



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231
11.19.13



The Caribbean Environment Programme



Wastewater, Sewage and Sanitation



[Contents](#)

[Effects](#)

[Human Health](#)

[The Environment](#)

- [Global versus Caribbean Studies on Sanitation and Sewage](#)
- [Laws, Regulations, and Policy Responses on Sewage](#)
- [What is the Caribbean Environment Programme \(CEP\) doing?](#)
- [What can you do?](#)
- [Links](#)
- [References](#)

Wastewater is any water that has been adversely affected in quality by anthropogenic influence and comprises liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations (<http://en.wikipedia.org/wiki/Wastewater>).



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231
Sewage is the part of wastewater that is contaminated with feces or urine, but is often used to mean any wastewater. When this is done sewage refers to wastewater from sources including domestic, municipal, or industrial liquid waste products disposed of, usually via a pipe or sewer system (<http://en.wikipedia.org/wiki/Wastewater>). Untreated sewage may contain water; nutrients (nitrogen and phosphorus); solids (including organic matter); pathogens (including bacteria, viruses and protozoa); helminthes (intestinal worms and worm-like parasites); oils and greases; runoff from streets, parking lots and roofs; heavy metals (including mercury, cadmium, lead, chromium, copper) and many toxic chemicals including PCBs, PAHs, dioxins, furans, pesticides, phenols and chlorinated organics.

Sanitation is the hygienic means of preventing human contact from the hazards of wastes to promote health. Examples of waste that can cause health problems are feces, solid wastes, domestic wastewater and industrial wastes. Hygienic means of prevention can be by using septic tanks sewage systems or simply by personal hygiene practices like hand washing with soap (<http://en.wikipedia.org/wiki/Sanitation>). The Joint Monitoring Program for water and sanitation of WHO and UNICEF defines improved sanitation as; connection to a public sewer; connection to a septic system; pour-flush latrine; simple pit latrine; ventilated improved pit latrine. Not improved sanitation is; public or shared latrine; open pit latrine; bucket latrines; http://www.wssinfo.org/en/122_definitions.html.

Effects

Sewage released into the rivers and oceans can cause a threat to both human health and the environment.

Human health

According to GESAMP (2001), contamination of the coastal marine environment by sewage leads to significant numbers of infectious diseases linked to bathing and swimming in marine waters and to the consumption of seafood. Human exposures to toxins associated with algae blooms also impose significant risks.

Most illnesses are caused by pathogens, which are biological/infectious agents that cause diseases or illnesses (Wikipedia <http://en.wikipedia.org/wiki/Pathogen>). They cause a wide variety of acute illnesses including diarrhoea, cholera, dysentery, typhoid, and hepatitis A. Pathogenic bacteria can survive in the sea from a few days to several weeks; viruses can survive in water, fish or shellfish for several months while the hepatitis virus can remain viable in the sea for over a year (GESAMP 2001).

Depending on its source and collection methods, sewage may also contain a range of chemicals and specialized wastes including industrial chemicals, nutrients such as nitrates and phosphates, heavy metals, pharmaceuticals, medical wastes and oils and greases. These result in additional threats to human health.

The Environment

Nutrients are essential chemical elements that organisms need to survive and reproduce (Smith & Smith 1998). Macronutrients, needed in large quantities, include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, magnesium, and calcium, while micronutrients like iron, copper and zinc are needed in lesser quantities (Smith & Smith 1998). Excess nutrients are discharged to the marine environment through sewage, fertilizers from agriculture and by nitrogen oxides from burning fossil fuels. According to GESAMP (2001) sewage tends to be the main source of nutrients near cities, while agriculture predominates in rural areas. Increased nutrients may lead to eutrophication which is an excessive growth of marine plant life and decay (Wikipedia <http://en.wikipedia.org/wiki/eutrophication>). Plants such as algae often experience a population increase (called an algal bloom) which limit the sunlight available and cause lack of oxygen in water. When oxygen levels decline, marine animals, coral reefs, seagrass beds and other vital habitats in the Wider Caribbean Region suffer and may die. Some algal blooms are



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231
toxic and may harm or even kill whales, dolphins and other marine mammals - and cause hundreds of millions of dollars worth of damage to commercial fisheries. Read more under the issue Nutrients.

Global versus Caribbean Studies on Sanitation and Sewage

According to a report published by UNICEF and the World Health Organization (2008) the world is not on track to meet the Millennium Development Goal (MDG) on sanitation and 2.5 billion people still lack access to improved sanitation facilities to the same study 1.2 billion people worldwide live without any sanitation facilities. Without an immediate acceleration the world will not even achieve the half of the MDG for sanitation by 2015. Based on the current trends there will still be 2.4 billion people worldwide without improved sanitation in 2015.

Improved sanitation facilities are defined as, facilities that ensure hygienic separation of human excreta from human contact; connection to a public sewer; connection to a septic system; pour-flush latrine; simple pit latrine; ventilated improved pit latrine. Not improved sanitation is; public or shared latrine; open pit latrine; bucket latrines (JMP Joint Monitoring Programme for Water supply & Sanitation).

The lowest coverage of improved sanitation facilities is found in sub-Saharan Africa and in Southern Asia.

A global study by the World Health Organization (WHO) estimates that bathing in polluted seas causes some 250 million cases of gastroenteritis and upper respiratory disease every year. Many studies show that respiratory and intestinal diseases and infections among bathers rise as a direct consequence of increasing amounts of sewage pollution in the water GESAMP (2001).

According to Shuval 2003, the estimated economic loss globally, caused by pathogenic microorganisms is about \$12 billion per year. Seafood contaminated by harmful algal blooms causes significant health problems and a study done by the European Environment Agency (EEA 2005) showed that the socio-economic impact in Greece, Italy and Spain is around 329 million annually.

The number of 'dead zones', which are areas of anaerobic conditions at the sea bottom, due to increased amounts of nutrients, has doubled since 1990 (GPA/UNEP 2006). A "dead zone" appears off Louisiana in the Gulf of Mexico each summer caused by excessive amounts of nitrogen flushed down the Mississippi River.

Sanitation in Latin America and the Caribbean is characterized by insufficient access, particularly in rural areas, and in many cases by poor service quality, with possible impacts on public health. According to the Joint Monitoring Program of UNICEF and the World Health Organization (2008) the percentage of people in the region who have access to improved sanitation facilities has risen from 68% in 1990, 77% in 2004 to 79% in 2006. According to the year 2004 calculations, of those 77%, 51% of the houses were connected to a sewer and 26% of the population had access to septic tanks and various types of latrines. In total 125 million or 23% of the people in the region did not have access to improved sanitation. In Haiti only 25% of the population in 1995 and 30% of the population in 2004 had access to improved sanitation (See figure 1). Honduras, Dominican Republic, Mexico and Guatemala are the countries with the largest increase in the access to improved Sanitation between 1995 and 2004.

The report published by UNICEF and the World Health Organization (2008) show that the Latin American and Caribbean progress towards the MDG sanitation target is on track and by 2015 84% of the region's population should have access to improved sanitation.



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231
According to the 2004 study “**GIWA Regional Assessment 3a for the Caribbean Small Island subsystem**”, wastewater treatment facilities are often absent or insufficient in many countries of the region. For example, in Saint Lucia only 13% of the population is connected to the sewage system (GEF et al 2001). The unregulated disposal of human waste, for example in Antigua & Barbuda, and insufficient drainage has resulted in standing pools of contaminated water. During severe weather conditions, these pools present a major source of sewage-related outbreaks of diseases (GEF et al 2001). Some bays in the US Virgin Islands have high levels of bacteria, especially those with a large concentration of boats. The increase of bacteria cause serious threats to human health and impair water quality with algal blooms. Additionally, fish kills have occurred repeatedly, and beaches have been closed because of poorly designed and failing sewage systems (DPNR/DEP & USDA/NRCS 1998). In Barbados the coral reefs have been impacted by eutrophication, causing changes in the species composition of the corals (Linton & Warner 2003). During the 1980s, many shallow reefs around Grenada & the Grenadines were degraded and became overgrown with algae, presumably resulting from a combination of sewage, agro-chemical pollution, and sedimentation caused by coastal development (Smith et al 2000).

According to the 2006 “**GIWA Regional Assessment 3b and 3c for Colombia, Venezuela, Central America and Mexico**”, 472 653 m³/day of untreated sewage is discharged into the sea along the Colombian Caribbean coast. Eutrophication in the Cartagena Bay and the Ciénaga de Tesca in Colombia have caused mass fish mortalities due to discharge of non-treated wastewater and fertilizer runoff (PNUMA 1999). In February 2000, there was also a mass fish mortality recorded in Barlovento Venezuela associated with pathogenic bacteria (UNEP 2002). Eutrophication has further caused degradation of coral reefs at Islas del Rosario, Colombia (Garzón-Ferreira et al. 2000). Between 1991 and 1996, a climatic anomaly and pronounced nutrient enrichment resulted in a severe phytoplankton bloom followed by sudden oxygen depletion, which led to a reduction of coral reef cover from 43% to less than 5% in Morrocoy National Park, Venezuela (Garzón-Ferreira et al 2000). Water quality and sediment studies conducted on the major rivers of eastern Venezuela found that around Matazas the sediments contained high concentrations of organic material and Coliforms which far exceed the Venezuelan water standards (Senior et al 1999). Most of the communities in the lower reaches of the Magdalena River Basin, Colombia do not have sewage treatment facilities and suspended solids and fecal matter affect the health of downstream coastal communities.

In Mexico, tourism generates large quantities of wastewater and the management of this has become problematic. The wastewater is often discharged directly into lagoons and bays such as Chetumal Bay and Nitchupé Lagoon in Cancun, Mexico. According to the 2006 GIWA study the tourism industry has lost income and fisheries production has been reduced in Costa Rica and Chetumal Bay as a result of pollution.

According to the 2004 “**GIWA Regional Assessment 4 for the Islands of the Greater Antilles**” one of the main sources of nutrients in the marine environment is untreated sewage. Wastewater treatment facilities are inadequate in many locations. In the Bahamas, 15.6% of the population has access to sewage collection services and 44% of sewage treatment plants are in poor condition (UNEP/CEP 1998). Human waste disposal in Haiti is the most urgent problem. There are no sewage collection services and only 40% (mostly urban) of the population use latrines and septic tanks, of which 80-90 % of the solids are dumped illegally into rivers and seas (UNEP/CEP 1998).

This study shows that the pollution by sewage in this sub- region has caused

- Fish mortality;
- eutrophication;



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

- threats to corals, swamp ecosystems and seagrass beds;
- biological diversity loss;
- red tides which have killed marine organisms;
- threats to human health due to elevated numbers of pathogenic microorganisms (e.g. viruses, bacteria) and toxins created by algal bloom;
- threats to tourism.

In The Bahamas, health authorities have advised its citizens to avoid the consumption of the marine gastropod Queen conch (*Strombus gigas*), at certain times of the year due to the presence of a *Vibrio* pathogen in these organisms. Consumption of conch infected with this pathogen has resulted in serious illness and one recorded human mortality.

Sewage is according to (Siung-Chang 1997) regarded as one of the most widespread causes of degradation of the coastal environment in the Caribbean. This was re-enforced by the regional priority rankings of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) categories, which showed sewage to be the first priority (GESAMP 2001). The identification of untreated domestic wastewater as the number one point source of contamination to the marine environment of the wider Caribbean (Ref) was a major factor leading to the development of the Protocol on the Control of Land Based Sources of Marine Pollution (LBS Protocol) of the Cartagena Convention.

According to UNEP/GPA (2006) the high costs of building and maintaining traditional sewage treatment plants are frequently the reason for not treating sewage before its disposal. Nevertheless, biological methods of treatment are available for sewage that is not contaminated with industrial waste and which are suitable to the tropical character of the Caribbean region (UNEP/GPA 2006).

Laws, Regulations and Policy Response on Sewage

Land and ocean-based sewage pollution is regulated in many different frameworks ranging from regional legislation, international non-binding and binding agreements, action plans and national legislation and regulations (UNEP 2005).

The most important regional legal framework is the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention). The Convention entered into force in 1986 and is a legally binding, regional multilateral environmental agreement for the protection and development of the WCR. The Protocol Concerning Pollution from Land-Based Sources and Activities (**LBS Protocol**) of the Cartagena Convention sets forward general obligations and a legal framework for regional co-operation, provides a list of priority source categories, activities and associated pollutants of concern and promotes the establishment of pollution standards and schedules for implementation. Annex III relates directly to domestic wastewater and establishes specific regional effluent limitations, as well as a time table for the implementation of wastewater treatment.

For the purpose of the Annex, effluent limits are divided in two classes, depending on the water in which they are discharged. Class 1 waters are particularly sensitive to impacts from pollution while Class 2 waters are less sensitive (see full text on LBS Protocol [\[cc2\]](#) for more detail). The effluent limits for domestic wastewater in the LBS Protocol are set to:



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

Parameter	Class 1 Waters	Class 2 Waters
Total Suspended Solids *	30 mg/l	150 mg/l
Biochemical Oxygen Demand (BOD ₅)	30 mg/l	150 mg/l
pH	5-10 pH units	5-10 pH units
Fats, Oil and Grease	15 mg/l	50 mg/l
Faecal Coliform or <i>E. coli</i> .or enterococci	Faecal coliform: 200 mpn/100ml E. coli: 126 organisms/100ml Enterococci: 35 org./100ml	Not applicable
Floatables	Not visible	Not visible

* does not include algae from treatment ponds

Facilities and communities in each country must comply with the provisions of the Protocol on a phased basis after the Protocol enters into force for that country. The following will apply related to treatment facilities:

Years after entry into force	Effluent Sources required to comply with standards
0	All new domestic wastewater systems – public and private
10	Existing domestic wastewater systems other than community wastewater systems
10	Communities with 10,000 – 50,000 inhabitants
15	Communities with more than 50,000 inhabitants already possessing wastewater collection systems
20	Communities with more than 50,000 inhabitants not possessing wastewater collection systems



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

Years after entry into force	Effluent Sources required to comply with standards
20	All communities except those relying exclusively on household (e.g. septic tanks) systems

On the International level, Annex IV of the International Convention for the Prevention of Pollution from Ships **MARPOL73/78** is one of the most important Conventions on the regulation on sewage discharges from the shipping sector. The Annex contains a set of regulations regarding the discharge of sewage into the sea, ships equipment and systems for the control of sewage discharge, the provision of facilities at ports and terminals for the reception of sewage, and requirements for survey and certification. It also includes a model International Sewage Pollution Prevention Certificate to be issued by National Shipping Administrations to ships under their jurisdiction. The Annex is optional, entered into force on 27 September 2003, and a revised Annex entered into force 1 August 2005. The 30th of November 2006, 113 countries representing over 75% of the world's tonnage had become party to this Annex. Cruise ships flagged under countries that are signatories to MARPOL are subject to its requirements, regardless of where they sail, and member nations are responsible for vessels registered under their respective nationalities. Read more at <http://www.imo.org/>.

Important global action plans are;

- The **Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)** is a programme that provides guidance for sustainable development of oceans and seas and their resources. Read more at <http://www.gpa.unep.org/>.
- **Agenda 21** is a programme run by the United Nations (UN) related to sustainable development. Read more at http://en.wikipedia.org/wiki/Agenda_21 and <http://www.un.org/esa/sustdev/documents/agenda21/index.htm>
- The **Johannesburg Plan of Implementation**, agreed at the World Summit on Sustainable Development affirmed UN commitment to 'full implementation' of Agenda 21, alongside achievement of the Millennium Development Goals and other international agreements. Read more at http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIToc.htm, <http://www.un.org/events/wssd/>, and http://en.wikipedia.org/wiki/Agenda_21.
- The United Nations Programme of Action on the Sustainable Development of Small Island Developing States, referred to as the **Barbados Program of Action (BPOA)**, is a policy document that both addresses the economic, environmental, and social developmental vulnerabilities facing islands and outlines a strategy that seeks to mitigate those vulnerabilities. Read more at <http://www.sidsnet.org/>, http://en.wikipedia.org/wiki/Barbados_Programme_of_Action and <http://www.unep.ch/regionalseas/partners/sids.htm>.
- The **Mauritius Strategy** (International Meeting for the 10-year Review of the Barbados Programme of Action). Read more at <http://www.sidsnet.org/MIM.html>.
- The **Millennium Development Goals (MDGs)** are eight goals to be achieved by 2015 that respond to the world's main development challenges. Read more at <http://www.un.org/millenniumgoals/>.

What is the Caribbean Environment Programme (CEP) doing?

The following recent projects and activities were conducted by CEP to protect the marine environment and are related to Land-based Sources of Pollution and Sewage:



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

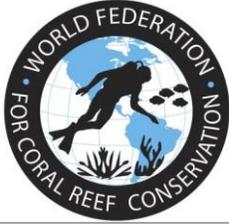
The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

- CEP actively promotes accession/ratification of the Protocol concerning Land-based Sources of Marine Pollution (LBS)
- National Promotional Workshops for the LBS Protocol are convened in the countries of the Wider Caribbean Region. As a result of this, the Governments of France and Saint Lucia ratified the Protocol in 2007 and 2008 respectively bringing the total number of Contracting Parties to four, including Panama and Trinidad & Tobago.
- The CEP in collaboration with the UNEP Global Programme of Action (GPA) and NOAA have assisted in facilitating the development and implementation of National Programmes of Action (NPAs) for the prevention of pollution from land based sources and activities. Direct support was provided by UNEP CAR/RCU to complete NPAs in Jamaica, Saint Lucia, Trinidad and Tobago and Barbados. Future activities will focus on strategic planning and sustainable financing for the implementation of NPAs in the Wider Caribbean Region.
- Following the preparation of a Sewage Needs Assessment Guidance document for implementing Annex III of the LBS Protocol, relating to Wastewater Management, pilot projects were completed in Saint Lucia, Jamaica and Tobago to develop national planning mechanisms to control marine pollution from domestic sewage and proposed detailed plans for improving infrastructure for sewage and wastewater management. Similar sewage needs assessments are ongoing in Panama and once finalized efforts will focus on the sharing of experiences from these national pilot assessments.
- A regional workshop to promote Environmentally Sound Technologies (EST) in the provision of sanitation and water at the community level was conducted in Kingston, Jamaica in collaboration with the International Environmental Technology Center, Division of Technology, Industry & Economics (UNEP-DTIE-IETC). Wastewater management professionals and community members from across the WCR reviewed available ESTs and discussed regional opportunities for funding for further action. One of the proposed initiatives highlighted at the workshop is the establishment of a Caribbean Revolving fund for Regional wastewater investment and management.
- The GEF funded project "Integrating Watershed and Coastal Areas Management (IWCAM) for Caribbean Small Island Developing States (SIDS)" supports legislative and policy reform at the island states level, capacity building to implement those reforms, and demonstration projects on key issues facing individual states.
- As a Co-Chair of the White Water to Blue Water (WW2BW) Partnership Initiative, the CEP continues to develop partnerships that would enhance integrated approaches in wastewater and sanitation, WW2BW also provides for discussions and information sharing between potential partners from these different areas to collaborate on projects to be implemented in the WCR. Other areas include sustainable agricultural practices, integrated coastal management, and sustainable tourism and environmentally sound marine transport in the WCR.

What can you do?

Simple ways of taking action;

- Use biodegradable soaps and detergents without phosphates.
- Avoid draining untreated sewage directly at sea, rivers or water bodies.
- Do not discharge sewage from boats into coastal waters.
- Report any dumping you may see. Note date, time and location of the incident.
- Choose cruise ships with sound environmental practices. In advance of the trip you can ask how they discharge waste.
- Do not bathe or fish near sewage outfalls due to the high risk of contamination.
- Don't flush household products such as cleansers, beauty products, medicines, paints, tampons, diapers down the toilet.



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

- Don't pour motor oil in the toilet or drainage system.
- When you wash your car use biodegradable soaps over grass or gravel.
- When having a flood discontinues use of your private sewage system. Use portable toilets or a container.
- During a flood the well may be contaminated so DO NOT DRINK THE WATER. Drink bottled water, or disinfect water before drinking.
- Do not bathe or swim in floodwater. It may contain harmful organisms.
- Do not use the sewage system until water in the disposal field is lower than the water level around the house.
- Join environmental groups that protect the environment.
- Teach children and adults with less knowledge that sewage is potentially harmful for both the health of humans and the environment.

Links

- International Maritime Organization, <http://www.imo.org/>
- Joint Monitoring Programme for water supply and sanitation UNICEF-WHO, <http://www.wssinfo.org/en/welcome.html>
- IYS Partner Organization, International year of sanitation 2008, <http://esa.un.org/iys/>
- The WELL website is a focal point for providing access to information about water, sanitation and environmental health and related issues in developing and transitional countries, <http://www.lboro.ac.uk/well/>
- The Council is an advocacy and knowledge network, and aims to be a key-source of information concerning sanitation, hygiene, water supply and any related topics, <http://www.wsscc.org/resources.php>
- IRC International Water and Sanitation Centre, bridging the knowledge gap and joint learning with partners for improved, low-cost water supply, sanitation and hygiene in developing countries, <http://www.irc.nl/index.php>
- WSP Water and Sanitation Programme, an international partnership to help the poor gain sustained access to improved water supply and sanitation services, <http://www.wsp.org/index.asp>
- Global Programme of Action for the protection of the marine environment from land based activities, information on sanitation and wastewater, <http://www.gpa.unep.org/content.html?id=246>
- UNDP information on water and sanitation, <http://www.undp.org/water/priorityareas/supply.html>
- Un Atlas of the Oceans, information on non point sources of pollution, <http://www.oceansatlas.org/servlet/CDSServlet?status=ND0yNTg3JjY9ZW4mMzM9KiYzNz1rb3M~>
- World Health Organization, <http://www.who.int/topics/sanitation/en/>

References

- Eea, 2005, *Priority issues in the Mediterranean environment*, eea Report No 5 European Environment Agency, Copenhagen
- DPNR/DEP & USDA/NRCS, 1998, *United Watershed Assessment Report - United States Virgin Islands*, Virgin Islands Department of Planning and Natural Resources in cooperation with USDA Natural Resources Conservation Service, Caribbean Area, St. Croix, USVI
- Garzón-Ferreira J, Cortes J, Croquer A, Guzmán H, Leao Z, & Rodríguez- Ramirez A, 2000, *Status of coral reefs in southern tropical America: Brazil, Colombia, Costa rica, Panamá and Venezuela*, In: Status of Coral Reefs of the World: 2000 (ed Wilkinson C) Australian Institute of Marine Sciences (AIMS) (2000), Australia



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

- GEF/CEHI/CARICOM/UNEP, 2001, *Integrating watershed and coastal area management in Small Island Developing States of the Caribbean*, Taken June 2003 from: <http://www.cep.unep.org/programmes/amep/GEF-IWCAM/SynthesisReport/FinalRegSynthesis.doc>
- GESAMP, 2001, *Protecting the Oceans from Land-based Activities - Land-based Sources and Activities Affecting the Quality and Uses of the Marine, Coastal and Associated Freshwater Environment*, GESAMP Reports and Studies 71
- JMP Joint Monitoring Programme for Water supply & Sanitation WHO/UNICEF, Taken 2008-03-20 from <http://www.wssinfo.org/en/welcome.html>
- JMP Joint Monitoring Programme for Water supply & Sanitation WHO/UNICEF, Taken 2008-03-20 from http://www.wssinfo.org/en/122_definitions.html
- Linton D M, & Warner G F, 2003, *Biological indicators in the Caribbean coastal zone and their role in integrated coastal management*, *Ocean and coastal management* 46:261-276
- Outlook, 2000, *Regional Office for Latin America and The Caribbean*, United Nation Environment Programme, Mexico City
- Senior W, Castañeda J, & Martínez G, 1999, *Evaluación ambiental de los grandes ríos*, Informe nanciado por PDVSA, Universidad de Oriente, instituto oceanográfico de Venezuela, Departamento de oceanografía. 50 p
- Shuval H, 2003, *Estimating the Global Burden of Thalassogenic Disease-Human Infectious Disease caused by Wastewater Pollution of the Marine Environment*, *Journal of Water and Health*, Vol. 1 no. 2, 2003, p 53-64
- Siung-Chang A, 1997, *A review of pollution issues in the Caribbean*. *Environmental Geochemistry and Health*, 19(2): 45-55
- Smith A H, Archibald M, Bailey T, Bouchon C, Brathwaite A, Comacho R, Goerge S, Guiste H, Hasting M, James P, Jeffrey-Appleton C, De Meyer K, Miller A, Nurse L, Petrovic C, & Phillip P, 2000, *Status of the Coral Reefs in the Eastern caribbean: The OECS; Trinidad & Tobago, Barbados, The Netherlands Antilles and the French Caribbean*, In: Wilkinson, I and Australian Institute of Marine Sciences (AIMS) (eds.) *Status of Coral Reefs of the World: 2000*, Australia
- Smith R L, & Smith T M, 1998, *Elements of Ecology*, San Francisco USA
- UNEP/CEP, 1998, *An Overview of Land Based Sources of Marine Pollution*, Technical Report No 40 UNEP Caribbean Environment Programme, Kingston, Jamaica
- UNEP/GPA, 2006, *The State of the Marine Environment: Trends and processes*, The Hague
- UNEP, 2002, *Global Environment Outlook 3*, United Nations Environment Programme, Nairobi, Kenya, 416 p
- UNEP/CEP, 1998, *An Overview of Land Based Sources of Marine Pollution*, Technical Report No. 40 UNEP Caribbean Environment Programme, Kingston, Jamaica
- UNEP, 1999, *Assessment of land-based Sources and Activities Affecting the Marine, Coastal and Associated Freshwater Environment in the Wider Caribbean Region*, UNEP/GPA Coordination Office and Caribbean Environment Programme, Kingston Jamaica
- UNEP/GEF/Kalmar Högskola, 2004, *Global International Water Assessment (GIWA), Caribbean Sea/Small Islands GIWA Regional assessment 3a*, Kalmar Sweden
- UNEP/GEF/Kalmar Högskola, Invemar, 2006, *Global International Water Assessment (GIWA), Caribbean Sea/Colombia & Venezuela, Central America & Mexico GIWA Regional Assessment 3b, 3c*, Kalmar Sweden
- UNEP/GEF/Kalmar Högskola/Cimab, 2004, *Global International Water Assessment (GIWA), Caribbean Islands Bahamas, Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico Regional Assessment 4*, Kalmar Sweden
- UNICEF & World Health Organization, 2008, *Progress on drinking water and sanitation special focus on sanitation*, Geneva Switzerland



PSA-040- Wastewater-Sewage Caribbean

Join us to save coral reefs

Vic Ferguson

The World Federation for Coral Reef Conservation 281.971.7703 P.O. Box 311117 Houston Texas 77231

- Wikipedia, Taken 2008-03-07 from <http://en.wikipedia.org/wiki/Pathogen>
- Wikipedia, Taken 2008-03-07 from <http://en.wikipedia.org/wiki/eutrophication>
- Wikipedia, Taken 2008-06-28 from <http://en.wikipedia.org/wiki/Wastewater>
- Wikipedia, Taken 2008-07-10 from <http://en.wikipedia.org/wiki/Sanitation>
- Windevohxel N, 2003, *Costas del caribe de Colombia-Venezuela*. Capítulo 1. PROARCA-Costas, The Nature Conservancy, World Wildlife Foundation, University of Rhode Island, Taken February 2003 from <http://www.wetlands.org/inventory&/SAA/Body/>

Vic Ferguson

The World Federation for Coral Reef Conservation

Executive Director

P.O. Box 311117

Houston, Texas 77231

vic.ferguson@wfcrc.org

www.wfcrc.org

281.971.7703 (office)

832.269.5589 (land line)

The only thing necessary for the triumph of evil is that good men do nothing".Edmund Burke