

## Impact Assessment of Hurricane Isidore in the Yucatán Península: The case of Campeche

E. Rivera-Arriaga† and G.J. Villalobos-Zapata†

† Management of Coastal Ecosystems, EPOMEX  
Center, University of Campeche,  
Campeche, Camp. 24030, México  
gtzrva@prodigy.net.mx  
gjvillal@mail.uacam.mx



### ABSTRACT

RIVERA-ARRIAGA, E. and VILLALOBOS-ZAPATA, G. J. 2006. Impact assessment of hurricane Isidore in the Yucatán Peninsula: The case of Campeche. Journal of Coastal Research, SI 39 (Proceedings of the 8<sup>th</sup> International Coastal Symposium), 1328 - 1331. Itajaí, SC, Brazil, ISSN 0749-0208.

Hurricanes are not strange events in Campeche. However, this is the first time that the government is devoting some funds to study the impacts of the last hurricane that hit Campeche. Most of the reports coming from official institutions make a summary of material costs and damages without taking into consideration the people, the hidden social costs, nor the institutional response to the people during such events. This research applied semistructured interviews to obtain on the ground information that has not been collected before. Results showed that flooding is the major cause of damage from Isidoro, and people suffered from direct and indirect impacts due to a lack of preparedness culture and to bad planning, while the environment did not suffer major impacts. The institutional response to Hurricane Isidore was good enough to attend most of the contingency, however, it can be perfectible. The authors consider that more research is required to fully assess the impacts of hurricanes in Campeche in order to develop environmental policies to address hazardous events, and that these policies should be tailored considering prescriptions from an integrated coastal management approach.

**ADDITIONAL INDEX WORDS:** *Coastal hazards, hidden costs, coastal management.*

### INTRODUCTION

Campeche is a coastal state of the Mexican Republic, located in the Yucatán Peninsula at the southern part of the Gulf of Mexico. The state has a surface of 56,858.82 square kilometers and a total population of 689, 656; from them 346,896 are somehow affected by the hurricanes, which results in 50.3 per cent of the population (INEGI, 2000). The coastal line of Campeche is 523.3 km. In general the shore is sandy and shallow, this is so evident that in some places like Seybaplaya and Champotón, usually the tide can retrieve the sea more than 500 meters from the shoreline.

The geographic location and shallow characteristic of the land in Campeche makes it an ideal candidate to suffer from the impacts of coastal hazardous events, such as hurricanes. Due to the geographic location of the state, it is very rare that a hurricane hits it directly. However, the state is vulnerable to the side effects of hurricanes, such as winds and rain, causing storm floodings and devastation. According to CENECAM (2002), there is a register from 1886 to 2002 of 1,014 tropical storms in the Atlantic Ocean, 116 of them have impacted the Yucatán Peninsula and 91 have affected Campeche. During the past 41 years, Campeche has suffered the impacts of ten hurricanes, four of them considered as dangerous for the state: one category 3 (Opal), two category 4 (Roxane and Isidore) and one category 5 (Gilbert) (Figure 1).

During the summer of 2002 the Yucatan Peninsula sustained hurricane Isidore. It entered directly inland hitting the coast of Yucatan, arriving to the border with Campeche and going back by the same path towards the Gulf of Mexico. The coastal area of Yucatan suffered great damage, with huge structural damage in the coastal zone and inland. Despite the fact that the hurricane did not enter to Campeche, the state suffers under the influence of the hurricane for the entire time the event was over the Peninsula. Heavy rainfall followed the hurricane and persisted for about two weeks, causing considerable damage to homes, crops, livestock, businesses, automobiles, as well as power lines, potable water pipelines, and highways and rural roads. Many areas were without power, water, food or medical supplies for several weeks. Heavy rains had also an effect in watersheds, with large volumes of water flooding into the main channels, and carrying tons of sediments, debris and everything in its path.

Hurricane Isidore caused devastating environmental, social and economic impacts to the coastal zone of Campeche. Additionally, during months following the hurricane several villages still were overtopped, or were inundated; and a large amount of fishes and marine organisms were found dead in the shores. People in the coastal zone had problems in returning home or getting to their works due to floods and roads destruction, causing economic losses to the family and state economies. In this paper we describe the environmental, social and economic effects caused by this hurricane, and give some recommendations for a better preparedness of both government and people of Campeche.

### METHODS

Hurricane Isidore hit Campeche from inland, so most of the damages were due to heavy rainfall that flooded from the center to the coastal zone; and to storm surge that flooded and eroded the coastal zone up to 25 kilometers inland. The federal and regional governments through the Consejo Nacional de Ciencia y Tecnología- devoted some funding to study the impacts of this event at a regional level considering the three states of the Yucatan Peninsula: Campeche, Yucatán and Quintana Roo. In this paper we are presenting only the results obtained for the coastal zone of Campeche.

We limited our study area to the coastal strip considered between the shoreline to the Interstate Highway 180. Key information was gathered from two types of sources: 1. Official reports coming from government agencies at state and municipal levels, and 2. On the ground information, where we conducted 183 semistructured interviews. For the first source we chose all the government agencies that were supposed to be related to responding to hazardous events, such as the Navy, The Army, the Federal Agencies for the Environment, Communications and Transportation, Water, and Health, the National Center for the Prevention of Hazardous Events (CENAPRED/CENECAM), the Red Cross, the state and municipal governments, as well as state agencies for the Environment, Health, and Civil Protection, and so on.

The second type of information sources considered a selection of: a) coastal populations, b) hotels; c) schools; d) hospitals; e) restaurants; and f) fishermen. We were interested in knowing the experience of the people and their communities,

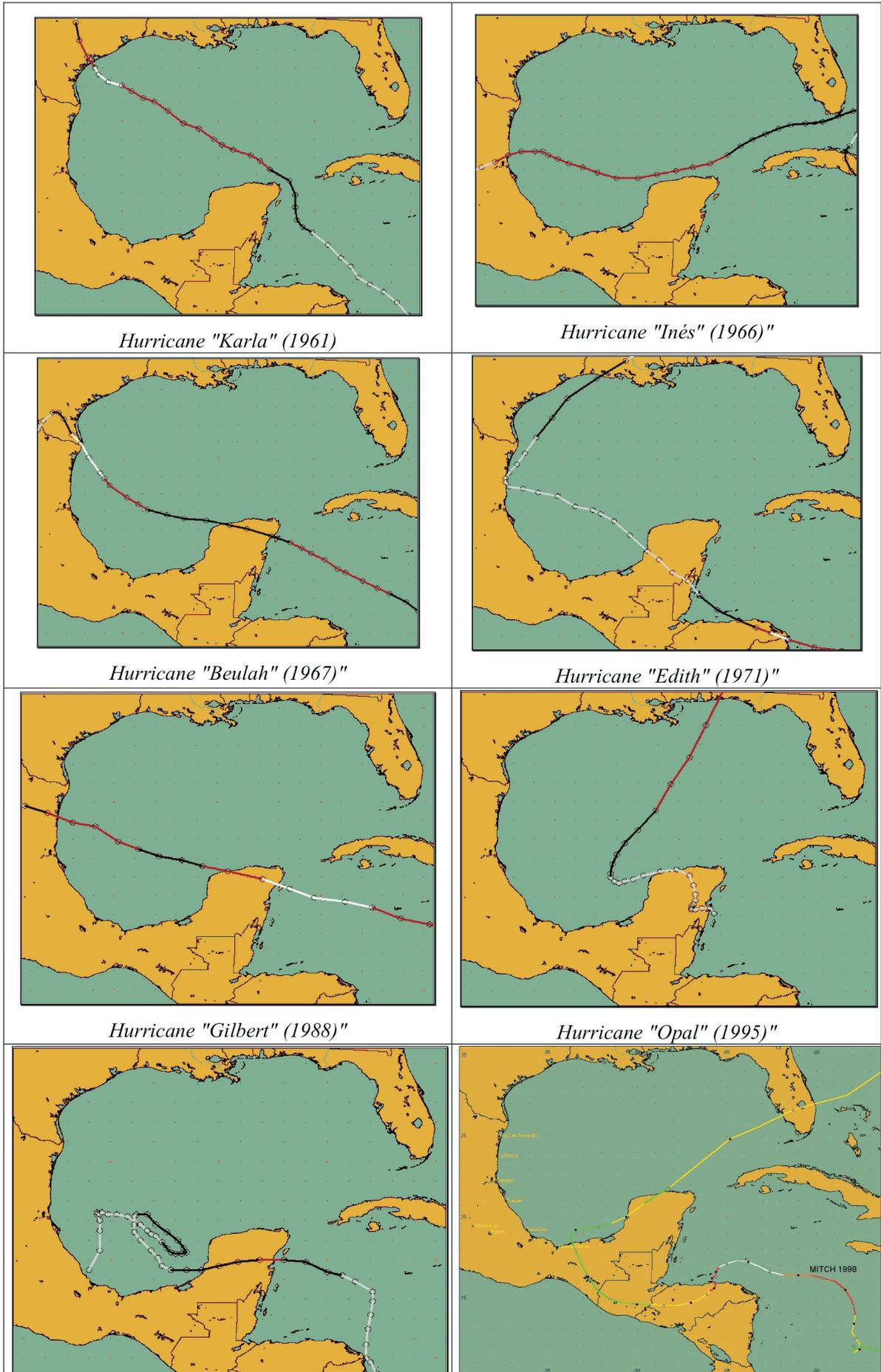


Figure 1. History of hurricanes affecting Campeche from 1961 to 2002 (Source: CENECAM, 2002).

and we considered important to find out information about the two sectors that were impacted the most: tourism and fisheries. Information obtained from interviews covered the following aspects:

- Social and Economic impacts on coastal populations: Quality of life, Impacts suffered by the hurricane, Economic losses, Health problems, Preparedness for such events, and Grading official assistance (if any).
- Economic impacts on sectors and institutions: Economic losses, Insurance coverage (if any), Time to recover, Preparedness, and grading official assistance

Environmental assessment in Campeche state was focused mostly to mangroves and the erosion caused in the shoreline. Other important negative effect in the environment was the flooding of field crops which caused a great impact in the food production of the state.

## RESULTS

### Coastal Populations

The major problem in all of these towns was flooding, and floods have many causes, such as changes in the height of roads, streets and avenues; solid waste that impede the water to go, closure of natural rain drainages, and the most important, bad planning of urban development that do not take into account vulnerability nor risk factors. The consequences of flooding are the following:

- Material losses. Most (if not all) of their belongings were lost and have not fully recovered yet
- Work problems. Could not go to their jobs for 3 to 10 days, workers did not receive their payments
- Energy shortages. With no electrical power there is a scarcity of potable water (electric pump do not function), problems with food storage (no refrigerator), and lack of information (no radio nor T.V.)
- Isolation. Scarcity of food, medicines, and even cash
- Emotional impacts. People suffered from nervousness, frustration, anger and panic, and had not got any support
- Health problems. Specially children and elder people mostly suffered from respiratory and stomach illnesses and were attended with home remedies.

### Services and Sectors

**Fisheries.** Most of fishermen had a better preparedness response than the rest of the population at each studied location. They received the hurricane early alert and from that moment on do not go out, most of them take good provisions for protecting their boats, engines, and nets. Most of all, the major problem faced by them is the period without fishing because they depend on almost daily base, of their captures for living.

**Tourism.** Campeche City is very recently considered as a required stop of tourists that go to or come from the City of Merida in Yucatán. Most of these tourists spent only one night in Campeche and then they go on their travel. Isidore made some of these tourists to spend at least one week in Campeche due to the damage of the interstate highway.

**Health.** Most of the hospitals in Campeche City were prepared to receive patients and provided them with medicine. However, there was one hospital which is located in a risk zone and suffered big losses when it was flooded and mud and water broke a wall and destroyed half of it. The headquarters of the Red Cross had to move their location due to flooding, which at the end did not interfered with the emergency operations carried on by their volunteer members. Nevertheless, a different story can be told for small towns within the coastal zone, where the lack of doctors, nurses and medical supplies were considered a major problem during such an emergency.

**Education.** All schools were closed due to the early warning given by the authorities. Most of the schools did not suffer from flooding and were even used as refuges by the Army during the hurricane. Few schools were flooded and had major losses in furniture and educational material. Children and youngsters lost around 10 days to return to their normal work schedule, mostly because of two major reasons: 1. The authorities wanted to give families some time to reorganize after the hurricane; and 2. Some schools were functioning as refuges and people in them were not able to go back to their homes because they were still flooded.

**Official Aid Response.** All the institutions that were interviewed had two responses to hazardous events, one attending the inside of the institution itself, and the other to attend the community. According to their information, all of them used full capacities to solve problems, reconstruct lifelines, rescue people, answer their calls for aid, help to distribute goods and emergency supplies, and coordinate actions with other institutions. The Mexican Army implemented their DN-III Emergency Plan to attend the population at a full scale, the Navy coordinated actions and participated in every aspect of a previous contingency plan of their own, and the rest of the institutions claimed to do the same. However, when we asked the people in the selected towns, their perception did not fully coincide with the institutions' responses. Many people felt alone, and that nobody answered their plea for help, many others are very thankful to the Army and the Navy for their support and help.

**Environment.** Mangroves did not suffer any impact from Isidore, the only impact observed related to mangroves was an increment of tannins coming out from mangrove systems. Fishes and other sea life were killed by the storm surge and had to be cleaned from the streets, houses and buildings after the event. Bird colonies, such as flamencos, moved from Yucatán to Campeche to nest since Isidore. More than 100 kilometers of roads were damaged due to erosion caused by the storm surge, especially in those roads built by the seashore and that did not respect the dunes.

## ANALYSIS

Results obtained from this research show that human activities and bad policy decisions and practices, particularly those concerned with construction and development of coastal settlements and roads, significantly magnified the deleterious impacts of Hurricane Isidore on human life and human economic activities. The official figures of damages from Isidore consider around 1.5 million dollars.

The list of problems, their root causes, and consequences can be summarized in table 1.

## DISCUSSIONS

Regardless of the emergency plans to aid and relief coastal populations, the siting of residences in flood-prone areas is also likely to remain problematic, depending on land-use planning efforts (or lack thereof). While other hurricanes had led to large-scale environmental damage, the experiences garnered from Isidore should lead to serious policy discussions and some improved environmental policy efforts in hurricane-prone regions.

Natural systems in the Caribbean and the Gulf of Mexico have been weathering hurricanes for millennia, with forests and species adapted to take advantage of the changing conditions of landscapes left behind by hurricanes. Nevertheless, the impact of these periodic disturbances on plants, animals and ecosystems may be greater now than ever before, due to the global effect of climate change, having a pattern of higher frequency, intensity and length in storms, than ever before. Moreover, when hurricanes cross the Caribbean to the Gulf of Mexico, their damaging effects are often magnified by past

Table 1. Analysis of the major factors affecting the coastal zone of Campeche.

Major Factor	Problem	Origin	Repercussions
<b>Rain</b>	<b>Flooding of coastal settlements and fields:</b> - Flooded houses and streets - Flooded crops - Isolation or difficulty to move - Food, medicines, fuel, and water shortage - Contamination of water - Presence of illnesses and epidemics	- Bad planning of coastal settlements - Alteration of micro topography, which alter the natural drain of rain -water to move out - Lack of vulnerability and risk assessment before developing a new settlement - Cloughness of natural rain drainage due to excessive sediment and debris input - Pollutinin of rain drainage - Saturation of underground water yields	- Economic loses of personal belongings - Health problems - Evacuation with each hazardous event - Loss of crops - Loss of animal-farm - Loss of livestock
<b>Wind</b>	<b>Strong winds:</b> - Energy lines blown down - Trees blown down - Roof asbestos and aluminun sheets blew off - Private property damages to palm roofs	- In the coastal zone in Mexico all the constructions have metal sticks within the concrete that are made the energy poles, and they suffer from corrosion. - A number of tall trees fall down despite the fact that many trees were pruned before hurricane season started - Numerous houses in the poorest zones of coastal settlements use metal sheets to build their homes or their roofs are made of palm leaves	- Energy poles fall down causing energy shortage from hours to days - Blockage of avenues and roads - Some trees fall down onto private property (houses and cars), and over energy lines -Metal sheets are dangerous flying debris
<b>Storm surge</b>	<b>Strong swell, flooding the coastal zone:</b> - Flooding the coastal zone - Shoreline erosion - Destruction of coastal roads	- Campeche City has alter dramatically (and still is altering) its shoreline filling up several meters (140 m) from the original coastal border, and cutting down the once protective mangrove areas, and constructing in those areas - Coastal settlements in Campeche have a history of suffering from flooding each time such an event arrives, but so far, nothing has been done to prevent or mitigate it - The interstate highway runs along the coastal border, without respecting the dunes nor wetland vegetation, and without proper drainage	- Every time that a hurricane has hit Campeche, the coastal zone, specially the filled ones, are flooded - Personal and public property is lost when flooding arrives - Roads are not safe during and after the event hits due to floodings, destruction processes, and material washed away by the rain or from the hills - Isolation of coastal settlements with difficulties to get the people out of there or bring them emergency aid and supplies - Long parts of the road need to be repaired or reconstructed after every hazardous event

and ongoing, human-caused disturbances to coastal and island ecosystems. Particularly vulnerable are already stressed ecosystems, such as mangroves, sea grasses, coral reefs, and species such as flamingos for which the combination of increasing human pressures and the natural cycle of hurricane disturbance can be devastating.

## CONCLUSIONS

Campeche is still in its infancy in educating its people and institutions to be prepared for hurricanes, there must be a committee that can take the task of developing contingency measures, training plans and actions for a better hurricanes response. On the other hand, hurricanes can bring opportunities for re-designing better policies for urban planing according to vulnerable and risk maps. People should know where these risk areas are located before purchasing a property to avoid personal losses. At the same time it would be important to consider that

more research studies are required to fully understand the impacts of hurricanes, and a monitoring program should be developed to collect data that allow future comparisons when a hurricane arrives, and that ultimately give us parameters for developing more research and mitigation actions.

## ACKNOWLEDGEMENTS

This research was made with the funding of CONACYT-Sisierra and with the collaboration of Mauricio González-Jáuregui, Ramón Zetina, Fernando Valencia, Víctor Sanchez, Luis Cortez, and Carlos Caballero.

## LITERATURE CITED

CENECAM, 2002. Atlas de Riesgos para Campeche, 160 p.  
 INEGI, 2000. Censo Poblacional