# Monitoring the Water Quality Parameters of Mayagüez Bay

## Abstract


Environmental pollution is an important problem that human are facing. The increasing population along with agricultural and industrial activities has generated more scenarios for water contamination. The proposed research will be focused on a comprehensive study of monitoring water quality parameters in Mayaguez Bay. The major sources of contamination of the Mayaguez bay come from rivers, industrial effluents, and city sewage. Rivers collect contaminants that are mainly originated from agriculture and industrial activities. There are three major rivers discharging directly into the Mayaguez Bay the Guanajibo, Añasco and Yaguez Rivers.

The United States Geological Survey reported that these rivers exhibited fecal coliform contamination. A tuna factory is also located in the Mayaguez Bay and its activities affect significantly the water characteristics of the bay. Another important source of contamination is the sewage pipe that continuously dumps treated water into the Mayaguez Bay.

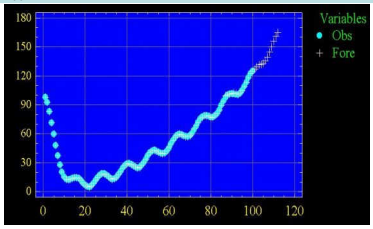
The current research attempts to estimate contamination in the Mayaguez Bay due to river discharge and also it is expected to use a remote sensing technique to design a water quality monitoring tool.


## Methodology

**The interaction of physical, chemical and biological processes affect the marine organism in coastal areas. The dynamics of these processes are operating over different spatial and temporal scales and its variability is highly affected by seasonal climate changes. The seasonal rainfall process in tropical areas induces temporal and regional differences in river discharge, which includes fluctuations in salinity, nutrient concentration, turbidity, heavy metal and other kind of contamination. Water turbidity limits the penetration of light and consequently affects the biological productivity. Land use and heterogeneous landscape of Puerto Rican coastal waters may affect the plankton communities at different spatial and temporal scale. Large variations in climate and topography conditions combined with human activity, produce significant changes in the amount and composition of river discharge.**

**Water Quality Stations**

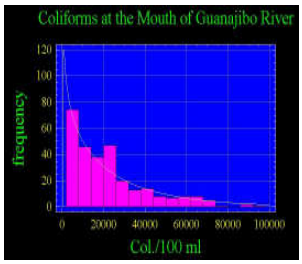

$$\beta_1\frac{d^2y}{dt^2}+\beta_2\frac{dy}{dt}+\beta_3 y=\alpha_1\sin(\alpha_2(t-1))+\alpha_3\cos(\alpha_2(t-1))+\alpha_4+\alpha_5 t+\alpha_6 t^2$$




**Observed and Predicted values**

**Agriculture and cattle activities generate the development of phosphates and nitrates that will be deposited in the coastal waters. Intense urban development, especially in coastal areas, accelerates soil erosion and increases the sediment load of rivers. These sediments are deposited within the coastal zone, or remain suspended and are transported to ocean waters. The Añasco, Yaguez, and Guanajibo rivers supply terrigenous sediments derived from igneous rock environments onto the narrow insular shelf of Mayaguez Bay. The Añasco River is the largest river in the west coast and its basin is mostly dedicated to agriculture. The Yaguez basin is mainly urbanized, and highly affected by sewage discharge and other human activities. The Guanajibo basin is mostly dedicated to agriculture.**

**The level of contamination of the Mayaguez Bay should be monitored with the purpose of designing an efficient strategy that modifies the human activities and consequently reducing the level of water pollution. The proposed research attempts to develop a practical tool to monitor some of the most important contaminates in the Mayaguez Bay.**

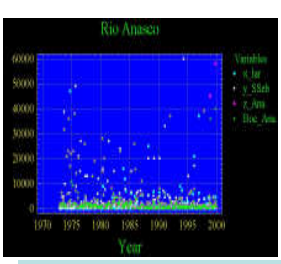


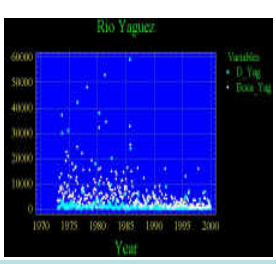

**Time Series Reconstruction**

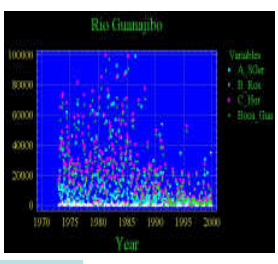
| $x$ | $P(X \le x)$ |
|---|---|
| 2,000 | 0.13 |
| 5,500 | 0.27 |
| 16,500 | 0.53 |
| 32,500 | 0.74 |
| 50,000 | 0.99 |

$$w_t=\begin{cases}0, & 0\le W_t<2{,}000,\\ 1, & 2{,}000\le W_t<5{,}500,\\ 2, & 5{,}500\le W_t<16{,}500,\\ 3, & 16{,}500\le W_t<32{,}500,\\ 4, & 32{,}500\le W_t<47{,}500,\end{cases}$$

$$p_t=\frac{1}{\eta_0}(a_0S_0+a_1Y_{1t}+a_2Y_{2t}+a_3Y_{3t})$$



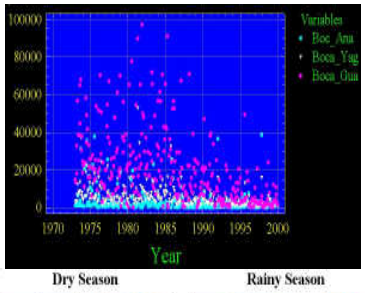



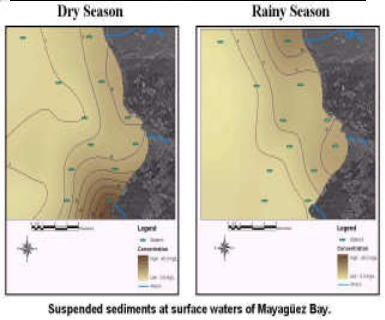

$$P(2000\le W_{345}\le 16{,}500)=P(w_{345}=1)+P(w_{345}=2)=\sum_{w_{345}=1}^{2}\binom{4}{w_{345}}p_{345}^{w_{345}}(1-p_{345})^{4-w_{345}}=0.4$$

## Results

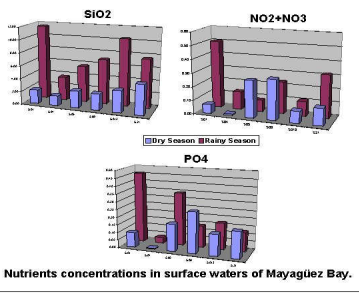
**Fecal Coliforms at Mayaguez Bay**




Dry Season | Rainy Season

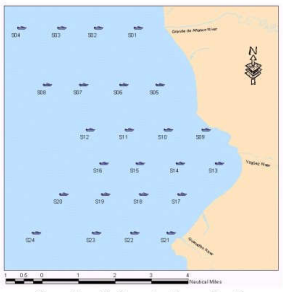


**Suspended sediments at surface waters of Mayagüez Bay.**




**Nutrients concentrations in surface waters of Mayagüez Bay.**

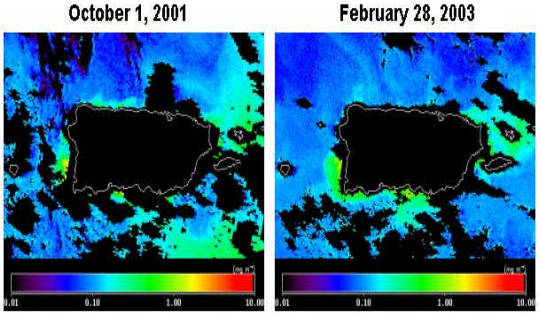
## Sampling




**Sampling Stations in Mayagüez Bay.**

**Bio-optical rosette used for field sampling.**

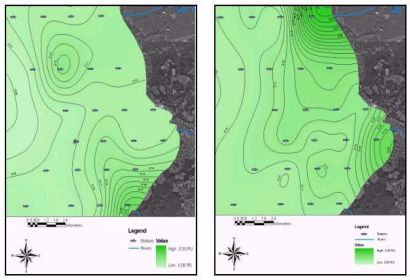
**October 1, 2001** | **February 28, 2003**



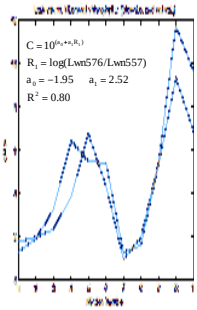

**SeaWiFS images collected during sampling periods.**

## Results

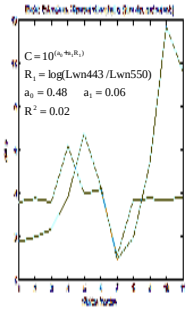
Dry Season | Rainy Season



**Chlorophyll fluorescence as measured with the bio-optical rosette.**




**Existing Model with bands: 576 and 557**




**Existing Model with bands: 443 and 550**

## Future Work

**Other analyses are now underway with the data collected during February and September 2003. All the data will be part of a GIS database that is being created for Mayagüez Bay and allow us to generate contour maps similar to those presented above. Similar field work and data analyses will be performed. This comprehensive study of the bio-optical properties of Mayagüez Bay is establishing the basis for our next step toward a better understanding of land-sea interactions. It is clear that new and improved techniques of remote sensing are necessary for this region. But we are already working on that. SeaWiFS images are used for the validation.**

## Acknowledgements


**This research has been supported by the "Puerto Rico Water and Sewer Authority" through the Institute of Water Resources and Environment of the University of Puerto Rico.**