



# WATER QUALITY RESPONSE TO HURRICANE EVENT IN COASTAL AREAS WITH DIFFERENT HUMAN IMPACT

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## 1. INTRODUCTION



Figure 1. Aerial image of Yucatan's coastal area showing water flow from coastal lagoon to the sea waters as effect of Isidore hurricane

Hurricanes are natural events which affect coastal morphodynamic, when the littoral is broken and let all materials contained at adjacent ecosystem (like coastal lagoons fig 1) flown to the sea, moreover excessive precipitation could be more than coastal waters can support on natural conditions without alter its own hydrological structure, if we add the fact that most people of the world live on or near coasts, we have that those events are the most significative in terms of environmental and economic impacts.

Most known effects of the hurricanes are movements of oceanic water due to strong winds that could favor sediment resuspension, as a result loose of transparency on the water column; less known are those in relation to the ecological function, because are high energy disturbance, hurricane's ecological importance is to promote pulsed production to the systems and to favors early succession stages.

## 2. STUDY APPROACH

As most of the tropical coast, Yucatan's littoral is frequently impacted by hurricanes, which change coastal ecosystem. During September 22-24 of 2002 a level II saffir-simpson hurricane called "Isidore" impacted the state with winds of 250 km/h and rainfall of 230 mm for Mérida just in 24 hr, when the annual mean rainfall for all the state is 760 mm.

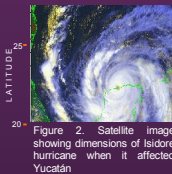


Figure 2. Satellite image showing dimensions of Isidore hurricane when it affected Yucatan

The existence of seasonal hydrobiology data ("nortes", dry and rainy seasons) since 2000 as a part of hydrological characterization and trophic status of north coast of Yucatan, the incidence of the hurricane in 2002 and the continuous monitoring until 2004, create adequate data set to asses the hydrobiological changes and the recover response of 4 ports of Yucatan (Celestún, Sisal, Progreso and Sisal) which are spatially distanced and have a different degree on the influence of hurricane and also have different anthropogenic impact.

## 3. STUDY AREA



Figure 3. Study area and location of study sites respect to the hurricane trajectory

Yucatan is located on the south of Mexico where rain regime define 3 weather seasons corresponding to "nortes" (nov-feb), dry (mar-may), and rainy (jun-act).

The coast of Yucatan is shallow, dominated by biogenic sands and covered by seagrasses and macroalgae on the bottom.

About 8.6 x 10<sup>6</sup> m<sup>3</sup>/km of groundwater discharges to the coastal zone during all the year, those waters are colder than seawater, and rich in nitrates and silicates

## 4. METHODS

Coastal seawater, was sampled at 12 stations for each site (sampling design showed below on the result section)

At each port we obtain a total of 15 samples ("nortes", dry and rainy seasons per year) from 2000 to 2004

The parameters measured were: temperature, salinity, pH, DO, NO<sub>2</sub>, NO<sub>3</sub>, NH<sub>4</sub>, SRP, SRSI and Chl-a

We used box-and-whisker plots graphics, to represent median and variability values of the parameters before and the effects of hurricane. Rainy of 2002 reflect 3 weeks after hurricane

## 5. RESULTS

### CELESTÚN



- ❖ Fisherman-town (5000 inhabitants)
- ❖ Has no severe anthropogenic impact, ecotourism is an important activity
- ❖ Was not considered within hurricane influence
- ❖ There was Hurricane effect on Chl-a concentration until 2003

Figure 4. Sampling design for Celestún

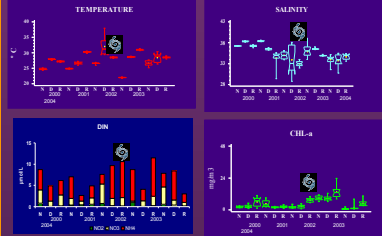


Figure 5. Main response variables at Celestún coastal seawater

### PROGRESO



- ❖ Has the highest coastal population, with 50,000 residents and a similar amount occupying the beach houses during tourist season
- ❖ Hydrological disruption due to construction of marine port terminal which prevents the east-west water flow
- ❖ Was on hurricane trajectory

Figure 6. Sampling design for Progreso

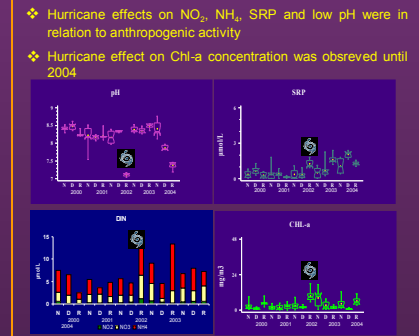


Figure 9. Main response variables at Progreso coastal seawater

### SISAL

- ❖ Fisherman-town of less than 5000 inhabitants, with shrimp-farms, in an area of >80 ha
- ❖ Severe affectation in relation to the hurricane trajectory

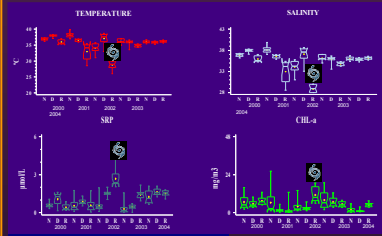


Figure 6. Main response variables at Celestún coastal seawater

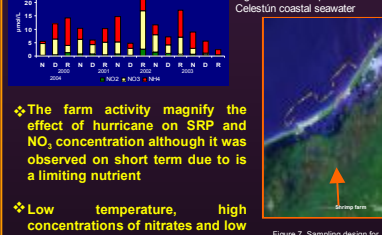


Figure 7. Sampling design for Sisal

- ❖ The farm activity magnify the effect of hurricane on SRP and NO<sub>3</sub> concentration although it was observed on short term due to is a limiting nutrient
- ❖ Low temperature, high concentrations of nitrates and low salinity indicated high influence of fresh water

### DZILAM

- ❖ Fishery-town (<3,000 inhabitants) and scarce anthropogenic activity
- ❖ It is characterized by great amounts of groundwater discharge through coastal springs
- ❖ Severe affectation in relation to the hurricane trajectory



Figure 10. Sampling design for Dzilam

- ❖ Chl-a recovered on dry of 2003 in spite of the fact that here was observed the higher increment
- ❖ NO<sub>2</sub>, NO<sub>3</sub>, SRSI, temperature and salinity reflect the influence of groundwater

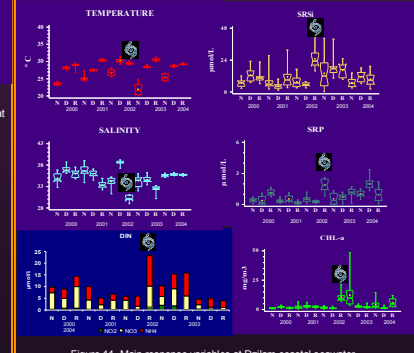


Figure 11. Main response variables at Dzilam coastal seawater

## 4. CONCLUSION

- ❖ Hurricane effects were appreciated > 60 km far from hurricane influence due to groundwater recharge product of intense precipitation
- ❖ The magnitude of changes on parameters values were higher at Sisal and Progreso which exhibit higher anthropogenic pressure
- ❖ High concentrations of Chl-a indicates that the hurricane increment productivity of the system
- ❖ Finally, monitoring is crucial to generate information to assess real impact of different magnitude events as natural and anthropogenic, this knowledge let us to advance and understand stability mechanism of tropical coast ecosystem