GEF CReW on the Ground

Applying Economic Resource Valuation for Improving Wastewater Management – The Case of Trinidad and Tobago

Applying Economic Resource Valuation for Improving Wastewater Management – The Case of Trinidad and Tobago

January 2017

Published by:
Caribbean Regional Fund for Wastewater Management Project (GEF CReW)
6th Floor, Dyoll Building, Inter-American Development Bank
40-46 Knutsford Boulevard
Kingston 5, Jamaica, W.I.

Phone: (876) 764-0815
E-mail: crew@iadb.org
Website: www.gefcrew.org
@gef-crew
GEF-CReW-Project

Table of Contents

The GEF CReW

The Global Environment Facility-funded Caribbean Regional Fund for Wastewater Management (GEF CReW) is a four-year project that began in 2011, extended for an additional 18 months with an end-date of January 2017. Implemented by the Inter-American Development Bank (IDB) and the United Nations Environment Programme (UNEP), it is an integrated and innovative approach to reducing the negative environmental and human health impacts of untreated wastewater discharges.

At the regional level, it has catalyzed a unique partnership between the IDB, UNEP and the Secretariat for the Cartagena Convention. At the country level, project implementation is further supported by partnerships between wastewater utilities, Ministries of Environment, Finance, Health, Education, and local communities.

GEF CReW works with 13 countries within the Wider Caribbean Region (WCR) to:

- Provide sustainable financing for the wastewater sector
- Support policy and legislative reforms in the wastewater sector
- Foster regional dialogue and knowledge exchange amongst key stakeholders in the WCR

There are three main interlinked components:

1. Investment and Sustainable Financing
2. Reforms for Wastewater Management
3. Communications, Outreach and Training

The 13 participating countries are: Antigua & Barbuda, Barbados, Belize, Costa Rica, Guatemala, Guyana, Jamaica, Honduras, Panama, Saint Lucia, Saint Vincent & the Grenadines, Suriname, and Trinidad & Tobago.

Introduction

The Caribbean Wastewater Challenge

Effective management of wastewater in the Wider Caribbean Region (WCR) has long been – and remains – a significant challenge faced by all of the countries. Numerous studies over the past two decades have concluded that sewage pollution – due primarily to rapidly expanding urban populations, poorly planned development, and inadequate or poorly designed and malfunctioning sewage treatment facilities – continues to be the most pervasive form of contamination of the coastal environment. Untreated sewage is one of the major threats to public health and the Region's rich biodiversity. By degrading the environment, ecosystem services that are critically important to the economic viability of Caribbean countries are compromised.

- **85% of wastewater entering the Caribbean Sea remained untreated**
- **51.5 % of households lacked sewer connections**
- **Only 17% of households were connected to acceptable collection and treatment systems**

The proper collection, treatment, and disposal of wastewater is essential to protecting human health and the natural environment, including coral reefs and other critical ecosystems and to supporting industries such as tourism and fishing, which are vital to the region's economy.

Governments in the Wider Caribbean recognize that land-based sources of pollution from municipal, industrial and agricultural sectors and their negative impacts on marine resources are a threat to the region's economic development and the quality of life of its people and acknowledge the urgent need to improve wastewater treatment.

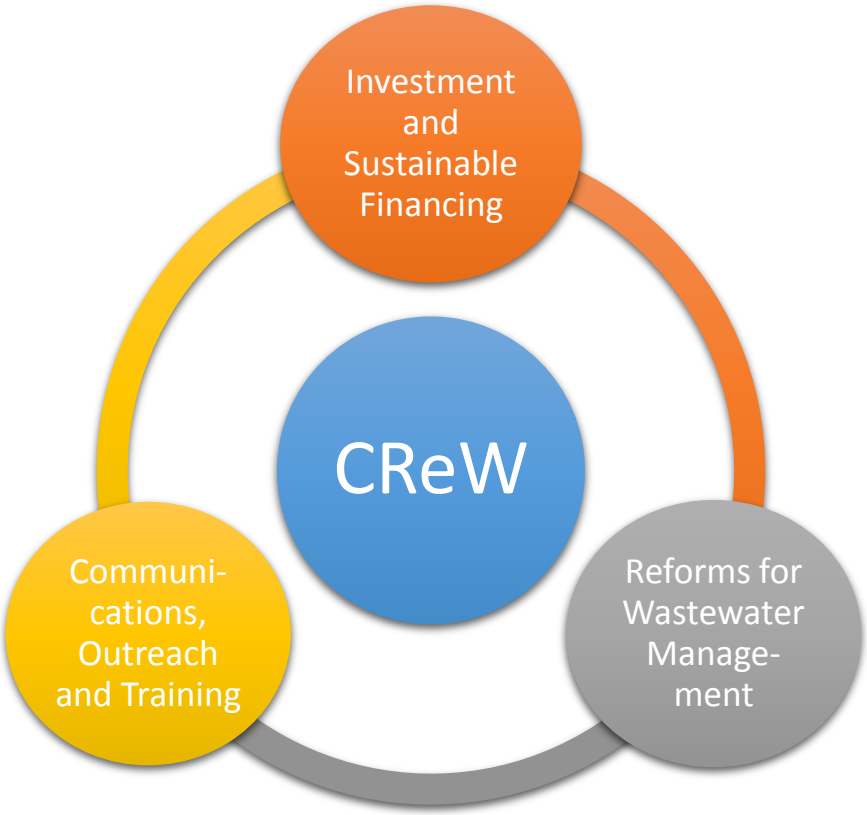
In 1999, governments of the WCR signalled their commitment to reduce marine pollution from untreated wastewater by agreeing to the Protocol on the Control of Land Based Sources of Marine Pollution (LBS Protocol). The LBS Protocol forms part of the only legally binding regional agreement for the protection

and development of the Caribbean Sea – the Cartagena Convention. Its entry into force in 2010 committed the Governments which ratified or acceded to it to making major improvements in wastewater management by introducing innovative and cost effective treatment technologies, improving the policy, regulatory and institutional frameworks, and expanding access to affordable financing.

The countries of the WCR generally face the same challenges and constraints in their efforts to address activities related to implementing the LBS Protocol (CReW March 2013):

- Lack of financing
- Inadequate (and sometimes uncoordinated) policy, legislative and institutional frameworks to facilitate the fulfilment of the countries' obligations under the Protocol
- Lack of human, financial and technical resources
- Old infrastructure
- Lack of adequate maintenance and poor operational systems
- A need for sustained water quality monitoring programmes and more comprehensive information management systems
- A need for more focussed public awareness and environmental education programmes in respect of pollution of the marine environment

The GEF CReW was developed to facilitate participating countries to address these challenges and meet their commitments to the Protocol. It aims to address the three significant challenges that have been identified for effective wastewater management: inadequate policy and legal frameworks, insufficient financing and the low priority placed on wastewater treatment.



Through Component 1: Investment and Sustainable Financing[1], CReW established national Pilot Financial Mechanisms (PFMs) in three countries to provide innovative, sustainable investment financing for environmentally-sound cost-effective wastewater management facilities, based on locally defined needs. The PFMs deliver grant funding for initial investments, to generate sufficient revenue to create a sustainable source of funding.

Component 2: Reforms for Wastewater Management[2], is financing actions and activities geared towards policy, institutional and legislative reform that will improve wastewater management. This component includes capacity building initiatives to improve the skills and knowledge at the national and local level needed in wastewater management policy formulation, planning and financing. These initiatives include, among others, strengthening the policy and institutional frameworks for wastewater management in the WCR, and building capacity for public-private partnerships and bottom-up planning within the wastewater sector.

Component 3: Communications, Outreach and Training, supports the Components 1 and 2 and focuses on dissemination of information and lessons learned as well as training and awareness raising. Therefore, it is valuable to the long-term success of the CReW-initiated activities.

[1] Component 1 is executed by IDB

[2] Components 2 and 3 are implemented by UNEP CAR/RCU - United Nations Environment Programme Caribbean Environment Programme Regional Coordinating Unit

Resource Valuation for Better Wastewater Management

Throughout most of the Wider Caribbean Region, wastewater treatment is viewed as a lower priority to drinking water treatment, with low levels of investment in wastewater management compared to the water sector (Bradford et al, n.d.). Most governments have not ensured that providers of wastewater services have sufficient funding to cover the costs of developing and operating wastewater systems and households and businesses are seldom willing to pay for available wastewater services (such as sewerage), or to invest in their own, unless required by law.

Increasing understanding and appreciation by governments of the importance of improving wastewater management, and the benefits that accrue as a result of better wastewater management is a priority for the GEF CReW Project. Governments and private sector investors see wastewater as having little to no revenue-earning potential and its treatment as a service that few wish to pay for. Changing these perceptions and attitudes is difficult. However, even small investments in appropriate systems can make a significant difference in improving wastewater management. Furthermore, promoting treated wastewater as a resource can encourage investment in the sector and realize even more environmental, social and economic benefits.

There are significant benefits of good wastewater management but because they are seldom quantified, they are undervalued or ignored. Resource valuation can assist countries by making stronger justification for wastewater investment and by helping to identify the most cost-effective management approaches. Economic valuation of wastewater management benefits enables the accounting for services which otherwise go unaccounted for in decision making. It helps to highlight economic importance, as well as helps with the setting of fees, and in determining compensation for damages.

Benefits of Good Wastewater Management

- Prevents human diseases and illnesses caused by water and soil infected by untreated or poorly treated sewage
- Protects ecosystems such as rivers, forests, wetlands, coral reefs and beaches

Recognizing the potential contribution of natural resource valuation to better wastewater management, CReW, under Component 2, implemented natural resource valuation studies in three demonstration sites in Panama (Isla Colón in the Bocas del Toro province) and Trinidad & Tobago (Chaguanas in Trinidad and the Buccoo Reef / Bon Accord area in Tobago). The valuation studies were conducted by the World Resource Institute (WRI) in collaboration with local agencies: the Environmental Management Authority (EMA) in Trinidad and Tobago and the Autoridad Nacional del Ambiente (ANAM) in Panama.

Why Natural Resource Valuation?

Natural Resource Valuation

is the process of placing monetary values on natural environmental resources, their services and effects, including those that are not usually accounted for by the market.

Decision makers must consider political, social, economic, and environmental factors in determining which projects to pursue, policies to enact and enforce, and investments to make. Economic analysis can help decision makers allocate scarce resources among competing societal demands. However, traditional economic analysis, such as cost-benefit analysis, often fails to fully consider benefits provided by coastal ecosystems and other natural resources. This is especially true for benefits that are not bought and sold in markets, such as those provided by clean water and coastal protection. Undervaluing the benefits that coastal ecosystems provide – as well as the costs of insufficient coastal protection – can lead to underinvestment in the protection and management of these ecosystems. Natural resource valuation – economic valuation of ecosystem goods and services – provides policy makers and decision makers with easy-to-understand monetary, biophysical, and social metrics.

Resource valuation can assist countries by making stronger justification for wastewater investment and by helping to identify the most cost-effective management approaches. Economic valuation enables the accounting for services which otherwise go unaccounted for in decision making. It helps to highlight economic importance of the wastewater sector and helps with the setting of fees, and in determining compensation for damages.

Wastewater Issues Important for Valuation

The best way to determine the value of good wastewater management is to examine the impact/cost of poor or no wastewater management on key aspects of life – notably human health and ecosystems with the related economic, environmental and social impacts. The benefits of effective wastewater treatment would be the avoidance of these costs as well as fewer opportunities for sustainable livelihoods lost.

Impacts on human health

Domestic wastewater contains enteric bacteria, viruses and protozoa which can cause several types of diseases in people exposed to this wastewater. The primary pollutants of concern for human health include microbial pathogens (frequently found in human and animal excreta), nutrients, heavy metals, chemicals (including pharmaceuticals), and other organic compounds (UNEP 2001). Exposure pathways for wastewater-related illnesses include bathing or swimming in contaminated water, eating contaminated seafood, inhalation of contaminated waters, exposure to an infected person, and mosquito bites.

Drinking water contaminated by untreated or improperly treated sewage can cause gastroenteritis and other diarrhoeal diseases, cholera, intestinal worm infections and typhoid fever. Eating shellfish from contaminated waters can cause typhoid fever, viral hepatitis, cholera, liver damage and even death. Swimming or bathing in rivers, lakes and coastal zones where untreated sewage, industrial effluent or agricultural wastes are discharged can cause a range of problems including diarrhoea, respiratory infections and skin irritation (CReW n.d.).

In 2003, a study estimated that polluted coastal waters generate 120 million excess cases of gastroenteritis and 50 million excess cases of ARD annually, resulting in a global cost of US$12 billion per year in public health expenses (Gray et al 2015).

Impacts on ecosystems

Freshwater, coastal and marine ecosystems can be impacted by partially treated and untreated wastewater effluent. Many Caribbean ecosystems – such as rivers, forests, mangroves, coral reefs, beaches and seagrass beds – are vulnerable to wastewater effluent. These ecosystems provide valuable services to society that have demonstrable market and/or non-market value. For example, these ecosystems provide critical habitat to commercially important fish, attract tourists from around the world, and protect coastal communities and infrastructure from tropical storms and hurricanes. Burke et al. (2008) found that the Buccoo Reef in Tobago provides valuable shoreline protection, tourism and recreation, and fisheries habitat services worth an estimated annual value of US$120 - US$164 million. Table 1 provides examples of the goods and services provided by coastal ecosystems.

Table 1: Examples of coastal ecosystem goods and services

ECOSYSTEM GOODS AND SERVICES	CORAL REEFS	MANGROVES	BEACHES	SEAGRASSES
Provisioning services				
Food (e.g., fisheries)	X	X	X	X
Raw materials	X	X	X	X
Medicinal resources	X	X		X
Genetic resources	X	X		X
Regulating services				
Flood/storm/erosion regulation	X	X	X	X
Climate regulation	X	X	X	X
Cultural services				
Tourism and recreation	X	X	X	
History, culture, traditions	X	X	X	X
Science, knowledge, education	X	X	X	X
Supporting services				
Primary production	X	X	X	X
Nutrient cycling	X	X		X
Species/ecosystem protection	X	X	X	X

Source: Waite et al. 2015.

Environmental Resource Valuation:
A tool for better decision making in wastewater management

Profile of Trinidad & Tobago – Need for the Project

State of Trinidad and Tobago's Environment

Compared with other countries in the Region, Trinidad and Tobago has an average environmental status as reflected in its ranking on the Environmental Performance Index (EPI). The EPI is constructed through the calculation and aggregation of 20 indicators reflecting national-level environmental data. These indicators reflect the state of the country's environmental health and ecosystem vitality and cover high-priority environmental policy issues, including air quality, forests, fisheries, and climate and energy, among others. In 2014 Trinidad and Tobago's ranking on the EPI was 79th out of 178 countries – near the middle of all WCR countries.[3] However, as Figure 1 shows, the country's performance with respect to water and sanitation was similar to its average score, with a comparative ranking of 76th in the world.

Trinidad and Tobago's poor wastewater management practices – from industrial, agricultural, municipal and community sources – have a negative impact on the quality of the country's water resources, human health and terrestrial and aquatic ecosystems.

Studies have indicated the presence of sewage-associated bacteria in several areas of the coast, in some instances at levels sufficiently high to indicate a hazard to human health through the transmission of gastro-intestinal illnesses and causing respiratory illnesses, as well as ear, eye, and skin infections to persons bathing in polluted water. Seafood marketability is affected, as the risk of contracting typhoid and cholera from consuming shellfish contaminated from contact with sewage is well documented and has, in the past, led to bans on the harvesting of shellfish in certain areas (CReW 2010).

NAME OF INDICATOR	SCORE	RANK
Overall Score	**52.28**	**79**
Health Impacts	63.01	108
Air Quality	99.88	8
Water and Sanitation	52.08	76
Water Resources	5.25	102
Agriculture	96	1
Forests	17.88	100
Fisheries	24.58	55
Biodiversity and Habitat	83.48	43
Climate and Energy	32.54	106

Figure 1: EPI Component Scores for Trinidad and Tobago

[3] http://archive.epi.yale.edu/epi/country-rankings

Inadequate wastewater management in Trinidad and Tobago occurs due primarily to inadequate regulatory and monitoring mechanisms to control the discharge of effluents into the public sewers; lack of an appropriate wastewater/sewerage tariff for public and private wastewater systems; the need for centralized sewerage systems at all urban centres and industrial estates – and inadequate small wastewater systems (CReW 2010).

Sewage pollution comes from both point and non-point sources. The former is caused mainly by inadequately treated effluent from sewage treatment plants, the latter from a wide range of agricultural, animal husbandry, and urban land use activities. Sewage is routinely found in river water samples taken in any of the developed areas. For example, pollution of the Courland River has been attributed to runoff from pit latrines in the drainage basin of the river and effluent discharged from a hotel into a storm drain which runs into the river. Campers and villagers utilizing the Maracas Bay River as a toilet facility have caused the river to be polluted with sewage. Sewage contamination of rivers in the catchment of the Caroni Arena Water Treatment Plant is evidenced by high chloride levels found in the catchment area. A study conducted in 2004-2005 revealed the presence, in all of the rivers monitored, of bacteria at levels exceeding environmental limits for domestic, agricultural, and recreational purposes (CReW 2010).

Source: Adapted from Yale Environmental Performance Index 2016 – http://epi.yale.edu

Sewage pollution is a major concern for most of southwest Tobago, in particular the area from Scarborough to Crown Point. The Scarborough central sewerage treatment facility which was designed to handle all of the sewage generated in that town operates at only one-fifth of its capacity because of the failure of domestic consumers to connect to the system. Treatment plants attached to the Milford Court and Buccoo Housing Estates do not function efficiently, and the effluent from these has been identified as being major contributors to the pollution of the Bon Accord Lagoon/Buccoo Reef complex (CReW 2010).

Poorly managed wastewater affects the plants, animals and organisms in freshwater and marine ecosystems. High nutrient levels from agricultural processes and raw or undertreated sewage can cause eutrophication of water bodies and fish kills. Sewerage outfalls from hotels in the southwest of Tobago have been found to threaten coral reefs, and have contributed to the degradation of the Buccoo Reef system.

Water and Wastewater Services

According to the WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation, 92 per cent of persons in Trinidad and Tobago had an improved sanitation facility in 2015 – increased from 90 per cent in 1990[4]. Improved sanitation facilities include flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet.

[4] http://data.worldbank.org/indicator/SH.STA.ACSN

WASA operates and maintains 36 wastewater treatment plants including four in urban centres of Port of Spain, San Fernando, Arima and Scarborough. As a result, 20 per cent of the population is served by central sewage treatment plants operated by WASA with 10 per cent being served by small privately owned plants, 64 per cent by on-site septic systems and 6 per cent by pit latrines[5]. However, the type of toilet facilities used is overwhelmingly linked to the degree of urbanization. The Population and Housing Census 2000 indicates that in Port-of-Spain, 73.9 per cent of the population uses a water closet linked to sewerage system and in rural areas this figure is as low as 1.1 per cent; in Tobago on average it is 4.3 per cent (CARICOM 2009). With the exception of the Beetham (Port of Spain) and the Scarborough (Tobago) Wastewater Treatment Plants, the wastewater infrastructure in the urban centers is over 25 years old. The Arima and San Fernando Wastewater Treatment Plants and collection systems, as well as the collection systems in Port of Spain and environs, are over 45 years old (WASA 2015). The Housing Development Corporation (HDC) also owns 22 plants with WASA working closely with HDC to take over these wastewater facilities.

Only those persons who are connected to the systems owned by WASA pay wastewater rates. While the Government-owned systems were maintained to some level of functionality, the privately owned ones, especially those in housing developments, are poorly maintained and almost all are in a state of disrepair.

Of special concern are the approximately 150 small private package wastewater treatment plants, or "orphan plants". Many of these facilities are poorly maintained and in some cases abandoned by their owners resulting in untreated effluent being discharged into water courses posing public health and environmental risks.

There is the need for implementation of appropriate wastewater/sewerage tariff for public (WASA) and private wastewater systems. Recognizing this, the Government has undertaken a review of wastewater/sewerage tariffs to appropriate levels with respect to domestic wastewater discharges and trade effluent discharges. The goal is a revised tariff structure, which is directly related to the true costs of sewerage and sewage disposal services, to cover the initial costs to provide infrastructure for new sewerage systems or expand/up-grade the existing sewerage systems and treatment plants; and to provide a source of continuing funding (revenue) for the operation and maintenance of the various sewerage.

Legislative, Regulatory and Policy Framework for Water, Wastewater and Environmental Management

Trinidad and Tobago is a signatory or a party to various regional and international conventions that impact the national, regional or global environments (GOTT 2005). With respect to protecting marine resources, these include:

- Convention on Fishing and Conservation of the Living Resources of the High Seas

[5] http://www.news.gov.tt/content/launch-wasa-malabar-waste-water-project#.V5r7no-cG3A

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat
- Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention) and the three supporting protocols[6]:
    - Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region
    - Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean
    - Protocol Concerning Pollution from Land-Based Sources and Activities – the LBS Protocol – ratified by Trinidad and Tobago on 28 March 2003

Following the 1992 Earth Summit, the Trinidad and Tobago Government committed itself to addressing national environmental issues and to improving environmental performance (Peters and Joseph 2015). Trinidad and Tobago has several laws that contribute to the management of wastewater both directly and indirectly (GOTT 2005).

In March 1995, the Environmental Management Act (EM Act) was passed; it was subsequently revoked and the **Environmental Management Act**, Chapter 35:05 was enacted in 2000. The goal of the EM Act is to ensure the protection, conservation, enhancement and wise use of the environment of Trinidad and Tobago. The Act established the Environmental Management Authority (EMA) as the primary government agency responsible for coordinating all environmental management activities in Trinidad and Tobago, including those of the non-governmental organizations and community-based organizations (GORTT 2009). The EMA is mandated to write and enforce laws and regulations for environmental management, educate the populace about national environmental issues, control and prevent pollution and conserve the country's natural resources.

Subsidiary legislation specifically related to wastewater management passed under this Act are[7]:

- The Certificate of Environmental Clearance (CEC) Rules
- The Water Pollution Rules

The **Certificate of Environmental Clearance Rules** guide the assessment of small and large-scale developmental projects which may have both positive and negative environmental effects and authorizes the EMA to grant a Certificate of Environmental Clearance (CEC) for these projects.

The **Water Pollution Rules** (WPR) 2001 (as amended) became operational in May, 2007 with the aim of ensuring that industries in Trinidad and Tobago control and reduce the volumes and concentrations of pollutants discharged in their waste water.
There are two major processes for the implementation of the WPR:

- Source Registration (SR), where a comprehensive register of water polluters is generated from identified sources based on vulnerable watersheds. Facilities that regularly discharge water pollutants into the environment at or above the specified levels are required to complete and submit an application to the EMA for SR. During the SR process, pollution levels of discharges are checked against acceptable benchmark levels. A facility not meeting the benchmark is identified as a water pollution source and is issued a Source Registration Certificate (SRC) and is monitored

[6] http://www.cep.unep.org/cartagena-convention
[7] http://www.trinidadlaw.com/home/general/subcategory.aspx?categoryID=19&subcategoryID=63

over a period of three years. A SRC does not by itself represent any endorsement, licence or permit to operate by the EMA.

- Permitting, which is the process to control and reduce the volume and concentration of effluent to meet the permissible levels. The permitting phase is initiated when monitored parameters exceed the permissible levels during the SR phase. The EM Act mandates the EMA to establish procedures for the issuance of a Water Pollution Permit (WPP) to authorize any facility to discharge wastewater under specific conditions. The WPP is based on the acceptable benchmarks for 29 parameters. These are set according to four specific receiving environments which are inland surface water, coastal near-shore, marine offshore, environmentally sensitive areas and/or groundwater.

The **Water and Sewerage Act,** first enacted in 1965 and subsequently amended, established the Water and Sewage Authority. Part IV of the Act is specific to sewerage, and governs the construction and development of sewerage works as well as possible mandatory connection to such works.

Trinidad and Tobago have several policies and plans that relate to sustainable development or the environment or wastewater management.

The main policy instrument governing the environment in Trinidad and Tobago, the **National Environmental Policy** (NEP), was adopted in 1998 and was designed to promote conservation and encourage the wise use of the environment. A key principle of the policy is that the cost of preventing pollution or minimizing environmental damage due to pollution is to be borne by those responsible for the pollution. In keeping with this principle, the EM Act mandated that the EMA determine the sources, distribution and types of water pollution, and develop a Water Pollution Management Programme to control and reduce the water pollution. The primary policy instrument used for achieving these objectives is the permit system of the WPR.

The policy states that the Government of Trinidad and Tobago will ensure that development decisions that impact on water resources are guided by acceptable water quality and quantity criteria and that these criteria can be met on a sustainable basis (GORTT 2009). With specific reference to wastewater management, it states that the Government will:

- Ensure that all sewage and wastewater receive the degree of treatment necessary to protect the waters of Trinidad and Tobago prior to being discharged. In addition, all wastewater from industrial or commercial facilities that are located close to a public sewerage system should be disposed into that system, subject to such quality and flow conditions as the owner of the sewerage system may apply.
- Ensure that environmental authorization or applications for environmental authorizations that involve construction of wastewater storage lagoons take into account that the specific circumstances outlined below should be treated with appropriate setbacks as outlined by the respective national planning agency.

The Vision 2020 National Strategic Plan, 2005 presented the national strategy to guide the country to 'developed nation' status by the year 2020, and was prepared by the Vision 2020 Multi-sectoral Core Group through a process that involved extensive consultation with stakeholders in the national community. The Plan identifies among environmental issues to be addressed, pollution from non-functioning sewerage treatment plants, industrial effluents, and oil spills; indifferent attitudes and values toward the environment; and failure to implement or enforce important environmental and natural resource management legislation.

As part of the implementation of Vision 2020, Trinidad and Tobago developed the Water and Wastewater Master Plan for Trinidad and Tobago to 2035 that will provide a framework for the comprehensive rehabilitation, reconstruction and extension of the country's water and wastewater infrastructure. The master plan aimed to transform the water and wastewater sector so that by the year 2014, 98 percent of the population would have a 24-hour continuous supply of water and at least 75 percent of households and other such entities would be connected to the central sewerage system by the year 2020.

The 2015 Waste Recycling Policy could provide a framework for reusing treated wastewater.

Wastewater Management in Trinidad and Tobago – the Institutional Framework

As noted above, the Water and Sewerage Authority (WASA) was established by the Water and Sewerage Act to manage the water and sewerage sector of Trinidad and Tobago. With respect to wastewater management, WASA is responsible for constructing and developing sewerage works and is empowered to hire contractors to undertake such works (IDB 2011). Furthermore, WASA may instruct that households be connected to the sewerage system, provided such houses have a water connection and are within 150 feet of the sewer.

The Environmental Management Authority (EMA) is the primary government agency responsible for coordinating all environmental management activities in Trinidad and Tobago. It enforces and manages the Certificate of Environmental Clearance Rules and Water Pollution Rules described above, thereby monitoring the actions of WASA and all wastewater treatment facilities.

The Tobago House of Assembly Department of Natural Resources and the Environment (DNRE) is charged with protecting Tobago's environment and promoting the sustainable use and management of its natural resources. The Department is also the arm of the EMA in Tobago – monitoring and enforcing the laws pertaining to the Certificate of Environmental Clearance and Water Pollution Rules among others.

Investments in Wastewater Systems

The Government of Trinidad and Tobago has commenced an aggressive programme for the enhancement of the sanitation sector targeting key geographic regions across the country for project development and implementation. The Government has established a target of 75 per cent access to piped wastewater services by 2020 (Janson 2014). The construction of the Beetham Sewerage Facility – funded by a loan from the Caribbean Development Bank – to service the entire Port of Spain, was completed in 2004.

Trinidad and Tobago receives funding from the International Bank for Reconstruction and Development (IBRD) for wastewater management projects. WASA is currently adopting and refurbishing a number of wastewater facilities from various government authorities which include the former National Housing Authority (NHA), now the Housing Development Corporation (HDC) and the Urban Development Company of Trinidad and Tobago (UDeCOTT). WASA plans to adopt and refurbish over one hundred and fifty sewage treatment plants within private land developments with the intention to integrate these smaller systems into larger regional sewerage treatment facilities (WASA 2015).

Economic Resource Valuation for Improving Wastewater Management in Trinidad and Tobago

The overall aim of the Natural Resource Valuation project was to improve the regional understanding of the connections between wastewater treatment and human and ecosystem health and to enhance the capacity within the Wider Caribbean Region for conducting economic valuations related to wastewater management investments and to use the findings to develop a generalizable economic valuation approach which could be applied in any country in the Wider Caribbean Region.

Project Objectives:

- Identifying infrastructure investment options for wastewater management, for both green and grey infrastructure
- Valuing costs and benefits of possible wastewater management options, including both direct and indirect benefits
- Developing a greater understanding and capacity for valuing coastal ecosystems and wastewater management options and improving regional understanding of connection between wastewater treatment and coastal ecosystems

"Governments asked: Can we use a methodology that can actually help us do perhaps two things: 1) assist us in determining what is the most appropriate wastewater investment option that we can choose, and 2) also try to assist us in making a stronger financial case for investing in wastewater management services …and to make a stronger investment case, we now need to value what are the resources that, by investing in wastewater treatment plants, will be protected.."

- Christopher Corbin, AMEP Programme Officer, UNEP

(CReW 2015)

The resource valuation study essentially examined the trade-offs between ecosystem and human health and the costs of investing in improved domestic wastewater management for the pilot sites.[8]

The policy question for the study was:

How do the benefits to ecosystems, the economy and human health compare to the cost of investing in improved wastewater management (within a given study area)?

In Trinidad and Tobago, two sites were chosen based on input from the Environmental Management Authority and the Water and Sewerage Authority and ensuring that the study results would be of immediate use to WASA (V. Ramkhalawan, personal communication, July 2016). The initial proposed study area in Trinidad focused on the Caroni River Basin, but the Basin includes multiple sub-catchments with diverse issues, uses, and different levels of data availability on current and future wastewater management infrastructure options. The area finally chosen was Chaguanas, a rapidly developing urban area that currently lacks sufficient wastewater treatment and which directly impacts the Caroni swamp (CReW December 2014). The study site selected includes the Cunupia and Guayamare catchments.

In tourism-focused Tobago the selected site was the Buccoo Reef / Bon Accord ecological complex – a Ramsar site[9], including the Courland catchment. In 2011, Alpha Engineering & Design (Alpha) prepared a draft Certificate of Environmental Clearance application for Bon Accord with proposed plans for the area including Bon Accord, Coral Gardens/Buccoo, and Milford Court areas. This proposal was accepted as a short- to medium-term future wastewater management improvement scenario for the valuation study. It includes upgrades to the Bon Accord and Golden Grove waste stabilization ponds and increased household and commercial connections to wastewater treatment infrastructure including sewerage mains and lift stations. Additionally, it was agreed that another future wastewater management scenario which could potentially be explored would include the expansion of the Alpha proposal to include additional tertiary treatment.

The economic valuation approach is designed to be highly participatory. Therefore, a steering committee was established to assist with valuation design, data collection, and dissemination of results. The committee comprised representatives from the Environmental Management Authority, Ministry of Environment and Water Resources, Water and Sewerage Authority, Institute for Marine Affairs, Tobago's

[8] While this case study focuses on Trinidad and Tobago, the general methodology and activities apply also to the study conducted in Panama.

[9] A Ramsar site is a wetland site designated of international importance under the Ramsar Convention.

Department of Natural Resources and the Environment and the Ministry of Planning and Sustainable Development (V. Ramkhalawan, personal communication, July 2016).

Additionally, introductory workshops were held in the pilot sites in October 2014 to raise awareness of the study objectives, gain input on data sources and key ecosystem and human health impacts to consider, and help define current and future wastewater management alternatives. Importantly, the workshop also included a guided discussion on developing a communications strategy for dissemination of analysis results. Representatives of government agencies, research institutes/academia, public and private sector institutions and local NGOs participated.

Follow-up workshops were also held in June and July of 2015 to share the valuation approach, present preliminary results to raise awareness and request data clarification, and conduct further data collection for the pilot sites. Workshop participants included steering committee members and a wider audience of applicable stakeholders with a direct or indirect interest in wastewater pollution issues.

Valuation Methodology

A literature review found that, overall, there have been very few economic valuation studies that estimate ecosystem and human health impacts related to improving domestic wastewater management - reflecting the challenge of addressing the research question of this study (Gray et al 2015).

Valuing the ecosystem and human health benefits of improved domestic wastewater treatment is challenging and requires multiple stages of analysis – estimating how reduced pollutant loading will influence water quality; how ecosystem condition and human health will change in response to the change in water quality; how the change in ecosystem condition (such as live coral cover on a coral reef) will influence ecosystem service provision (such as tourist visitation to the reef); and how people value a change in ecosystem service provision and human health risks. Box 1 highlights some specific challenges.

The selection of the type of analysis to be conducted is often based on the challenges identified in Box 1. The qualitative decision support tool, Multi-Criteria Decision Analysis (MCDA), provides a narrative approach for understanding these biophysical connections based on best available data and expert input, and allows those interested in the research question to weigh the benefit and cost trade-offs based on a key set of criteria deemed important for decision making including changes in costs, water quality, ecosystem impacts, and human health impacts. The quantitative decision support tool, Benefit-Cost Analysis (BCA), requires understanding and quantifying the biophysical connections between a wastewater management investment, the resulting change in water quality, and the resulting change in provision of ecosystem services and human health risks demonstrated by incidence of wastewater-related illnesses.

The economic valuation approach used in this study provides guidance for Caribbean stakeholders for the consideration of trade-offs of investing in wastewater management improvement (Gray et al 2015). It builds on the ecosystem valuation framework established by the WRI (Waite et al. 2014) in the guidebook, "Coastal capital: Ecosystem valuation for decision-making in the Caribbean," which includes three phases: (1) Scoping; (2) Analysis; and (3) Outreach (Figure 2). The methodology for this study followed the three phases but focused on issues related to wastewater management and included an evaluation of the benefits to human health.

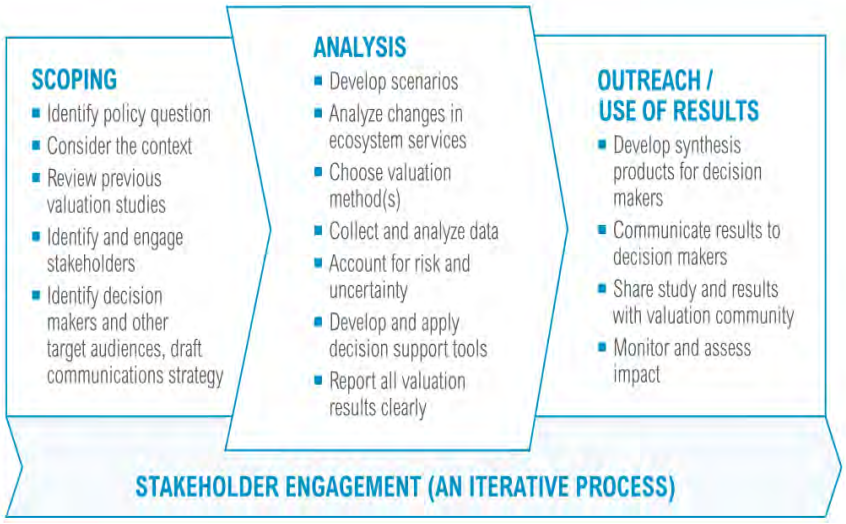


Figure 2: Steps in conducting coastal ecosystem valuation to inform decision making in the Caribbean
Source: Burke et al 2014

The **Scoping** phase is designed to explicitly define the policy question; identify key stakeholders to engage throughout the valuation process (for data collection, awareness raising, or decision-making purposes); identify useful literature and data including economic valuation and scientific studies to support valuation efforts; identify key evaluation criteria for decision making; and identify target audiences for dissemination and communication of results.

The **Analysis** phase includes extensive data collection, followed by evaluation of that data to inform the choice of a valuation approach and decision support method. The main steps in the analysis process are:

1) Identify the key decision-making criteria for evaluating wastewater treatment options.

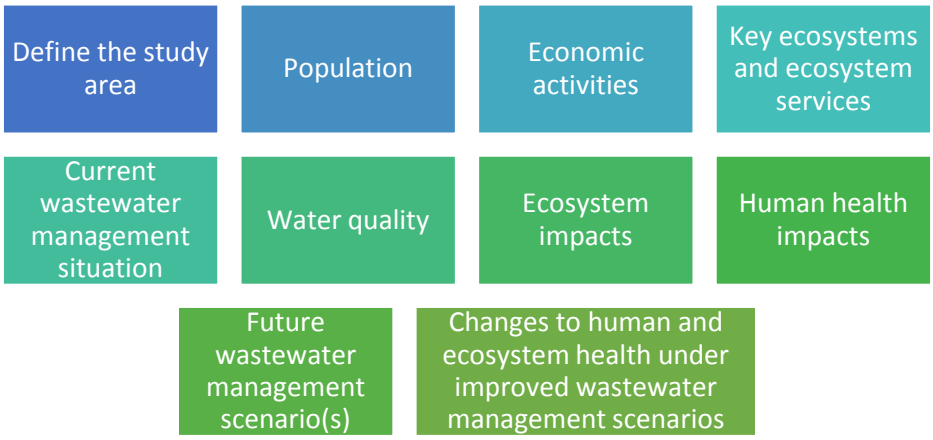
2) Use a Characterization Form to define the study site, develop an understanding of the current wastewater management

Box 1

Challenges related to economic valuation of wastewater management

- For many areas of the world, water quality data simply aren't available, so tracking changes in water quality and ecosystem and human health response is not possible.
- For many areas of the world, statistics on health data (e.g., number of cases of gastroenteritis) are also not available.
- It is difficult to forecast how an ecosystem will respond to a change in water quality, either to a given pollutant or to multiple pollutants. Biophysical models are required for such analysis, and may not be available for all geographic settings. It is also difficult to forecast how ecosystem service provision will change in response to a change in ecosystem condition.
- It is difficult to determine how many cases of wastewater-related diseases like gastroenteritis are directly attributable to domestic wastewater pollution because there are other risk factors. For example, there might be additional sources of water pollution than domestic wastewater which contain the same pollutants, and some illnesses are also attributable to non-water related risks.

situation, identify future wastewater management scenarios, and collect data on relevant decision-making criteria[10]. The characterization form requires users to provide information on the following areas:



3) Decide whether the available information is sufficient to support quantitative analysis (BCA), or whether qualitative analysis (MCDA) is more appropriate

4) Compare costs and benefits of wastewater management options using either a MCDA or BCA.

The data required to implement a full BCA were not available for any of the pilot sites. As such, MCDA was employed within this study. The MCDA for this study was based on typical economic analyses used by infrastructure decision makers, but tailored for water resource managers and updated to consider ecological and health co-benefits from wastewater treatment.

The **Outreach** step is designed to communicate the results of the economic analysis to target audiences to influence decision making regarding wastewater investments. During the scoping phase, stakeholders can be engaged to understand which communication channels are best suited for the study area and for specific stakeholder groups – as was done during the introductory workshops for this study.

Both BCA and MCDA allow decision makers to compare infrastructure investment scenarios based on benefit and cost considerations.

BCA allows decision makers to compare scenarios based on a quantitative metrics and requires monetization of benefits and costs. The infrastructure scenario that maximizes net benefits can easily be identified as the best investment option.

MCDA can be used to determine overall preferences among different investment options by scoring and ranking infrastructure scenarios. MCDA is applicable in situations where not all benefits and costs can be monetized. It also has the advantage of allowing decision makers to weigh the trade-offs for infrastructure scenarios based on non-quantitative factors (e.g., operational complexity of wastewater infrastructure). MCDA can produce a single referred infrastructure scenario for consideration, a ranking of options, a condensed list of scenarios for future consideration, and/or a characterization of acceptable or unacceptable scenarios.

[10] The complete form can be found in Valuing the Costs and Benefits of Improved Wastewater Management Annex 1: Characterization Form and Technical Summary Templates at http://gefcrew.org/index.php/resources

Results of Valuation Study in Trinidad and Tobago[11]

The major ecosystem types considered for the analyses include coastal mangroves, rivers, seagrass beds, beaches, and coral reefs. Issues examined included:

- population size
- main economic drivers
- current infrastructure in place and the types of technologies that would likely be put in place in the future – and the current and expected impacts

The two sites were quite different: Southwest Tobago is a largely eco-tourism driven economy, which include focus on coral reef ecosystems, whereas Chaguanas is a growing commercial center with limited tourism, though some visitors to Trinidad visit the Caroni Swamp.

The Characterization Forms for the pilot sites were completed by WRI with support from wastewater and environmental authorities. During workshops organized by the EMA in 2015, stakeholders were asked to review the Characterization Form and summary results, and to complete an MCDA exercise by completing an evaluation matrix. The evaluation matrix allows weighting and scoring of scenarios against a list of key evaluation criteria established by workshop participants. The scenario with the highest score was assumed to be the best option.

Together with the two countries involved in these pilot studies, the WRI developed a standard list of criteria but stakeholders consulted at each site determined the relative weighting of each criterion. For example, Trinidad ranked energy cost not very high because they have a relatively inexpensive energy supply, which is different from most other countries in the region that would probably rank energy costs much higher. So national expert knowledge is important in determining, within each country context, how much weighting to give to each of these criteria that would influence the type of wastewater application that is chosen.

Figure 3 shows a sample evaluation matrix with the list of criteria, the weighting for each criterion and the comparative scores for the existing situation and the proposed future scenario.

[11] This section is largely from Gray et al 2015.

Criteria	Weight	Score	
		Current Situation	Future Scenario
Capital costs	4.8	4.0	2.3
Annual recurring costs	3.8	2.8	2.5
Energy consumption	2.3	2.3	3.0
Ease of operation	3.8	1.8	3.3
Wastewater treatment capacity	4.8	1.3	4.5
Vulnerability	4.8	2.0	3.3
Ambient water quality impact	5.0	1.5	4.0
Pollutant removal effectiveness	4.8	1.3	4.3
Untreated domestic wastewater	4.3	1.3	3.3
Ecosystem impacts	5.0	1.3	4.3
Ecosystem service impacts	4.8	1.5	3.8
Human health impacts	5.0	1.5	3.5
Economic disruption/growth	4.0	3.8	2.3
Tally (Weight * Score)		**111**	**195.4**

Figure 3: Sample evaluation matrix

Overall, MCDA results for each pilot site suggest that the forecasted benefits from investment in improved wastewater management exceed the costs, as indicated by a higher score for the future scenario(s) as compared with the current wastewater management situation. Some common themes and some differences in the results are described below.

Buccoo Reef/Bon Accord, Tobago – Results from two workshops showed that the future scenario is favored over the current situation. The future scenario included expanding collection systems and linking more homes to waste stabilization ponds at Bon Accord and Golden Grove. The total scores were 195 and 162 for the future scenario vs. 111 and 97 for the current scenario (at workshops held in Port of Spain and Tobago, respectively). Both sets of results support investment in the "future scenario," driven mostly by anticipated benefits in increased wastewater treatment capacity, improved ambient water quality, and (to a lesser extent) reduced impacts to ecosystems and human health.

Chaguanas, Trinidad – The MCDA focused on the scenario for which WASA provided data: the refurbishment of the Edinburgh 500 plant and the development of a new WWTP (the Chaguanas WWTP). However, WASA is now exploring a revised scenario for the area. Analysis results support investment in the future scenario evaluated, driven mostly by anticipated benefits in increased wastewater treatment capacity, improved ambient water quality, and (to a lesser extent) increased pollutant removal efficiency, reduced recurring costs and reduced ecosystem and human impacts.

Summary of Study Results: Southwest Tobago (Buccoo Reef / Bon Accord Area)

Site Location

The study area was in SW Tobago, including most of St. Patrick's and parts of St. Andrew's parishes. The area includes the Buccoo Reef / Bon Accord ecological complex – a Ramsar site; the Courland, Buccoo, and Bon Accord water catchments; and the Bon Accord, Milford Court, Samaan Grove, Coral Gardens, and Buccoo communities.

Ecosystems in Study Site

Key ecosystems in the study area:

- Coral reefs – the Buccoo Reef
- Bon Acord Lagoon (including Nylon Pool)
- Mangroves
- Seagrass
- Beaches

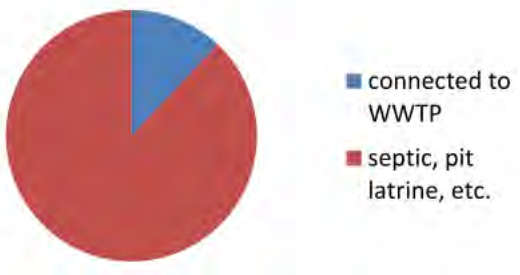
Key ecosystem services and their values:

- **Tourism** – the primary source of GDP for Tobago. Over 60% of visitors to Tobago go on snorkel or glass-bottom boat trips to Buccoo Reef and many visit the Nylon pool. Tourism and recreation at Buccoo Reef contributed between US$7.2 and $8.8 million during 2006, and the amount is likely higher today.
- **Fisheries** – coral-associated fisheries in Tobago contributed between US$0.8 and $1.5 million in 2006.
- **Shoreline protection** – the "damages avoided" due to the presence of the Buccoo Reef are valued between US$140 and $250 million over a 25-year time period.
- **Carbon sequestration** – mangroves, seagrasses, and associated soils are important stocks of carbon.

Population and Wastewater Treatment

The study area included about 15,000 people

- (5,000 households) in 2011, based on a pro-rating of data from the Central Statistical Office (CSO).
- Current population growth is ~1.2% per year.
- Within Tobago, about 12 per cent of the population is connected to a wastewater treatment plant (WWTP), with the remaining 88 per cent using pit latrines, on-site septic or soakaway systems.



Wastewater Treatment in Tobago		
Current WW treatment Situation: • Bon Accord / Milford Court WWTP – membrane bioreactor since 2003 • Buccoo / Coral Gardens WWTP - membrane bioreactor since 2004 • Waste stabilization ponds (WSPs) at Golden Grove and Bon Accord • Grey water from many homes is discharged directly into storm drains	**Condition / Issues / Limitations** • Not meeting water quality standards • Equipment past lifetime • Current needs exceed system capacity • During heavy rains, untreated wastewater is released into Bon Accord Lagoon and Buccoo Bay • Coastal waters also receive pollutants from unauthorized developments, a fish processing plant, grey water discharge, and malfunctioning septic tanks, pit latrines and soakaways	**Operating Costs** • Annual capital expense TT$1.0 million[12] per plant • There is also periodic (approximately every 5 years) investment for major upgrading and maintenance costing about TT$2-3 million per plant • Annual operating expense TT$0.5 million per plant

Impacts of Current Wastewater Management Practices	
Observed or likely impacts due to WWT situation: • Elevated wastewater pollution during wet season • Increased nutrient pollution in lagoon and on inner reef • Higher biomass of micro-algae in lagoon and on reef • Some occurrence of algal blooms • The inner portion of Buccoo Reef (facing lagoon) is degraded relative to the outer reef • Mangroves are doing well under increased nutrients • Seagrass harmed by increased sediments and competition with macro-algae. Shifts to turtle grass are a symptom of WW pollution. • Possible health impacts are less clear. Pathogens from WW are found in the study area, where people swim and fish. Diving companies report incidences of ear infections.	Potential Economic loss: • Tourism and recreation respond to degradation of coral condition, as well as to information about water quality impairment (for swimming on beaches, at nylon pool or snorkeling/diving). • A degraded Buccoo Reef provides less protection of the shoreline, so increases risk of erosion and flooding.

WW Improvement Scenario 1 (Short/Medium-Term Solution)		
WASA funded a contractor (Alpha Engineering) to develop a short- to medium-term solution for SW Tobago but funding for implementation is not yet identified. The plan includes expanding collection systems (using gravity lift stations), and linking more homes to waste stabilization ponds at Bon Accord and Golden Grove:	Anticipated impacts • More people connected to WWT system • Meet Water Pollution Rules • Fewer outfall locations	Capital Costs: TT$ 147 million (this total is likely outdated, but included): • TT$ 5 million engineering design • TT$ 22 million land management

[12] US$1 = approximately TT$ 6.7

WW Improvement Scenario 1 (Short/Medium-Term Solution)		
• At Bon Accord, a small-bore system will transport liquid waste to the Bon Accord WSP, allowing elimination of dysfunctional package plants. • The Milford Court WWTP will be converted to anaerobic tanks, with effluent going to Golden Grove (GG) WSP. • The small-bore systems for Bon Accord and Milford Court will not treat gray water. • At Coral Gardens / Buccoo, the WWTP will be converted to anaerobic tanks, with effluent piped to GG WSP. Septic tanks will be upgraded. A full-bore gravity collection main will collect sewage from the school, goat race facility, community centre, fish depot, and pan yard. Both black and grey water will be treated from the lower Buccoo area.	• Lower O&M costs than current situation (due to • removal of package plants) • Protect tourism reputation	• TT$ 120 million capital cost The capital cost estimate did not include the cost of connecting houses. O&M Costs: TT$30 million / year

MCDA results

	Score	
	Current Situation	**Future Scenario**
From formal EMA/WRI workshop in Port of Spain, Trinidad	111	195
From informal workshop in Tobago (WASA Lowlands office)*	97	162

*Evaluation criteria, Annual recurring costs and Ease of operation were not used in this analysis.

Summary of Study Results: Chaguanas, Trinidad

Site Location

Chaguanas is rapidly growing, and its sewerage catchment definition is evolving to accommodate this growth. The study area includes the Cunupia, Guayamare watersheds and part of the Caparo watershed, which discharge into the southern part of the Caroni Swamp (known as the Felicity section). The Chaguanas study area is ~ 3,000 – 5,000 hectares and includes ~9-12 sewerage catchments.

Ecosystems in Study Site

Key ecosystems in the study area:

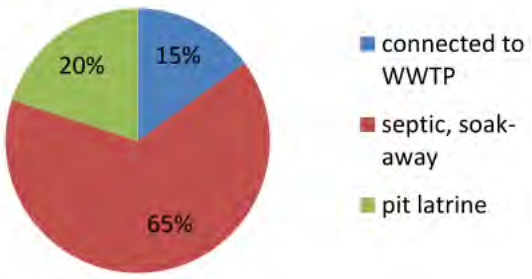
- Caroni Swamp (a Ramsar protected site) that includes eight species of mangrove and herbaceous marsh
- Rivers and streams

Key ecosystem services and their values:

- Tourism and recreation (kayaking, boat tours, and birding in Caroni Swamp – viewing the Scarlet Ibis; recreational fishing)
- Fisheries (oysters and fish in Caroni Swamp)
- Flood attenuation (the swamp stores and mitigates)
- Species protection/Biodiversity (home to 190 bird species)
- Raw materials (wood from mangroves)
- Carbon storage (in mangroves and seagrass)
- Nutrient and sediment filtering (by mangroves and seagrass)
- Genetic and medicinal resources
- One economic valuation of fisheries and tourism and recreation in the Caroni Swamp estimated they were contributing TT$2020 per hectare in 1974. It is likely much higher today.

Population and Wastewater Treatment

- In 2011, the population of the Borough of Chaguanas was 83,516 (CSO). This includes 24,644 households. Annual population growth has been 2 per cent from 2000 to 2011.
- WASA and CSO estimate that the population will be ~123,000 – 151,000 by 2040.
- Wastewater – 14-15 per cent of the population is connected to a sewerage system / wastewater treatment plant (WASA & CSO 2000); 65 per cent are on septic or soak-away systems; 20 per cent have pit latrines; and <1 per cent have no treatment.



Wastewater Treatment in Tobago		
Current WW treatment Situation • There are currently 14-15 package plants and possibly more planned. Some of the smaller package plants are in dire disrepair. WASA has received approval to refurbish 2 package plants (Homeland Gardens, Orchard Gardens, and Point Pleasant). • Orchard Gardens is currently discharging raw sewage. • The major plants (Edinburgh 500, Penco, Lange Park, and Charlieville) are operated satisfactorily by WASA.	**Condition / Issues / Limitations** • The current infrastructure was put in place before 2001 (and before the Water Pollution Rules were developed), so environmental impact statements and monitoring of discharge is not required. • Population will exceed capacity of current plants. • Local conditions are not really conducive for on-site treatment (high water table levels, inadequate soil conditions, flood prone areas). • Some package plants are in disrepair and are discharging raw sewage (e.g., Orchard Gardens). • There are some unauthorized / unplanned developments • Grey water is not treated from the 86% of the population using on-site treatment. This water can have high bacterial, fat, and grease content.	**Operating Costs** • Costs vary by plant type (based on size and technology). • Average package plant investment / capital costs run (depending on loading) ~$10 million TT, and average O&M might run ~ $20 – 30K TT /plant/ month (excludes electricity and major capital); Orchard Gardens costs are lower. • Average lifetime of package plants is ~10 years.

Impacts of Current Wastewater Management Practices	
Observed or likely impacts due to WWT situation: • Ecosystems – Raw sewage is discharged into receiving streams. These are tributaries to the Caroni Swamp. • Human health – several foodborne pathogens found in the study area have links to wastewater - salmonella, Shigella, rotavirus, and norovirus. • Contaminated shellfish are a risk to human health (via food poisoning).	Potential Economic loss: • This information was not available. Some portion of current ecosystem services listed above.

WW Improvement Scenario 1: Two regional wastewater treatment plants (WWTPs)		
This plan includes the refurbishment of the Edinburgh 500 plant to treat developments in the southern area and the development of a new WWTP (the Chaguanas WWTP) to treat developments in the northern section, with sewerage connections to connect everyone in the Borough to these two WWTPs:	Anticipated impacts • Better control of treatment • More households connected to reliable treatment	TT$1,391.31 million total for capital expenses

WW Improvement Scenario 1: Two regional wastewater treatment plants (WWTPs)		
• The Edinburgh 500 plant would have a capacity of 12,000 m^3/day, and would use an activated sludge-extended aeration process. The Chaguanas WWTP would have a capacity of 54,000 m^3/day but the technology is unknown. • Both grey and black water will be treated; treated wastewater could be reused based on this solution. • All current WWTPs and package plants would be decommissioned.	• Less untreated wastewater	

WW Improvement Scenario 2: One regional wastewater treatment plants (WWTP)		
The plan includes the construction of a regional wastewater treatment plant and sewerage connections with the goal of connecting everyone to this centralized system: • Treatment technology would likely include anaerobic digesters and clarifiers (conventional treatment). • The population that is difficult to connect will use septic systems with added disinfection. • All current WWTPs and package plants would be decommissioned. • Both grey and black water will be treated; Treated wastewater could be reused based on this solution.	Anticipated impacts • Better control of treatment • More households connected to reliable treatment • Less untreated wastewater	Will be estimated by a contractor. (WASA is in the planning stage of hiring a consultant to conduct a cost-effectiveness analysis and identify a future wastewater management strategy.)

MCDA results

Score	
Current Situation	**Future Scenario**
125.2	190.3

Challenges

Challenges in conducting the economic valuation study in the Trinidad and Tobago sites and utilizing the results included:

- **Inadequate data**
  Data were obtained from several national institutions, including WASA, the Ministry of Tourism and the Tobago Hotel Association, and the Central Statistical Office. However, in general, the pilot sites lacked sufficient data on:
  - water quality (wastewater discharge, freshwater and coastal water quality)
  - ecosystem health related to wastewater

- health statistics (e.g., number of cases of gastroenteritis) thereby presenting difficulty in determining how many cases of wastewater-related diseases are directly attributable to domestic wastewater pollution because of other risk factors
- detailed projections of future wastewater infrastructure options and costs, or estimates of costs for current wastewater infrastructure components and operations

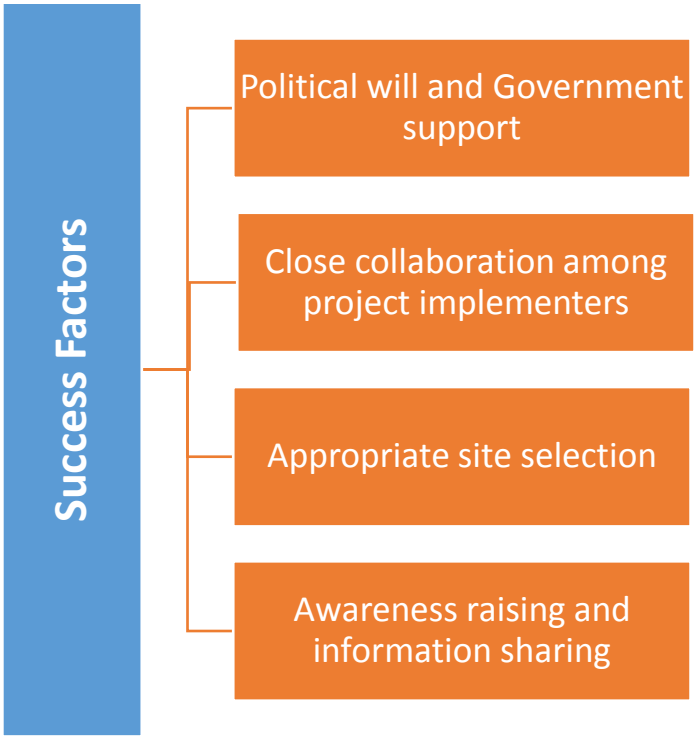
The paucity of data made it difficult to track changes in water quality and ecosystem and human health response.

Also, while Trinidad and Tobago has water quality standards in place for coastal water bodies, there are constraints in terms of technical capacity and financing to collect data and monitor water quality.

- **Dissemination of study results – change in government**
  The valuation study was finalized in August 2015. As noted above, stakeholders from many ministries and agencies had participated in the study and had been sensitized to the objectives and preliminary results. However, in September 2015, there was a change in government in Trinidad and Tobago. The restructuring of certain ministries and their portfolios caused delays in the dissemination of the study results as new stakeholders had to be included and relationships clarified. The study results are being disseminated to the new stakeholders and the expectation is that the Government will act on its recommendations.

Success Factors

A number of factors contributed to the success of the resource valuation project in Trinidad and Tobago.



Political will and Government support

Trinidad and Tobago was one of the first countries to ratify the LBS Protocol (in 2003). The ratification of this protocol – and the overarching Cartagena Convention – demonstrated the Government of Trinidad and Tobago's commitment to reducing pollution. In recent years the Government has increased recognition of the importance of wastewater management and is implementing initiatives – some with the support of CReW – to improve the wastewater sector in the country. In its 2014 Budget Statement, the Government announced that it is expanding and improving wastewater treatment, collection, and disposal systems in Malabar, San Fernando, Maloney, Cunupia, and Scarborough, Tobago. These projects will increase access to centralized wastewater systems from 30 percent to 45 percent of the population (Janson 2014).

The loan conditions for IDB-funded wastewater infrastructure improvement projects include requirements to ensure that WASA will actually maintain the funded assets, requiring the Government to find a way to provide the necessary funds to WASA for maintenance, for example through the national budget and allowances for WASA to recover operating and maintenance costs. i.e. costs relating to the wastewater treatment plants which were rehabilitated with the loan, including the costs of administration, operations, maintenance, and, insofar as possible, replacement of existing assets (Janson 2014).

As a first step towards addressing the needs of the wastewater sector, approval has been granted for the creation of a Wastewater Division within WASA[13]. This division would therefore not have to focus on matters related to potable water, which typically have higher priority.

Therefore WASA will be enabled to implement decisions based on the results of the evaluation study – knowing that there is Government support for new wastewater management initiatives.

Close collaboration among project implementers

At the beginning of the project all the major stakeholder organizations were under the same ministry – the Ministry of Environment and Water Resources, which facilitated easy collaboration without having to deal with competing priorities and agendas (V. Ramkhalawan, personal communication, July 2016). While inter-sectoral collaboration is also useful, such initiatives often have to address different mandates and organizational cultures to achieve meaningful partnerships.

Appropriate site selection

Selection of the project sites was based largely on WASA's recommendations. As the entity responsible for implementing any wastewater initiatives, they were able to guide the project so that this evaluation exercise would fit in with its current and proposed plans and provide the greatest benefit. For example, WASA already had plans for one initial site selected in Trinidad and requested that another site be chosen – Chaguanas was the resulting selection. From the project's perspective, as this was a pilot study and meant to provide guidance for wider application of the methodology among project countries, it was also an interesting alternative site because of the contrast it provided, *i.e.* a more urban, commercial area in comparison to the Tobago site which is more tourism-focused.

Awareness raising and information sharing

The introductory workshops held in the pilot sites at the beginning of the project were key to raising awareness about the project and to share information that was needed for the study. Each workshop included an overview of the GEF CReW project; the resource valuation study objectives; an overview of the pilot sites including wastewater regulations, pollution sources, and current treatment facilities; a guided discussion on current and future wastewater management scenarios; an introduction to the proposed resource valuation methodology and data needs; a guided discussion on relevant costs and benefits to include; exploration of potential data sources, including applicable studies; and identification of data gaps, which could be used to design data collection programmes for expansion of the valuation study or for wastewater management monitoring and evaluation programmes.

Participants discussed the development of a communications strategy for dissemination of analysis results. They identified the key decision makers (i.e. who should the study influence?); the best strategy to deliver results to target audiences including the best communication channels; and upcoming events and conferences which would provide opportunities to disseminate results.

[13] http://www.unep.or.jp/ietc/Publications/TechPublications/TechPub-15/3-9IlandCaribbean/9-11_1.asp

After the valuation studies were completed, the experiences from the development and application of the resource valuation methodology were shared with GEF CReW participating countries at a Regional "Resource Valuation Workshop" on 23-24 August 2015 in Miami, Florida, on the edge of the Caribbean Water and Wastewater Association's 24th Annual Conference and Exhibition. Twelve of the Project's thirteen participating countries were represented. At this workshop, participants discussed the methodology and shared experience and results. Importantly, the participants worked on national action planning exercises based on the methodology of the studies.

Lauretta Burke, WRI, presents study results

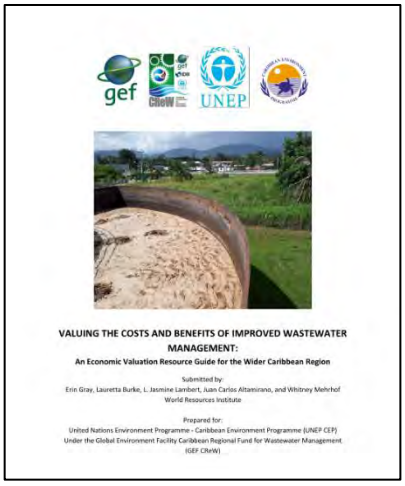
The reports and resource materials on valuation have all been made available via the GEF CReW website. Highlights of the study and the methodology, as applied at the Buccoo Reef site in Tobago are explained in a video "The Value of Action", which was produced and disseminated to promote the approach. The video also is available on the GEF CReW website.

Benefits of the Project

Two resource valuation studies conducted

Under this project, resource evaluation studies were conducted in two very different locations – Chaguanas in Trinidad and the Buccoo Reef / Bon Accord area in southwestern Tobago. Multi-Criteria Decision Analysis results for each location suggest that the forecasted benefits from investment in the proposed improved wastewater management solutions exceed the costs.

Results for these sites are preliminary. It is important for stakeholders in Trinidad and Tobago to use these results as a starting point and conduct a more robust MCDA analysis. Results of any MCDA should be interpreted by national decision makers with guidance from economic valuation practitioner(s) in order to determine if the proposed investment should be undertaken.



Demonstration of resource valuation methodology

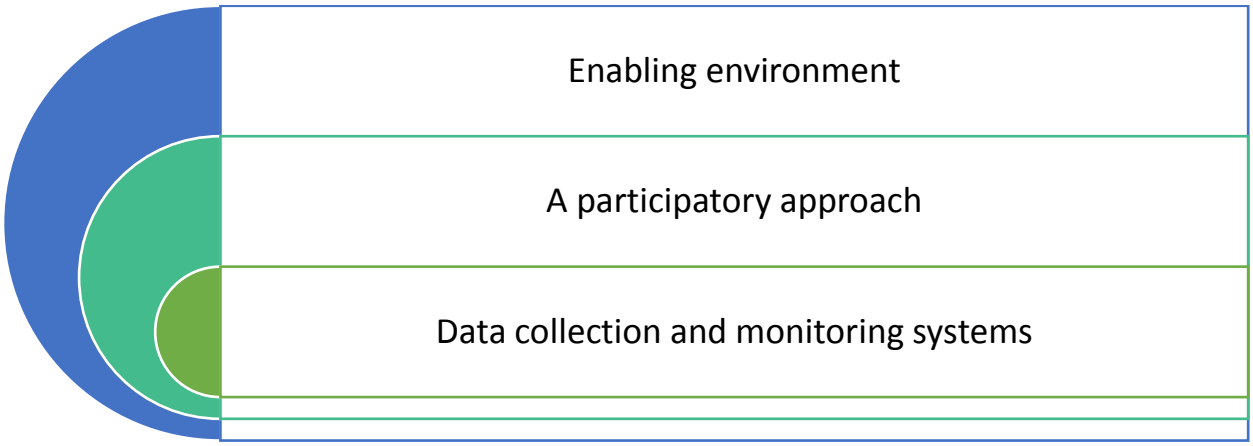
This project provided a demonstration of resource valuation methodology that can be used in data-rich and data-poor countries. It provided a template for data collection with specific questions as well as a template for presenting the summary results to stakeholders. These templates include items that may sometimes be overlooked. For example, it suggests that the summary results include a description of how/when/where the evaluation matrix is completed – this information validates the results and increases accountability and transparency.

Gray et al's Resource Guide (2015) – especially Part II: Economic Valuation Methodology Guidance – provides detailed guidance on conducting a more in-depth analysis. For the three phases – scoping, analysis and outreach – it provides specific questions to ask and suggestions for stakeholders and evaluation criteria as well as criteria for selection of the best method of analysis. Also, the resource guide includes supplementary material that can be useful for leaders and participants in the valuation process

such as a glossary of common wastewater terms, information on wastewater pollution and ecosystem impacts and human health risks from exposure to wastewater pollution, and a comparison of wastewater treatment technologies applicable to the Wider Caribbean Region. These materials are available on the CReW website.

This approach can be used in any country to compare the status quo to different wastewater treatment scenarios. It can help decision-makers, even in cases where data is imperfect or scarce, by bringing stakeholders together and allowing experts to weigh in. It is flexible and can help those who make decisions to better understand what stands to be gained or lost by continued inaction.

Lessons Learned



Enabling environment

An enabling environment is critical to facilitate the implementation of decisions made as a result of this valuation study. The EMA has acknowledged that there are sources of water pollution which should be within the permitting process that have not been registered (Peters and Joseph 2015). Enforcement of the CEC and Water Pollution Rules has to be improved. Peters and Joseph found that the facilities with WPR permits would not have complied voluntarily with the Rules if they were not legislated. However, there is evidence to suggest that the implementation of the WPR has increased the level of awareness of water-related environmental issues among the staff of the EMA, the facilities being monitored and by the general public – leading to an improvement in the culture with respect to water pollution.

A participatory approach

The project clearly demonstrated the participatory nature of the process. From the beginning of the project a wide range of stakeholders were engaged in project planning and implementation. As discussed above, key elements were: a steering committee, introductory workshops to guide the studies and follow-up workshops to discuss the preliminary results. This approach resulted in ownership of the process by local stakeholders. Other benefits included: increased understanding by national stakeholders of the importance of resource valuation (as well as how to conduct such a valuation), use of the most up-to-date local information on current and planned wastewater management initiatives; a focus on locally-important issues; and verification of analysis results.

Data collection and monitoring systems

Programmes that require mandatory data collection and reporting of wastewater-related data will improve future valuation studies and all wastewater management initiatives. These data include discharge/effluent parameters, water quality parameters of both freshwater and coastal receiving bodies.

Challenges and Opportunities for Continuity/Sustainability and Replicability

Challenges

Commitment by decision makers

The main challenge within Trinidad and Tobago will be to convince policy and decision makers to make investment decisions for Chaguanas and the Buccoo Reef / Bon Accord area as well as to make the case to employ this resource valuation approach for investment in wastewater initiatives in other areas of the country. This will involve sharing the study results with these key stakeholders in a way that will make a compelling argument for investment. This also applies to other countries where valuation studies are conducted.

Opportunities

There are many opportunities to ensure that the valuation methodology will lead to informed decision making.

Sharing Results and Lessons Learned

Even though the study was conducted in only two countries, the ultimate aim was to look at implications for the entire Wider Caribbean Region. The Regional "Resource Valuation Workshop" held in August 2015, in association with the CWWA's Annual Conference and Exhibition, provided a forum to engage all CReW participating countries in learning about the experiences from the development and application of this resource valuation methodology and to discuss how they could use it in their own wastewater management planning. The methodology is designed to be used within a wide range of countries and the workshop enabled countries throughout the region to learn from Trinidad and Tobago's experience and to start applying it in their own national action planning exercises.

Legislative, policy and institutional framework

To facilitate increased investment in wastewater facilities, the Government of Trinidad and Tobago needs to continue to strengthen the legislative and policy framework. For example, to monitor compliance with the Water Pollution Rules, the legislation should be amended to allow the EMA to carry out unannounced visits (Peters and Joseph 2015). This would facilitate the establishment of an auditing mechanism for the current self-monitoring and self-reporting required by the permittees. In addition, the EMA should consider providing appropriate general and limited site-specific, compliance assistance, consistent with the primary purpose of the WPR, as this can motivate more cooperation from polluting enterprises. There have been suggestions for the EMA to set up its own laboratory. This would facilitate the regularization of the monitoring of the pollution parameters by the EMA.

Trinidad and Tobago has a well-established system of freedom of information and the EMA is encouraged to have public disclosure policies that would provide information to communities, consumers and other stakeholders on the environmental performance of individual polluting entities. This can raise the awareness of the general public and bring public pressure on defaulters as it creates a political dynamic that increases formal regulatory pressure on the defaulters.

To improve the management of the sector, Trinidad and Tobago can use the Wastewater Management Policy toolkit developed under CReW Component 2. The toolkit is a practical reference guide and will assist wastewater managers, chief technocrats and senior policy officers to improve capacity in developing and implementing wastewater management policies.

There is need also to create and update important codes of practice to guide wastewater practitioners. For example, the national standard, "Code of Practice for the Design and Construction of Septic Tanks and Associated Secondary Treatment and Disposal Systems" should be reviewed to incorporate more effective septic tank designs and use of drainfields instead of soakaways to minimize impact to groundwater (Williams n.d.).

Expansion to other sectors

The focus on domestic wastewater should be expanded to include industrial effluent as well (V. Ramkhalawan, personal communication, July 2016). In Trinidad, this would include the oil and gas companies and in Tobago the main focus would be the hotel and tourism sector (present also in Trinidad). The private sector would need to be involved to a greater extent since they are the primary emitters of industrial wastes which have to be dealt with separately, outside of municipal wastewater systems

"I want wastewater to become a resource rather than a burden, a world where the perception of wastewater has changed 180 degrees toward the good. A world where wastewater is not called wastewater anymore because it has become a source of incomes for the community rather than a focus of diseases."

***-** Alfredo Coello Vazquez, GEF CReW Project Coordinator*

(CREW June 2015)

Wastewater as a resource

There is an economic opportunity for Trinidad and Tobago to focus on wastewater as a resource. The use of treated wastewater effluent is a new paradigm within the country. Through WASA, the Government is seeking to incorporate treated wastewater effluent, as part of the Integrated Water Resources Management (IWRM) concept in providing a sustainable source of water. This concept has greater relevance due to increased urbanization, population density; increased industrialization and the lack

of fresh water resources, particularly within the central and southwestern parts of the country. This is further compounded by inadequate maintenance practices for the network and distribution system, leading to transmission and distribution losses (WASA 2015).

The operations at the Beetham Wastewater Treatment facility represents the signature initiative in Trinidad and Tobago and the wider English-speaking Caribbean, focusing on water reclamation for intended water reuse by other demand sectors. The plant employs some of the leading technologies such as reverse osmosis followed by ultra violet disinfection which has been proven to be an effective and an environmentally friendly treatment having higher virus inaction, with no toxic by-products, in meeting the effluent quality standards. This plant is designed to meet effluent quality standards established by the EMA. It is envisaged that with the development of these centralized wastewater systems, wastewater reclamation and reuse can be expanded to present a viable alternative for the development of water supplies nationally and present significant business opportunities for WASA. There is also the opportunity for new business development for the Authority through commercial transfers of reclaimed water to the industrial, agricultural and commercial sectors.

The construction of several other projects are being planned to make the use of reclaimed water a reality in Trinidad and Tobago. In cases where water resources are limited, the potential benefits of recycling reclaimed water outweighs the disadvantages. However important questions remain about the levels of treatment, monitoring and testing needed to ensure the safety of recycling 'reclaimed water".

A viable and transferable methodology for resource valuation

As noted above, this valuation methodology is meant to persuade / motivate decision makers by making a business case for investment in wastewater management infrastructure and supporting policies – not only in Trinidad and Tobago but in countries throughout the region. The detailed guidance documents provide a template for conducting similar valuation studies in each WCR country and the project also provided a template for the process to increase the impact and effectiveness of the study results.

"The benefit to Trinidad, in the long run it will do two things for us – it will assist us in investment decisions not just in the area of wastewater management but also in other areas where we need to do resource valuation; and it will also assist in encouraging us to collect more data and to understand the need for more data collection."

- Hayden Romano, General Manager for Technical Services, Environmental Management Authority

References

Bradford, Elizabeth J., Aaron Hutchins, Elizabeth C. Smith and Jonathon Weier. n.d. Making the Case for Increasing Public and Private Investments in Wastewater Treatment: The Importance of Integrating Effects on Natural Capital

Burke, L., Prager, D., Cooper, E., Greenhalgh, S., 2008. Coastal capital: Economic valuation of coral reefs in Tobago and Saint Lucia. World Resources Institute. Washington, DC.

Caribbean Community (CARICOM) Secretariat. 2009. National Census Report Trinidad and Tobago 2000. The Regional Statistics Sub-Programme.

Caribbean Regional Fund for Wastewater Management (CReW). CReW's Lines. Newsletter of the Caribbean Regional Fund for Wastewater Management. Various issues: Volume 1 Issue 1. June 2012 – Volume 5 Issue 1. March 2016.

_____. 2015. The Value of Action - GEF CReW and Economic Resource Valuation. Documentary.

_____. 2014. Charting a New Course for Wastewater Management in the Wider Caribbean Region: GEF CReW's Journey.

_____. 2010. Regional Sectoral Overview of Wastewater Management in the Wider Caribbean Region.

_____. n.d. Wastewater Series: Fact Sheet # 2 Wastewater and Human Health

Government of the Republic of Trinidad and Tobago. 2009. National Environmental Policy.

Gray, Erin, Lauretta Burke, L. Jasmine Lambert, Juan Carlos Altamirano, and Whitney Mehrhof. 2015. Valuing the Costs and Benefits of Improved Wastewater Management: An Economic Valuation Resource Guide for the Wider Caribbean Region. World Resources Institute, United Nations Environment Programme - Caribbean Environment Programme, Global Environment Facility Caribbean Regional Fund for Wastewater Management

Inter-American Development Bank. 2011. Trinidad & Tobago Wastewater Infrastructure Rehabilitation Program (TT-L1018): Orphan WWTPs in the Maloney Sewerage Region. Environmental and Social Analysis and Environmental and Social Management Plan

Janson. 2014. "Review of the Access to, Availability of, and Organizational Readiness for Uptake of Funding for the Wastewater Sector in Selected Participating Countries: Final Report." Caribbean Regional Coordinating Unit.

PCG. 2012. GEF-CReW Inception Report

Peters, Everson J. and Vivian Joseph. 2015. An Evaluation of the Compliance of the Water Pollution Control Rules in Port of Spain, Trinidad.

United Nations Environment Programme. 2014. Mid-Term Evaluation. GEF Funded Project "Testing a Prototype Caribbean Regional Fund for Wastewater Management" (GEF CReW)

Waite, R., L. Burke, E. Gray. Coastal Capital: Economic Valuation for Decision-making in the Caribbean. Washington, DC: World Resources Institute. 2014.

Water and Sewerage Authority. 2015. In the Know with H_2O. WASA 50 Years and Beyond.

_____ 2007. Business Plan 2007-2011.

Williams, Wayne O. n.d. Sustainable Wastewater Management in Trinidad and Tobago

Caribbean Regional Fund for Wastewater Management Project (GEF CReW)
6th Floor, Dyoll Building, Inter-American Development Bank
40-46 Knutsford Boulevard
Kingston 5, Jamaica, W.I.

Phone: (876) 764-0815
E-mail: crew@iadb.org
Website: www.gefcrew.org
@gef-crew
GEF-CReW-Project