronically stressed regions of a country are disproportionately losing natural capital and entering into a self-reinforcing destructive pattern. Ideally, relevant measures from this list would be at or near the scale of intervention.

Potential Measures

As noted, measures for natural capital are ideally at the subnational to local level. Suggested measures at that scale are listed below:

- Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
- Arable or agricultural land (is the region losing potentially farmable land to desertification or other threats)



Definition: Corruption broadly refers to public power being exercised for private gain, including both petty and grand forms of corruption, as well as ‘capture’ of the state by elites and private interests.

Rationale: Persistent corruption in a system of governance creates barriers to adequately organizing and responding to problems. Corruption can impact aid, development assistance and investment as well as other preconditions and critical drivers, creating dysfunctional system patterns and a vicious cycle of decline.

Literature Highlight:

“Patronage and clientelism hamper efforts to pursue effective Disaster Risk Reduction (DDR) across the country and corruption undermines government functioning across the board...affects all stages of DRR, from the diversion of response funds through to mismanagement of land zoning. Irregularities in the distribution of disaster response aid have been documented...while political interest influences the willingness and ability of subnational entities to enforce land-use policies.” [7]

10 PRECONDITION: ABSENCE OF CORRUPTION

Existing Indicators

Below is a list of existing indicators that support measurement of corruption.

- Executive oversight (Berggruen Report, V-DEM)
- Control of Corruption (World Bank)
- Corruption Perceptions Index (Transparency International)

Limitations of existing measurement

Scholars and practitioners have found it difficult to measure corruption precisely because it is often hidden. Limitations of current corruption measures include that it relies on analysis based on the law (executive oversight) and public sector perceptions of corruption. Neither stipulated powers nor perceptions, however, provide full accounting; thus, it is likely underestimated. Furthermore, national measures of corruption may be generally low, while there may be large regional/subnational differences in the prevalence of corruption.

Potential Measures

Below is the suggested metric that supports measurement of corruption:

- Frequency of external audits at the subnational level for international investments



Definition: Income includes regular sources of household revenue such as salary, and other routine but less frequent sources such as remittances. In terms of higher scales, we can think of this as tax income for the state, oil revenues, etc.

Rationale: Reliable sources of income allow for a household and region to meet basic needs, but also plan and stabilize. This can provide the opportunity for wealth creation, which serves as a buffer for disruptions, such as a climate event.

Literature Highlight:

“The variability of production is very important for the families because it represents their principal income (on average 50 to 65%) and they depend on this income for food security, health and education.” [15]

11 DRIVER: INCOME (ASSETS)

Existing Indicators

Below is a list of existing indicators that support measurement of income.

- Personal remittances, received
- Gross National Income (US\$)
- Adjusted net national income per capita (current US\$)
- Tax revenue (% of GDP)
- Poverty headcount ratio at \$2.15 a day

Limitations of existing measurement

Existing data is generally at the national level. Data at the national scale potentially obscures differences between regions and the ability to measure the impacts of interventions. For target areas, subnational data that tracks one or two critical income measures, such as remittances or income at the appropriate scale, allows for better information for investment and the impacts of investment.

Potential Measures

Below is a list of suggested metrics that support measurement of income. These are suggested measures at the regional, subnational, and department-level scales.

- Personal remittances, received
- % of income from dominant crop
- Routine assistance (e.g., food)
- Routine payment (e.g., payment for environmental services)



Definition: Occupational flexibility refers to the ability to move between livelihoods or survive off multiple sources of income at the household level. At the community or subnational level, it is diversification in the economy or sources of livelihood.

Rationale: Having the flexibility to transfer or supplement occupations allows for a household to adjust to sudden or slow-onset shocks from a variety of sources such as climate events, pandemics, wars, and food supply disruptions. This provides stability by allowing alternative means of generating income.

Literature Highlight:

“In general, traditional agro-ecosystems are less vulnerable to catastrophic loss because the wide variety of crops and various spatial and temporal arrangements show compensation in case of loss.” [15]

12 DRIVER: OCCUPATIONAL FLEXIBILITY (FLEXIBILITY)

Existing Indicators

Below is a list of existing indicators that support measurement of occupational flexibility.

- Universal Economic Fitness (World Bank, Economic Complexity)
- Unemployment, total (% of total labor force)
- Employment in agriculture (% of total employment)
- Population ages 15-64 (% of total population)
- Male employment in agriculture (% of total male employment)
- Female employment in ag (% of total female employment)
- Employment in services (% of total employment)
- Employment in industry (% of total employment)
- Unemployment with basic education (% of total labor force)
- Unemployment with intermediate education (% of total labor force)
- Unemployment with advanced education (% of total labor force)

Limitations of existing measurement

Occupational flexibility is inherently difficult to measure. As such, current measures may only give potential insights on occupational flexibility if taken together, but the number of sectors, the complexity of the economy, and the level of unemployment despite education levels are indicators of economic health, not flexibility. What existing measurement lacks is information about whether the state is committed to producing occupational flexibility (e.g., from land reforms laws, government retraining programs, education, etc.) and whether people are actually flexible to access new options. Moreover, as with other issues, unemployment or loss of livelihood is felt at the household to community level; national metrics do not capture distributional differences in occupational flexibility. Economic and livelihood diversity is a critical measure, but ideally at the regional/subnational levels.

Potential Measures

Many of the above metrics at the regional/subnational levels would be useful. Below is a list of additional metrics that support measurement of occupational flexibility.

- Regional/subnational economic diversity
- National programs for retraining in local region (binary)
- Retention rates for national programs for retraining
- Technical and vocational colleges in local region (binary)
- Number of agricultural workers affected by land reform policies



Definition: Collaborative or network governance for managing shared resources to facilitate coordination and social learning. This form of management can include combinations of resource users, NGOs, or governments.

Rationale: Collaborative or network governance as Social-Ecological Management Networks can provide opportunities for dissemination of new practices, interactive learning, and cooperative management. Strong social-ecological management networks in a community can lead to better environmental and conservation outcomes, thereby creating a local framework for community development without degrading the environment.

Literature Highlight:

“During the early 1980’s, the Farmer to Farmer movement spread to Mexico, Nicaragua and Honduras, where communities were organized to promote sustainable agricultural techniques such as soil conservation, in-row tillage, crop residue management, cover crops, agroforestry, companion planting and use of organic fertilizers.” [11]

13 DRIVER: SOCIAL-ECOLOGICAL MANAGEMENT NETWORKS (ORGANIZATION)

Existing Indicators

Researchers were not able to locate reliable existing metrics for this construct. Given that such networks are more sustainable with a convenor, however, measures of **enabling entities** would include measures of *Bureaucratic capacity at the subnational level* and the presence of *regional cooperatives*.

Potential Measures

Support for enabling entities such as cooperatives may lead to the development and monitoring of social-ecological management networks in critical regions.



Definition: Infrastructure broadly refers to the set of investments, policies, facilities, and organizational structures needed to support a well-functioning society. This includes physical infrastructure as well as human and social.

Rationale: Dependable physical and social infrastructure not only facilitates regional development, but provides response capacity and safeguards during periods of disruption, such as from a climate event. This supports stability in a region.

Literature Highlight:

“The (radio) station collected information from listeners who called in on their cell phones to report landslides, overflowing rivers, collapsed houses, and families in need of rescue.” [4]

14 DRIVER: INFRASTRUCTURE (ASSETS)

Existing Indicators

Below is a list of existing indicators that support measurement of infrastructure.

- Paved roads (Infrastructure)
- Quality of roads
- Investment in energy with private participation (current US\$)
- Individuals using the Internet (Communication/ICT (ICT Infrastructure) (World Bank)
- Current health expenditure (% of GDP)
- Economic Complexity (OEC)
- Access to electricity (% of population)
- Adequacy of social insurance programs (% of total welfare of beneficiary households)
- Adequacy of social safety net programs (% of total welfare of beneficiary households)
- *Investment in ICT with private participation (current US\$)
- Global Connectivity Index
- Global Health Security Index

Limitations of existing measurement

As noted with regard to previous measures, national level measures do not provide information on disproportionality of investments. With regard to critical regions in a country, subnational measures are preferable.

Potential Measures

Subnational measures of investments and facilities should include, at minimum:

- Quality of roads
- Access to electricity
- Communication/ICT infrastructure



Definition: Access to Capital includes a broad range of security and wealth building practices, facilitation, and supports. This includes microlending, microgrants, livestock, investments in agricultural inputs, insurance schemes, reducing barriers to access, and intermediaries serving as lending, learning, and equipment hubs.

Rationale: Access to Capital was expanded from the original ‘Access to Credit’ construct given its purpose for building adaptive capacity and the range of means of fulfilling that purpose. Regular Access to Capital serves as both a means of stabilizing a disrupted region following a climate event as well as a means of building wealth during prosperity to provide a buffer for difficult times.

Literature Highlight:

“The experience of Christian Aid and CCD in the wake of Hurricane Mitch, providing loans to help poor people rebuild their homes and their communities, confirms its efficacy as an agent of change empowering women, giving families back their dignity, strengthening local organisations and providing solidarity... it can empower poor people by enabling them to design and implement their own disaster mitigation strategies, both physical and financial.” [13]

15 DRIVER: ACCESS TO CAPITAL (ASSETS)

Existing Indicators

Below is a list of existing indicators that support measurement of access to capital.

Microcredit/Microgrants:

- Number of all microfinance institution branches per 100,000 adults
- Presence of microcredit organizations
- Access to microgrants in region (binary)
- Access to animal wealth development (binary; regional measure)

Inputs as capital:

- Pesticide (FAO Trade, Import Value)
- Irrigated agricultural land (FAO)

Intermediary opportunities and barriers:

- Membership in CCRIF or similar (binary; protection of collateral)

Limitations of existing measurement

Existing measures are not at an actionable scale. Binary metrics at the regional level can be created to identify those organizations providing services in target regions. Several metrics related to reliability and access at the subnational level would be useful.

Potential Measures

Access to credit:

- Access to microcredit and/or microgrants in region (binary)
- US\$ per year in microgrants/credit in region
- Average, median, mode of US\$ microgrants/credit in region
- Payback rate (for microcredit)

Livestock as capital:

- Number of animals invested in region/value invested in animals

Inputs as capital:

- US\$ invested in fertilizers, pesticides, irrigation, etc.

Intermediary Opportunities and Barriers:

- Presence of cooperatives/third party organizations in region
- Percentage of cooperatives providing microcredit/grants
- Percentage of cooperatives providing access to technology
- Percentage of organizations requiring collateral
- Percentage of loans with no collateral required (including land title)
- Percentage of organizations with external oversight/certification



Definition: Wealth includes savings, land title, in addition to other forms of assets (stocks, buildings, animals, etc.)

Rationale: Wealth is critical to stabilizing a community or household following disruption, as well as for access to other goods and services through serving as collateral for credit, etc.

Literature Highlight:

“Shocks also undermine investments in assets. Major shocks can pose a financial burden on households, often forcing them to cut back on food and health care expenditures, thereby raising the risk of malnutrition and other negative effects on health.” [3]

16 DRIVER: WEALTH/SAVINGS (ASSETS)

Existing Indicators

Below is a list of existing indicators that support measurement of wealth/savings.

- Access to animal wealth development (binary)*
- Percentage of people with ownership or secure rights over agricultural land (out of total agricultural population), by sex
- Slum population
- Bank account ownership (% of population age 15+)
- Adjusted net savings per capita (current US\$)
- Stocks traded, total value (% of GDP)
- Household debt to income ratio (only available for Colombia)
- Membership in CCRIF or similar (binary; protection of wealth)
- Percentage of GDP spending on FEMA-type agency (protection of wealth)

*Operation region of Heifer International

Limitations of existing measurement

Subnational and community level data are nearly non-existent when it comes to measuring individual wealth or assets.

Potential Measures

Measures above would ideally be in the targeted regions of a country at the subnational level. Below is a list of suggested metrics that support measurement of wealth/savings:

- Access to animal wealth development (binary)*
- Percentage of people with ownership or secure rights over agricultural land (out of total agricultural population), by sex
- Slum/informal settlement population
- Household debt to income ratio
- Household net worth
- Household savings



Definition: The ability and willingness of a community to relocate. This may include government efforts to manage internal displacement from hazardous regions.

Rationale: In regions that communities are routinely subjected to climate hazards, the long-term, sustainable approach may be relocation. Nearly all climate hazard induced migration is unplanned, yet planned withdrawal from a specific hazardous area, for example a coastal region subject to flooding could provide for intentional resettlement and better outcomes.

Literature Highlight:

“...the hurricane forced the community to replant crops and rebuild housing away from low-land flood areas. Land was also reallocated in a way that benefited the rural poor. This region has is now less affected by similar future climate-related events.” [6]

17 DRIVER: GEOGRAPHIC FLEXIBILITY (FLEXIBILITY)

Existing Indicators

Below is the existing indicator that supports measurement of geographic flexibility.

- Planned migration/withdrawal blueprints for communities in national adaptation plans

Limitations of existing measurement

Migration/withdrawal plans for communities due to climate hazards are not common. Such plans mean government preparedness has to be proactive, rather than reactive, and include resources (land/relocation investments) for implementation.

Potential Measures

Below is a list of suggested metrics that support measurement of geographic flexibility:

- Perception of severity climate change (indicator of if people would willingly leave)
- Government expenditures for climate adaptation planning/implementation



Definition: Access to land includes physical access to land for the purposes of settlement and food production, but also legal rights to land through land title.

Rationale: Land rights and legal land title facilitates adaptive behaviors in the face of disruption, particularly by lower income populations - from indigenous communities to urban settlements. Among other benefits, formal land rights can enable the payment of environmental services (PES), opportunities for assistance for formal relocation, and access to credit.

Literature Highlight:

“Another concern is that due to lack of available land, many homes are being rebuilt in disaster areas. Some victims are being settled in makeshift shelters which are likely to remain permanently due to inability or unwillingness of governments to resolve long standing land availability problems.” [10]

18 DRIVER: ACCESS TO LAND (ASSETS)

Existing Indicators

Below is a list of existing indicators that support measurement of access to land.

- Property rights and rules-based governance
- Percentage of people with ownership or secure rights over agricultural land (out of total agricultural population), by sex (land title)
- Internal displacement
- Slum population

Limitations of existing measurement

For target areas, existing measures should be at the scale of the geography of interest.

Potential Measures

All of the measures above should be collected at the regional, subnational level.



Definition: Bureaucratic Capacity includes a broad range of functions and capacities within government to plan, support, and coordinate across levels and agencies in the delivery of services and the enforcement of regulations.

Rationale: Creating systems of effective response to climate events and proactive planning, investment, and enforcement for climate adaptation requires technical expertise, stability in institutional knowledge, and structures and resources for coordination, integration, and implementation. An effective bureaucracy also builds trust in government, which further increases the efficiency of efforts and investments.

Literature Highlight:

“The Ministry of Environment in Haiti is a relatively new institution and is still building its capacity to enforce environmental laws and regulations. Poorly defined or enforceable land-use strategies, complicated land-tenure issues, and poor water management systems leave Haitians at risk.” [8]

19 DRIVER: BUREAUCRATIC CAPACITY (ORGANIZATION)

Existing Indicators

Below is a list of existing indicators that support measurement of bureaucratic capacity.

- Public sector management and institutions cluster average
- Quality of public administration (CPIA)
- Quality of budgetary and financial management (CPIA)
- Property rights and rule-based governance (CPIA)
- Regulatory Quality
- Government Cohesion (coordination capacity)
- Bureaucratic remuneration (coordination capacity)
- Criteria for appointment decisions in the state administration (coordination capacity)
- Rigorous and impartial public administration (coordination capacity)
- Particularistic or public goods (coordination capacity)
- General government total expenditure (delivery capacity)
- Public sector theft (absence of) (delivery capacity)
- State authority over territory (delivery capacity)
- Transparent laws; predictable enforcement (delivery capacity)

Limitations of existing measurement

All of the data is at the national level; it would be important to have certain indicators for target areas as subnational data. Furthermore, the Country Policy and Institutional Assessment (CPIA) database does not include most of the target countries.

Potential Measures

The existing measures at the regional/subnational level for target areas would be helpful for informing and measuring investments - particularly those from the V-Dem database.



Definition: Community empowerment refers to the capacity, willingness, freedom, and authority/influence of a community and its members to actively shape their future, including managing their resources. Broadly, community empowerment is related to the degree of administrative, fiscal, and political decentralization, but also reflects feelings of freedom and safety to choose.

Rationale: Resilience and the ability to adapt to changing circumstances requires that people are able to have choice, power, and capacity to do so. Further, community empowerment affects agency; when people believe they have more control over impacts to their communities and households, they are more likely to take action.

Literature Highlight:

“Re-establish the operation of the local organization for emergency response and sustainable recovery through processes of empowerment and capacity building under the auspices of rights-based approach to “building back better.” [9]

20 DRIVER: COMMUNITY EMPOWERMENT (EMPOWERMENT)

Existing Indicators

Below is a list of existing indicators that support measurement of community empowerment.

- Global State of Democracy Index
- State Legitimacy
- Freedom of Expression Index

Limitations of existing measurement

As with some of the other constructs, community empowerment is inherently difficult to measure. Regardless of the scale, it conceptually aggregates several factors that impact the ability of communities or households to shape their future, many of which do not have existing measures. For those that do, some serve as only a limited proxy; for example, the measure associated with decentralization, state legitimacy, is based on perceptions rather than degrees of legal devolution of fiscal, planning, and implementation powers. Experiences of community empowerment may be characterized by geographic, ethnic/racial, and gender disparities, among others.

Potential Measures

Below is a list of suggested metrics that support measurement of community empowerment:

- Decentralization measures at the national and subnational levels (reporting structure, budget, personnel, decision-making authority)
- National/subnational surveys on resident perceptions of empowerment (engagement, freedom, sense of agency, etc.)
- Narratives on community experiences of empowerment and agency



Definition: Government bodies at the national, subnational and/or community level have developed plans for managing climate adaptation and/or disaster response.

Rationale: National climate adaptation and disaster response planning is essential for a country to be prepared for the effects of climate change. External/international organizations such as the United Nations Office for Disaster Risk Reduction, may be involved to support and leverage technical, financial, and organizational capacities across sectors toward this end.

Literature Highlight:

“Funding to actually deliver national and subnational risk management plans is lacking, and recovery, prevention and mitigation actions are not systematically implemented.” [7]

21 DRIVER: CLIMATE AND DISASTER PLANNING (ORGANIZATION)

Existing Indicators

Below is the existing indicator that supports measurement of climate and disaster planning.

- National adaptation plan (binary presence/absence)

Limitations of existing measurement

The presence of a national climate adaptation plan is a vital baseline, but the comprehensiveness of the plan, coupled with its ability to create effective policy changes and implementation, needs deeper investigation beyond a binary measure. Coordination between government agencies and resources often creates barriers in our target countries. As such, Bureaucratic Capacity should be considered in tandem with this measurement.

Potential Measures

Below is a list of suggested metrics that support measurement of climate and disaster planning:

- Third-party evaluation/external audits of climate plan goals and Indicators
- Budget of national disaster management body
- Regional implementation and funding of adaptation or disaster planning
- Shelters managed by disaster management body (distribution/number)
- Representation of vulnerable populations/groups in planning



Definition: Learning reflects the capacity of people and/or communities to recognize change, attribute this change to causal factors, and assess potential response strategies. Learning is related to several other subconstructs, particularly education and socio-ecological management networks. The capacity for learning is related to the access to and the quality of education, while management networks provide exposure to new knowledge and understanding from climate change impacts to new approaches to resource management.

Rationale: Without learning, neither individuals nor societies will be able to adapt to change. Adaptive capacity hinges on the capacity to learn from previous experiences, new information, and new approaches. The ability of communities and states to retain and manage information to inform its decision-making is central to learning capacity. With these and sufficient mechanisms for learning and integration of learning, better disaster and climate planning and implementation are enabled.

Literature Highlight:

“Farmers were trained to take measurements and analyze the condition of their soil and farms. They learned to make sketches and maps of their plots and to identify their positions in relation to the valleys and other topographic characteristics. They also became more familiar with both types of agricultural practices.” [11]

22 DRIVER: LEARNING (ACCESS TO AND CAPACITY FOR)

Existing Indicators

Below is a list of existing indicators that support measurement of learning.

- Government expenditure on education, total (% of government expenditure)
- Human Flight and Brain Drain (Information Capacity)
- Persistence to last grade of primary, total (% of cohort)
- People's Climate Vote (Knowledge about climate change in population)
- Children out of school (% of primary school age)

Limitations of existing measurement

Access and capacity to learn is not exactly the same as education and information capacity. Rather, integrating and using education and information for decision-making is what characterizes learning. Existing measures, like for most indicators, focus on the outcomes rather than process. Furthermore, extending a common theme for adaptive capacity, national indicators fail to provide information about the distribution of particular investments or outcomes. Target areas should develop regional/subnational data capacity to the greatest extent possible.

Potential Measures

Below is a list of suggested metrics that support measurement of learning:

- Cooperatives in local region (binary)
- Funding allocated for implementation of climate adaptation/disaster plans
- Number of post-climate event fatalities, by type, by location (annual measure)
- Number of displaced persons post climate event, by type, by location (annual measure)



23 DISCUSSION

Researchers approached the identification of key performance indicators (KPIs) by first exploring the current understanding and findings related to the key concepts foundational to adaptive capacity in the five target countries. An important strength of this approach is that it characterizes qualities needed for communities to be adaptive and resilient, regardless of whether those qualities have existing, sound measures. As such, our examination allows for a more conscientious use of existing metrics, an understanding of the limitations of the metrics with regard to building adaptive capacity, and the opportunity to build out additional metrics to better support the concept or construct underpinning adaptive capacity. This approach provides the user with more flexibility.

23.1 Limitations

This examination has limitations inherent to the approach. First, source documents are a potential cause of bias in the findings. With the intention of identifying robust constructs, as noted in the process section of Stage Two, researchers compared and triangulated findings from diverse source documents. Although we endeavored to reflect a range of document types, geographies, and timeframes, there can be trends in attention to particular issues or topics across sectors (agencies, NGOs, academia). This would potentially overrepresent the importance of a given topic in the source documents. Second, measurement is a potential source of error. Even when there are existing measures, there can be substantial challenges in operationalizing a construct well. Third, translation to investment is another limitation; there are challenges associated with moving from an important conceptual issue to meaningful investment domains within the constraints of a particular context. By this we mean that, even if we know constructs of importance (e.g., access to capital) and measures that represent positive change in that area (e.g., microlending rates in the local region), the complexity of socio-ecological systems makes it difficult to know where to intervene to best leverage investments. Further, the contextual subtleties of any community call for the equally nuanced application of information – e.g., what generally works for asset-building might look similar across countries, but how investment operates to build assets in particular locations may differ.

23.2 Considerations

Some themes extended throughout the constructs. For example, most intervention and outcome measures for building adaptive capacity would need to occur at a subnational scale. Although it may be important that minimum levels of preconditions or an enabling environment be provided at the national level, the subnational/local level experiences the impacts of disruption directly. Further considerations include the importance of contextual influences on the implementation of any investment. While the constructs may be generalizable (e.g., “access to capital”), interventions will need nuanced implementation models to fit the particular limitations of a context (e.g., gender inequity, form of capital, barriers to access, etc.). Again, a summary of the core findings for this work are provided in the analysis discussion (Section 4) and the construct pages (Sections 6-22).



23.3 Investment opportunities

Many of the constructs discussed represent systemic challenges. Nonetheless, strategic investment could leverage a variety of outcomes toward building adaptive capacity.

Community-based intermediary organizations such as cooperatives are able to serve a multitude of functions that provide benefits across nearly all of the adaptive capacity areas. Some countries and regions have existing cooperatives (e.g., coffee cooperatives) and even national or subnational organizing bodies for building and supporting cooperatives. For example, the *Federación Nacional de Cafeteros de Colombia* (*National Federation of Coffee Growers of Colombia, FNC*) has a stated mission and vision that supports economic and social development, while promoting environmentally sound practices. Their work includes research and technology transfer. Another organization, *Maximizing Opportunities in Coffee and Cacao in the Americas (MOCCA)*, operates in Guatemala, Honduras, and Nicaragua and is funded by the USDA. MOCCA's strategic priorities includes providing a range of services related to adaptive capacity, including access to financing, farmer training, and research and dissemination of best practices.

Intermediary organizations or cooperatives often already support access to markets, fair prices, and technical assistance through shared learning [72]. Reimagined with additional resources, capacities, and external audits, these entities could serve as a foundation for building out a range of functions that support adaptive capacity. Where they already operate, they might be able to expand their role, and, where they are absent, they can be encouraged, through funding and support, to move into new areas, while keeping independence from government.

- **Assets** (Income, Access to Capital, Wealth). Regions with existing cooperatives already serve the purpose of helping to build *income* by aggregating the crops of smaller farms for more competitive pricing. New or existing cooperatives could support income in a variety of contexts (e.g., forested regions) in other ways, such as serving as a conduit for Payment for Environmental Services (PES) where there are challenges to natural capital stocks. A cooperative could also be the hub of *access to capital*, whether through inputs such as seed or fertilizer, or distributing third-party microgrants or microcredit following a severe or slow onset weather event. It could also provide shared equipment (e.g., mechanical drying) that increases the viability of harvests but may be too expensive for single farmer investment. Finally, these stabilizing activities could help to prevent maladaptive behaviors that tend to reduce wealth long-term, leaving regions more vulnerable.
- **Learning** (Access to and Capacity for). Cooperatives have historically served as a channel for technical assistance, dissemination of best practices, and opportunities to learn about new inputs (e.g., drought resistant crops) [73]. A cooperative could also be a dedicated site for collecting regional data on the key activities of the cooperative itself. Without information at the scale of intervention, it is difficult to evaluate what works and to monitor changes over time.
- **Organization** (Socio-ecological Network Management, Climate Planning). With proper assurances to minimize corruption and monopolistic control over the organization, a



cooperative could also serve as a neutral convenor for socio-ecological networks. Codified from empirical case research, these have shown to be effective methods for managing shared resources, such as water. They have also been effective in promoting shared learning and disseminating best practices in managing natural assets [74]. Similarly, these organizations may be core partners in disaster response and climate planning implementation.

- **Community Empowerment.** Locally managed cooperatives with (international) third party certification/auditing (e.g., Fairtrade International) have the potential to increase capacity and influence regionally [75]. Increased voice in regional management may aid in building out deficiencies in state capacity from the bottom up.



24 APPENDIX 1: ND-GAIN KEY

Vulnerability Indicators (1=High Vulnerability)		Readiness Indicators (1=High Readiness)	
Indicator	Brief Description	Indicator	Brief Description
food_01	projected change of cereal yields	econ_01	doing business
food_02	projected population change	gove_01	political stability and non-violence
food_03	food import dependency	gove_02	control of corruption
food_04	rural population	gove_03	regulatory quality
food_05	agriculture capacity	gove_04	rule of law
food_06	child malnutrition	soci_01	social inequality
wate_01	projected change of annual runoff	soci_02	ict infrastructure
wate_02	projected change of annual groundwater recharge	soci_03	education
wate_03	fresh water withdrawal rate	soci_04	innovation
wate_04	water dependency ratio		
wate_05	dam capacity		
wate_06	access to reliable drinking water		
heal_01	projected change of deaths from climate change induced diseases		
heal_02	projected change in vector-borne diseases		
heal_03	dependency on external resource for health services		
heal_04	slum population		
heal_05	medical staff		
heal_06	access to improved sanitation facilities		
ecos_01	projected change of biome distribution		
ecos_02	projected change of marine biodiversity		
ecos_03	natural capital dependency		
ecos_04	ecological footprint		
ecos_05	protected biome		
ecos_06	engagement in international environmental conventions		
habi_01	projected change of warm periods		
habi_02	projected change of flood hazard		
habi_03	urban concentration		
habi_04	age dependency ratio		
habi_05	quality of trade and transport infrastructure		
habi_06	paved roads		
infr_01	projected change of hydropower generation capacity		
infr_02	projected change of sea level rise impacts		
infr_03	dependency on imported energy		
infr_04	population living under 5m above sea level		
infr_05	electricity access		
infr_06	disaster preparedness		



25 APPENDIX 2: CODEBOOK OF INDICATORS

1. GAIN INDEX SECTORS¹

ND-GAIN assesses the adaptive capacity of a country to cope or adapt to the impacts of climate change through outcome indicators within six life-supporting sectors: food, water, health, and ecosystem services.

1.1 WATER SECURITY

1.1.1 Drinking Water Access

- The capacity to deliver reliable domestic water supplies.
- Example: A household connection, public standpipe, borehole, protected well or spring, or rainwater collection. This includes metrics capturing desalinization, as it becomes widespread worldwide.

1.1.2 Water Dependency Ratio

- The proportion of the total renewable water resources originated outside the country.

1.1.3 Surface Water

Management, protection and use of any water that is accessed from the surface (e.g. rivers, streams and oceans, and includes dam capacity as an indicator).

1.1.4 Ground Water

Management, protection and use of any water that is accessed from the ground (includes freshwater withdrawal rate as an indicator)

1.2 FOOD SYSTEM SECURITY

1.2.1 Agricultural Capacity

- A combination of three indicators of agricultural technology, namely fertilizer use, areas equipped for irrigation, and pesticide use.

1.2.2 Aquaculture

- Fishing, Fish Farming.

1.2.3 Food Import Dependency

- Proportion of consumption obtained from imports (includes all kinds of crops & foods, e.g. meats and oils)

1.2.4 Crop Diversification

- Variety of crops being cultivated in a particular region, as opposed to monocultures.

1.2.5 Producer Diversification/Facilitation

- Variety of actors producing crops, as opposed to a monopolized sector (includes farmers & credit cooperatives).

1.2.6 Access to Food

- Sometimes an outcome of adaptive capacity dimensions, say the presence of assets in the form of wealth, can simply result in increased or sustained access to food.

1.3 ECOSYSTEM SERVICES

1.3.1 Ecological Footprint

- Deficit/surplus in land and water needed to meet a country's demand on ecosystem services.
- Example: A country with a surplus (more supply than demand) has capacity to produce more from within its boundaries, thus is likely to have more options to adapt to a changing climate.

1.3.2 Natural Capital Dependency

- Country's reliance on ecosystem services exposed to disruption by climate change.
- Examples: crop, pasture, forest (timber) (non-timber) and protected areas (Not Oil/Gas).

1.3.3 Biodiversity Protection

- Protecting the quality of the environment for continued ecosystem services (e.g. marine and terrestrial protected areas such as state parks). Includes protected biome and water quality measures as indicators.

¹ All sources for the concepts defined in this section stem from the original ND-GAIN Index. Only the health domain underwent significant modifications before coding.



1.3.4 Soil Degradation

1.3.5 Deforestation

- Includes not only loss of old forest growth, but also other kinds of forests such as mangroves.

1.4 HEALTH, QUALITY OF LIFE & WELLBEING

1.4.1 Public Services

- Defined differently from social investments at the precondition level, this is public services understood as outcome or push factors. For example, instead of education being key for a farmer to understand the connections between his actions and the environment, thus learning in the process (precondition or lead indicator), access to education would rather be understood as an actor migrating given the lack of schools in an area, likely related to a lack of a precondition itself (lack of infrastructure for example). Only use this code when public services are mentioned as outcomes of domains in a paragraph.

1.4.2 Economic Opportunity

- Defined differently from assets such as income or wealth in that it is not understood as a precondition for adaptive capacity but rather as economics working as an outcome/push factor. For example, a presence of arbitrary price-control policies producing a decline in industry and thus a lack of jobs could be understood as a category, say regulatory quality (lead) within the organization domain leading to a lack of jobs (outcome), and thus migration.

1.4.3 Internal Migration

- Defined as the internal displacement of individuals within a country. This is usually understood as a failed adaptive capacity outcome, given individuals are forced to change environments/abandon their homes and systems in order to survive. This project thus understands adaptation as bound within geographical boundaries.

1.4.4 Physical Health

- Includes minor and major injuries, in addition to death.

1.4.5 Mental Health

- Psychological well being.

1.4.6 Security and Violence

- Similarly defined as an outcome/pushed factor as opposed to its precondition counterpart.

1.5 PRECONDITION

- Code to be used when the presence/absence of an adaptive capacity domain is found, however not tied to any sector-specific outcome.

2. ADAPTIVE CAPACITY DOMAINS

Whether and how people respond to environmental change is widely recognized to be driven by their adaptive capacity, defined as the conditions that underpin people's ability to anticipate and respond to change²; to recover from and minimize the consequences of change; and to take advantage of new opportunities. Research has recently identified a broad range of determinants for adaptive capacity, organized in six dimensions/domains, ultimately deciding to retain 5. We understand domains of adaptive capacity to be lead indicators, meaning underlying variables that are either necessary or sufficient for the occurrence of an identified outcome indicator of adaptive capacity within a sector.

2.1 ASSETS

- People are more resilient to social-ecological changes when they can access a diversity of financial, technological, service-related (i.e., health care), and other assets in times of need.³

2.1.1 Income⁴

² Barnes, M. L., Wang, P., Cinner, J. E., Graham, N. A. J., Guerrero, A. M., Jasny, L., Lau, J., Sutcliffe, S. R., & Zamborain-Mason, J. (2020). Social determinants of adaptive and transformative responses to climate change. *Nature Climate Change*, 10(9), 823–828. <https://doi.org/10.1038/s41558-020-0871-4>

³ Ibid.

⁴ Ibid.



- Income includes regular sources of household revenue such as salary, and other routine but less frequent sources such as remittances. In terms of higher scales, we can think of this as tax income for the state, oil revenues, etc.⁵

2.1.2 Access to credit⁶

- Access to Capital includes a broad range of security and wealth building practices, facilitation, and supports. This includes microlending, microgrants, livestock, investments in agricultural inputs, reducing barriers to access, and intermediaries serving lending, learning, and equipment hubs.
- *Contains following subcodes from original codebook:* Insurance, Access to credit.

2.1.3 Access to Land⁷

- Access to land includes physical access to land for the purposes of settlement and food production, but also legal rights to land through land title.
- *Contains following subcodes from original codebook:* Land Title

2.1.4 Infrastructure (Physical and Human/Social)

- Infrastructure broadly refers to the set of investments, policies, facilities, and organizational structures needed to support a well-functioning society.
- *Contains following subcodes from original codebook:* Quality of Trade and Transport Infrastructure, Paved Roads, Social-Health Investments, ICT Infrastructure.

2.1.5 Wealth/Savings

- Wealth includes savings, land title, in addition to other forms of assets (stocks, buildings, animals, etc.)

2.1.6 Natural Capital

- Natural capital includes assets from nature that can provide environmental services and livelihoods at the household level or inputs for economic production at the national level.
- Example: A community may not make their livelihoods fishing from a river, yet they may want to use its beauty as a source of tourism by a community to gain income.

2.2 ORGANIZATION

- The way that society is organized can enable/inhibit resilience by influencing whether and how people share knowledge, cooperate, and access resources beyond their domain. This includes relationships at different scales, including social networks and institutions.⁸
- Examples: Recovering from natural disasters often requires individual people to help each other out and state agencies to coordinate relief efforts.

2.2.1 Social-ecological management networks⁹

- Collaborative or network governance for managing shared resources to facilitate coordination and social learning. This form of management can include combinations of resource users, NGOs, or governments.
- This definition comprises peer-to-peer alignment in addition to peer-to-peer learning in the context of environmental dependency. Such alignments need not take the shape of a formal network, but can also include informal relationships between peers.
- Example: Households sharing and building knowledge with each other about several different fish species and potentially their different ecosystem functions and/or parts of the ecosystem they inhabit. Households sharing information about a climate event and helping each other out during said event.
- *Contains following subcodes from original codebook:* Socio-Ecological Ties, Access to Markets.

2.2.2 Corruption¹⁰

⁵ Modified original definition to include larger scales of income such as taxes at the national level.

⁶ Ibid.

⁷ World Neighbors. (2000). Lessons from the Field: Reasons for Resiliency Toward a Sustainable Recovery After Hurricane Mitch.

<https://www.wn.org/wp-content/uploads/2016/12/LFF-Reasons-for-Resiliency-Toward-a-Sustainable-Recovery-After-Hurricane-Mitch.pdf>

⁸ Cinner, J. E., & Barnes, M. L. (2019). Social Dimensions of Resilience in Social-Ecological Systems. *One Earth*, 1(1), 51–56. <https://doi.org/10.1016/j.oneear.2019.08.003>

⁹ Barnes, M. L., Wang, P., Cinner, J. E., Graham, N. A. J., Guerrero, A. M., Jasny, L., Lau, J., Sutcliffe, S. R., & Zamborain-Mason, J. (2020). Social determinants of adaptive and transformative responses to climate change. *Nature Climate Change*, 10(9), 823–828. <https://doi.org/10.1038/s41558-020-0871-4>

¹⁰ GAIN



- Broadly refers to public power being exercised for private gain, including both petty and grand forms of corruption, as well as ‘capture’ of the state by elites and private interests.
- 2.2.3 **Bureaucratic Capacity**
 - Bureaucratic capacity includes a broad range of functions and capacities within government to plan, support, and coordinate across levels and agencies in the delivery of services and the enforcement of regulations.
 - *Contains following subcodes from original codebook:* Intersectoral Coherence, Technical Assistance, Cross-Scale Coherence, Professional Bureaucracy, Regulatory Quality/Government Effectiveness.
- 2.2.4 **Violence**¹¹
 - The prevalence of violent acts that are state-sponsored, non-state sponsored, and/or domestic based that are perpetrated upon people based on geographic location (gang activity), gender identity, ethnic identity, income level and/or occupation type. Violent acts include homicide, assault, and terrorism.
- 2.2.5 **Climate and Disaster Planning**
 - Government bodies at the national, subnational and/or community level have developed plans for managing climate adaptation and/or disaster response.
 - *Contains following subcodes from original codebook:* Climate Planning, Disaster Management Body.
- 2.2.6 **Inequality (Economic, Gender, Racial)**
 - Inequality broadly refers to the unequal distribution of resources, power, and economic opportunity among different groups of people.
 - Social inequality refers to inequality in terms of income and wealth, as well as in the access to public services and state resources.
 - Sexual and gender inequality refers to social, political, and economic inequality in terms of sex and gender. Gender and sex are related but different concepts: sex refers to biological attributes, while gender refers to socially constructed roles. Both sex and gender are composed of a spectrum, rather than a binary (i.e., there are more than two sexes and genders).
 - Finally, racial inequality refers to inequality on the basis of a person’s race. In many cases, people experience more than one form of inequality.
 - *Contains following subcodes from original codebook:* Social Inequality, Gender Inequality, and Racial Inequality.
- 2.2.7 **Weak State**
 - Weak State refers to a constrained size/presence of the government, which is manifest in ways such as the inability to tax and spend, to maintain the rule of law, or to provide essential services. This definition is expansive and encompasses limited government at both the national, subnational and local/community levels.
 - For example: The Choco in Colombia has been historically a region where authorities have not enjoyed resources to implement social policies, from schooling to hospitals.
- 2.3 **FLEXIBILITY**¹²
 - Flexibility reflects the capacity of individuals, communities and institutions to deal with change by being able to switch between strategies. It is closely related to having diversity in a system to provide a sort of “insurance” to prevent shocks from having catastrophic consequences.
 - Example: Households in Madagascar heavily involved in vanilla farming dealt with a 10-fold drop in its price by diverting to fishery. Flexibility is not only a function of the diversity of options (vanilla and fish) available but also reflects people’s ability and willingness to engage these alternatives.
- 2.3.1 **Occupational Flexibility**
 - Occupational flexibility refers to the ability to move between livelihoods or survive off multiple sources of income at the household level. At the community or subnational level, it is diversification in the economy or sources of livelihood.
 - Example: Move from managing one’s own plot of land to being a laborer at a plantation. At a larger scale, export diversification as opposed to dependency on oil (Dutch disease, etc).
 - *Contains following subcodes from original codebook:* Occupational Options.

¹¹ Ibid.

¹² Cinner, J. E., & Barnes, M. L. (2019). Social Dimensions of Resilience in Social-Ecological Systems. *One Earth*, 1(1), 51–56. <https://doi.org/10.1016/j.oneear.2019.08.003>



2.3.2 Geographic Flexibility

- The ability and willingness of a community to relocate. This may include government efforts to manage internal displacement from hazardous regions.
- Example: Planned withdrawal from a specific hazardous area, for example a coastal region subject to flooding.

2.4 LEARNING (Access to and Capacity For)¹³

- Learning reflects the capacity of people and/or communities to recognize change, attribute this change to causal factors, and assess potential response strategies.
- Learning is related to several other subconstructs. First, learning is substantially related to access and quality of education. Second, in the context of social-ecological systems, learning can help to build awareness of complex linkages and feedbacks between people and ecosystems that may help to build or erode resilience over time. Knowledge about climate change is also of importance; if people understand the existence and risks of climate change, they are more likely to take action. Learning is also related to the capacity and space for experimental knowledge. If the population is able to try new things (e.g., new technologies or types of seeds for agriculture), they can learn what are best practices. Finally, information capacity impacts learning. The ability of individuals, communities, and states to retain and manage information to inform its decision-making is central to learning capacity. For example, a state's scientific capacity would ideally allow for informed decision-making and information dissemination among the population.
- *Contains following subcodes from original codebook:* Education, Information Capacity, Knowledge of Climate Change

2.5 COMMUNITY EMPOWERMENT¹⁴

- Community empowerment refers to the capacity, willingness, freedom, and authority/influence of a community and its members to actively shape their future, including managing their resources. Broadly, community empowerment is related to the degree of administrative, fiscal, and political decentralization, but also reflects feelings of freedom and safety to choose.
- *Contains following subcodes from original codebook:* Devolution/Administrative, fiscal, political (de)centralization, Chooses/Active in decision-making, Power/Influence.

3. SUMMARY/DETAILS

3.1 PRESENT

- Adaptive capacity construct (lead indicator) is present in the analyzed text

3.2 ABSENT

- Adaptive capacity construct is not present in the analyzed text.
- Example: They refer to fishermen as not having technological resources in the form of fridges to store their fish. Hence, they are lacking an asset. As such, this is coded as asset, technology, but as absent.

3.3 LI POSITIVE

- Adaptive capacity construct is referred to as leading to a positive outcome in the analyzed case.
- Example: In the previous example, assets in the form of technological resources are mentioned in a negative context, hence (positive = 0)
 - If positive = 1; if not positive = 0

3.4 NEGATIVE

- Adaptive capacity construct is referred to as leading to a negative outcome in the analyzed case.
- This code is merely a different version of a "LI POSITIVE = 0".

¹³ Ibid.

¹⁴ Adapted from the "Agency" concept in Barnes, M. L., Wang, P., Cinner, J. E., Graham, N. A. J., Guerrero, A. M., Jasny, L., Lau, J., Sutcliffe, S. R., & Zamborain-Mason, J. (2020). Social determinants of adaptive and transformative responses to climate change. *Nature Climate Change*, 10(9), 823–828. <https://doi.org/10.1038/s41558-020-0871-4>



3.5 SCALE

3.5.1 Household

- May refer to an individual or a single family.

3.5.2 Community

- Small group of interconnected individuals.
- Example: Villages, Towns, Neighborhoods, Indigenous Communities, small municipalities (<20.000).

3.5.3 Local

- Large group of interconnected individuals at the municipal government level.
- Example: Large and medium cities (>20.000), ex, New York City, Cincinnati.

3.5.4 Subnational

- Group of individuals at the second-largest territorial-political level within a nation-state.
- Example: (Province, State, Department)

3.5.5 National

- Group of individuals at the largest territorial-political level within a nation-state. Also known as the state or country level.

3.5.6 Multiple Countries

- Affected group of individuals extends across nation-state boundaries.
- Example: Dry Corridor

3.6 QUOTE/EXAMPLE

- Code to be used when a particularly quotable phrase or clear and didactic example is found in text, and is thus “flagged” for possible direct use in the final report. An example may be a particularly good description of one of the categories within assets or any of the domains, a paragraph that refers to a more general trend found in the data (the relationship between two domains), etc.

3.7 INTERVENTION IDEAS

- Code meant to flag sections of documents where interventions/investment ideas are presented. Often, these cannot be coded using our normal coding arrangement because they don’t talk about what things or adaptive capacity dimensions are actually present/missing. However, they look into the future and might serve ODNI or us in writing the report and figuring out possible responses to what we see.

3.8 INDICATOR

- Code meant to flag mentions of interesting possible indicators for our categories. There are plenty of reports that not only mention adaptive capacity dimensions but also possible measures of these.
- Example: A measure of gender discrimination is mentioned as being female labor participation rates.

3.9 TEMPORAL PRECEDENCE

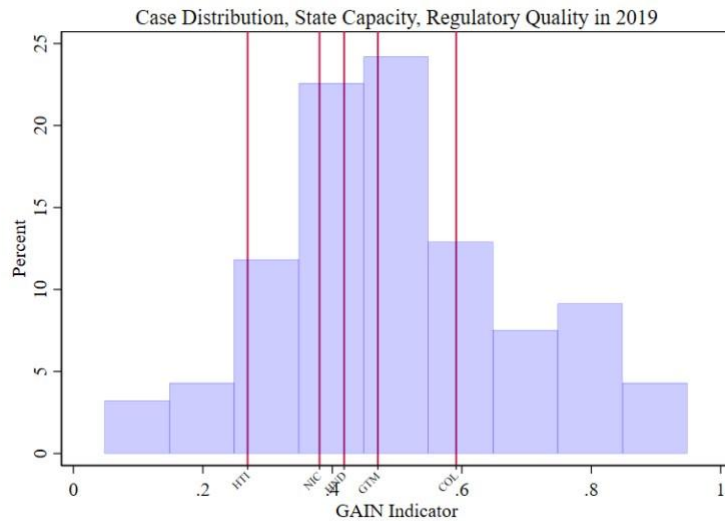
- An aim of the project is to be able to reconstruct the order in which variables, in this case domains of adaptive capacity, occur in order to produce an outcome. This code is to be used when a paragraph clearly mentions two or more domains of adaptive capacity, however in a causal sequence.
- When used, do explain the direction of the causal relationship briefly in the comments.
- Example: With organization (gender discrimination) out of the way, only then can women in a small rural area of Guatemala gain access to assets (land titles) and begin planting their own food (outcome).



26 APPENDIX 3: BENCHMARKING PRECONDITIONS

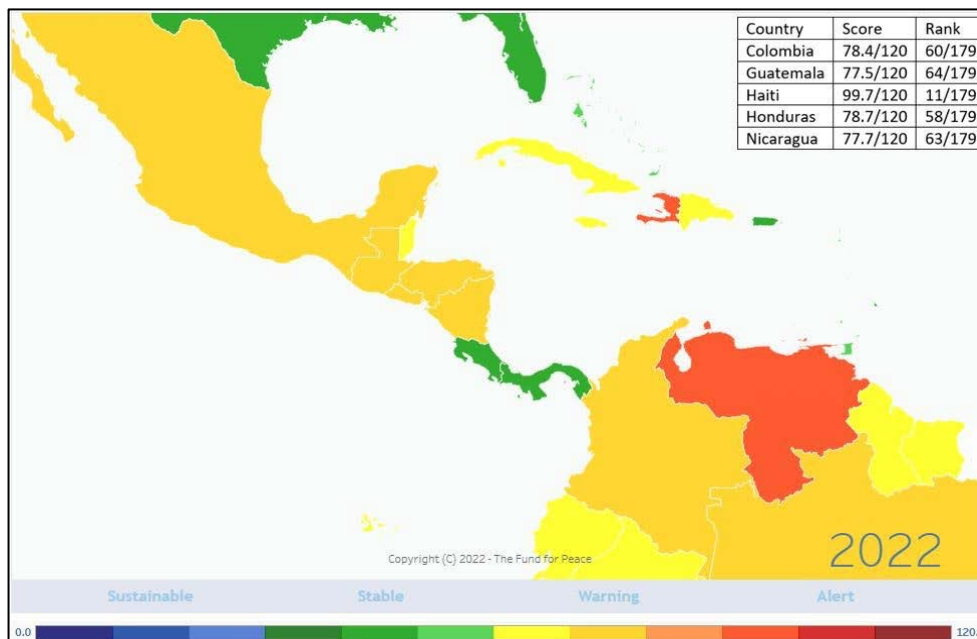
Weak State Capacity

- COUNTRY INDEX: GOVE_03: Regulatory quality (WGI)



NOTE: Haiti is in the bottom decile.

- The Fund for Peace: Overall Fragile States Index (FSI), 2022 This index evaluates a state's vulnerability to collapse across four dimensions: cohesion, economic, political, and social. Among the 179 countries rated by the FSI, Haiti is in the bottom decile, while all others are near or just above the bottom third.



- The Fund for Peace: Public Services indicator, 2022 This indicator considers the presence of basic state functions, the breadth of service provision.

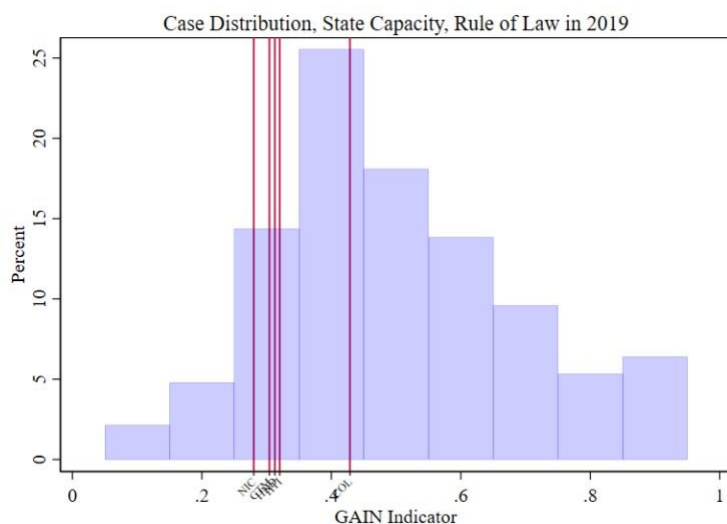


Country	Score	Rank	Percentile
Colombia	6.3/10	100/179	56%
Guatemala	6.9/10	115/179	64%
Haiti	9.7/10	173/179	97%
Honduras	7.3/10	122/179	68%
Nicaragua	6.6/10	110/179	61%

Among the 179 countries, Haiti is in the bottom decile; Guatemala, Honduras, and Nicaragua are near the bottom third; and Colombia is closer to the median.

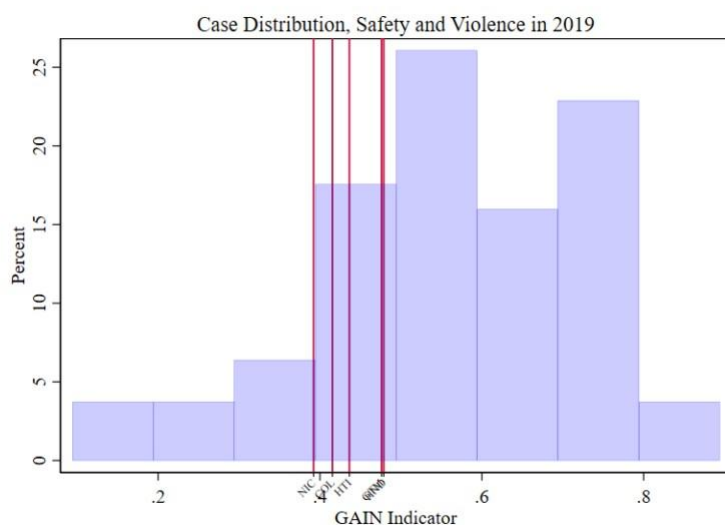
Safety and Violence

- COUNTRY INDEX: GOVE_04: RoL (WGI)



NOTE: Guatemala, Honduras, and Haiti are in the bottom quartile; Nicaragua is in the bottom decile.

- COUNTRY INDEX: GOVE_01: Political stability and non-Violence (WGI)



NOTE: Colombia, Haiti, and Nicaragua are in the bottom quartile.

- The Fund for Peace: Security Apparatus indicator, 2022

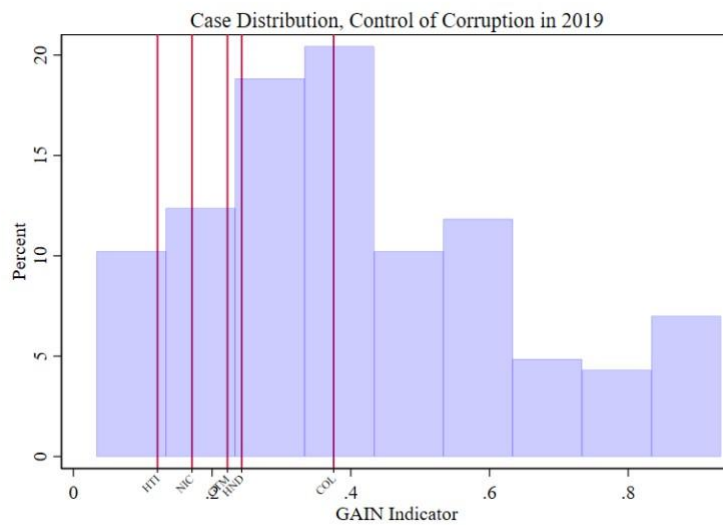
This indicator considers the security threats to the state, and also considers serious criminal factors perceived trust by citizens in domestic security.

Country	Score	Rank	Percentile
Colombia	6.6/10	133/179	74%
Guatemala	6.5/10	130/179	73%
Haiti	6.3/10	125/179	70%
Honduras	6.7/10	137/179	77%
Nicaragua	5.9/10	111/179	62%

Among the 179 countries, Nicaragua is near the bottom third, while others are around the bottom quarter.

Corruption

- COUNTRY INDEX: GOVE_02: Control of corruption



NOTE: Guatemala, Honduras, and Nicaragua are in the bottom quartile; Haiti is in the bottom decile.

- Transparency International: Corruption Perception Index (CPI), 2021

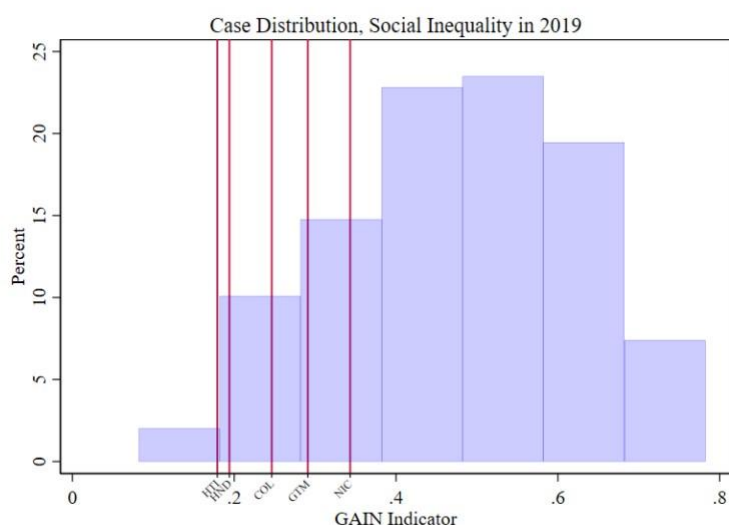
Among the 180 countries rated in the CPI, Colombia is near the median, while Guatemala and Honduras are in the bottom quintile, and Haiti and Nicaragua are in the bottom decile.



Inequality



- GAIN indicators: SOCI_01: Social inequality (bottom quintile as share of national income or consumption)



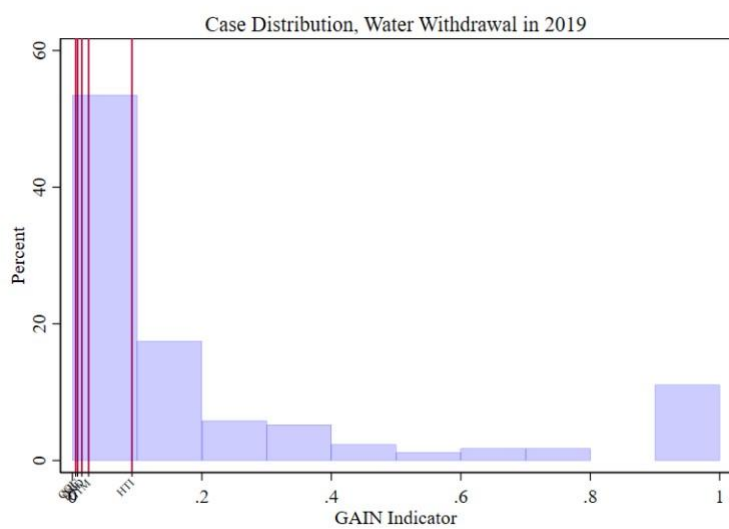
NOTE: Guatemala and Nicaragua are in the bottom quartile; Colombia, Honduras, and Haiti are in the bottom decile.

- The Fund for Peace's Uneven Economic Development indicator, 2022
This indicator evaluates inequality within the economy, including both actual inequality and perceptions of inequality; it also considers economic opportunity

Country	Score	Rank	Percentile
Colombia	6.3/10	118/179	66%
Guatemala	6.8/10	126/179	70%
Haiti	9.3/10	176/179	98%
Honduras	6.7/10	122/179	68%
Nicaragua	6.9/10	129/179	72%

Among the 179 countries, Haiti is in the bottom decile, while all others are in the bottom third.
Natural Capital

- Country Index indicators: wate_03 (1=highly vulnerable): Freshwater withdrawal



NOTE: No countries are in the bottom quartile.



27 APPENDIX 4: CATEGORY SOURCES

Access to Capital Reference List

Inter-American Development Bank (2000)
World Neighbors Foundation (2000)
Famine Early Warning Systems Network (2012)
Global Agricultural Monitoring (2019)
Segnestam (2017)
Adaptation Fund (2021)
World Bank Group (2021) - Pooling Catastrophe Risk
Baca et al. (2014)
Baez et al. (2017)
Puerto (2018)
USAID-ProLand (2019)
Stein et al. (2018)
Christian Aid (1999)

Access to Land Reference List

International Federation of Red Cross And Red Crescent Societies (1999)
McHugh (1999) - Congress
Productive Landscapes (2020) - PES
Adaptation Fund (2020)
Segnestam (2017)
Republic of Nicaragua (2021)
Famine Early Warning Systems Network (2012)
USAID (2020) Fact Sheet
Waddick (2017)
World Neighbors Foundation (2020)
Baca et al. (2014)

Access to Natural Capital Reference List

Global Agricultural Monitoring (2019)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
Adaptation Fund (2021)
Baca et al. (2014)
CGIAR (2014)
Cerullo (2022) Mongabay
Siddiqi et al. (2019)



USAID (2021) CDCS
Productive Landscapes (2020)
Wesche (2021)
Lakhani (2021) Guardian

Bureaucratic Capacity Reference List

McHugh (1999) Congress
USAID Climate Change Integration Support (2017)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Siddiqi et al. (2019)
International Drug Policy Consortium (2021)
Puerto (2018)
Wesche (2021)
Productive Landscapes (2020)
Segnestam (2017)
World Bank Group (2021) Pooling Catastrophe
World Food Programme (2018)
World Food Programme (2019)
Climate Integration Support Facility (2017)
UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
Stein et al. (2018)
United Nations Educational, Scientific and Cultural Organization (2019)
European Commission's Directorate-General for European Civil Protection and Humanitarian Aid Operations (2006)
United States Agency for International Development (2020)
Christian Aid (1999)
Tetra Tech ARD (2014)
World Neighbors Foundation (2000)

Climate & Disaster Planning Reference List

Cadmus Group (2019)
UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
McHugh (1999) Congress
European Commission's Directorate-General for European Civil Protection and Humanitarian Aid Operations (2006)
Republic of Nicaragua (2021)
International Federation of Red Cross And Red Crescent Societies (1999)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Adaptation Fund (2021)



World Bank Group (2021) Pooling Catastrophe
World Food Programme (2019)
USAID Climate Change Integration Support (2017)
Wesche (2021)
Puerto (2018)
United States Agency for International Development ProLand Program (2019)
Cerullo (2022) Mongabay
Siddiqi et al. (2019)
Internal Displacement Monitoring Center (2022)

Community Empowerment Reference List

SOLÍS (2022)
Segnestam (2017)
World Food Programme (2018)
World Food Programme (2019)
Cultural Survival (2010)
Wesche (2021)
Andrade et al. (2022)
Siddiqi et al. (2019)
Christian Aid (1999)
Productive Landscapes (2020)

Corruption Reference List

Cadmus Group (2019)
SOLÍS (2022)
Cultural Survival (2010)
Wesche (2021)
Siddiqi et al. (2019)
Christian Aid (1999)
USAID (2021) CDCS
Internal Displacement Monitoring Center (2022)
Viceisza et al. (2020)
Burnett (2021) NPR

Geographic Flexibility Reference List

Cadmus Group (2019)
UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
United Nations Educational, Scientific and Cultural Organization (2019)



Inter-American Development Bank (2000)
World Neighbors Foundation (2000)
Famine Early Warning Systems Network (2012)
International Federation of Red Cross And Red Crescent Societies (1999)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
Baca et al. (2014)
USAID Climate Change Integration Support (2017)
CGIAR (2014)
Siddiqi et al. (2019)
Waddick (2017)
Baez et al. (2017)

Income Reference List

Cadmus Group (2019)
Eckstein et al. (2017)
UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
United Nations Educational, Scientific and Cultural Organization (2019)
McHugh (1999) Congress
Inter-American Development Bank (2000)
SOLÍS (2022)
The White House (1999)
United Nations Office for the Coordination of Humanitarian Affairs (2021) Humanitarian Response Plan
Famine Early Warning Systems Network (2012)
Global Agricultural Monitoring (2019)
European Commission's Directorate-General for European Civil Protection and Humanitarian Aid Operations (2006)
United States Agency for International Development (2020)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
World Food Programme (2018)
Adaptation Fund (2021)
Baez et al. (2017)
USAID Climate Change Integration Support (2017)
Wesche (2021)
United States Agency for International Development ProLand Program (2019)
Siddiqi et al. (2019)
Stein et al. (2018)
Tetra Tech ARD (2014)



Christian Aid (1999)
United States Agency for International Development (2021) Country Development Strategy
Lakhani (2021)
Burnett (2021) NPR
Productive Landscapes (2020) - PES
Viceisza et al. (2020)
REPUBLIC of NICARAGUA (2021)

Inequality Reference List

Cadmus Group (2019)
McHugh (1999) Congress
SOLÍS (2022)
World Neighbors Foundation (2000)
United Nations Office for the Coordination of Humanitarian Affairs (2021) Humanitarian Response Plan
REPUBLIC of NICARAGUA (2021)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
World Food Programme (2018)
Adaptation Fund (2021)
World Food Programme (2019)
Baez et al. (2017)
Andrade et al. (2022)
United Nations Humanitarian Country Team in Colombia (2014)
Siddiqi et al. (2019)
Christian Aid (1999)
Internal Displacement Monitoring Center (2022)

Infrastructure Reference List

Cadmus Group (2019)
UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
McHugh (1999) Congress
Inter-American Development Bank (2000)
Global Agricultural Monitoring (2019)
United States Agency for International Development (2020)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
Adaptation Fund (2021)
World Bank Group (2021) Pooling Catastrophe



Cultural Survival (2010)
Baca et al. (2014)
Baez et al. (2017)
Wesche (2021)
Puerto et al. (2018)
United Nations Humanitarian Country Team in Colombia (2014)
Siddiqi et al. (2019)
Stein et al. (2018)
Christian Aid (1999)
United States Agency for International Development (2021) Country Development Strategy
Waddick (2017)
Productive Landscapes (2020) - PES
Tetra Tech ARD (2014)

Learning Reference List

Cadmus Group (2019)
UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
Bucknam et al. (2001)
United States Agency for International Development (2020)
Republic of Nicaragua (2021)
International Federation of Red Cross And Red Crescent Societies (1999)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
World Food Programme (2018)
Adaptation Fund (2021)
World Bank Group (2021) Pooling Catastrophe
World Food Programme (2019)
Cultural Survival (2010)
Baca et al. (2014)
Wesche (2021)
Puerto et al. (2018)
United States Agency for International Development ProLand Program (2019)
Andrade et al. (2022)
United Nations Humanitarian Country Team in Colombia (2014)
Siddiqi et al. (2019)
Tetra Tech ARD (2014)
Christian Aid (1999)
Lakhani (2021)
World Bank Group (2020) hydrometeorological
Productive Landscapes (2020) – PES



Occupational Flexibility Reference List

Cadmus Group (2019)
United Nations Educational, Scientific and Cultural Organization (2019)
Inter-American Development Bank (2000)
Famine Early Warning Systems Network (2012)
United States Agency for International Development (2020)
Republic of Nicaragua (2021)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
World Food Programme (2018)
Adaptation Fund (2021)
Baca et al. (2014)
Baez et al. (2017)
CGIAR (2014)
Wesche (2021)
Andrade et al. (2022)
Stein et al. (2018)
Lakhani (2021)
Waddick et al. (2017)
International Drug Policy Consortium (2021)

Social-Ecological Management Networks Reference List

UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
McHugh (1999) Congress
World Neighbors Foundation (2000)
United States Agency for International Development (2020)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
World Food Programme (2018)
World Bank Group (2021) Pooling Catastrophe
World Food Programme (2019)
Cultural Survival (2010)
Baca et al. (2014)
Baez et al. (2017)
Wesche (2021)
Puerto et al. (2018)
United States Agency for International Development ProLand Program (2019)
Andrade et al. (2022)



United Nations Humanitarian Country Team in Colombia (2014)
Siddiqi et al. (2019)
International Drug Policy Consortium (2021)
Productive Landscapes (2020) – PES

Violence Reference List

UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
United Nations Educational, Scientific and Cultural Organization (2019)
Republic of Nicaragua (2021)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
Wesche (2021)
United Nations Humanitarian Country Team in Colombia (2014)
Siddiqi et al. (2019)
Stein et al. (2018)
Christian Aid (1999)
United States Agency for International Development (2021) Country Development Strategy
Burnett (2021) NPR
Internal Displacement Monitoring Center (2022)
Viceisza et al. (2020)

Weak State Reference List

Cadmus Group (2019)
UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
United Nations Educational, Scientific and Cultural Organization (2019)
Republic of Nicaragua (2021)
International Federation of Red Cross And Red Crescent Societies (1999)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Adaptation Fund (2021)
Cultural Survival (2010)
Wesche (2021)
Siddiqi et al. (2019)
Christian Aid (1999)
United States Agency for International Development (2021) Country Development Strategy
Internal Displacement Monitoring Center (2022)
Viceisza et al. (2020)



Wealth Reference List

UNDP-UN Environment National Adaptation Plan Global Support Programme (2018)
United Nations Office for the Coordination of Humanitarian Affairs (2021) Humanitarian Response Plan
Famine Early Warning Systems Network (2012)
Global Agricultural Monitoring (2019)
Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) (2017)
Segnestam (2017)
World Food Programme (2018)
Adaptation Fund (2021)
Cultural Survival (2010)
Baez et al. (2017)
Christian Aid (1999)



28 CITATIONS

1. Cinner, J.E., et al., *Building adaptive capacity to climate change in tropical coastal communities*. Nature Climate Change, 2018. **8**(2): p. 117-123.
2. Barnes, M.L., et al., *Social determinants of adaptive and transformative responses to climate change*. Nature Climate Change, 2020. **10**(9): p. 823-828.
3. Baez, J.E., A. Fuchs, and C. Rodriguez-Castelan, *Shaking Up Economic Progress*. 2017, World Bank Group: Washington, DC.
4. *Guatemala Communities Hit Hard by Tropical Storm Agatha*. 2010; Available from: <https://www.culturalsurvival.org/news/guatemala-communities-hit-hard-tropical-storm-agatha>.
5. *National Intelligence Estimate: Climate Change and International Responses Increasing Challenges to U.S. National Security Through 2040*, N.I. Council, Editor. 2021.
6. Waddick, K., *Effects of Climate Change on Agriculture in Guatemala and Honduras*. Global Majority E-Journal, 2017. **8**(2): p. 109-120.
7. Siddiqi, A., K. Peters, and J. Zulver, *'Doble afectación' Living with disasters and conflict in Colombia*. 2019, Overseas Development Institute.
8. *Haiti Environmental Fact Sheet*. 2020, United States Agency for International Development: Washington, D.C.
9. *El Salvador, Guatemala & Honduras: Humanitarian Response Plan Summary 2021*. 2021, United Nations Office for the Coordination of Humanitarian Affairs.
10. McHugh, L., *Central America: Reconstruction After Hurricane Mitch - Congressional Research Service*. 1999, Foreign Affairs, Defense, and Trade Division: Washington, D.C.
11. *Reasons for Resiliency: Toward a Sustainable Recovery after Hurricane Mitch*. 2000, World Neighbors Foundation: Tegucigalpa, Honduras.
12. *El Salvador, Guatemala & Honduras: Humanitarian Needs Overview*. 2021, United Nations Office for the Coordination of Humanitarian Affairs.
13. *In debt to disaster: What happened to Honduras after Hurricane Mitch - Honduras*. 1999; Available from: <https://reliefweb.int/report/honduras/debt-disaster-what-happened-honduras-after-hurricane-mitch>.
14. Wesche, P., *Rights of Nature in Practice: A Case Study on the Impacts of the Colombian Atrato River Decision*. Journal of Environmental Law, 2021. **33**(3): p. 531-555.
15. Baca, M., et al., *An Integrated Framework for Assessing Vulnerability to Climate Change and Developing Adaptation Strategies for Coffee Growing Families in Mesoamerica*. PLOS ONE, 2014. **9**(2): p. e88463-e88463.
16. *Guatemala Data Overview*. 2022; Available from: <https://data.worldbank.org/country/guatemala>.
17. *DOS Guidelines for Policy and Operations: Guatemala, February*, U.S.D.o. State, Editor. 1963: Office of the Historian, Shared Knowledge Services, Bureau of Administration.
18. *Guatemala Country Profile*. 2019.
19. *Human Development Report 2020*, UNDP (United Nations Development Programme).
20. IPCC, *Climate Change 2022: Impacts, Adaptation, and Vulnerability*, in *Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, H.-O. Pörtner, et al., Editors. 2022: Cambridge, UK.
21. *Guatemala - Vulnerability*. Climate Change Knowledge Portal 2021.
22. *Honduras Data Overview*. 2022; Available from: <https://data.worldbank.org/country/honduras>.



23. *Honduras Country Profile*. 2018.
24. *Honduras - Vulnerability*. Climate Change Knowledge Portal 2022; Available from: <https://climateknowledgeportal.worldbank.org/country/honduras/vulnerability>.
25. *Nicaragua Data Overview*. 2022; Available from: <https://data.worldbank.org/country/nicaragua>.
26. *Nicaragua Country Profile*. 2018 2018/5//.
27. *Nicaragua: 2022 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for Nicaragua*. 2023, International Monetary Fund. p. 112.
28. *Nicaragua - Vulnerability*. Climate Change Knowledge Portal 2021; Available from: <https://climateknowledgeportal.worldbank.org/country/nicaragua/vulnerability>.
29. *Colombia Data Overview*. 2022; Available from: <https://data.worldbank.org/country/colombia>.
30. *The key to climate action and sustainable peace? Women's full and equal participation*. United Nations News 2022 2022/3/31.
31. *Colombia Country Profile*. 2018; Available from: <https://www.bbc.com/news/world-latin-america-19390026>.
32. *Colombia Vulnerability*. Climate Change Knowledge Portal 2021; Available from: <https://climateknowledgeportal.worldbank.org/country/colombia>.
33. *Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index*. 2020; Available from: <https://gain.nd.edu/our-work/country-index/>.
34. *Haiti Data Overview*. 2022; Available from: <https://data.worldbank.org/country/haiti>.
35. *Haiti Country Profile*. 2022.
36. *Haiti Vulnerability*. Climate Change Knowledge Portal 2021; Available from: <https://climateknowledgeportal.worldbank.org/country/haiti/vulnerability>.
37. Thaler, K., *Nicaragua: A Return to Caudillismo*. Journal of Democracy, vol. 28, no. 2, Apr. 2017, pp. 157-69., 2017. **28**(2): p. 157-169.
38. Fatton, R., *The Impairments of Democratization: Haiti in Comparative Perspective*. Comparative Politics, 1999. **31**(2): p. 209-229.
39. Sawicki, D.S., *Improving Community Indicator Systems: Injecting More Social Science into the Folk Movement*. Planning Theory & Practice, 2002. **3**(1): p. 13 - 32.
40. Pintér, L., et al., *Bellagio STAMP: Principles for sustainability assessment and measurement*. Ecological Indicators, 2012. **17**: p. 20-28.
41. Waas, T., et al., *Sustainability Assessment and Indicators: Tools in a Decision-Making Strategy for Sustainable Development*. Sustainability, 2014. **6**(9): p. 5512-5534.
42. Vincent, K., *Uncertainty in adaptive capacity and the importance of scale*. Global Environmental Change, 2007. **17**(1): p. 12-24.
43. Engle, N.L., *Adaptive capacity and its assessment*. Global environmental change, 2011. **21**(2): p. 647-656.
44. Cinner, J.E. and M.L. Barnes, *Social Dimensions of Resilience in Social-Ecological Systems*. One Earth, 2019. **1**(1): p. 51-56.
45. Brooks, N., W.N. Adger, and P.M. Kelly, *The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation*. Global environmental change, 2005. **15**(2): p. 151-163.
46. Colloff, M.J., et al., *Adapting transformation and transforming adaptation to climate change using a pathways approach*. Environmental Science & Policy, 2021. **124**: p. 163-174.



47. Mortreux, C. and J. Barnett, *Adaptive capacity: Exploring the research frontier*. Wiley Interdisciplinary Reviews: Climate Change, 2017. **8**(4): p. e467.
48. Wyborn, C., et al., *Co-producing sustainability: reordering the governance of science, policy, and practice*. Annual Review of Environment and Resources, 2019. **44**: p. 319-346.
49. Creswell, J.W. and J.D. Creswell, *Research Design Qualitative, Quantitative, and Mixed Methods Approaches*. 5th ed. 2017, Los Angeles, CA: Sage Publications.
50. *ProLand Program: Progress Toward Sustainable Landscapes in Colombia*. 2019, United States Agency for International Development
51. Stein, A., C. Moser, and I. Vance, *Asset Planning for Climate Change Adaptation in Poor Neighborhoods of Tegucigalpa, Honduras*. 2018, Inter-American Development Bank.
52. *Final Agreement to End the Armed Conflict and Build a Stable and Lasting Peace*. 2016, Republic of Colombia & Revolutionary Armed Forces of Colombia—People's Army (FARC-EP).
53. *World Report*. 2021, Human Rights Watch.
54. Myers, N., *Natural Resource-based Export Initiatives in Central America and the Caribbean*. 1991.
55. González Ballar, R., *The Payment for Environmental Services in Costa Rica*. 2014.
56. *El Niño response in the Dry Corridor of Central America: an evaluation*. 2018, World Food Programme.
57. *Implementing Measures for Climate Change Adaptation and Disaster Risk Reduction Mitigation of School Facilities in Haiti*. 2019, United Nations Educational, Scientific and Cultural Organization.
58. Andrade, H., M. González, and L.F. Jara. *Indigenous Women Who Shine to Protect Forests in Colombia*. 2022 2022/4/26; Available from: <https://www.climatelinks.org/blog/indigenous-women-who-shine-protect-forests-colombia>.
59. Segnestam, L., *Gendered Experiences of Adaptation to Drought: Patterns of Change in El Sauce, Nicaragua*. Latin American Research Review, 2017. **52**(5): p. 807-823.
60. *Productive Landscapes: What Do Experience and Research Tell Us About Using PES To Limit Deforestation? A Synthesis of the Evidence and Case Studies From Uganda and Colombia*. 2020, United States Agency for International Development.
61. Ghadge, A., *ICT-enabled approach for humanitarian disaster management: a systems perspective*. The International Journal of Logistics Management, 2023. **34**(6): p. 1543-1565.
62. *Second consecutive year of failed yields for subsistence farmers in Central America's Dry Corridor*, in *The Crop Monitor*. 2019, Global Agricultural Monitoring.
63. *Central America: Floods and Landslides - Information Bulletin n° 4 - Costa Rica*. ReliefWeb 1999; Available from: <https://reliefweb.int/report/costa-rica/central-america-floods-and-landslides-information-bulletin-n-4>.
64. *Climate Risks To Food Security In Food for Peace Geographies - Haiti*. 2019, Cadmus Group.
65. *Guatemala Food Security Outlook Update - August 2012*. 2012, Famine Early Warning Systems Network.
66. *Nicaragua, Country Programme 200434: an evaluation*. 2019, World Food Programme.



67. *Climate Risk Profile - Haiti*, C.I.S. Facility, Editor. 2017, United States Agency for International Development.
68. Solís, L.G. *Central America Is Still Recovering from Hurricane Mitch*. 2022 2022/5/3; Available from: <https://www.americasquarterly.org/article/central-america-is-still-recovering-from-hurricane-mitch/>.
69. *National Adaptation Plans in focus: Lessons from Haiti*, in *UNDP-UN Environment National Adaptation Plan Global Support Programme*. 2018, United Nations Development Programme.
70. Puerto, L.I.N., *Localising the 2030 Agenda in Colombia*. 2018, Dag Hammarskjöld Foundation.
71. *Vulnerability and Resilience to Climate Change in Western Honduras*. 2014, Tetra Tech ARD: United States Agency for International Development.
72. Bernard, T. and D.J. Spielman, *Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia*. Food policy, 2009. **34**(1): p. 60-69.
73. Candemir, A., S. Duvaléix, and L. Latruffe, *Agricultural cooperatives and farm sustainability—A literature review*. Journal of Economic Surveys, 2021. **35**(4): p. 1118-1144.
74. Lutz-Ley, A.N., et al., *Dialogic science-policy networks for water security governance in the arid Americas*. Environmental Development, 2021. **38**.
75. FAO, *Agricultural cooperatives, responsible sourcing and risk-based due diligence*. 2022, Food and Agriculture Organization of the United Nations: Rome.