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An Overview of Urban Vulnerability to Natural Disasters and Climate Change in Central America & the Caribbean Region

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Summary

Central America and the Caribbean is one of the most hazard-prone regions in the world. In addition, the region is heavily affected by poverty, unemployment, critical management of natural resources, and urban conglomeration in capital cities, especially in the Small Island Developing States, increasing vulnerability and risk to natural disasters and climate change. This paper examines characteristics of urban vulnerability to natural disasters and climate change in the Central America and the Caribbean Region. It argues that even though the region is not vast in size, the diversity within creates different characteristics of vulnerability to natural disasters and thus requires an extensive variety of disaster risk reduction approaches and adaptation techniques.

Keywords: Urban Vulnerability, Disaster Risk, Central America, the Caribbean

JEL Classification: Q5, Q54

The research leading to this paper has received funding from the European Commission, FP7. 2007-2013, under grant agreement no. 283177 (CATALYST). The author gratefully likes to thank Jaroslav Mysiak and Elisa Calliari for valuable suggestions and assistance in this research.

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Abstract
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An overview of urban vulnerability to natural disasters and climate change in Central America & the Caribbean Region[1]

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1. Introduction: Conceptual Note and Methodology for the Study

Natural disasters are increasingly affecting the world, taking lives unexpectedly, creating many other injured and homeless. They disrupt local, national and even global economies, with the capacity to change the direction of development. Statistics indicate a rising trend in the number of disasters, affected population and damage from natural disasters especially within the last two decades[2] (See WB 2010. In 2011 alone, natural disasters affected 98 countries, killing about 30 thousand and affecting over 200 million people, and resulting in record economic damages over 366 billion US dollars (CRED 2012, 1). Adding to the current situation, the *Special Report of the Intergovernmental Panel on Climate Change* models project "substantial warming in temperature extremes," "likely" increase in "the frequency of heavy precipitation" and "tropical cyclone wind speed," and "upward trends in extreme coastal high water," all pointing out to the increase in the occurrence and severity of climatological and weather related hazards in the 21st century (IPCC 2012, 9-13).

Central America and the Caribbean Region (CAC) is one of the most hazard-prone areas in the world. Historically, it has been affected by a variety of natural hazards ranging from geophysical, such as earthquakes, landslides and volcanic eruptions, to hydro-meteorological hazards, such as tropical storms and floods, and climate variations such as the El Nino and La Nina Southern Oscillations. Today, with the likely impacts of climate change, the region is becoming more prone to natural hazards. Furthermore, the region is home to about 200 million people, and it is heavily affected by poverty, unemployment, critical management of natural resources, and concentration of urban population in single centers, especially in the Small Island Developing States (SIDS), which increases vulnerability and risk to natural disasters and climate change.

The diversity and the problems within the region, ranging from urban complexities in the megacity of Mexico City to ecosystems vulnerability in the Small Island Developing States and the vast variety of hazards they are exposed to create a variety of risk factors, which require specific attention and multiple strategies for disaster risk reduction and climate adaptation. This paper aims to portray the range of vulnerabilities embedded within the urban areas of the Central America and the Caribbean Region, in order to help create specific policy making strategies for disaster risk reduction and climate adaptation.

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[1] Parts of this paper have been previously presented: Gencer E.A. 2012 "Urban Vulnerability in Central America and the Caribbean Region" Presented in the CATALYST Regional Workshop for Central America and the Caribbean within the 7th Annual Caribbean Conference on Comprehensive Disaster Management (CDM 7). Montego Bay, Jamaica.
Unless otherwise noted, all figures and tables in this paper are by the author.

[2] This could be related to "greater exposure, more reporting, or a combination of both" (WB 2010, 26-27).

Figure 1. Central America and the Caribbean Political Map 2013.

Source: CIA - Central Intelligence Agency Available at: http://www.cia.org

This introductory section provides a conceptual note for the study and develops its outline. The second section gives a brief overview of the concept of vulnerability and vulnerability analyses for disaster risk reduction and climate change adaptation. The third section examines urban vulnerability. It first starts with an overview of hazard exposure and urban dynamics in Central America and the Caribbean. Secondly, it continues with discussing social, physical and institutional elements of vulnerability in the urban realm and how it relates to the Central America and the Caribbean Region at large. The final section brings together all the discussions in this paper and proposes further urban vulnerability analysis in Central America and the Caribbean Region.

2. A Brief Overview of the Concept of Vulnerability and Vulnerability Analysis

The study of disasters involving the concept of vulnerability goes back to the 1970s, to the "social vulnerability paradigm" and the structuralist arguments that "structures of human society actually dictate human adjustment to hazards and in some cases even perpetuate a hazardous situation" (Mileti 1999, 28). Since then, the theory of social vulnerability branched out into multiple sub-sectors with theories such as "marginalization theory" (Susman, O'Keefe and Wisner), "political ecological theory of vulnerability" (Oliver-Smith 1989), and "political vulnerability theory" (Blaikie, Cannon, Davis, and Wisner 1994)[3]. During the same decades, risk assessment studies started to incorporate elements of vulnerability and exposure in addition to hazard, when, in 1975, Robert Whitman gave "emphasis on the notion that damage was not only due to the severity of the natural phenomenon, but also to the fragility or the vulnerability of the exposed elements," allowing "a more complete understanding of risk and disaster" Cardona (2004, 41). Today, the definition of risk assessment by the United Nations International Strategy for Disaster Reduction (UNISDR) contains the analysis of vulnerability, and it is described as "a methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing

[3] See for further detail: Gencer 2007 and Gencer 2008.

conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend" (UNISDR 2009, 26).

Within the last decade, more emphasis is started to be given to the definition and quantification of vulnerability in disaster risk assessment studies. Among them, the *Disaster Risk Index* (DRI) (Pelling 2004) with a partnership of the United Nations Development Programme (UNDP), and the United Nations Environment Programme - Global Resource Information Database (UNEP-GRID), *Natural Disaster Hotspots: A Global Risk Analysis* (Dilley et al. 2005), with a partnership of the World Bank (WB) and Columbia University, *Indicators of Disaster Risk and Risk Management* (NUC and IDB 2005) of the Americas Program, and the *Social Vulnerability Index* (SoVI) (Cutter/Boruff/Shirley 2003) provide indicators to measure vulnerability of populations to natural disasters. The Central American Probabilistic Risk Assessment (CAPRA) Project of the GFDRR (2009) supports the countries of the Central America to develop a Disaster Risk Information Platform based on probabilistic hazard assessment is combined with exposure and vulnerability data.

Additionally, several theorists have discussed the use of the term "vulnerability" and existing indicators to measure them. Among them *Measuring Vulnerability to Natural Hazards (*Birkmann 2006), "Background Note for the 2010 World Development Report" (Fussel 2009), "Determinants of Risk: Exposure and Vulnerability" (Cardona et al. 2012) in the Special Report of the IPCC are among the state of the art review and analysis of the term "vulnerability" and its quantification.[4] On the other hand, while the UNISDR terminology of vulnerability and risk assessment provides a generic base for the international community of disaster risk research and community, there is a divergence in the way the term "vulnerability" is used and assessed by different disciplines. Moreover, most mentioned vulnerability studies do not focus or differentiate on the urban environment, creating an imminent need for the definition of urban vulnerability and its analysis.

This paper uses as its base the definition of "vulnerability" as described by the UNISDR. Accordingly, vulnerability is the potential for loss (human, physical, economic, natural, or social) due to a hazardous event. It is the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UNISDR 2009, 30). Furthermore, vulnerability encompasses the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. Taking this definition as a starting point, the paper concentrates on the dynamics of urbanization (exposure of populations), characteristics of the built environment (physical susceptibility), socio-economic composition of residents and sectors (social susceptibility), and urban governance (institutional capacity) to identify characteristics of urban vulnerability to natural disasters and climate change in the Central America and the Caribbean Region.

3. Urban Vulnerability in Central America and the Caribbean Region

Urbanization and rapid population growth lead to the concentration of population in hazard- and risk- prone urban areas. Adding to the exposure of urban population, substandard infrastructure and housing, material assets, and inherent socio-economic inequalities increase susceptibility in urban areas (Gencer 2007) , making "[c]ities and towns… on the frontline of disaster risk reduction," and bearing "the brunt of insured economic losses from disasters" (UNISDR 2012, 1). This section examines the current status of exposure and urbanization in the Central America and the Caribbean region, and then delves into the characteristics of vulnerability in both informal and

[4] For more information see Mysiak et al. 2012.

formal areas in the CAC, in order to comprehend urban vulnerability that can translate itself into risk when hazards strike.

3.1. Historical and Geographical Roots of Urban Vulnerability, Hazard Exposure and Urban Dynamics in Central America and the Caribbean

The Central America and the Caribbean Region (CAC) has had a tumultuous history with natural disasters. Droughts, floods, hurricanes, storms, landslides and earthquakes have become more frequent and/or severe in recent years, threatening the region's economies and natural resources and constituting a large impediment to growth and development through the loss of life, capital and food security (Guha-Sapir/Hargitt/Hoyois 2004).

The CAC region is prone to high-intensity earthquakes and high intensity tropical cyclones as well as being exposed to the main impacts of the climate change with changes in tropical cyclone activity, threat of sea level rise and increase in droughts, as has been observed in the adapted figure (fig. 2) from United Nations Global Risk Data Platform. In figure 2, largest cities of the CAC are located in the hazard map, indicating that largest urban areas in the region are bounded by constraints of physical geography and exposure to hazards.

On the other hand, exposure and risk in these urban centers are derived from a number of conditions, including that of their historical urbanization patterns and current urban dynamics. Due to their historical development and the bounding geography they are based in, urbanization patterns of the cities in Central America and the Caribbean Region have taken different paths. Historically, Central American countries were exposed to colonization and drew largely on the *Law of the Indies*[5] and the accompanying social and spatial segregation for their urban planning schemes. Starting after the 1930s, based on export ports and later the Pan-American Highway, primate cities emerged, carrying a large load of the national populations. In Mexico, massive urbanization schemes occurred after the 1970s, creating subsequent urban problems, such as poor air quality and informal settlements, however, a move into intermediate cities and urban dispersion is currently taking place.

Whereas, urbanization in the Small Island Developing States of the Caribbean Region have taken a slower approach and varied based on their colonizing nations. For instance, the Spanish Colonies, such as Cuba, the Dominican Republic and Puerto Rico were based on the Law of Indies; and their major cities were prosperous, located on strategic transshipment ports and built behind massive fortresses. However, with the demolishment of these protecting high fortresses and the expanse of urban areas, these cities have become open to storms and hurricanes in the modern era.

On the other hand, other European colonies of the Caribbean were mostly based on plantation economy. From very early on, there was an induced inherited inequality in these colonies due to slavery. Major cities were located in protected bays for unloading slaves and machinery, and forts were mostly built on hilltops. While slaves mostly lived in shacks, post-slavery, they developed early squatting schemes, which turned into large informal settlements post-rapid urbanization creating different conditions of urban vulnerability in these nations of the Caribbean.

[5] The *Law of Indies* is a grid based urban pattern legalized in Spain in the 16th century and used throughout the colonial Spain incorporating elements of barrios.

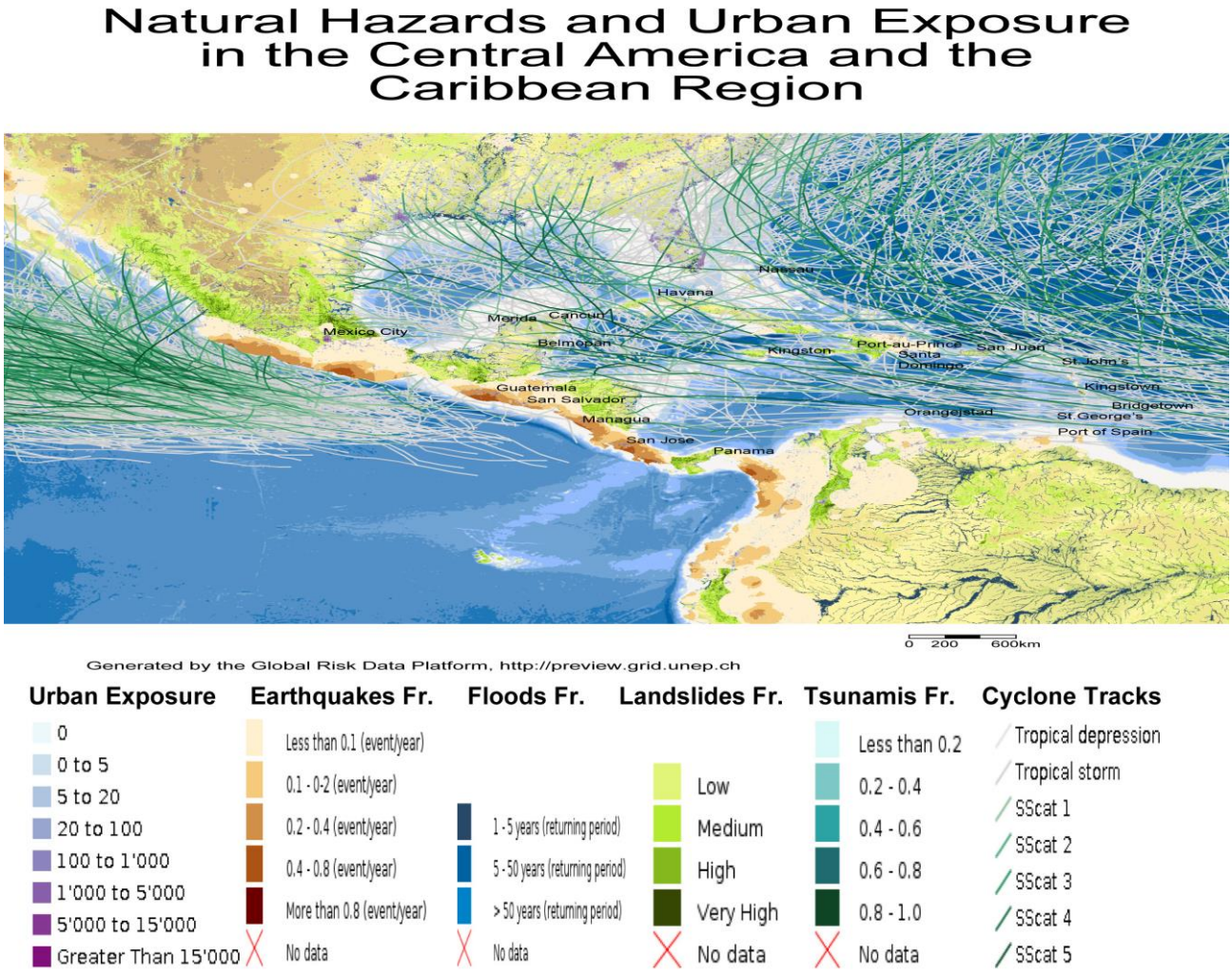


Figure 2. Natural Hazards and Urban Centers in Central America and the Caribbean Region

Source: Author's Adaptation of map generated by the Global Risk Data Platform, http://preview.grid.unep.ch (Courtesy of UNEP/GRID – UNISDR 2013).

Table 1. CAC Level of Urbanization and Projections (Gencer 2012)

Central American and Caribbean Countries	Level of Urbanization (2010)	Rate of Change (2020)	Rate of Change (2030)
Anguilla	100.0	0.00	0.00
Antigua and Barbuda	30.3	0.70	1.67
Aruba	46.9	0.40	0.73
Bahamas	84.1	0.24	0.21
Barbados	44.5	1.38	1.25
Belize	52.2	0.86	0.91
British Virgin Islands	41.0	0.98	1.32
Cayman Islands	100	0.00	0.00
Costa Rica	64.4	0.75	0.63
Cuba	75.2	0.05	0.26
Dominica	67.2	0.32	0.52
Dominican Republic	69.2	0.78	0.52

Central American and Caribbean Countries	Level of Urbanization (2010)	Rate of Change (2020)	Rate of Change (2030)
El Salvador	64.3	0.75	0.62
Grenada	39.3	1.24	1.40
Guadeloupe	98.4	0.01	0.01
Guatemala	49.5	1.00	1.02
Haiti	52.1	2.12	1.06
Honduras	51.6	1.10	0.96
Jamaica	52.0	0.32	0.74
Martinique	89.0	0.01	0.10
Mexico	77.8	0.37	0.32
Montserrat	14.3	1.67	2.45
Nicaragua	57.3	0.63	0.76
Panama	74.8	0.71	0.40
Puerto Rico	98.8	0.07	0.01
Saint Kitts and Nevis	34.2	0.89	1.61
Saint Lucia	28.0	0.89	1.65
Saint Vincent and the Grenadines	49.3	1.02	1.06
Trinidad and Tobago	13.9	2.64	2.70
Turks and Caicos Islands	93.3	0.34	0.09
United States Virgin Islands	95.3	0.13	0.05

Source: Calculated and drawn from raw data in UN-DESA 2010. "World Urbanization Prospects: the 2009 Revision," United Nations, New York.

Today, Central America and the Caribbean Region is a highly urbanized area with 11 of the 31 countries more than 75 percent, and only 8 countries less than 50 percent urbanized, making the CAC region urbanization level above average of the world[6] (see Table 1 and Table 2). However, according to the *World Urbanization Prospects* (UN-DESA 2010), this high rate of urbanization is expected to slow down between 2010 and 2030 in most areas which are highly urbanized. On the other hand, urbanization rates are expected to be still high in Central America and in some of the SIDS, which currently have lower urbanization levels indicating the need to focus on preventive policies in newly urbanizing nations.

Table 2. CAC and World Urbanizations Levels and Projections (Gencer 2012)

	World	CAC	Africa	Europe	Asia
Urbanization Levels (%) 2010	57.27	61.87	43.52	70.71	56.07
Rate of Change (2010-2020)	0.98	0.65	2.2	0.35	0.8
Rate of Change (2020-2030)	1.1	0.77	1.4	0.46	0.9

Source: Calculated and drawn from raw data in UN-DESA 2010. "World Urbanization Prospects: the 2009 Revision," United Nations, New York.

Despite the high level of urbanization in the CAC, due to the smaller size of nations in the SIDS, most cities are small cities with populations less than 500,000 people (see Table 3). On the other

[6] Highlights in Table 1 show rates above world average.

hand, urban areas are more diverse in Central American countries, with a large distribution of population in megacities over 10 million people. Indeed, the share of large and medium size cities in Central America is higher than the rest of the world, due to the concentration of population in mostly capital cities as single nodes (see Table 3 and Table 4), for instance such as San Juan with a population making up 70 percent of Puerto Rico's population or Managua with 52.5 percent of Nicaragua's population.

Table 3. CAC and World Population of Capital Cities (Gencer 2012)

Central American and Caribbean Countries	Population of capital cities (2009)	
	('000)	(%)*
Belize	20	6.4
Costa Rica	1.416	30.9
El Salvador	1.534	24.9
Guatemala	1.075	7.7
Honduras	1	13.4
Mexico	19.319	17.6
Nicaragua	934	16.3
Panama	1.346	39
Anguilla	2	10.8
Antigua and Barbuda	27	30.3
Aruba	33	31.1
Bahamas	248	72.5
Barbados	112	43.8
British Virgin Islands	9	40.7
Cayman Islands	32	56.5
Cuba	2.140	19.1
Dominica	4	21.4
Dominican Republic	2.138	21.2
Grenada	40	38.9
Guadeloupe	13	2.8
Haiti	2.643	26.3
Jamaica	580	21.3
Martinique	89	21.9
Montserrat	1	13.9
Puerto Rico	2.73	68.6
Saint Kitts and Nevis	13	24.8
Saint Lucia	15	8.9
Saint Vincent and the Grenadines	28	25.8
Trinidad and Tobago	57	4.3
Turks and Caicos Islands	6	18.9
United States Virgin Islands	54	48.9

* city pop. as a percentage of tot. Pop.

Source: Calculated and drawn from raw data in UN-DESA 2010. "World Urbanization Prospects: the 2009 Revision", United Nations, New York.

Table 4. Distribution of Urban Population by Size of Agglomerations (%) 2010 (Gencer 2012)

	≥ 10 million	5-10 million	1-5 million	500K–1 million	< 500K
Caribbean	-	-	32.5	6.3	61.2
Central America	17.7	-	25.1	15.4	41.8
World Average	9.3	6.7	22.1	10.2	51.6
Africa	3.56	4.08	27.64	8.94	55.74
Asia	9.07	7.5	21.7	9.77	51.97
Europe	3.07	5.37	15.27	9.85	53.18

Source: Calculated and drawn from raw data in UN-DESA 2010. "World Urbanization Prospects: the 2009 Revision," United Nations, New York.

Table 5. Capital City Population as Share of Total Population (%) (Gencer 2012)

World Average	CAC	Africa	Asia	Europe
23.02	26.12	13.96	19.22	23.26

Source: Calculated and drawn from raw data from UN-DESA 2010. "World Urbanization Prospects: the 2009 Revision," United Nations, New York.

Indeed, average share of capital city population is much higher in the CAC region than the rest of the world[7] (see Table 5). The concentration of population in mostly single nodes and especially in capital cities pose a major disaster risk in the Central America and the Caribbean region, putting a large portion of the national population at risk in hazard exposed capital cities, as well as creating the potential of major economic and political crises, especially in the Small Island Developing States. Unfortunately, in the CAC region this high exposure is combined with social and physical susceptibility in urban areas creating an imminent danger of risk to natural disasters and climate change.

3.2. Social and Physical Susceptibility and Institutional Capacity in Urban Areas in Central America and the Caribbean Region[8]

In urban areas, disaster risk occurs from a combination of factors: exposure due to concentration of population and assets, increased susceptibility due to physical condition of buildings and infrastructure and socio-economic composition of residents, and lack of institutional capacity (Gencer 2013a, 14). There is a strong tie between vulnerability and poverty in the urban realm, and an understanding of urban poverty encompassing both economic and non-economic factors provides insight to disaster vulnerability in urban areas (Gencer 2007, 155 and Gencer 2008, 293). Unfortunately, in Central America and the Caribbean, high rates of urbanization are complemented with lower than World's average GDP per capita distribution correlating to high rates of urban poverty (see Figures 3, 4, 5, 6).

[7] Highlights in Table 3 show rates above world average.

[8] This section is conceptually based on Gencer E.A. 2007. *The Interplay between Natural Disasters, Vulnerability, and Sustainable Development*. Ph.D diss. New York: Columbia University; and parts of it are previously published in Gencer, E.A. 2008. *Natural Disasters, Vulnerability, and Sustainable Development: Examining the Interplay, Global Trends and Local Practices in Istanbul*. Saarbrucken; VDM Verlag and Gencer, E.A. 2013. *The Interplay between Urban Development, Vulnerability, and Risk Management: A Case Study of the Istanbul Metropolitan Area*. Springer Briefs in Environment, Security, Development and Peace, Vol. 7., Heidelberg- New York- Dordrecht- London: Springer.

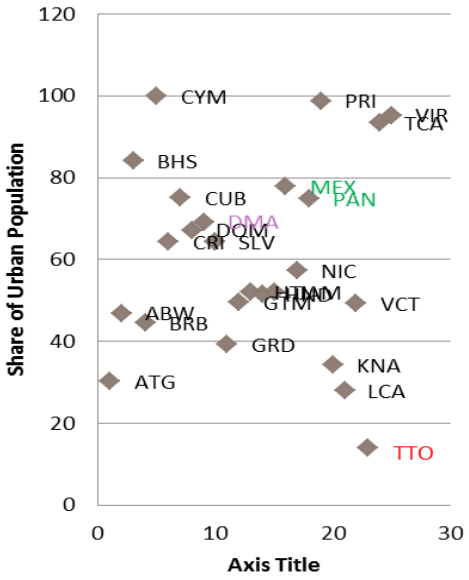


Figure 3. Urbanization Levels of CAC Countries (Gencer 2012)

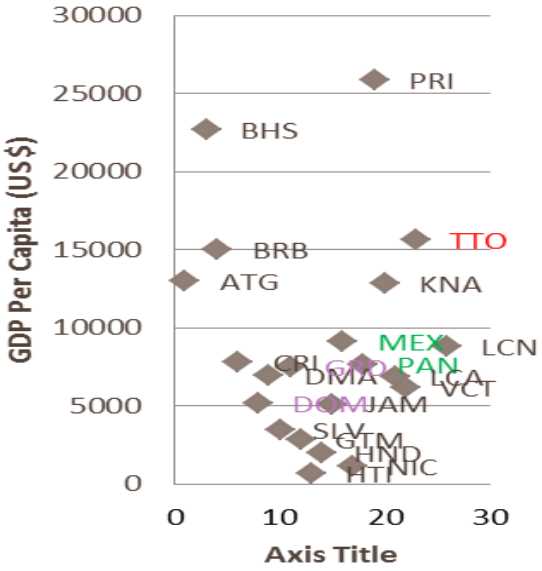


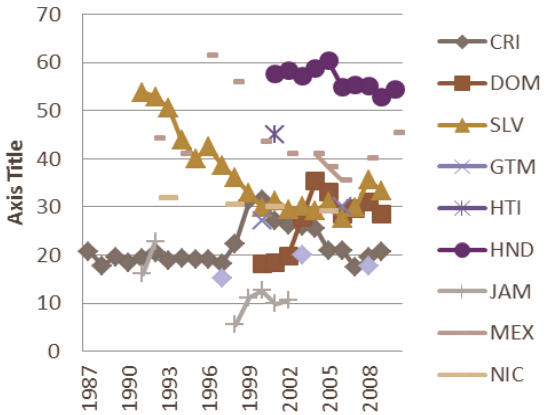
Figure 4. GDP per Capita Distribution of CAC Countries (Gencer 2012)

Source: Drawn from raw data from World Bank 2012. "World Development Indicators 2012," (http://www.worldbank.org) (accessed in November 2012).

EUU: European Union Countries
CSS: Caribbean Small States
LCN: Latin America & the Caribbean
WLD: World
SSF: Sub-Saharan Africa

Figure 5. World's Regions 2010 GDP Per Capita Distribution (US$ 2000) (Gencer 2012)

Source: Drawn from raw data from World Bank 2012. "World Development Indicators 2012," (http://www.worldbank.org) (accessed in November 2012).



CRI: Costa Rica
Dom: Dominican Republic
SLV: San Salvador
GTM: Guatemala
HTI: Haiti
HND: Honduras
JAM: Jamaica
MEX: Mexico
NIC: Nicaragua

Figure 6. Selected CAC Countries Poverty Headcount Ratio at Urban Poverty Line (Gencer 2012)

Source: Drawn from raw data from World Bank 2012. "World Development Indicators 2012," (http://www.worldbank.org) (accessed in November 2012).

Furthermore, due to rapid urbanization that have not been met with available infrastructure and resources and exclusion of the incoming rural poor from formal housing have resulted in the large expansion of informal settlements, especially in the Central American Countries. Along with conditions of urban poverty, informal economy, and challenged urban management systems, informal settlements and their residents have become increasingly susceptible to vulnerabilities from natural disasters (Gencer 2007, 124). Statistics indicate that 27 percent of the urban population in Latin America and the Caribbean live in slums[9] (Dodman/Horday/Satterhwaite 2009, 23). Central America and the Caribbean Region, and particularly most of the Central American countries, such as Nicaragua with 45.5 percent, and some of the larger Small Island Developing States, such as Haiti with 70.1.percent, have a large share of urban slum dwellers pointing to the increased risk in their urban areas (See Figs 12, 13).

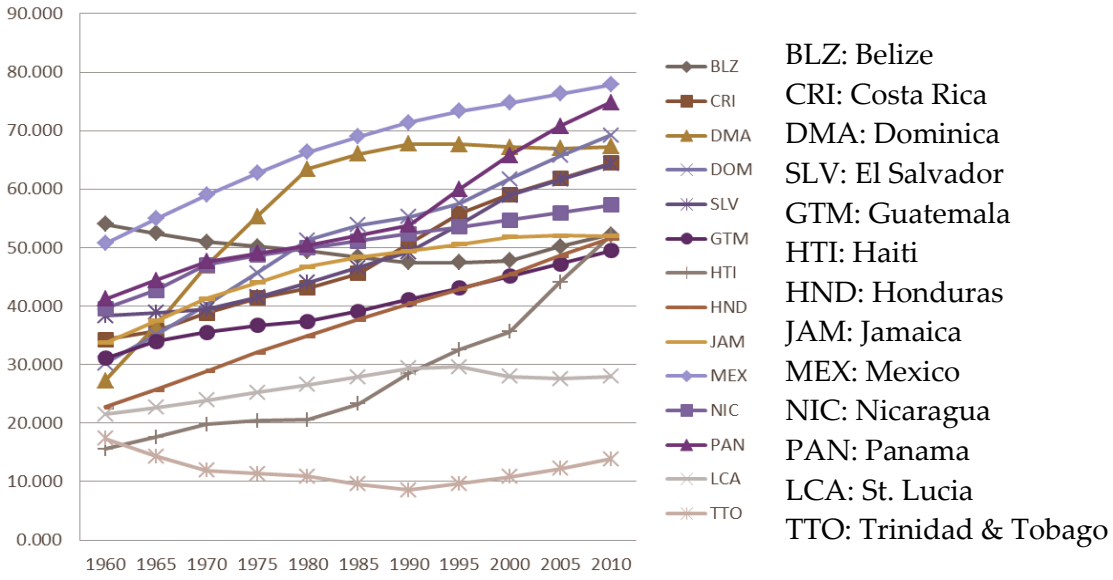


Figure 7. Urbanization Levels in CAC Countries with Share of Slums equal or more than 10 Percent of their Urban Population (Gencer 2012)

Source**:** Drawn from raw data © SSP Database (Version 0.9.3) (http://secure.iiasa.ac.at/web-apps/ene/SSPDB).

Table 6. Share of Slum Population in Total Urban Population in CAC Countries[10] (Gencer 2012)

CAC Countries	**Share of Slum Population in total Urban Population**
Belize	62 (01)/18.7 (07)
Costa Rica	13 (01) /10.9 (05)
El Salvador	35 (01) /28.9 (05)
Guatemala	62 (01) /38.9 (09)

[9] Informal settlements have recently been defined and used under the large umbrella of the term *slum* by the United Nations Human Settlements Programme (UN-Habitat). Standard and operational understandings of slums include both its traditional definition as declining housing areas that have deteriorated with the movement of their original dwellers to new and better areas of the cities, as well as informal settlements in urban periphery of mostly developing nations and that encompass both squatter settlements and illegal subdivisions (Gencer 2007, 124). In this paper, the term *slum* and *informal settlements* are used interchangeably.

[10] Numbers in parentheses refer to years of data collection (for instance 01 refers 2001).

CAC Countries	Share of Slum Population in total Urban Population
Honduras	18 (01) /34.9 (05)
Mexico	20 (01) /14.4 (07)
Nicaragua	81 (01) /45.5 (05)
Panama	31 (01) /23 (05)
Anguilla	41 (01)
Antigua and Barbuda	7 (01)
Dominica	14 (01)
Dominican Republic	38 (01) /14.8 (09)
Grenada	7 (01) /6 (05)
Guadeloupe	7 (01) /5.4 (05)
Haiti	86 (01) /70.1 (09)
Jamaica	57 (01) /60.5 (05)
Martinique	2 (90)
Saint Lucia	12 (01) /11.9 (05)
Trinidad and Tobago	32 (01) /24.7 (05)

Source: Drawn from raw data from World Bank 2012. "World Development Indicators 2012," (http://www.worldbank.org), and the UN-Habitat (http://www.unhabitat.org) (both accessed in November 2012).

Most informal settlements carry physical vulnerabilities due to their location or construction practices (Gencer 2007, 124; Gencer 2008, 263). These settlements are often "located on land not deemed appropriate for habitation because of its steep terrain or geological characteristics that make it prone to subsidence, landslides, or mudslides" (UN-Habitat 2003, 69). Slum dwellers and squatters often settle in these dangerous locations as the only option for their livelihoods and survival. According to the Global Facility for Disaster Risk Reduction (GFDRR)'s country notes on *Disaster Risk Management in the Latin America and the Caribbean Region* (WB and the GFDRR 2010, 4), in Haiti, "[s]evere environmental degradation, the presence of settlements in low-lying and floodplains are key contributing factors towards the country's vulnerability." In Belize, where the slum population is equal to nearly half of the urban population, the "low-lying coastline accommodates approximately 45% of its total population in densely populated urban areas such as Belize City (approximately 20.5% of total population)," and "[t]hese coastal centers represent some of the country's most vulnerable to storm events as they lie approximately one to two feet below sea level" (ibid., 94).

Environmental degeneration, loss of rural incomes, and strict building regulations have contributed to the development of informal settlements in risk-prone urban fringes of many countries (Gencer 2007, 125; Gencer 2008, 264). For instance, situated between the Pacific Ocean and the Andes, Lima is subject to floods, mud and landslides, in addition to being prone to earthquakes. With the Pan-American Highway linking Lima to other port cities, rapid urbanization along the coastline contributes to increased levels of risk (UNISDR 2004, 1:60). Within the last decades, in addition to the city's coastal growth, informal squatter settlements have proliferated around the fringes of Lima in unstable alluvial soil along the riverbanks or in hillsides (Oliver-Smith 1999, 248-294). Janice Perlman (1993, 34) has argued that "counterproductive incentives" have increased the informal housing sector in this Latin American city. Perlman (ibid.) explained that in Lima, "[t]he average period needed to acquire a house formally is nearly seven years; to obtain a land title takes 31 months, and to secure a construction permit takes another 12 months. Thus, the vast majority of low-income families are forced into the vulnerable position of

having to find housing 'informally,' without minimal legal protection." Oliver-Smith (1999, 273) has written about the development of these settlements in Lima: "During the 1950s, there were 56 such settlements located on the periphery of the city; in 1984 there were 598 such *barriadas*. Now called *pueblos jovenes*[11] (young towns), they contained close to 40 percent of Lima's population. Older *barriadas* gradually evolved into permanent communities and grouped together to form separate municipalities." Similar patterns of vulnerability are reported in Nicaragua, where "informal settlements tend to be situated in areas of high risk and are a physical and spatial manifestation of poverty and inequality in cities" (WB and GFDRR 2010, 199). Accordingly, "[a]bout 85% of the houses in Nicaragua are self-constructed;" and the requirement that "any house built larger than 100 square meters must apply the municipal code for construction….is rarely met in these informal settlements and many remain poorly constructed, lack basic social services, and are located in high-risk areas" (ibid., 200).

Many times, inadequate building materials accompany risk by physical exposure in squatter settlements, as structures are often built with non-permanent materials, such as "earthen floors, mud-and-wattle walls or straw roofs" (UN-Habitat 2003, 11). Quick makeshift structures are observed in impromptu urbanizations and sprawls of many low-income countries (Gencer 2007, 126; Gencer 2008, 265). For instance, in Grenada, "[m]uch of the island's construction occurs on steep slopes often exceeding 45 degrees. There is little protection from the direct impacts of wind forces and prolonged rainfall promotes slope destabilization," and the "[i]nformal constructions are at greatest risk as they do not benefit from adequate engineering" (WB and the GFDRR 2010, 161).

Most makeshift squatter settlements built with impermanent or recycled materials belong to the newcomers or to the very poor (Gencer 2007, 127; Gencer 2008, 266). In many cases, these settlements lack municipal services and infrastructure (ibid). For instance, in Haiti, where 70 percent of the population is slum, only 17 percent of the population has access to improved sanitation facilities. Likewise, in Nicaragua, with 45.5 of slum population, only 52 percent has access to improved sanitation, and in Anguilla with 40.6 percent slum population, only 60 percent of the population has improved drinking water sources showing the high degree of vulnerability due to lack of infrastructure in informal settlements. Additionally, lack of proper infrastructure facilities and unplanned urbanization schemes combine to create new hazards in informal settlements, where inadequate waste disposal in riverbeds and ravines, in addition to the urbanization of watersheds and wetlands may modify hydraulic regimes. This is the case in Quito, Ecuador, where with pressure of unplanned urbanization, approximately 3.2 kilotons of solid waste is disposed of in ravines each year; obstructing drainage and increasing flash flood hazard (UNDP 2004, 61).

As informal settlements grow larger and denser, lack of sanitation, clean water and garbage removal, in addition to congested living conditions add to the disaster vulnerability of slum dwellers; resulting in further environmental and health problems (Gencer 2007, 127; Gencer 2008, 267). The UN Millennium Task Force on Slum Dwellers report that lack of provision for water and sanitation and high levels of overcrowding contribute to many communicable and non-communicable diseases (from respiratory infections to malaria), injury, and premature deaths (from rapid spread of vaccine preventable diseases) in several urban slums in Dhaka, Nairobi, and São Paula (UN Millennium Project 2005, 59-60). In the Dominican Republic, where 17.6 percent of

[11] The popularisation of *pueblos jovenes* in official terminology, instead of the former term of *tugurios* (inner-city slums) *and barriadas* (squatter communities), is argued to be an attempt of authorities "to address the damaging effect of prejudice against slums" (UN-Habitat 2003, 10).

the population is slum dwellers, and the proportion of the population using improved drinking water sources and improved sanitation facilities are 86 to 83 percent respectively, "[t]he health status of the population influences vulnerability," with food or water-borne, water contact or vector borne infectious diseases (WB and the GFDRR 2010, 129). Indeed, in the CAC countries where there is a high rate of urban slum dwellers, estimated mortality rates for infants less than age 1 per 1000 births is very high, such as in the Dominican Republic, 46; Nicaragua, 40; and in Haiti 87 deaths occur per 1000 births (Dodman/Hardoy/Sattherwaite 2009, 29-30).

In many informal settlements and peripheral municipalities, vulnerability does not end with such physical exposure or social fragility (Gencer 2007, 128; Gencer 2008, 267). Lack or inefficiency of public urban services and institutions—transportation networks, hospitals, fire- or police stations—translate into *lack of response capacities* at times of disasters (ibid.). In Costa Rica, "[t]he fast growing metropolitan population in the Central Valley generates major stresses on the limited natural resources, public utilities and municipal services," making affordable housing "a major socio-economic constraint that forces low-income families to relocate to higher-risk areas" (WB and the GFDRR 2010, 47). Insecure land titles obtained through developers add to the impossible disaster recovery of these settlers, who can neither obtain government aid nor credit with their illegal titles. Additionally, as is observed in the example of St. Lucia, "[t]he lack of legal title (land ownership/tenure) has led to unsustainable land use and poor land conservation practices which results in soil erosion and land slippages as well as silting of rivers and coastal waters" (ibid., 229). It was also observed in Honduras that "extensive flooding and the large number of landslides exacerbated by the environmental degradation conditions that have occurred over several decades" and created much of the impact of Hurricane Mitch "were largely due to the extensive poverty in the area" (ibid., 173-174). Likewise, in Jamaica, with 60 percent of the population is slum dwellers, "[i]n addition to the exposure of 96.3% of the national population, 94.95 of the national territory and 96.3% of the GDP to two or more hazards, vulnerability is also linked to poverty," as the country has a low rank in the Human Development and Human Poverty Indexes of the United Nations (ibid., 186). Social exclusion, ethnic or immigrant status, poor education and limited job opportunities add to the income poverty of these residents, limiting their mobility and resettlement and creating one of the biggest challenges for urban risk reduction in the Central America and the Caribbean region (Gencer 2007, 128; Gencer 2008, 267).

On the other hand, physical susceptibility to disasters is not a condition that belongs solely to the very poor, nor does it need to transfer into risk. In many cases, adequate building standards and urban planning actions alone can help manage or reduce disaster risks (Gencer 2007, 136; Gencer 2008, 275). However, these actions have been absent, or in case of availability, not properly applied in many urban areas that have been economically more advantageous than the informal settlements or slums. Oversight of control due to inadequacy or corruptions of local governments and officials add to the problem in many urban areas, especially in the housing responses to rapid population growth since the 1980s, where problems usually start with an increase in building activity with an unqualified construction sector and lack of government control (ibid.).

For instance, both in the Island of Grenada and St. Vincent and the Grenadines, "[n]ew construction, particularly in relation to tourism, continues with little formal land use planning or construction code enforcement," as the construction codes that exist are not evenly applied (WB and the GFDRR 2010, 161 and 239). Likewise, "[p]oor regulated construction and land use practices" are found to be "among the biggest contributors to risk from losses" in the Island of Saint Lucia," where "[l]ack of uniform enforcement of building codes contributes to the vulnerability of island infrastructure (ibid., 229). In other cases, non-adequate applications of building codes or deficient structural configurations are the main cause. Many times, structural

configurations are executed after the completion of buildings, as residents try to reconfigure their living spaces without consultation to architects or civil engineers (Gencer 2007, 138; Gencer 2008, 275). Similar to the situation in the Small Island Developing States, in Panama, which has one of the larger urban settlements in the Central America and the Caribbean region, "[t]he poor enforcement of national and local land use regulations, the uncertainty about compliance with building codes, rapid demographic growth and unplanned urban and industrial expansion" are found to be "responsible for most of the current and significant increases in vulnerability" signifying the susceptibility of populations and assets at the wake of loose enforcement or building code and regulations (ibid., 21).

Worldwide earthquakes in several urban areas within the last decades have shown the vulnerability of buildings due to the lack of application of design codes or building standards, particularly in post 1980s construction. The 1985 earthquake in Mexico showed that "buildings constructed before 1950, with flexible, inadequately detailed, and almost unconfined concrete elements, have performed, in several instances, better than those with modern construction" (Meli 1993). Roberto Meli and Sergio Alcocer (2004, 31) attribute this situation to the replacement of the thick infill and façade masonry walls with lighter and weaker partition elements without updating the detailing rules of the 1950s. Therefore, they explain, "the poorly detailed modern reinforced concrete frames exhibited more severe earthquake damage than older frames with equally poor detailing but with more substantial nonstructural elements" (ibid.). In the 1985 Mexico earthquake, a second set of damages was recorded in mostly government-sponsored projects. Documenting the impact of that earthquake, Sergio Puente (1999) wrote that 30 percent of the government hospital capacity in Mexico City was lost with the earthquake; and that most of these buildings were post-1950s constructions. According to Puente, one of the biggest damaged residential areas was the Nonalco-Tlatelolco housing estate, which was comprised of 102 separate buildings. The estate was constructed in the early 1960s, and it "was intended to be a model of state responses to joint needs for slum clearance, new housing, and improved architectural design" (ibid., 306). Likewise, in Haiti, "the stunning impact of the January 12, 2010 earthquake" was found to be partly due to "the weak and unregulated public construction sector" (WB and GFDRR 2010, 5-6).

In some cases, locations on geologically hazardous areas intensify or become a direct cause of damages (Gencer 2007, 141; Gencer 2008, 280). For example, Bruce Bolt (2004, 279) wrote that due to considerable distance between the earthquake source and the Valley of Mexico, "few structures built on firm soil and rock suffered damage." On the other hand, one area near the city center that was "underlain by a thick deposit of very soft, high-water content sands and clay" encompassed "most of the buildings that collapsed" in the 1985 earthquake (ibid, 280). Likewise, it is suggested that "[u]nless national building norms are created," due to its adverse soil conditions, Haiti, particularly in Port-au-Prince, "will suffer equivalent or worse damage in future" (WB and GFDRR 2010, 5-6).

In Central America and the Caribbean Region, it has been documented that that despite the existence of building codes in many nations, they are not applied uniformly due to the lack of enforcement and corruption, increasing susceptibility and risk from natural disasters. Indeed, corruption statistics based on the *Corruption Index 2011* (Transparency International 2011) reveal that in the CAC region, of the 17 countries that have been rated, 7 of them average the worse half of the 182 countries who were rated for corruption ranging from being ranked 91 to a worse 175. Of these 4 of them were Central American countries with larger urban areas; a number of smaller island states ranked fairly well in corruption statistics, mostly those whose economies were based on tourism industries (see Table 6).

Countries that scored high on corruption also scored high on urban poverty statistics. Costa Rica who ranked 50 in corruption worldwide had 20 percent of its urban population living below poverty line. The numbers were 80 to 33 for El Salvador, 129 to 54 for Honduras, 100 to 45 for Mexico, 86 to 11 for Panama, and 129 to 28 for Dominican Republic respectively, indicating the potential correlation between corruption and urban poverty.

Table 6. Corruption and Urban Poverty in the Central America and the Caribbean Region

Country	Corruption Rank / 182 Countries	Urban Poverty Headcount
Costa Rica	50	20.7
El Salvador	80	33.3
Guatemala	120	
Honduras	129	54.3
Mexico	100	45.5
Nicaragua	134	
Panama	86	11.1
Bahamas	21	
Barbados	16	
Dominica	44	
Dominican Republic	129	28.6
Haiti	175	
Jamaica	86	
Puerto Rico	39	
Saint Lucia	25	
Saint Vincent	36	
Trinidad and Tobago	91	

Source: Compiled from data in Transparency International. *Corruption Index 2011*. Available at: http://www.transparency.org/research/cpi, and the World Bank 2011. *World Development Indicators 2011* (WDI Online). Available at: http://www.worldbank.org (Both accessed in July 2012).

The "deadly consequences" of many earthquakes have been attributed to the "collusion between corrupt contractors and corrupt building inspectors" that "had resulted in lax enforcement" (Williams 2011, 18). Some researchers challenge this view arguing that "the typical problem in developing countries is not dishonest building inspectors, but the fact that such inspections do not take place" (Keefer et al. 2010). Either condition points out to the lack of institutional capacity and good urban governance, especially with post 1980s rapid and uncontrolled urbanization and the liberalization of state and the construction sector in many nations (Gencer 2013b, 29) and the Central America and the Caribbean region.

4. **Conclusion**

This paper has shown that urban disaster risk in the Central America and the Caribbean Region is a result of the combination of a) hazard and exposure: the concentration of majority of national populations in single urban systems and location of these core urban centers in hazard-prone areas, and b) susceptibility of populations and assets and lack of institutional capacity. Indeed, the brief overview of the factors that create or increase disaster vulnerability in the region has shown the susceptibility of populations due to urban poverty, encompassing both economic and non-economic factors, in many urban areas of the region. Secondly, physical limitations of the region

combined with loose enforcement of the building codes (and thus lack of institutional capacity) create susceptibility of assets and people creating vulnerability in urban areas of the CAC.

The following Table 7 summarizes characteristics of the built urban environment in Central America and the Caribbean. It delves into these characteristics in both the informal settlements and the inner urban areas with formal housing where susceptibility varies. Location, construction materials and building typology, building codes and regulations, construction agent, reason for location choice, infrastructure, land ownership / tenure, characteristics of urban poverty and assets are some of the elements that make up susceptibility in urban areas.

As has been observed, physical planning, construction and building design standards are essential elements in disaster risk management. On the other hand, as much as adequate zoning, building regulations and legal tools are necessary, they can sometimes be too rigid and expensive for urban residents to employ, leading way to an untrained informal construction sector and settlements (Gencer 2007, 157; Gencer 2008, 295). Evidence has shown "the inverse relationship between informality and the imposition of regulations" in many developing countries (Deininger 2003, 176). And many times, local governments develop urban plans to regulate urban development and expansion, lack of consultation with cities' residents and interest groups lead to poor results in their employment.

Table 7. Characteristics of the built environment and susceptibility in Central America and the Caribbean (Gencer 2012)

	Informal Settlements	**Formal Housing / Inner Urban Areas**
Location	Low-lying floodplains Urban fringes / steep terrain Geologically unstable land	Geologically unstable land
Construction materials / Building typology	Impermanent / recycled materials (boards / sheets of galvanized iron) More permanent cement blocks by time	Poorly detailed modern reinforced / unreinforced concrete frames (post 1950s)
Regulations	Too rigid	No construction enforcement / corruption
Agent	Self-built	Unqualified construction sector
Reason of location choice	Necessity	Choice of location
Infrastructure: Water, sanitation, Public services, transportation, hospitals – critical services	Lack or inefficiency	
Land ownership / tenure	Occupied/ illegal – insecure titles Individual occupation in the Caribbean Organized in Central America	
Urban Poverty	Female households in the Caribbean (11.9 % Female unemployment rate) GINI Index for all Central American States are ≥50 Urban Violence	
Assets		Concentration of assets in primary cities / tourism sector

As the differences of the characteristics of susceptibility between the informal and formal urban areas as exemplified in the example of the execution of building codes in Central America and the Caribbean indicate, there is no one solution to disaster risk reduction and various strategies need to be applied to the needs of diverse communities. However, any vulnerability and risk reduction program requires a persistent need of elements such as willing and proactive local governments

with financial and technical resources, as well as public awareness, empowerment, and participation of urban residents.

Based on the urban vulnerability overview and conclusions gathered from this paper, it is proposed to develop a new model of urban vulnerability analysis in the Central America and the Caribbean region. Such a vulnerability analysis should integrate characteristics of vulnerability that have been discussed in this paper into the existing vulnerability analysis methods. Those characteristics should include principles of good urban governance (for institutional capacity), the dynamics of urbanization and characteristics of the built environment (for physical vulnerability), and socio-economics of residents and sectors (for social equity and continuous economic growth). Such a multi-dimensional and integrated vulnerability analysis can provide the way to reducing disaster risk while producing a sustainable urban development, where "environmental quality, economic growth and social justice coexist" (Beauregard 2003).

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