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Where do Haiti's Sewage Effluents and Runoff Go? Ecosystem Hazards in Port-au-Prince Bay

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Haiti is faced to many problems: such as economic, natural disaster, deforestation. Wastewater from agricultural, domestic and industrial activities is source of excessive nitrogen and phosphate loads in aquatic environments, generating a danger of pollution. Most of these pollutants are poured off into Port-au-Prince Bay by Bois de Chêne ravine without prior treatment.

Nutrient from agriculture sewage, contaminant from hospital, pollution from industry and all of the waste and unsanitary of the Port-au-prince urban area can cause phenomenon of eutrophication and destroy or weaken our Coastal ecosystem.

Moreover, The worst is no study haven't done yet to better understand to real effect at the population level or acute effect on the environment.

But It's obvious that the ocean doesn't have barrier and that this issue is not only a Haitian problem but also It's a serious Public Health concern.



Haiti is a small country in the Caribbean. It is About the size of Maryland(US state). It surface area is about 27500 square kilometers. It is bounded to the north by Atlantic ocean, on the west by Caribbean sea, on the south by Jamaica and on the east by Dominican Republic.

Overview of Port-au-Prince bay



For several decades, aquatic ecosystems are subjected to physicochemical changes generated by human activities.

Bay of Port-au-Prince is a narrow zone 15 km wide and all sub watersheds in the city meet there. It is therefore the natural receptacle of all runoff from the city. These waters carry along human waste from toilet, various effluents and untreated industrial and household waste that contribute significantly to pollution of the bay.

First of all I need to mention an important facteur that will help you have a better understanding of the problem. Haiti's population is about 9 million people. But almost one third of the people live in Port-au-prince. We talk about a small city of 2 million people(IHSI,2003).

The mouth of the drainage canal spewing garbage and raw sewage into the ocean

- ▶ Detergents
- ▶ Insecticides
- ▶ Pesticides
- ▶ Paints
- ▶ Oil
- ▶ Feces
- ▶ Plastic
- ▶ Radioactive elements

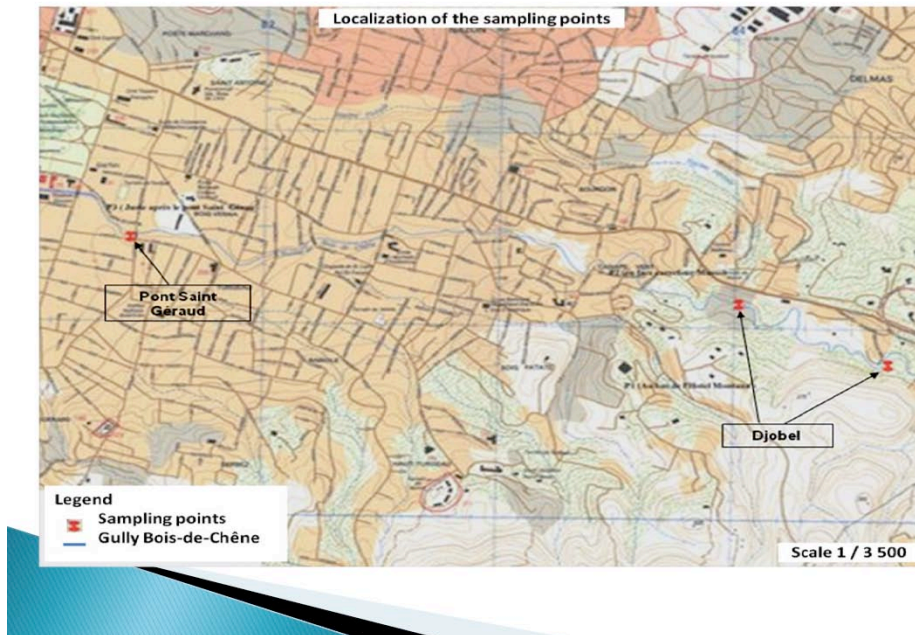


Port-au-Prince Bay receives over 50 million gallons of untreated domestic, municipal and industrial effluents every day(E. Emmanuel, 2004).

The wastewater generated by households, industries and services urban centers (hospitals, schools, factories, markets, sports facilities ...),Agriculture sewage full of organophosphate substance methyl parathion, malathion, diazinon are drained by the Canal Bois-de-Chêne before being discharged into the sea without any treatment prior(J.lacour,2004).

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Experimental Site



The canal Bois-de-Chêne is one of the biggest collectors of the drainage system of the urban community of Port-au-Prince. It turns from East to West to the bay of Port-au-Prince. This canal is 10 km long.

The canal Bois-de-Chêne is fed by a certain number of ponds hillsides constituted by calcareous and basalt materials. By erosion, transport and deposit, the detrital materials or alluvial deposits settled in the canal. About twenty gullies train the network of drainage of the Morne l'Hôpital. Nine more important cross this one in the part East and constitute the tributaries of the canal Bois-de-Chêne. These gully carry out agriculture waste from one of the more important field of vegetables production, from hospital industry, market etc..

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Water quality data and average concentration load

- ▶ pH- 7.34-7.90
- ▶ Conductivity- 890-2290uS/cm
- ▶ DO- ranged from 1.35 to 4.05< TVL(5mg/l)
- ▶ Heavy metals Pb(II), Cr(III), Cr(VI) and Ni(II), Cd, Zn highly toxic and have bioaccumulation tendency
- ▶ Pb 200µg/l in ground water > 10 µg/l TVL
- ▶ Total coliform-350 colony/100 litres of filtered ground water



These data are from different studies. Many study have been done regarding the water quality of sewage on this canal for many different purpose.

This alkalinity reflects the predominance of ammonia, dissolved gases highly toxic to fish. sign of Eutrophication.

Conductivity 890-2290uS/cm show an important mineralization level. It could be due to metallic salt, which are toxic to aquatic organisms

DO ranged from 1.35 to 4.05< TS(5mg/l) and that make sense because this canal represent the ideal condition to the growth of micro organism-Could be the consequence of biological degradative reactions of the organic matters containing in the channel.

Data for Total coliform show a clear evidence of domestic wastewater contamination.

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Water quality data and average concentration load

► Results of COD analysis

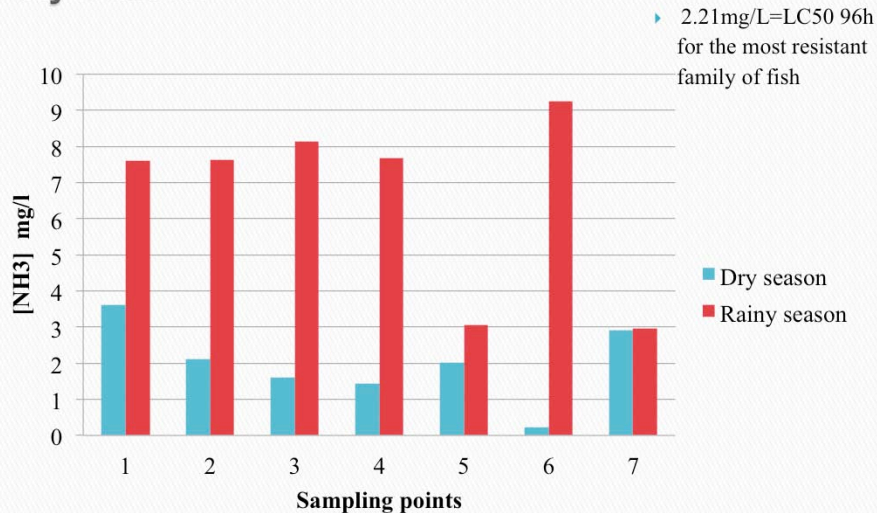
Sampling points	P1	P2	P3	P4	P5	P6	P7	P8	Threshold values (MATE, 1998)
COD (mg/L)	1155	1128	1073	1268	945	933	883	946	125



In absence of information on the different chemical substance of the wastewater, the COD (Chemical oxygen demand) parameter is sometimes used to characterize in global manner the concentrations of organic pollutants. Its measure corresponds to an estimation of presented oxidizable matters in wastewater, whatever their origin organic or inorganic (Rodier et al., 1996). COD can also provide information on the presence of organic substances which can not be oxidized by aerobic biological process (U.S. EPA, 1993).

COD maximum concentration was greater than the European threshold value for COD. This high might be due to the fact that the discharges studied mainly from domestic and commercial use, or such effluents are loaded with organic matter.

Levels of N & P pollution in rainy season and dry season



To understand the contribution of PAPUW to eutrophication, the concentrations of ammonia and phosphates from wastewater effluents were also determined. Haiti is a tropical country. We don't have summer and winter but dry and rainy season. Our ecology, environment and agriculture is influenced by these important factors.

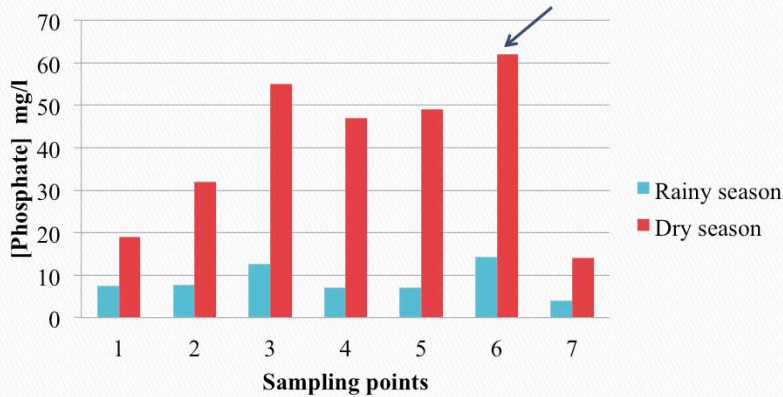
Two campaigns were shared out between two different rainfall seasons from February to May. Rainy season (November to March) and dry season (April-May) Grab samples were taken from 7 stations (J. Lacour, 2004).

Ammonia (2 to 16.06 mg/L) - Threshold values of water Agency France is (2 à 8 mg/L important pollution). American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV): 25 ppm, 17 mg/m³ TWA; 35 ppm, 24 mg/m³ STEL

Seasonal average concentration 8.57 mg/L by more than 4 times the maximum permissible limit (2 mg / L) (European Commission, 1998) - ACGIH (TLV) 2mg/m³. It's probably due to bacterial mineralization of dead organisms.

Ammonia concentration dumped into the bay is around 2.21mg/L, corresponding, in Eco toxicity tests at a lethal concentration (LC50 96h) for resistant families of fish, such as cyprinids (Garric, 1987).

Levels of N & P pollution in rainy season and dry season



Threshold values=2mg/l(CE)

Pollution worsen within dry season

Loading of 0.5 mg/L of phosphate is already an index of pollution in aquatic environments (Rodier, 1996). The minimum concentration in dry season 14mg/l is seven time higher than TVL(2mg/l) (CE,98).

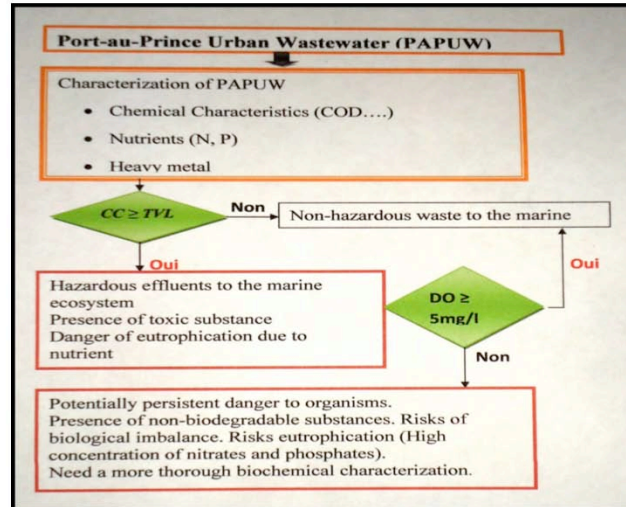
In short, to get a better idea- the average phosphate concentration in the dry season (31.67mg/L) which is poured at the Bay of Port-au-Prince is more than 15 times the sustainable limit for aquatic ecosystems.

Phosphates could be due to the closely located hotels, public housing wastewater and laundry detergent discharges to this drainage ditch and from agriculture sewage. The difference between the levels of phosphate concentration for the rainy and dry seasons is striking. It reflects a high dilution of phosphate for the rainy season.

It is especially interesting to note that paradoxically the danger increases for the rainy season, despite the apparent dilution in the case of phosphates. This must be linked to the fact that nitrates is limiting. These are potentially more important since ammonia (higher in the rainy season) is likely to nitrification.

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The conceptual framework for primary hazard assessment of PAPUW



From E. Emmanuel et al(2004) Effects wastewater on urban wastewater systems and on aquatic ecosystem

This is a conceptual framework built to assess ecological and environmental hazard of wastewater to marine life. The characterization of the environmental hazards of wastewater on the bay ecosystem, was studied by comparing the obtained results for the selected parameters with threshold values on effluents discharge.

Comparison of study's data and Threshold values (EC)

Level of pollution

Chemical Characterization CC	COD (mg/L)	NH ₃ (mg/L)	PO ₄ ³⁻ (mg/L)	DO (mg/l)	COD/ TOC
Average loaded	1041	2.16	32.44	3.01	3.4-4
Threshold values TV	125	2	2	5	3



The different results obtained from the application of the framework showed that PAPUW generate an effluent very hazardous for the aquatic organisms of the bay ecosystem.

This loading of NH3 means there is a overabundance of oxygen-dependant bacteria. This concentrations may be harmful to stock

Phosphates: algal blooms, excessive weed growth and the loss of species diversity can occur. Use as food source for water-borne bacteria

DO: reduce Oxygen for fish,

COD: With these values The oxygen may diminish to levels that are lethal for most fish and many aquatic insects.

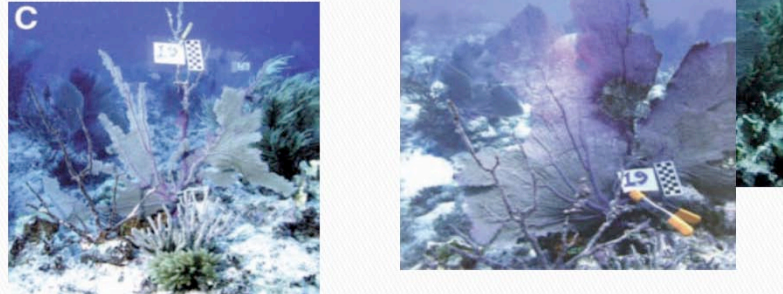
COD/TOC ratio is used to identify upsets in process conditions. IT may provide more information than individual measurements of COD and TOC

–High ratio indicates easily oxidizable organics

–Change in ratio indicates a change in the composition of organics in the process.

Potential Impacts on aquatic ecosystem

- ▶ Severe pathology (corals, sponges, fish)
- ▶ Opportunistic infection (bacteria, fungus)



Time series of damage caused by *Aspergillus sydowii* on a monitored sea fan: (A) 16 June 1996, (B) 8 August 1996, (C) 10 November 1997 (113) (Photos by Craig Quirolo, Reef Relief).

The changes in the environment cause disease. Despite scientific advances, no much is known. Some evidence come from a little number of correlative studies that show increased prevalence of coral diseases and increased parasite burden in oysters in more degraded sites. Silt in run-off has been a leading cause of coral mortality worldwide (Harvell et al, 1999).

Aspergillus sydowii a fungal pathogen of Caribbean sea fan corals (*Gorgonia* spp.) has been associated with transmission of disease in terrestrial run-off. In 1995, aspergillosis was present throughout most of the Caribbean including the Florida Keys (Nagelkerken et al., 1997).

The fungus *Aspergillus sydowii* is a mesophilic soil organism, esp. a plant, that lives in stagnant or foul water which is also known as a food contaminant and occasionally as an opportunistic pathogen of humans (e.g. Olutiola & Cole, 1977; Rinaldi, 1983; Smith, 1989; Gharelb & Nour El Dein, 1990).

Although there has been little evidence for this disease, it has been suggested that poor water quality saps the health of corals (e.g. Pastorok & Bilyard, 1985) and thus increases susceptibility to disease. Moreover, concomitant with increases in disease outbreaks have been increases in sedimentation, eutrophication, pollution, over-fishing and temperature (Grigg & Dollar, 1990; Williams & Bunkley-Williams, 1990).

Potential Impacts on aquatic ecosystem



- ▶ Turbidity and odor
- ▶ Toxic algal blooms, Red tides
- ▶ Human health disease via bivalves
- ▶ Ciguatera, vibrio cholera

Environmental characteristics may have a close relationship with the red tides in sea. These include the currents, water masses, diluted water plume and its redirection, upwelling, fronts, nutrient variation, the red tide algae from the local water, and the structure of the plankton community, which could affect the growth, migration, assembling, resting and competition of red tide causative species(M. ZHOU, 2010).

Potential Impacts on aquatic ecosystem

- ▶ Loss of biodiversity
- ▶ Damaging coastal environment
- ▶ Sedimentation –loss of habitat
- ▶ Decrease coastal population
- ▶ Collapse fishing and Coastal Ecosystems
- ▶ Ecological extinction



Pollution, excess nutrient from sewage and fertilizer effluents is a primary cause of marine eutrophication; soil erosion and acid rain add additional nitrogen and phosphorus. Those can increase algal growth on canal and sewage lagoons. Other pollutants upset the balance of marine ecosystems. Toxins, such as polychlorinated biphenyls, heavy metals, and pesticides, accumulate in food chains, causing damage to marine organisms, altering the ecosystem's equilibrium. Changes along coastlines are contributing to public health hazards, and are causing hypoxia in the breeding grounds of marine animals and plants(P. Epstein et al, 1993).

Habitat degradation and pollutant inputs, often brought about by human activity, can facilitate disease outbreaks . Work on aquatic mammals indicates that pollutants, for example, organochlorides, have immunotoxic properties, impairing natural killer cell activity, as well as a series of mitogen- and antigen-induced T cell responses. Because most coastal waters are typically affected by suites of anthropogenic pollutants and inputs, it often is difficult to identify any one specific cause of deteriorating health or disease Outbreak(Harvell et al,1999).

Potential Impacts on aquatic ecosystem



No more reproduction places

Species migration and disappearance

The sewages infected with hormones produce mutation to the fish. The fish that live in the proximity of centrals which discharge sewages change their sex because of the pollution with harmful substances from the contraceptives pills and cosmetic products. According to the research works ,the pollution of the water causes physical changes on mature fish , that undergoes a process of feminization, due to the absorbed hormones from the sewages(Harvell et al,1999).

Potential Impacts on aquatic ecosystem



- ▶ Polyethylene bags prevents the hatching of some fish and sea turtles
- ▶ Behavioral problems

Water pollution is one of the danger that sea turtles face. Turtles are often killed because of water pollution from garbage thrown in the water. Turtles have been declared endangered in many areas of the world because of the actions of humans. All of this pollution would prevent baby sea turtles from going to the ocean. Another danger is that Hundreds of thousands of sea turtles, sea birds, seals, whales and other marine mammals die every year from eating discarded plastic bags or plastic pieces mistaken for food.

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conclusion

- ▶ High pollution
- ▶ Potential High contamination of the canal
- ▶ Disquieting sign of a potential impact on marine life



That's perfectly legitimate to have concerns about the non-treatment of Haiti's wastewater.

In Haiti, runoffs, wastewater cause eutrophication, loss of biodiversity etc...Even though we cannot completely prevent the pollution of the sea, we have to do the minimum which is to treat wastewater before they go in the ocean.

More study need to be done for a better understanding of the impacts of urban and rural wastewater on aquatic ecosystem Project that integrated satellite images, interviews, and ecological data to understand the relative influence of Urban Wastewater on Port-au-Prince bay.

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