WASTEWATER MANAGEMENT PLATFORMS FOR THE WIDER CARIBBEAN REGION

A SITUATION ANALYSIS

UN environment

United Nations Environment Programme

CARIBBEAN ENVIRONMENT PROGRAMME

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Introduction

Effective management of wastewater in the Wider Caribbean Region (WCR) is a significant challenge faced by the region. Currently in the Caribbean, approximately 85 per cent of untreated waste-water is discharged into seas, rivers and bays.

This wastewater comes from oil refineries, sugar factories, domestic sewage, food and beverage processing and manufacturing operations. These land-based sources of pollution from municipal, industrial and agricultural sectors and their negative impacts on marine resources are a significant threat to the region's development and the quality of life of its people.

This report presents a situation analysis of elements that could constitute a wastewater management database platform for the Wider Caribbean Region. This platform should address the following:

- Storage of basic data related to water, wastewater production and sanitation services
- Storage of data related to wastewater management such as:
  - Effluent standards
  - Wastewater treatment plants
  - Operation of wastewater treatment plants
  - Wastewater laws, regulations and permits
- Display and interpretation protocols
- Data collection and update protocols

Examples of components range from global databases collated by international organizations, with data for all countries to regional, national and sub-national data platforms.

Global Water and Wastewater Databases

There are a small number of databases that contain information related to water, wastewater and sanitation for all countries throughout the world. Six key examples are described below.

World Health Organization

The WHO and UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) keep a database containing water supply and sanitation coverage estimates as well as all the data from household surveys which were considered for these estimates. Country reports are available, which provide data on estimates on the use of water sources and sanitation facilities during the period 1980 – 2015. The online database allows the user to create dynamic maps, graphs and tables. Figure 1 displays a map showing improved sanitation in countries in the Wider Caribbean Region.
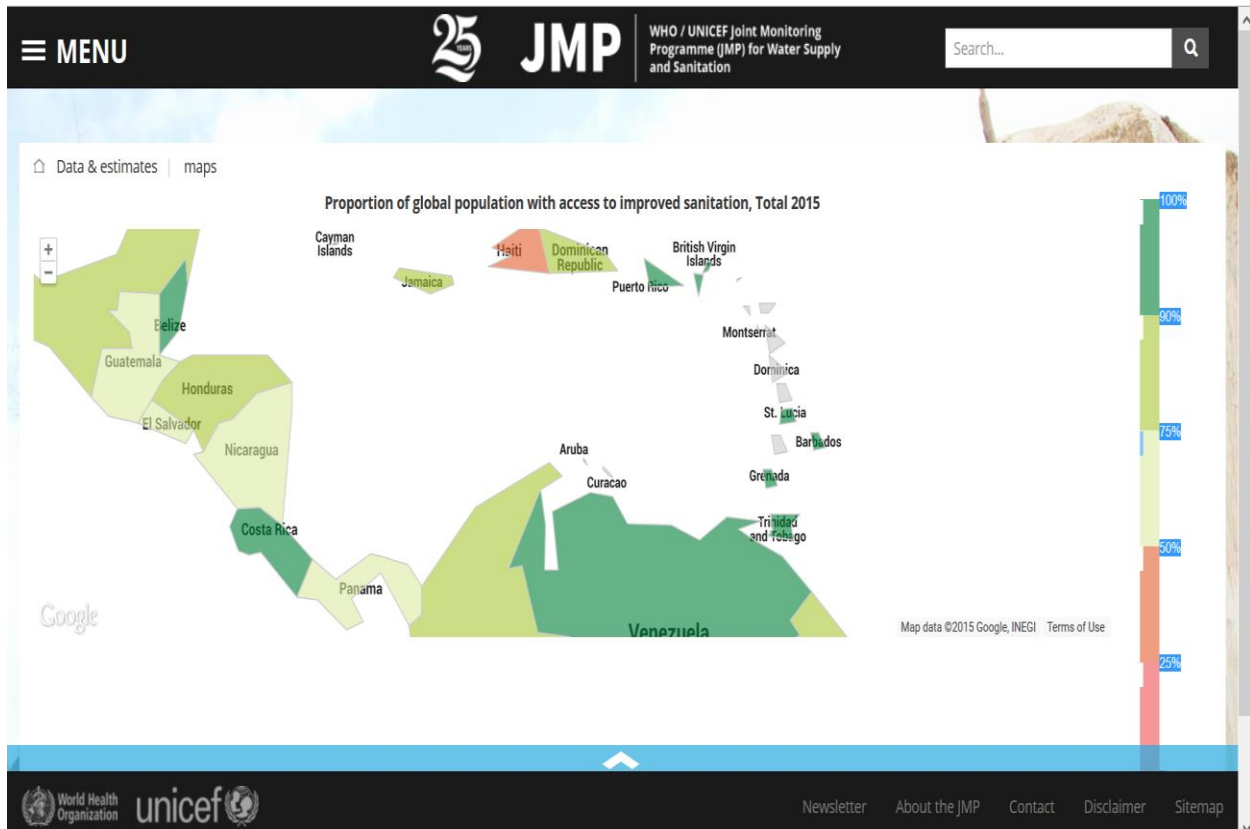
*Figure 1: Improved Sanitation – from the JMP Database*

The Water Law and Standards database is a joint project of WHO and the United Nations Food and Agriculture Organization (FAO). The database of national water legislation is ready for use and is linked to FAO's existing FAOLEX database of legislation on natural resources. It provides information on whether there is a basic water law in the country; what kinds of water it covers; who owns water; who is authorized to use water and how; whether and how pollution is controlled; and the nature of the government's administrative structure for water resources management. The database of national water quality standards is under construction.

AQUASTAT

AQUASTAT, operational since 1993, is FAO's global information system on water and agriculture, It collects, analyses and disseminates data and information by country and by region. Its aim is to provide users interested in global, regional and national analysis, such as policymakers, decision makers and researchers, with comprehensive information related to water resources, water use and agricultural water management across the world.

Originally, AQUASTAT did not have a wastewater section *per se* in the country profiles, with some related information – if available – in the "Water resources" or "Water use" section of the profile. A new thematic section dedicated to municipal wastewater was added to AQUASTAT, in partnership with IWMI and the CGIAR Research Program on Water, Land and Ecosystems. It was developed to provide the best available national-level data on municipal wastewater

production, collection, treatment, discharge or direct use in agriculture (Mateo-Sagasta and Salian, 2012). It reflects the need for data on how much municipal wastewater is potentially available or actually used for productive purposes, recognizing that wastewater is a source of water all the year round, rich in nutrients and, if safely used, can be a highly productive resource. Figure 2 shows the data provided within the municipal wastewater theme.
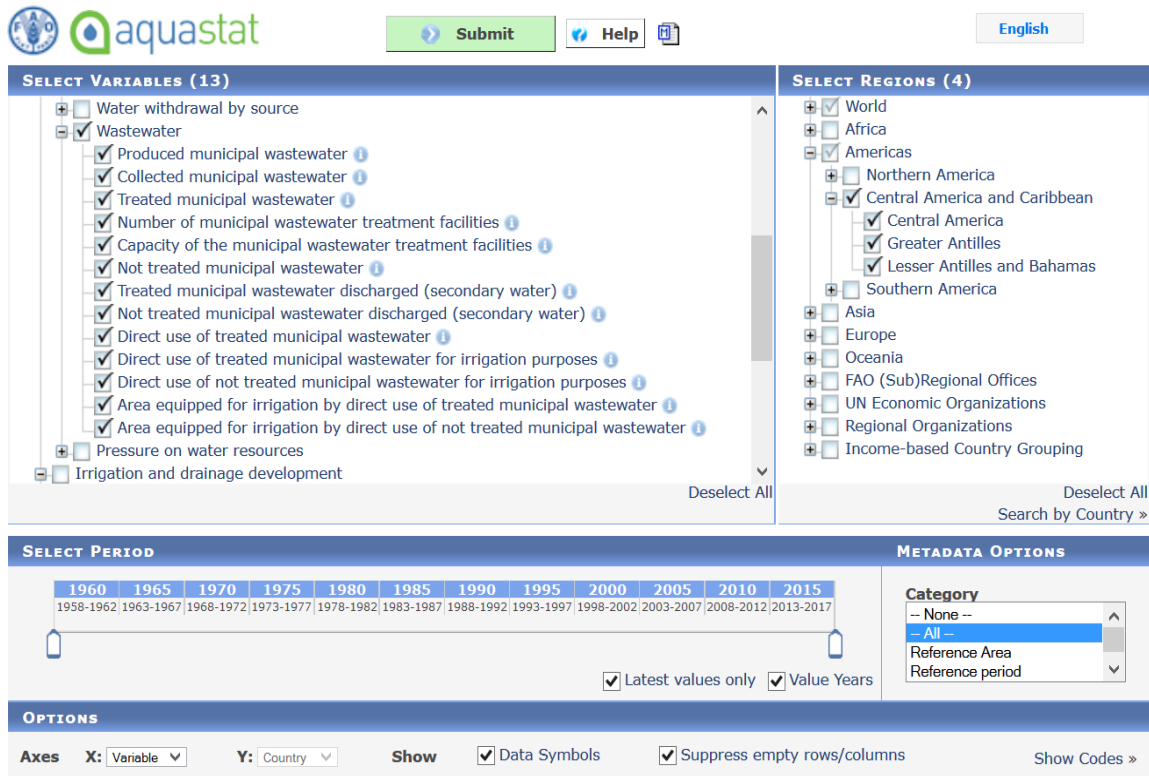
Figure 2: Data provided for municipal wastewater theme in AQUASTAT

In comparison to other existing wastewater and sanitation databases that focus on a percentage of sanitation coverage or pollution loads, AQUASTAT focuses on the volume of municipal wastewater. This is to facilitate the integration of these data into the existing water resource and water use accounts in the different countries.

Figure 3 illustrates the flow of wastewater from production to use. The variables squared in blue of that diagram are available by opening the wastewater category in the AQUASTAT main country database.
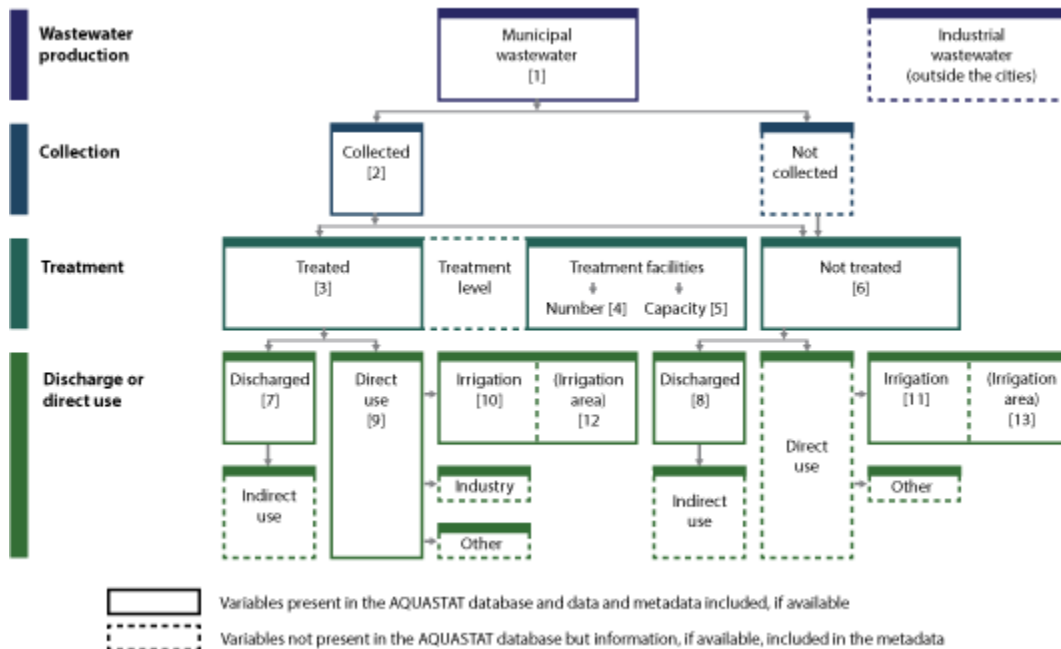
Figure 3: Flow of wastewater from production to use

AQUASTAT data collection takes place through review of country briefs and national reports, databases, technical reports, peer-reviewed publications, information provided by national experts, presentations from national authorities in seminars, internet search, etc. Since data is derived from many different sources, inconsistencies may occur over the course of time. Therefore, each time new data becomes available, a detailed review and validation of all data is conducted, using both newly obtained data and what is already available in the database.

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UN Atlas of the Oceans

The UN Atlas of the Oceans is an Internet portal that provides information relevant to the sustainable development of the oceans. It is designed for policy makers, scientists, students, resource managers and ocean industry. The development of the Atlas began in November 1999 by UN agencies and supports Chapter 17 of Agenda 21, the blueprint for the sustainable development of oceans adopted at the 1992 Earth Summit in Rio de Janeiro.

The Atlas provides four main entry points to access information:
- ABOUT (the oceans) - history, biology, maps and statistics, research, climatology and ecology
- USES (of the oceans) - fishing, shipping, mining, tourism, dumping and marine biotechnology
- ISSUES - food security, climate change, governance, human health
- GEOGRAPHY - information categorized by geographical area

Information related to uses of the oceans includes, among other issues, disposal of waste from land (including sewage, non-point sources, carbon dioxide sink); human settlements on the coast; and ocean dumping and ship wastes (including dredging of ports, voluntary dumping, disused oil platforms, discharges from cargo and passenger ships, nuclear waste disposal). Each topic includes background information, the role of UN-Oceans agencies, legal and policy frameworks, institutions, research needs, and an assessment of what the future holds.
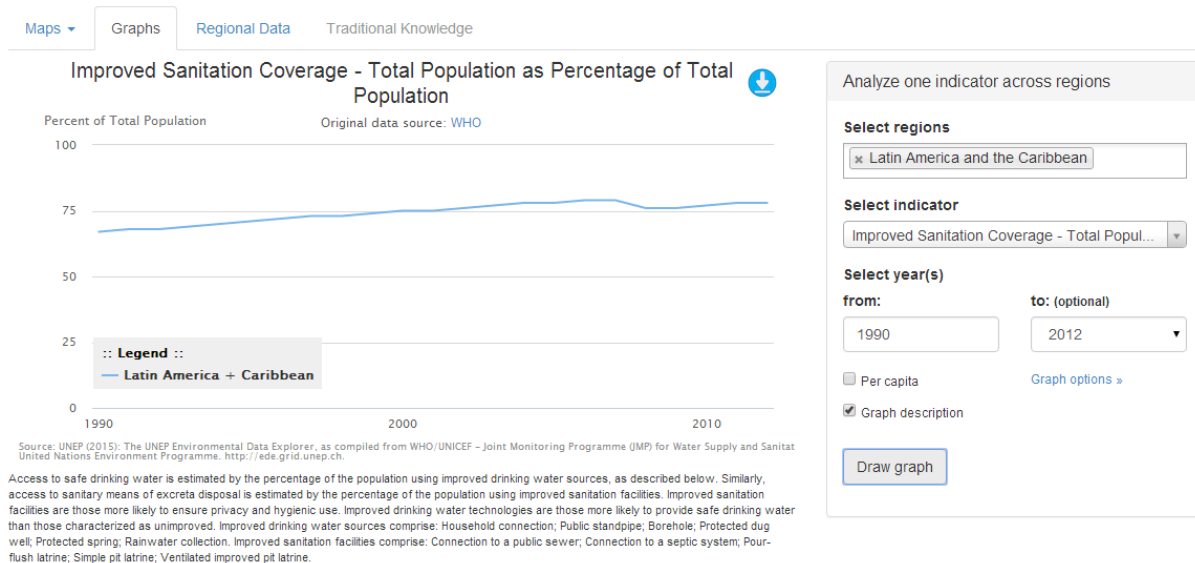
UNEP Live:

The UNEP Live platform was launched in January 2014 by UNEP to make environmental data from national and regional reporting available to everyone. Furthermore, the site aims at facilitating the exchange and sharing of latest data, information, assessments and knowledge amongst member countries, research networks, communities of practice and society in order to keep the environment and emerging issues under review.

The platform is primarily aimed at government ministries who collect and use data for reporting, government ministries who monitor the state and trends of the environment, the United Nations system, policy-makers who want to know the state and trends of the environment, assessment practitioners and major groups and stakeholders interested in environmental information. The data can be accessed either by country or region, by selecting a specific theme or by selecting a strategic development goal (SDG).

No specific wastewater data exists for the Latin America region and the Caribbean, however, several data sets cover wastewater related topics, such as: water footprints, drinking water, access to sanitation and industrial/municipal/agricultural water use. Figure 4 shows 'Improved Sanitation Coverage – Total Population as Percentage of Total Population' for the Caribbean region.

Figure 4: Data provided for Improved Sanitation Coverage in UNEP Live

The data for Figure 4 covers a timescale of 22 years; however, for other categories data for the Caribbean region is only available for one year. For example, this is the case for the category 'water footprint of domestic water consumption', as data for this category is only available for 1996.

As previously mentioned, individual country data can also be accessed on the UNEP Live website. Nevertheless, overall major data gaps exist for water related categories for Caribbean countries.

UNEP GPA - the Global Wastewater Initiative

The Global Program of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was created in 1995 by UNEP. It resulted in the establishment of the Global Wastewater Initiative (GW^{2}I) in 2013, which today represents one of the GPA's focus areas.

The GW^{2}I was developed to alter world water politics, by reducing further pollution and furthermore, by emphasizing that wastewater is a valuable resource for future water security. It represents a global multiple stakeholder platform that consists of several UN agencies, international organizations, governments, scientists and private sectors, in addition to major stakeholders. The GW^{2}I aims at supporting the creation of partnerships to initiate comprehensive, effective and sustained programs that invest into WW management.

The GW^{2}I is a voluntary network of stakeholders and is represented by an international Steering Committee and a Secretariat, which is administered by the UNEP/GPA. The work is separated into thematic issues and covers different aspects of wastewater challenges but also potentialities, such as wastewater reuse, nutrient removal, biogas production, etc.

The main focus of the GW^{2}I covers the following areas:

- Building a strong network of partners, and enhance the collection and dissemination of information;
- Contributing to Global challenges and debates on wastewater issues, by activities such as research into community wastewater perceptions, contribution to policy briefs on wastewater, dissemination of information on good wastewater management practices etc.;
- Strengthening of the scientific basis for managing and monitoring the impacts of wastewater on the coastal and marine environment, especially in relation to evaluating ecosystem services affected by wastewater management;
- Contributing to the implementation of demonstration projects on wastewater treatment technologies;
- Support communication and outreach to raise awareness for wastewater challenges and opportunities.

Environmental Performance Index - wastewater treatment indicator

The Environmental Performance Index was developed by Yale University in 2014. As part of this assessment a wastewater treatment indicator was developed, which was calculated for most countries and resulted in a global database to measure country performance on wastewater treatment. The index was calculated based on data from country-specific findings as well as reports from the United Nations and other agencies.

Yale University states itself, that the data for the calculation of the wastewater treatment indicator was limited and variable across the globe. Therefore the University created an interactive map showing the wastewater treatment performance of the calculated countries. This map is open to assessment for external experts. National or scientific experts may give their comments and feedback on the calculated data. The Yale University hopes that through the submitted feedback current gaps can be filled and problems solved, which will lead to an improved the overall assessment.

Figure 5 shows the map for the wider Caribbean region. The color shades indicate the percentage of wastewater treated, whereas lighter colors indicate a higher treatment percentage and darker colors a lower treatment percentage. On the sidebar to the right one can see the country information for Jamaica: the percentage of wastewater that receives at least primary treatment (orange), the percentage of the population connected (green) and each country's final wastewater treatment score (the product of these two percentages) (blue).
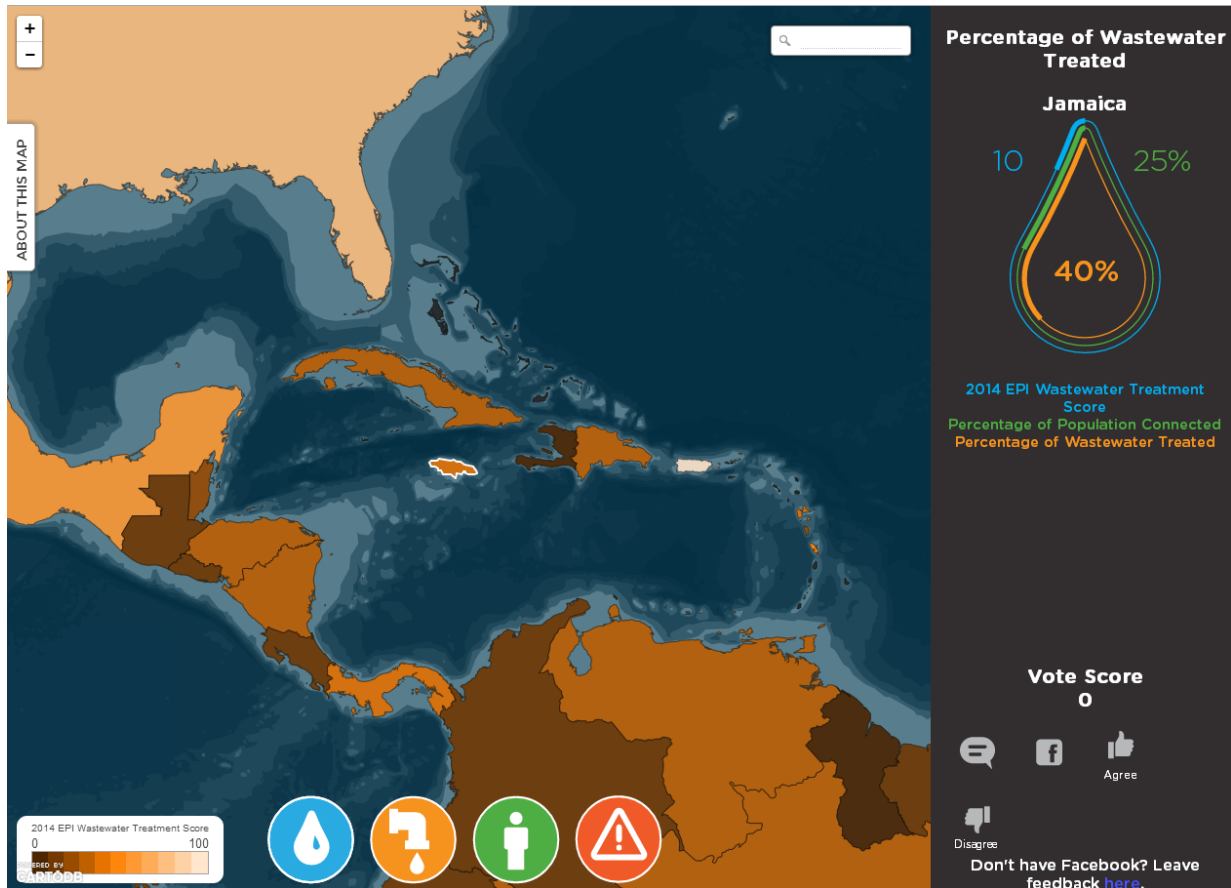
Figure 5: Data provided for the wastewater treatment indicator for the Caribbean region and specifically Jamaica, provided by the Yale University

The Yale University also included a tool which highlights countries for which improved data is urgently needed to calculate the wastewater treatment indicator. Figure 6 shows these countries in the Caribbean region. Countries which require more data are colored in red. It can be seen that several countries in the Caribbean need improved data. On the right hand side one can see the country information for Dominica, which has been highlighted on the map as a country that requires more data.
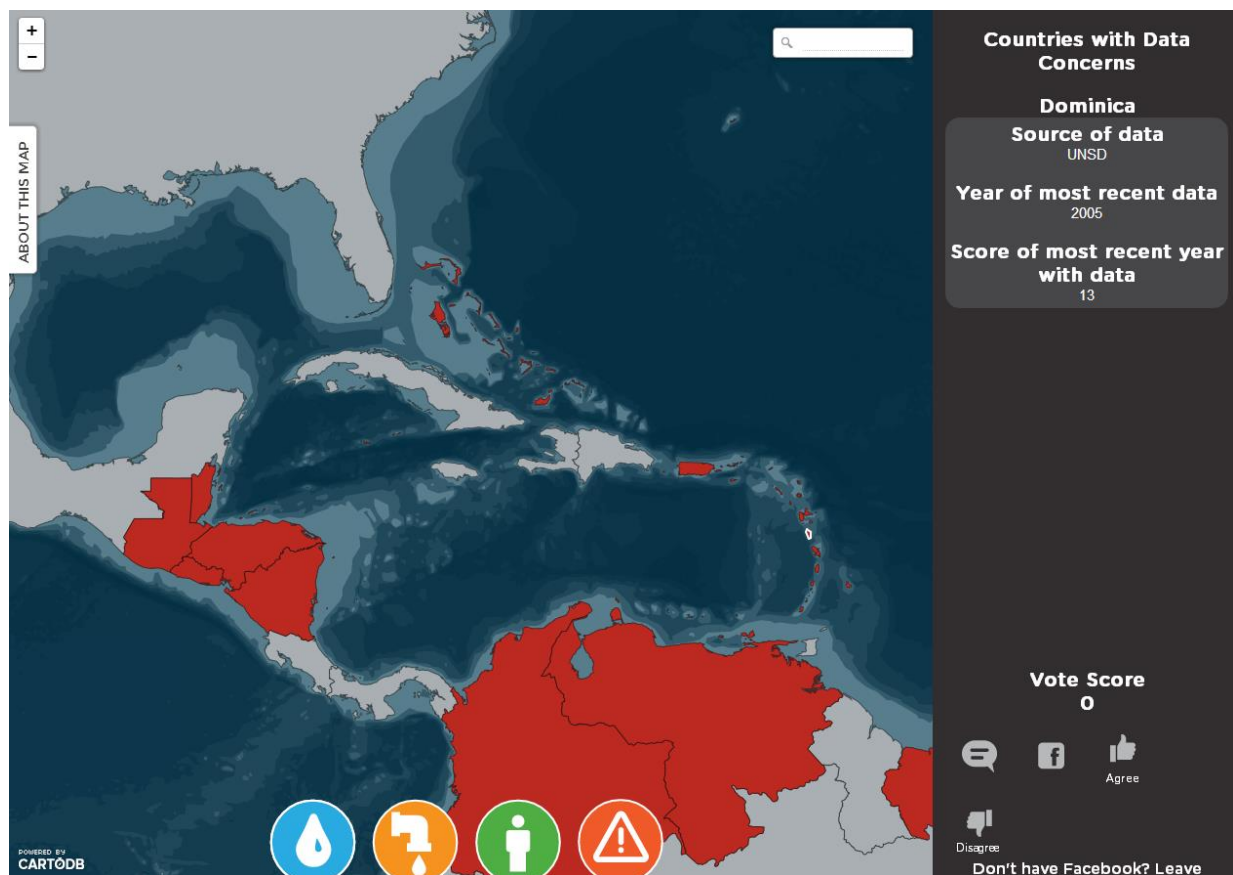
Figure 6: Caribbean region map showing countries for which data on wastewater treatment must be improved to allow an improved assessment of the wastewater treatment indicator, provided by the Yale University

Data Interpretation

There are vast amounts of data regarding water, wastewater and sanitation as well as other related issues such as human health, coral reef health, general pollution and other environmental topics – available in international and national databases and reports. A great challenge is to interpret these data, especially for the non-technical and non-scientific community. An example of a service to collate and present environmental data is described below.

GRID-Arendal

GRID-Arendal considers itself to be a non-profit foundation with a public mission. It was established to support the UN in the field of environment, mainly through the UN Environment Programme (UNEP), to create environmental knowledge enabling positive change. This is achieved by organizing and transforming available environmental data into credible, science-based information products, delivered through innovative communication tools and capacity-building services targeting relevant stakeholders.

In 2015 GRID-Arendal is implementing a programme to enhance the capability of developing countries to undertake their own, independent, State of the Marine Environment assessments using an internationally recognized, Expert Elicitation methodology.

The GRID-Arendal Maps & Graphics Library is an ongoing project to collect and catalogue all graphic products that have been prepared for publications and websites from the last 15 years in a wide range of themes related to environment and sustainable development. There are currently 3,088 graphics available in the database.

Figure 7 shows an example of a map presenting expected climate change impacts in Latin America and the Caribbean from this library. When additional data is available regarding wastewater management, services such as this will be able to provide interpretive products to assist decision and policy makers, researchers and the general public.

Expected impacts of climate change in 2050

Legend:

- ○ Increased vulnerability to extreme events
- Biodiversity threatened
- Coral reefs and mangroves threatened
- |||||| Risk of desertification

Malaria
- □ Current affected zones
- Possible extension in 2050

Rainfall
- //// Increase
- //// Decrease

- Coasts threatened by sea level rise
- ○ Cities threatened by sea level rise
- Reduced water availability
- ✴ Negative effects on fisheries
- ✴ Negative effects on agriculture
- ☼ Glacier shrinkage
- ✴ Increased risk of forest fires
- △ Increased aridity and scarcity of water resources
- ▲ Changes in ecosystems
- ▲ Negative impacts in mountain regions
- ▲ Ozone depletion

Sources: R. Landa et al., Cambio climático y desarrollo sustentable, 2010; ECLAC, Climate Change. A regional perspective, 2010.

Figure 7: Map Showing Climate Change Impacts in Latin American and the Caribbean from GRID-Arendal

Data Collection and Updating

As GRID-Arendal shows, data interpretation is only as good as the data that is available. This is a concern in all global databases, which generally depend on statistics and information collected by national organizations. Consequently, there is great variability in the quality and quantity of data available for countries throughout the world. More developed countries with more resources generally have a higher quantity and quality of data available. Crowdsourcing is an

innovative, new approach that is being examined for gathering current and widespread environmental data.

Crowdsourcing

The Environmental Performance Index (EPI) is a measure of a country's environmental performance constructed through the calculation and aggregation of 20 indicators reflecting national-level environmental data related to environmental health and ecosystem vitality. However, global data is lacking on a number of key environmental issues, which means that the EPI is somewhat based on inaccurate or missing data. The creators of the EPI – based at the Yale Center for Environmental Law and Policy – have proposed the use of crowdsourcing to supplement the environmental datasets that the EPI uses (Hsu and Schwartz, 2013). This would also improve the data available to any decision maker or researcher.

Crowdsourcing would mean obtaining environmental data by soliciting contributions from a large group of people, especially from online communities. This is already successful in other sectors, such as financial services. Crowdsourcing applications like Danger map – a crowd-sourced environmental pollution map making ripples in China – are increasingly popular tools for creating information which did not previously exist. Danger Maps, a website started in 2012, allows people to look up sites such as toxic-waste treatment facilities, oil refineries and power plants. The website owner has plotted about 6,000 pollution sources based on government data and user input on Baidu Map, China's equivalent of Google Maps. This information, previously held only within government agencies, is now available to any interested party. There are many other inexpensive tools to enable crowd-sourced data collection in an increasingly "wired" world.

The World Resources Institute has teamed with the Center for Global Development to aggregate vast amounts of satellite data on forest cover, developing algorithms that will detect when deforestation might be happening in any part of the world. If those algorithms and data are wrong, the Global Forest Watch 2.0 platform allows users to contribute their own observations. The US National Ecological Observatory Network (NEON), is aggregating and designing communicative platforms for the information already available about climate change, land use change, and invasive species impacts. They are doing it in such a way that makes their resources open and receptive to new information as it comes in. This approach could be utilized to gather data related to wastewater and sanitation.

Wastewater Discharges

Domestic sewage is a significant contributor to marine pollution in the Wider Caribbean Region. It originates mostly from households, public sanitation facilities and businesses. For wastes from communities where most homes and businesses have piped water, typical pollutant composition of domestic sewage is shown in Table 1(CEP 1998).

Table 1: composition of domestic sewage in the Wider Caribbean Region

Parameter	Value
Total Suspended Solids (TSS)	200-300 mg/ L
5-day Biochemical Oxidation Demand (BOD)	200-250 mg/ L
Chemical Oxidation Demand (COD)	350-450 mg/ L
Total Nitrogen as N	25-60 mg/ L
Total Phosphorus as P	5-10 mg/ L
Oil and Grease	80-120 mg/ L

In unsewered areas, septic tanks are common. Septage, from these tanks, must be removed every few years to ensure effective operation of the system. Typical pollutant composition of septage taken to wastewater treatment facilities is shown in Table 2.

Table 2: composition of domestic sewage in the Wider Caribbean Region

Parameter	Value
Total Suspended Solids (TSS)	10,000-25,000 mg/ L
5-day Biochemical Oxidation Demand (BOD)	3,000-5,000 mg/ L
Chemical Oxidation Demand (COD)	25,000-40,000 mg/ L
Total Nitrogen as N	200-700 mg/ L
Total Phosphorus as P	100-300 mg/ L
Oil and Grease	2500-7500 mg/ L

These values can be compared with the effluent standards presented in the next section.

Industrial wastewater has a wide range of pollutant concentrations and wastewater from different industries are characterized as follows:
- Oil refineries (70 per cent of the entire BOD load in the Caribbean): high in BOD, dissolved salts, odour, phenol, and sulphur compounds
- Food processing industries, distilleries, and soft drink industries (5 per cent of the BOD load in the Caribbean): very high BOD concentration, suspended solids, dissolved solids, variable pH, and a high level of organic matter
- Chemical industries (1 per cent of the entire BOD load in the WCR) A: low BOD strength, frequently toxic to aquatic organisms at very low concentrations. Pesticides and insecticides used for agriculture are the primary chemical wastes in the Caribbean. These wastes are high in organic matter and are toxic to bacteria and fish.

Figure 8 dramatically shows the discharges near a town, potentially leading to a eutrophic area or "dead zone" where the marine ecosystem is severely affected. While there are numerous

images of similar heavy discharge areas, a tool to display actual discharges and water quality parameters (and in comparison with local effluent standards) would benefit decision and policy makers and would help to prioritize specific geographic areas to reduce the level of riverine and marine pollution.
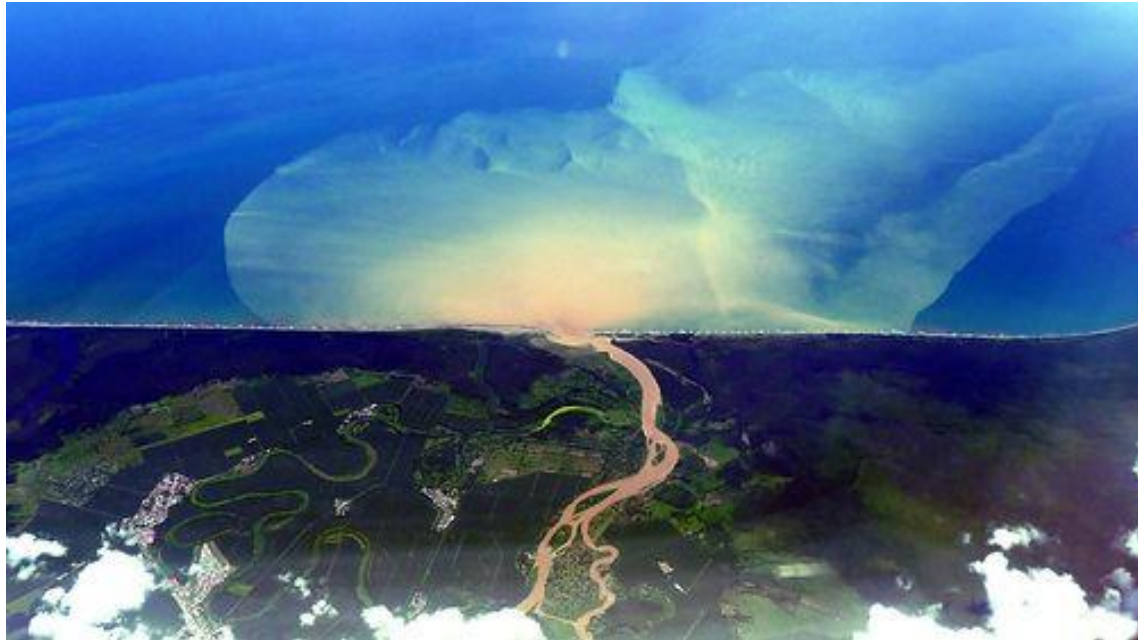
Figure 8: A river on the Meso-American coast discharges sediment and nutrient-laden water to the Caribbean Sea. Photo credit: Malik Naumann | Marine Photoban

Wastewater Effluent Standards

Meeting effluent standards has been recognized as a critical part of wastewater management. The UN has proposed that an indicator on wastewater treatment be added to the post-2015 monitoring framework – measure movement toward the Sustainable Development Goal #6: Ensure availability and sustainable management of water and sanitation for all. The proposed indicator is: "Percentage of wastewater flows treated to national standards, by domestic and industrial source" (SDSN 2014). This recognizes that it is not sufficient to provide sanitation services to populations (although this, of course, is important – and is measured by another SDG indicator, "Percentage of population using safely managed sanitation services – urban/rural").

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. The effluent limits for domestic wastewater in the LBS Protocol are shown in Table 3.

Table 3: Domestic Wastewater Effluent Limits in the LBS Protocol

Parameter	Class 1 Waters[1]		Class 2 Waters[2]
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 *E. coli. or* enterococci	Faecal coliform: 200 mpn/100ml E. coli: 126 organisms/100ml Enterococci: 35 org./100ml		Not applicable
Floatables	Not visible	Not visible	
Source: CEP			

*does not include algae from treatment ponds

A baseline assessment study on wastewater management in six WCR countries revealed that these countries have developed – to some degree – laws and regulations governing collection, management, treatment and disposal of sewage and wastewater (into both inland waters and the marine environment), as well as protection of water resources from pollution. Some countries (for example Costa Rica) have specific regulations governing management of sludge from septic tanks, reuse of wastewater. Most also have regulations that specify and aim to enforce compliance with sewage effluent standards. It is likely that other countries in the WCR are similar to these six.

CReW aims to facilitate the revision or development of such standards that are in agreement with the standards specified in the LBS Protocol (shown in Table 3). Indeed, Jamaica's standards for sewage and trade effluent quality equal or exceed (i.e. are more stringent than) the standards in the LBS Protocol for discharges into Class I waters (see Table 4).

**Table 4: Comparison of Effluent Standards for Jamaica and LPS Protocol**

Parameter	NRCA Standard for Pre-1997 Facilities	NRCA Standard for Post-1997 Facilities	LBS Protocol Standard for Class I Waters
BOD$_5$	20 mg/L	20 mg/L	30 mg/L
Total suspended solids	30 mg/L	20 mg/L	30 mg/L
Faecal coliform	1,000 MPN/100mL	200 MPN/100mL	200 MPN/100mL

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[1] Class 1 waters are particularly sensitive to impacts from pollution
[2] Class 2 waters are less sensitive

pH	6-9	6-9	5-10

National environmental agencies typically record the performance of industrial facilities, agricultural entities, hotels, as well as wastewater treatment plants with respect to compliance with these standards. However, there are no easily accessible databases that provide this information, which could be used to show compliance with the LBS Protocol, on a regional level. Figure 9 displays shoreline degradation in relationship to coastal population. It would be useful to be able to create maps such as this, showing coastal water quality in relation to factors such as population, provision of sewerage, effluent standards etc.
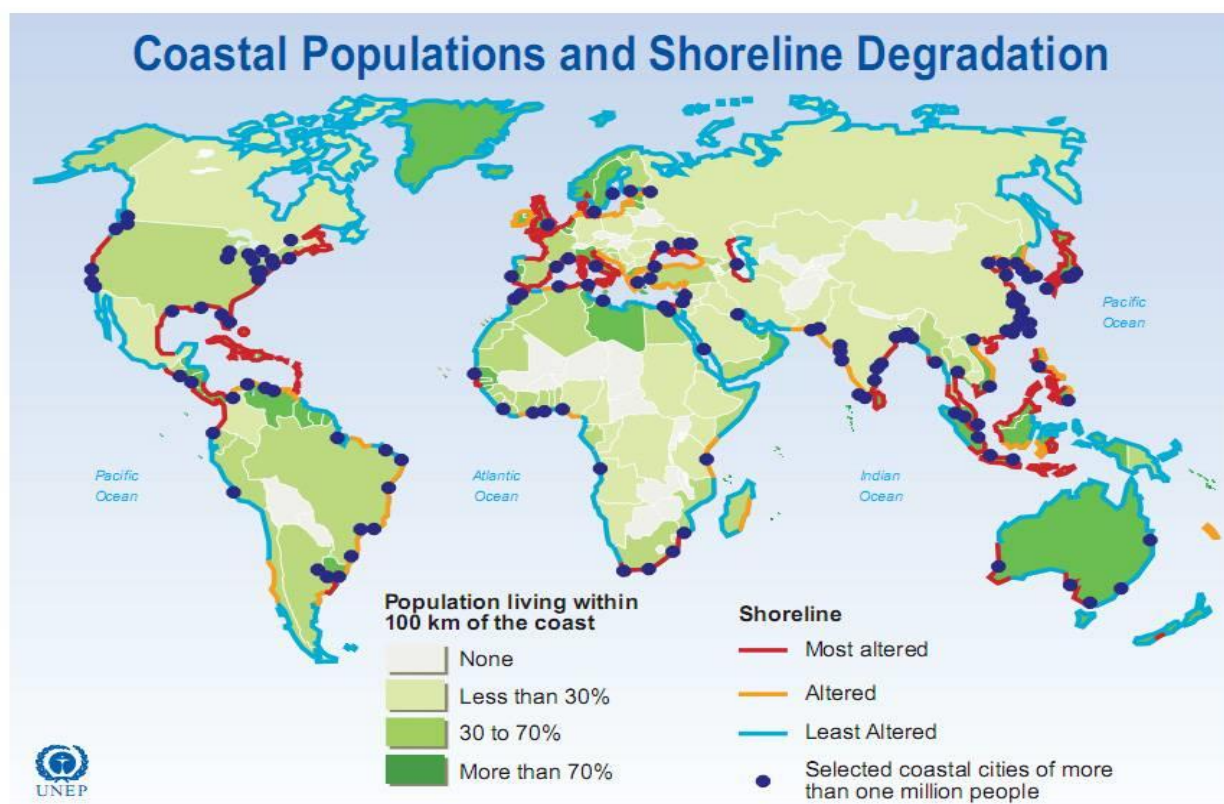
Figure 9: Coastal Populations and Shoreline Degradation
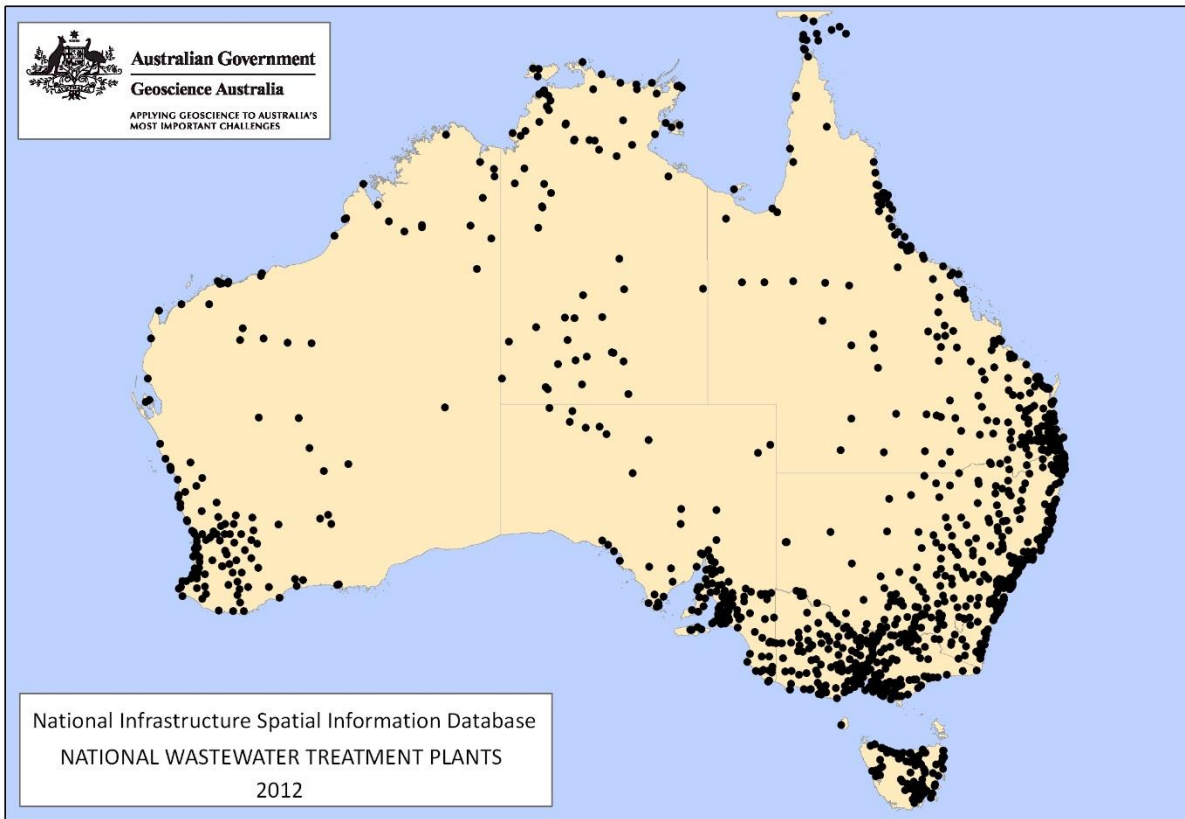
Wastewater Treatment Databases

Australia's National Wastewater Treatment Plants Database

The National Wastewater Treatment Plants Database presents the spatial locations of Australia's known wastewater treatment plants (Figure 10). The purpose of the National

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[3] Available from NEPA website: http://www.nepa.gov.jm/standards/sewage_effluent_standards.pdf
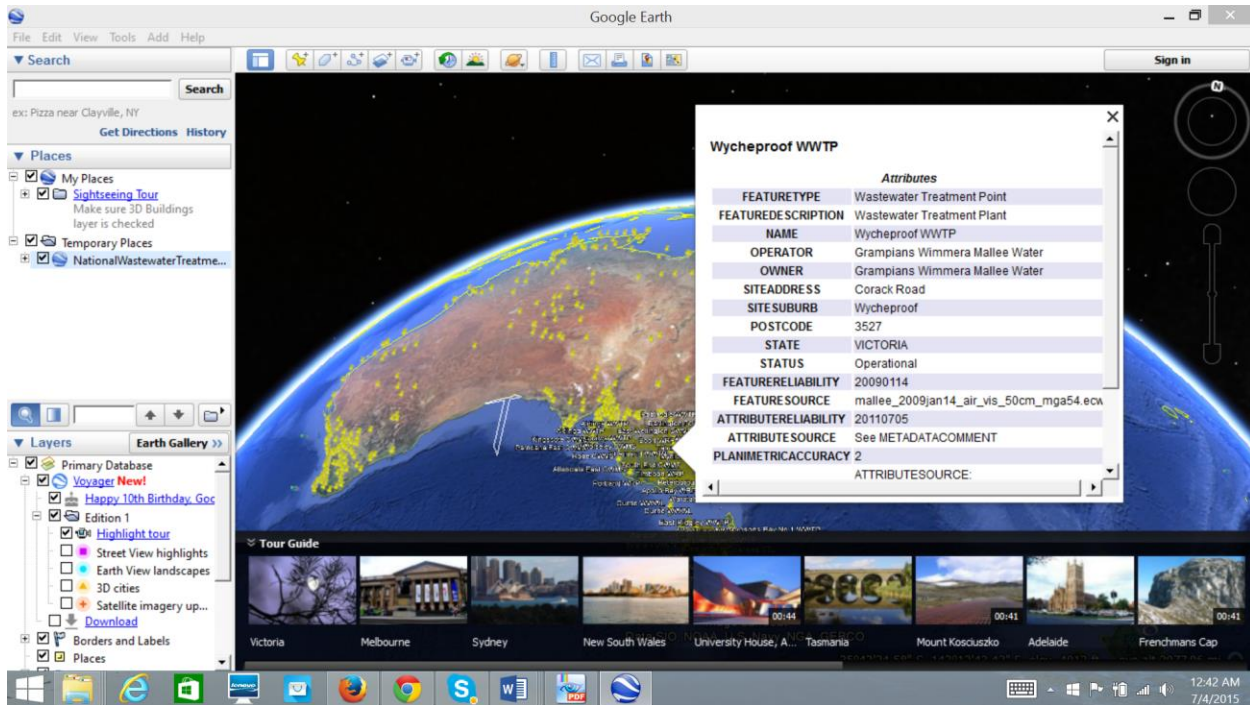
Wastewater Treatment Plants Database is to support decision makers from industry, governments and other interested parties make better, and more informed decisions based on evidence based information.

Figure 10: Locations of Australia's Known Wastewater Treatment Plants

The primary information source used to locate and attribute the wastewater treatment plants was the Water Services Association of Australia (WSAA) for regulated and unregulated sites. Where required, the primary information source was supplemented with publicly available information from state and local government websites and Water Authorities wastewater treatment plant websites. The database is revised every one to five years.

The data is accessible through a pre-defined map – as shown in Figure 10 – or through Google Earth, which allows users to use different scales and viewpoints and to access information about a particular facility by clicking on the image (See Figure 11).

Figure 11: Viewing National Wastewater Treatment Plants Database Using Google Earth

McIlvane Databases on Wastewater Treatment Facilities

The McIlvane Company is a consulting firm that provides information on markets, technical experts and national and regional databases on topics related to a range of facilities including water and wastewater facilities. The databases include information on treatment equipment type, which can be used as a search criterion.

Specific databases include:

- Industrial Water Plants and Projects (USA) – Plant details include sources of emissions equipment that is installed and water discharge information. It also includes addresses and contacts. Current air and water permits are provided.
- Industrial Facilities with Water Discharges (USA) – Provides flowrate, addresses, contact name and phone numbers for 75,000 facilities which discharges water to receiving streams or water bodies. The database can be accessed by industry, company name or state.
- Municipal Wastewater Treatment Facilities and People Database (North America) – Provides details of 20,000 municipal wastewater treatment plants in the USA and Canada with email and phone contacts. Users can search by equipment type e.g centrifuge or odor control and by state or alphabetically by plant name
- Public Water Plants and People (North America) – Provides details of 19,000 municipal drinking water plants in the USA and Canada

These online databases are kept current and are for sale for US$1,600 – US$3,000 per year.

Wastewater Operator Databases

Arizona's Wastewater Certified Operators Database

The Arizona Department of Environmental Quality is the state government entity responsible for protecting and enhancing public health and the environment in the US state of Arizona. The department does this by overseeing the state's environmental laws and authorized federal programs to prevent pollution of the air, water, and land, and to ensure clean-up of such pollution when it occurs.

The Department maintains an online database of Water and Wastewater Certified Operators, active operators to research the status of their expiration dates. Also, it can be used by international or national stakeholders to obtain information on groups of operators, sorting them by type (responsible for water distribution, collection, treatment, or wastewater), grade and city. For example, the database could be used to find all Grade 2 Wastewater Treatment Operators located in Flagstaff.

New England's Wastewater Operator Database

Established by the New England Interstate Water Pollution Control Commission, the New England Wastewater Operator Database allows employers and/or licensed wastewater operators to obtain a recent "snapshot" of the database for approved Massachusetts wastewater Operators. The online database may search based on Last Name, Home State, Town, or by Status/Grade. It displays operator information, including whether the certification is for municipal, industrial or combined facilities.

The New England Interstate Water Pollution Control Commission is a not-for-profit interstate agency that meets the water-related needs of its seven member US states: Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont – which include two of the USA's primary cities (Boston and New York City). The Commission serves and assists the states by coordinating activities and forums that encourage cooperation among the states, developing resources that foster progress on water and wastewater issues, representing the region in matters of federal policy, training environmental professionals, initiating and overseeing scientific research projects, educating the public, and providing overall leadership in water management and protection.

Conclusions

Examples of elements of a wastewater management database platform can be found that could be used in its current state or adapted for use by the countries in the Wider Caribbean Region. Critical issues include data availability, updating, sharing and dissemination in a form that is understood by the target audience.

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