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# MULTISCALE APPROACHES OF NATURAL RISKS MITIGATION IN CENTRAL AMERICA AND THE CARIBBEAN BASIN

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**ABSTRACT:** Both Caribbean and Central America regions share a common fate with regard to similar natural risks. Responses to past disasters followed similar tendencies and major mitigation actions often resulted from major crises during the last decades. This presentation is a reflection on the efficiency of risk reduction in Central America and the Caribbean region when the efforts of mitigation were never as important and adapted to social evolutions as today. Nevertheless, the constant recent increase of human land occupation in at risk areas, as well as the consequences of global change, mainly on coasts and flood prone areas have induced a succession of crises that all the responses and mitigation measures didn't succeed to avoid. It is nowadays convenient to question the current limits of mitigation policies. As they are highly vulnerable exposed sectors, insular coasts are specially analyzed.

**Keywords:** disaster responses; risk mitigation; West-Indies; natural disasters; coastal exposure

It is the conjunction of disasters in particular Mitch and incitements on an international scale which allowed the beginning of a new era of natural risks mitigation in Central America and in the Caribbean. More integrated, based on a sharing of resources and on regional cooperation, natural risk mitigation became part of development policies. To do that, mitigation shifted into strategies applied in different scales.

## 1. A COMMUNE DESTINY FOR CENTRAL AMERICA AND THE CARIBBEAN BASIN

Among the most striking disasters which affected the Central America and Caribbean regions during the last decades, two events have been extreme by their human and material impacts: hurricane Mitch and the 2010 earthquake in Haiti. Mitch (October 1998) has been highly deadly as it generated torrential rainfall when weakening as a tropical storm then a tropical depression over Central America. In the Caribbean basin, the tragedy in Haiti (the earthquake of January 12<sup>th</sup> 2010, 7.2 magnitude) has been the most disastrous event of the last decades. Both events have been real tragedies. They can be compared considering the number of victims, even if the human toll for Haiti was much higher, as they both caused a tremendous shock to the affected societies. However they have had different spatial impacts: a high concentration of victims in the metropolitan Port-au-Prince area (Haiti) but overspread victims for hurricane Mitch in Central America, mainly in Honduras (17509 deaths and missing persons) and Nicaragua (3456 deaths and missing persons). Nevertheless, other less deadly events have also had major impacts for the affected territories: September 2004, hurricane Ivan hit Grenada and hurricane Jeanne Puerto Rico, the Dominican Republic then Haiti; November 2010, hurricane Tomas hardly struck Saint-Lucia. Jeanne hardly affected Haiti leading to 5000 victims mainly caused

by floods and mudflows due to intense rainfalls as it slowed down and lost intensity. The city of Gonaïves has been flooded for several days leading to a humanitarian disaster.

Each event has been specific leading to particular crises management and responses difficulties. For example, in the Lesser Antilles, hurricane Lenny, (November 1999) had a very unusual trajectory on the Caribbean sea, with a final shift south-eastward in the Atlantic ocean from the northern West-Indies to the central ones. At that time, this atypical special case was not included in forecasts models leading to weather forecasts uncertainties.

Each of these events, whatever the regions they affected, led to adjusted measures based on lessons learned, to improve crises management and responses with the purpose of reducing socio-natural risks. These measures were adopted at different levels of responsibility: local, national, regional (as intergovernmental structures) ones. They also resulted from a strong raising of consciousness at a global scale, leading to United Nations adapted policies.

## 2 NEW SYSTEMIC AND MULTISCALE APPROACHES OF RISK MITIGATION

Whatever their status, independent states or dependent territories of Central America and the Caribbean have more or less synchronously built answers following similar schemes to better manage crises and anticipate them, mainly during the last two decades. The emergence of a real culture of risk is without doubt one of the strongest brand of innovation of the last years in addition to the improvement of the operational actions and of prevention and mitigation. These measures mainly came from lessons learned from disaster experiences like Mitch in Central America. They came from international, national and regional (as

intergovernmental structures like CDMA<sup>1</sup> in the Caribbean and CEPREDENAC<sup>2</sup> in Central America) initiatives such as the policies which succeeded post-Mitch forums.

In July 2009, the regional forum Mitch + 10 put in place by CEPREDENAC as part of SICA<sup>3</sup>, brought together participants from the international, national and regional official authorities and civil society representatives. This forum resulted in a joint statement that reaffirmed, five years after the Mitch + 5 one, that natural risks are basically induced by economic, social and environmental predispositions leading to disasters with important impacts. Several points of the declaration reflected a new vision compared to the past when risk management mainly consisted in responses to emergency and reconstruction needs. Risks could no longer be dealt with in a sectorial approach, but as a cross-cutting issue which induces an overall strategy whose implementation must be an integral part of sustainable development.

The regional level (Central America) of post-Mitch strategy must be connected to the global one managed by the United Nations. Their orientations for natural disaster reduction has been defined in particular during the 1994 Yokohama first world conference as a key event of IDNDR<sup>4</sup>, then during the second one, in 2005 in Hyogo (Kobe), within the framework of the ISDR (International Strategy of Disaster Reduction).

The structures or systems, resulting from global, regional (as Central America and the Caribbean regions) and national recent implementing strategies follow the global same schemes even if each country or territory has its specificity and its proper legislation (Figure 1). Inside each state or territory, there is also a strong integration between the different spatial levels: from the State level to the municipality and the district ones (local ones).

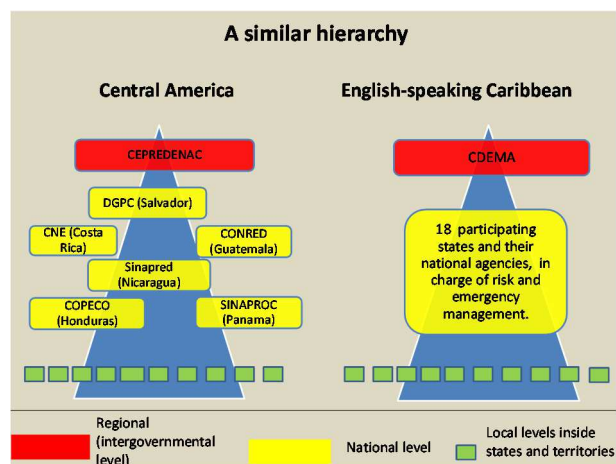


Figure 1: Disaster mitigation and emergency management structures in Central America and the Caribbean.

Among the recent changes stimulated by the Hyogo

framework of action, there is a tendency to better take in account the local levels. For example, an experiment of international cooperation was organized from March, 2008, in the district of Cóbano (province of Puntarenas) by the National Committee for disaster prevention, in association with the JICA (Agency of international cooperation of Japan): the project called BOSAI (Prevention of the Disasters, in Japanese) (Jenkins Molieri, 2001). Many other examples of actions taken in diverse countries of the studied region could be provided with local implications. Initiatives equivalent to BOSAI were also launched in the English-speaking Caribbean via CDEMA since the 1990s.

Nowadays, everywhere in Central America and the Caribbean, prevention and mitigation follow the Hyogo framework of action so that systemic risk issue and multiscale approaches prevail. Nowadays it is obvious that natural risks cannot anymore be managed in a sectorial manner but must be dealt as transverse problems what infers the implementation of global strategies integrated in sustainable development policies at all levels of spatial scales.

But if risk mitigation is from now considered as an obvious necessity by all decision makers, in reality, there is a big distortion between the policies, the intentions, and the facts. The actual facts show how hard it is to eradicate risks as multiple constraints and constantly changing vulnerability lead to inevitable crises.

### 3 RISKS IN TRANSFORMATION BUT NOT ERADICATED

Though many efforts have been made for risk reduction, crises, continue to occur. Most of them are not of high intensity but they still often disturb societies and economies.

The first difficulty results from the diffuse character of the impacts, states and territories have to cope with. This diffuse character results at first from an increasing spatial occupation with the population growth. Whatever is done for risk mitigation, human activities contribute to generate crises, thus to increase risks. In Central America, the observations show that instead of decreasing, the occurrence of natural disasters increases. From 1980 until 2000, a 5% annual increase of crisis events occurred (CEPREDENAC-SICA, 2009).

The analysis of the spatial impacts of the floods and the landslides that occurred from 2000 until 2006 in Costa Rica confirms this observation (Arroyo Gonzales, 2010). For the last twenty years, in Costa Rica the frequency of the socio-natural events have increased. They have been disasters both for the environment and the affected societies. These bigger frequencies resulted from recent extension of human activities as well as from the new use of land. These crises reflect an increase of recurring events as well as new affected zones. In Salvador also, landslides

<sup>1</sup>Caribbean Disaster Management Agency

<sup>2</sup> Centro de coordinación para la prevención de los desastres naturales en América Central.

<sup>3</sup>Sistema de la Integración Centroamericana

<sup>4</sup>International decade for natural disaster reduction

caused both by intense rains and earthquakes (2001), result to many reactivations of previous ones, as well in natural domain as in artificial banks, cut for constructions, bridges, or roads. More road infrastructures, buildings, that are absolutely needfull for development lead to more crises situations. In Costa Rica, three provinces were touched by floods and landslides, the San Jose, Puntarenas and Alajuela provinces (Figure 2). Among these provinces where crises have been most numerous two of them are the most inhabited (San José and Alajuela) and one is strategic for Costa Rica (the Puntarenas one). They are urbanized and they concentrate a high variety of agricultural, industrial and commercial activities.

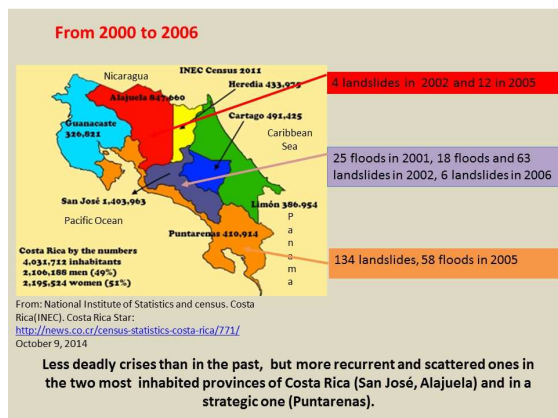


Figure 2: Increasing crises with population and activities growth in Costa Rica.

Despite very important multi-sectorial efforts (financial, technical, organisational...) to limit them and reduce their negative impacts, the recurring and numerous landslides in Martinique (French West-Indies), reflect key issues it is nowadays still not possible to substantially stop or reduce (according to L. Péronet doctoral thesis work<sup>5</sup>). This island has known its demographic transition after the mid 20th century so that population density is nowadays high, with more than 350 inhabitants per square kilometer. Its mountainous topography in a tropical context leads to strong slope instability. In fact, the recurring landslides that strike various places of Martinique result as much from natural sliding prone slopes as from their artificialisation. Scattered houses and infrastructures over large areas... are often hit by landslides during rainy periods that need lots of technical and financial means for repair and rebuild. Uncontrolled water discharges, soil sealings by scattered urbanisation, washouts along infrastructure trenches..., are many human factors inducing slopes slips. Martinique is a key example of the highly exposed territories of the Caribbean region to hard rainfalls induced hazards and of a strong exposure of its population to frequent disturbances due to recurrent crises.

<sup>5</sup> Lucie Péronet: Doctorate student (Université des Antilles et de la Guyane), EA 929, AIHP-GEODE, Landslides in the Lesser Antilles, a contribution to the

The Caribbean and Central America regions show paradoxal tendencies: at the same time lots of efforts have been done to better deal with crises due to socio-natural risks, and the exposed populations are better protected face to the multi-hazards they are exposed to. Nevertheless, the frequency of disaster or crises does not decrease because many factors such as land management, are still not clearly controlled.

Considering the future, lots of paradoxal tendencies appear also with many certainties and uncertainties as well. Coasts are particularly exposed to significant modifications due to climate change. Nevertheless, time scale must be taken in account to better evaluate what will happen in the future along the highly humanized coastline.

#### 4. UNCERTAINTIES BUT MULTISCALE CERTAINTIES FOR THE FUTURE: THE COASTS CASE

Islands are particularly interesting to consider referring to coasts evolutions and the tendencies of their occupation for the future. The West-indian islands are very good case studies for projections in the future.

##### 4.1 The present tendencies of coastal dynamics

Coastal erosion is an excellent indicator of the changes that are currently taking place; indeed, though the Caribbean coasts are retreating at an accelerating rate (this phenomenon is also observed on a global scale) the impact on the population remains relatively stable.

For example, during hurricane Luis in 1995, the La Vigie beach in Saint Lucia withdrew 11 meters in less than 48 hours, whereas usually, it only retreats a few tens of centimeters per year (Fisheries department, and al., 2003). It is the same in Saint Kitts, where the *South Friar's Bay beach* withdrew twenty meters in 24 hours, following the passage of hurricane Georges (1999), while it declined annually under 2 m (Department of the environment and al., 2004).

In Saint Vincent, and more generally in the Grenadine Islands, although coastal erosion is less pronounced due to a well developed coral frame that reduces the swells and promotes premature release of energy- the beaches remain vulnerable to weather events. For example, in Mustique Island, the Honor Bay beach withdrew about 5 m, during the passage of the tropical storm Lili (September 2002) and the thickness of the sedimentary cover has been reduced by more than 60% (- 1 m).

Despite the increasing erosive mechanisms due altogether to natural and human factors and the increasing coastal development for people and their activities, the coastal vulnerability does not seem to

comparative analysis of their crises management. Under the direction of Professor F.Pagney Bénito-Espinal.

have increased over the recent years. Indeed, the available statistics do not show any correlation between the accentuation of the coastal erosion hazard and the number of people affected. This could be explained by better public information and particularly the implementation of more and more suitable protective methods. Despite this observation, some certainties seem tempered by great uncertainties.

#### 4.2 Strong certainties for long-term outcomes

Global warming is one of the phenomena we are talking more and more about, but we know very little about its potential impacts. However, one thing seems certain: over the next seven decades, the average troposphere temperature is expected to rise by approximately 1.4 to 5.6 degrees Celsius. Due to the melting of continental and high mountain glaciers, the average sea level is expected to rise. According to the latest IPCC (2014), in the Caribbean, the average sea level rises annually from 2.5 to 3.5 mm. Based on this observation, it is possible to simulate the positive eustatic variation that is likely to affect the coastal Caribbean within the next sixty years. If nothing is done, Martinique will lose about forty km<sup>2</sup> (mainly along its southern low coasts, also along its eastern marine “culs-de-sac”, and at the coastal fringe that surrounds the bay of Fort-de-France (Figure 3), while a significant portion of the industrial zone of Jarry, the Pôle Caraïbe airport, and the lowlands of the existing landfill of Grand-Camp in Guadeloupe will be flooded.

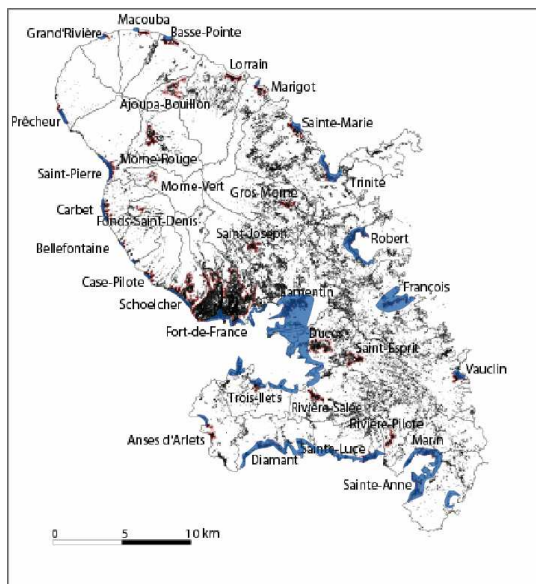


Figure 3: Location of the submerged areas following a rise in sea level of about fifteen inches (Martinique).

The situation is not much better in the neighboring islands (Figure 4), where large coastal portions will suffer severe seawater intrusion, thus jeopardizing economic infrastructures (especially touristic), and

even the water supply. The vulnerability of the population is directly engaged.

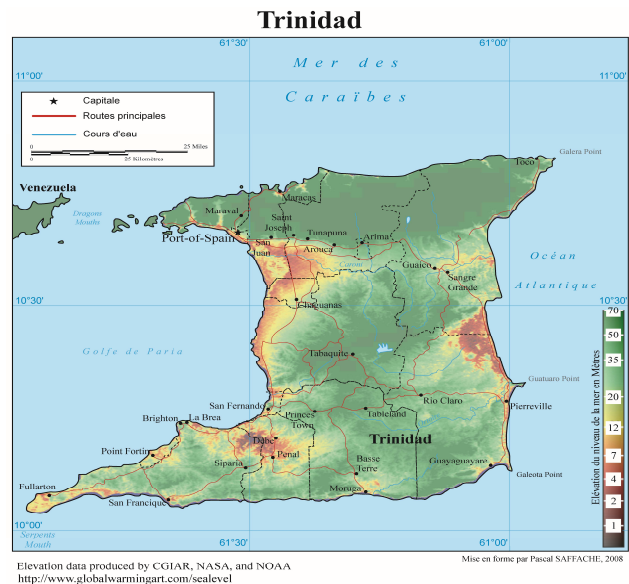


Figure 4: Location of potential seawater intrusion on the Trinidadian territory.

Although these considerations are more and more known, it does not prevent people to massively occupy the coastal strip; developers also put strong pressure to sustain and urbanize these areas. In the short-term, the economic benefits seem to win against the durable protection of populations.

The situation is exactly the same with regard to flooding. Despite the many recent tragedies recorded during recent decades (such as tropical storms on Martinique: Klaus, 1990 - Cindy, 1993 ...), people continue to occupy the floodplains, and even sometimes minor river beds. The authorities (as municipalities or any other ones) don't systematically do something against this situation.

#### CONCLUSION

Faced with this situation, there is a double question: how did we get here? What to do?

The fragile situation of the Caribbean islands is particularly exacerbated, because these territories are small, often steep, affected by all the spectrum of major natural hazards (except avalanches). They are also especially coveted by developers or economic agents, who only dream of quick profits. To this complex situation is superimposed a significant population growth, therefore there is the need to develop these territories, by all means so as to avoid social explosion. The desires of the developers are quickly satisfied, even though their investments do benefit very few local people.



If we add to this picture a misunderstanding, or an overspread lack of knowledge, of the risk and their operating mechanisms, everything seems to be clamped for a large-scale tragedy to occur.

In these circumstances, what should be done?

First, awareness raise to hazards and risks should be promoted; the younger population should be the main target so as to include this type of action over time.

Second, environment should be better integrated in the development projects and their impacts in the short, medium or long terms should be evaluated before allowing their achievement. Finally, apply the law, so as to overcome the most glaring vulnerabilities (structures located in the beds of rivers, along "waterfronts", on steep slopes, on liquefiable soils, etc.), and especially make every citizen an "eco-citizen" so as he gets fully involved in policies to reduce populations vulnerability.

More generally, in the Caribbean and Central America, if policies already tend to control vulnerability by important efforts for population awareness, for more severe building codes application, and a better land use, these efforts are not efficient enough to dramatically reduce it. Moreover, due to global change transformations, the hypothesis of severe crises in more or less long terms are certain. Thus, to facilitate the resilience of the potential affected societies, it is also of major importance to improve preparedness to better deal with crises management and anticipate them.

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