



GEF CReW+ Project in Caribbean Region

GLOBAL WATER PARTNERSHIP-CARIBBEAN



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The collaboration of Global Water Partnership-Caribbean (GWP-C), was spearheaded by the Cartagena Convention Secretariat and financed by The Global Environment Facility (GEF) under the GEF CReW+ Project.

The GEF CReW+ is a partnership project funded by the Global Environment Facility (GEF) that is being co-implemented by the Inter-American Development Bank (IDB) and the United Nations Environment Programme (UNEP) in 18 countries of the Wider Caribbean Region (WCR).

This project builds upon its previous successful phase “The Caribbean Regional Fund for Wastewater Management (CReW)” project (2011-2017). CReW+ is being executed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the Organisation of the American States (OAS) and the Secretariat of the Cartagena Convention (CAR/RCU) on behalf of the IDB and UNEP respectively.

The 18 participating CReW+ countries (Barbados, Belize, Colombia, Costa Rica, Cuba, Dominican Republic, Grenada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Panama, Saint Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname and Trinidad and Tobago) vary geographically from large, continental countries to small island states, with significantly different political, linguistic and cultural contexts.

About the GEF: The Global Environment Facility (GEF) has provided \$22 million in grants and blended finance and mobilised nearly \$120 billion in co-financing for more than 5,200 projects and programmes. The GEF is the largest trust fund focused on enabling developing countries to invest in nature and supports the implementation of international conventions on biodiversity, climate change, chemicals and desertification. It brings together 184 governments, plus civil society, international organisations, the private sector and partners.

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The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Global Environment Facility (GEF), the Inter-American Development Bank (IDB), the United Nations Environment Programme (UNEP), the Cartagena Convention Secretariat (CAR/RCU), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the Organization of American States (OAS) or the countries they represent.

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1. GEF CReW+ Project

The GEF CReW+ is a partnership project funded by the Global Environment Facility (GEF) that is being co-implemented by the Inter-American Development Bank (IDB) and the United Nations Environment Programme (UNEP) in 18 countries of the Wider Caribbean Region (WCR). The concept was approved in November 2017 for an amount of 14,943,938 US\$ by the GEF Trust Fund. The GEF CReW+ started 2020 with an inception phase.

This project builds upon its previous successful phase “The Caribbean Regional Fund for Wastewater Management (CReW)” project (2011-2017). CReW+ is being executed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, the Organisation of the American States (OAS) and the Secretariat of the Cartagena Convention (CAR/RCU) on behalf of the IDB and UNEP respectively. The executing agencies are responsible for achieving its goals and outcomes, within the respective Technical Cooperation Agreements, and consistent with GEF, IDB and UNEP policies and procedures.

The eighteen participating CReW+ countries (Barbados, Belize, Colombia, Costa Rica, Cuba, Dominican Republic, Grenada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Panama, Saint Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago) vary in size from large, continental countries to small island states, with significantly different political, linguistic and cultural contexts. The technical specialists from the implementing and executing agencies are coordinating with the

CReW+ focal points to support implementation of project activities.

About GEF: The Global Environment Facility (GEF) has provided \$22 billion in grants and blended finance and mobilized nearly \$120 billion in co-financing across more than 5,200 projects and programs. GEF is the largest trust fund focused on enabling developing countries to invest in nature and supports the implementation of international conventions on biodiversity, climate change, chemicals and desertification. It brings together 184 governments, as well as civil society, international organizations, the private sector and partners.

GEF CReW+ cooperates with national, regional, and local stakeholders on the range of innovative sanitation technologies and efforts to safeguard freshwater resources. This also includes consultation with the private sector.

At the institutional level, GEF CReW+ promotes the development of norms, strategies and policies concerning water resources and wastewater management. Aiming at long-term service provision for all, the project identifies sustainable finance mechanisms such as payment for ecosystem services, incentive creation and revolving funds. The technical activities of GEF CReW+ comprise design and construction of natural wastewater treatment plants and sanitary facilities, based on the results of country-specific assessments. Furthermore, knowledge management forms a crucial part of GEF CReW+, including the development of a communication strategy. The strategy includes comprehensive inventories of material on wastewater infrastructure, reuse, watershed protection and financing tools at the regional and national level.

The Wider Caribbean Region faces multiple challenges in the wastewater and sanitation service provision. About 70% of the region's population lacks access to safely management sanitation facilities and adequate hygiene services.

It is estimated that between 70% and 80 of domestic wastewater is discharged into the environment partially treated or untreated. Weak legislative, political, and

regulatory frameworks as well as the lack of financial resources to enable adequate levels of treatment further compound the problem. This causes severe pollution of groundwater, soil, watersheds and ultimately the Caribbean Sea resulting in significant environmental, economic and social impacts.

The GEF CReW+ project provides innovative and nature-based solutions to mitigate the effects of partially or untreated wastewater on the environment and public health.

Valuing water as a precious resource, the concept of Integrated Water and Wastewater Resources Management (IWWM) applied in the GEF CReW+ project is based on the four Rs of the circular economy approach: reduce, reuse, recycle, and recover. The project treats wastewater not as waste, but as a valuable resource with reuse potential in agriculture, industries and other commercial sectors. With regards to the environment, treating wastewater safely supports regional efforts for sustainable development by reducing pollution, safeguarding marine biodiversity and protecting human health. GEF CReW+ thus contributes directly to the achievement of the SDGs 3, 6, 11, 14 and 15.

2. GWP-C and GEF CReW+ Partnership

The Global Water Partnership-Caribbean (GWP-C), a well-regarded regional organisation based in Grenada, is dedicated to promoting Integrated Water Resources Management (IWRM) as a means of ensuring the sustainable and equitable use of water resources. Established in 2004, GWP-C is part of the Global Water Partnership (GWP), an international network headquartered in Stockholm, Sweden, which operates in 13 regions worldwide and includes over 3,000 partners globally. GWP-C represents the Caribbean region within this global network, benefitting from shared resources, expertise, and a collective commitment to advancing water security.

In the Caribbean, GWP-C works across over 22 countries and territories, collaborating with over 110 partners, including governments, NGOs, academic institutions, private sector entities, and youth organisations. This extensive network and strategic positioning enable GWP-C to effectively address the region's unique water management challenges through innovative, inclusive, and sustainable solutions.

The GEF CReW+ project, a multi-country initiative co-implemented by UNEP and the Inter-American Development Bank (IDB), addresses critical wastewater and water management issues in the Wider Caribbean Region. GWP-C's partnership in the project aligns seamlessly with its mission, leveraging its expertise, extensive network, and global affiliation to deliver innovative, community-based, and sustainable water solutions.

GWP-C's contributions to the GEF CReW+ project include:

1. **Capacity Building:** Through targeted training initiatives under Components 1 and 4 of the projects, GWP-C awarded scholarships, conducted workshops, and developed training materials to strengthen local expertise in IWRM and IWWM.
2. **Knowledge Management and Advocacy:** As part of Component 4, GWP-C advanced public awareness and information exchange on IWRM

As an integral part of the GWP global network, GWP-C draws on international best practices and leverages global resources to address local and regional challenges effectively. Its role as an executing partner in the GEF CReW+ project added significant value, ensuring the implementation of innovative solutions, the engagement of diverse stakeholders, and the promotion of long-term, sustainable water management practices. The partnership has not only strengthened regional capacity for IWRM but also showcased the impact of global-local collaboration in addressing critical water and sanitation challenges in the Caribbean.

3. Implementation of Activities

3.1. Executive Summary

The GEF CReW+ Project through GWP-C provided support for activities in two main components. These include:

Component III. Provision of innovative small-scale, local, rural, peri-urban and community-based solutions for IWWM. *Outcome 3.3. Improved knowledge and skills within targeted communities to enable implementation of innovative low-cost integrated water and wastewater management solutions.* Output 3.3.1 Training on innovative low-cost integrated water and wastewater management such as through webinars, MOOC, training programmes with the participation of civil society

- + Training and Capacity Building under the CReW+ Project

Component IV. Knowledge Management and Advocacy on the importance of IWWM in order to achieve the Sustainable Development Goals. *Outcome 4.1 Improved awareness and understanding of the advantages of implementing integrated approaches within targeted communities to enable implementation of low-tech and integrated water and wastewater management solutions and Outcome 4.2 Improved access to an information exchange mechanism, including knowledge of experiences and lessons learnt, as well as improved information sharing capability with GEF and the wider, local and national communities amongst all 18 participating countries.* Output 4.1.1 A communications strategy developed and implemented, including information and dissemination of products related to IWWM and watershed management; and Output 4.2.1 Documented best practices, lessons and experiences from all Components

- + Knowledge Management, Communications and Awareness under the CReW+

Project

3.2. Execution of the activities

Training and Capacity Building under the CReW+ Project

Executing Agency: Global Water Partnership - Caribbean

Under this activity there were five sub activities:

1. Awarding of ten (10) scholarships to professionals in IWWM and IWRM fields to undertake training opportunities and professional development at selected institutions. GWP-C submitted several other revised implementations plans and budgets as requested by UNEP with the anticipation of a no-cost extension being granted. In the final version of the revised implementation plan submitted the number was revised to five or six scholarships. GWP-C publicised the opportunity on its website, social media pages and to its network on June 29th, 2022. At the request of UNEP this was later extended to other CReW+ countries. Although GWP-C received several applications many of them did not fit the criteria for course content, completion date and successful completion and were not granted the scholarship, which resulted in the lower than anticipated number. Scholarship recipients were from Barbados, Suriname and Trinidad and Tobago.
 - a. Tahira Khan - Certificate in Wastewater Management. Global Learning Institute
 - b. Oclaya Verwey - Python Essentials for Water II. Australian Water School (AWS)
 - c. Ginny Bijaar - Engineering: Building with Nature. Delf X. Delf University of Technology.
 - d. Ivanna Odle - QGIS Beginner to Advanced Level. Technical and Specialised

training (TYC-GIS).

2. Issued a call for expression of interest to interested organisations, institutions for the development and implementation of capacity building course (s) with a focus on I/W/M and I/W/R/M. (awarding of three (3) grants)—GWP-C advertised the opportunity on its website and social media, and its network on June 29th, 2022, but due to low expression of interest it was readvertised on November 25th, 2022, extending the option to all CReW+ countries. Grants were awarded to successful applicants from Trinidad and Tobago, Colombia and Panama.
 - a. Agricultural Society of Trinidad and Tobago - Capacity Building Forums to collect information regarding the use of Treated Wastewater by the Agricultural, and landscaping sectors.
 - + **Participants/beneficiaries:** 204. Number of females: 71 (18-35 years). Number of males: 233 (18-35 years). Number of children: 0 (12-18 years)
 - + **Capacity Building/Training:** 10. Number of males: 5 (18-35 years). Number of females: 5 (18-35 years). Number of children: 0
 - b. Forest Hydrology and Urban Water Research Group - Capacity building for integrated water and wastewater management in the Caribbean.
 - c. Women Biodiversity Corporation - Climate Integrated Ethnographical Management of Water in the Colombian Amazon Basin.
 - + **Participants/beneficiaries: 3003 Ticuna indigenous.** Number of females: 1150 (18-35 years). Number of males: 905 (18-35 years). Number of children: 948 (12-18 years)
 - + **Capacity Building/Training:** 216 Ticuna indigenous. Number of males: 110 (18-35 years). Number of females: 106 (18-35 years). Number of children: 0
3. Develop and execute an online course in collaboration with The University of the West Indies—Due to numerous challenges (e.g. an extremely lengthy approval process, and unforeseen costs) experienced in the development, approval, and execution of a course of this nature, it was not advanced as initially planned. In the final revised version of the implementation plan submitted to

UNEP this item was revised to instead focus on training in water and wastewater operations through the University of Technology in Jamaica. On April 27th, 2023, GWP-C advertised the opportunity. Following which successful applicants from Grenada, Guyana, Jamaica, St. Lucia and Trinidad and Tobago were awarded full and partial scholarships. 8 persons benefitted from Certification from California State University on Operation of Wastewater Treatment Plants, Volume 1, Course A Safety, Beginning Treatment and Lagoon systems, and Water Treatment Plants Operations, Volume 1. Some testimonies can be found [here](#).

4. Building capacity of approximately 27 youths (20 female, 7 male), and 17 (12 female, 5 male) media persons on how storytelling can be used to communicate information on IWW within IWRM. An assignment (field trip) will form part of the capacity building training—GWP-C advertised the workshop on July 20th, 2022, to media and youth from Caribbean CReW+ countries. These virtual sessions targeted Caribbean youth and journalists, focusing on wastewater management and its links to climate change, gender, and innovative reuse technologies. The youth workshop aimed to raise awareness through social media campaigns, while the journalist workshop provided guidance on covering wastewater issues and creating impactful content to engage the public and policymakers. The workshop session was spread out between September and November 2022, culminating with the presentation of the final assignment videos, some of which can be found here.
5. One (1) regional capacity building workshop on Shit Flow Diagrams (SFD) diagrams and awarding of a grant to develop one SDF for a selected country/city—GWP-C advertised the workshop on February 3rd, 2022, on its website, its social media platforms and to partners. The training ran from March 21st - April 1st, 2022 and targeted participants that were managers, regulators, officials of water and wastewater utilities, mid-level to senior technicians, university graduates, NGOs, statutory bodies, government agencies, private

sector, individual practitioners/consultants, researchers, academia with prior basic knowledge or relevant experience working in the water and sanitation sector. The SFD training programme, first of its kind for the Caribbean, sought to sensitise and equip practitioners in preparing the SFD and using it for preparing city-wide sanitation strategies. Twenty-seven (27) participants (11 female, 15 male) from the following countries participated in the training: Barbados, Belize, Curaçao, Dominica, Grenada, Guyana, Jamaica, St. Lucia, St. Vincent and the Grenadines, Turks and Caicos Islands, The Bahamas, Montserrat and Trinidad and Tobago. As a follow up to the SFD training, an SFD Course Opportunities, Next Steps, and Way Forward meeting was held on May 3rd, 2022, facilitated by the Centre of Science and Environment India (CSE) and the Global Water Partnership-Caribbean (GWP-C). The objective of the meeting was to inform eligible participants of the International Online Training Programme on Preparation of Shit Flow Diagram (SFD) for Caribbean Countries about the opportunities that exist for the development of SFDs in their own municipalities, cities or countries. As a result, two SFDs were developed and published by participants of the training from Jamaica and Guyana.

Challenges in implementation:

1. Awarding of ten (10) scholarships to professionals in IWWM and IWRM fields

Challenges:

Many applications did not meet the criteria, such as course content relevance and successful completion requirements.

The number of scholarships had to be reduced to five or six due to these constraints.

Difficulty in ensuring applicants provided proof of course completion to qualify for

funding.

2. Issuing a call for expression of interest for capacity-building course development

Challenges:

Initial low expression of interest led to the need for re-advertising the opportunity.

Extensions to the call for applications were required to reach a broader pool of candidates across CReW+ countries.

3. Developing and executing an online course in collaboration with The University of the West Indies

Challenges:

Lengthy approval processes delayed the project timeline.

Unforeseen costs further complicated implementation.

The focus had to shift to training in water and wastewater operations with the University of Technology in Jamaica due to these issues.

4. Building capacity of 50 youths, professionals, and media persons on storytelling

Challenges:

The field trip component was not implemented, altering the training format.

Participation levels required adjustment, and a shift to virtual sessions was necessary.

Encouraging participants to produce final assignments (videos) required additional effort.

5. Regional capacity building workshop on Shit Flow Diagrams (SFD)

Challenges:

Attendance was significantly lower than the target (27 participants vs. 300 expected).

Despite the low turnout, two SFDs were developed instead of the planned single SFD, requiring adjustments in scope.

Knowledge Management, Communications and Awareness under the CReW+ Project

Executing Agency: Global Water Partnership - Caribbean

Under this activity there were four sub-activities:

1. Regional science communication workshop targeting journalists with a focus on I/WWM-- GWP-C advertised the workshop on July 20th, 2022, to media and youth from Caribbean CReW+ countries. These virtual sessions targeted Caribbean youth and journalists, focusing on wastewater management and its links to climate change, gender, and innovative reuse technologies. The youth workshop aimed to raise awareness through social media campaigns, while the journalist workshop provided guidance on covering wastewater issues and creating impactful content to engage the public and policymakers. The workshop session was spread out between September and November 2022.
2. National Video Series on Wastewater Management (Post workshop assignment for the development of video/documentary on I/WWM). In addition to the final assignment interested youth and media personnel were invited to undertake the task of producing a 5-minute video discussing I/WWM in their particular country. However, due to low uptake from the original workshop participants this opportunity was advertised. Applicants from the following countries were given the task to produce these videos: Barbados, Saint Lucia, St. Vincent and the Grenadines, Suriname and Trinidad and Tobago.

3. Grant awarded to shark tank competition winner under the theme I/WWM–GWP-C advertised the opportunity on April 25th, 2022. The 2022 Young Caribbean Water Entrepreneurs Shark Tank Competition, providing young Caribbean innovators aged 18-34 the opportunity to pitch water-related projects addressing themes like water and agriculture, health, and wastewater management. In partnership with organizations like UNEP and the Caribbean Climate Innovation Center, two US\$4,000 seed funding awards are available for the best ideas. The competition aims to empower youth to contribute to water security in the region. Finalists for the competition were from the Dominican Republic, Jamaica, Trinidad and Tobago, and Haiti, with the winners coming from Jamaica and Trinidad and Tobago¹.

The awardees in the 2022 Young Caribbean Water Entrepreneurs Shark Tank Competition aimed to address climate change and water resource management issues. The team from Jamaica developed “Kee Farms,” a regenerative ocean farm that leverages seaweed and oyster cultivation to remove carbon from the atmosphere, provide economic opportunities, and reduce environmental risks. The Trinidad and Tobago team presented solutions focusing on sustainable wastewater management. Both projects emphasize innovation, scalability, and impact in managing water and environmental challenges in the Caribbean region.

4. Knowledge management products such as perspective papers, and fact sheets developed–GWP-C through its Technical Committee produced two perspectives papers on the following topics: 1) Wastewater Management in the Caribbean: A Jamaica Case Study and 2) A Toilet Paper. For each of these papers short

¹ See link for details: <https://www.gwp.org/en/GWP-Caribbean/WE-ACT/news-page/News-and-Activities/finalists-from-jamaica-and-trinidad-and-tobago-deliver-winning-pitches-in-the--2022-young-caribbean-water-entrepreneurs-shark-tank-competition/>

promotional videos were also done.²

Challenges in implementation:

1. Regional Science Communication Workshop Targeting Journalists

Challenges:

Low engagement required extended efforts to attract participants.

Coordination of virtual sessions across multiple dates and participants presented logistical complexities.

Ensuring the content was impactful and aligned with the participants' expectations.

2. National Video Series on Wastewater Management

Challenges:

Low uptake from the original workshop participants led to the need for broader advertising.

Limited interest from the initial target audience required expanding the pool of applicants for the video development.

Ensuring the produced videos met quality and thematic expectations added further monitoring requirements.

3. Grant to Shark Tank Competition Winner under the Theme of IWWM

Challenges:

² https://drive.google.com/file/d/1pR4Q80a_Kp66moDf8_K3u0IXYvRp8Ynh/view?usp=sharing,
<https://drive.google.com/file/d/15Edf2gfLgXM10fKQAnx07FI2XISuGZZL/view?usp=sharing>.

Attracting high-quality, innovative project proposals within the eligibility criteria was a challenge.

Limited funding necessitated a highly competitive selection process, potentially excluding worthy ideas.

Managing the competition logistics and providing adequate support to winners for implementation was resource intensive.

4. Knowledge Management Products (Perspective Papers and Fact Sheets)

Challenges:

Identifying and prioritizing relevant topics based on regional needs and assessments required extensive consultation and research.

Ensuring rigorous peer review to maintain quality and relevance delayed finalization.

Developing engaging promotional materials (e.g., videos) to disseminate these products effectively demanded additional effort and expertise.

3.3. Results

Activity 1 -Training and Capacity Building under the CReW+ Project

Output 3.3.1 Training on innovative low-cost integrated water and wastewater management such as through webinars, MOOC, training programmes with the participation of civil society

Four (4) scholarships awarded to four (4) professionals under IWWM and IWRM from CReW+ participating countries.

1. Tahira Khan - Certificate in Wastewater Management. Global Learning

Institute

2. *Oclaya Verwey - Python Essentials for Water II. Australian Water School (AWS)*
3. *Ginny Bijaar - Engineering: Building with Nature. Delf X. Delf University of Technology.*
4. *Ivanna Odle - QGIS Beginner to Advanced Level. Technical and Specialised training (TYC-GIS).*

Three (3) grants awarded and training completed

Training workshops delivered: 3 (courses, webinars, MOOCs etc.) (#)

1. Capacity Building Forums to collect information regarding the use of Treated Wastewater by the Agricultural, and landscaping sectors.
2. Capacity building for integrated water and wastewater management in the Caribbean. Forest Hydrology and Urban Water Research Group
3. Women Biodiversity Corporation - Climate Integrated Ethnographical Management of Water in the Colombian Amazon Basin.

Number of people trained per training courses, webinars, MOOCs etc.: 226
Persons (#)

1. Capacity Building/Training: 216 Ticuna indigenous. Number of males: 110 (18-35 years). Number of females: 106 (18-35 years). Number of children: 0
2. No data available
3. Capacity Building/Training: 10. Number of males: 5 (18-35 years). Number of females: 5 (18-35 years). Number of children: 0

One (1) online course developed in collaboration with The University of the West Indies and Caribbean WaterNet

Training workshops delivered: 2 webinars.

1. Operation of Wastewater Treatment Plants, Volume 1, Course A Safety, Beginning Treatment and Lagoon systems, and

<p>2. Water Treatment Plants Operations, Volume 1</p> <p>Number of people trained per training courses, webinars, MOOCs etc.: 8 Persons (#)</p>
<p><i>One (1) regional capacity building workshop targeted at youths, professionals and media persons on how storytelling can be used to communicate information on IWWM within IWRM</i></p> <p>Training workshops delivered: 1 workshop.</p> <p>Number of people trained per training courses, webinars, MOOCs etc.: 27 Persons (20F, 7M) (#)</p>
<p><i>One (1) regional capacity building workshop on Shit Flow Diagrams (SFD) diagrams held and 1 SFD developed for a selected country/city</i></p> <p>Training workshops delivered: 1 workshop.</p> <p>Number of people trained per training courses, webinars, MOOCs etc.: 27 (11F, 15M) Persons (#)</p>

Activity 2 - Knowledge Management, Communications and Awareness under the CReW+ Project

<p><i>Output 4.1.1 A communications strategy developed and implemented, including information and dissemination of products related to IWWM and watershed management</i></p>
<p><i>One (1) regional science communications workshop targeting journalists with a focus on IWWM held</i></p> <p>Training workshops delivered: 1 workshop.</p> <p>Number of people trained per training courses, webinars, MOOCs etc.: 17 (12F, 5M)</p>

Persons (#)
<p><i>National Video Series on Wastewater Management developed</i></p> <p>Activities for the strategy implemented: 7 (#) videos (https://www.gwp.org/en/GWP-Caribbean/WE-ACT/news-page/News-and-Activities/gwp-c-iwwm-video-series/)</p>
<p>Output 4.2.1 Documented best practices, lessons and experiences from all Components</p>
<p><i>Grant awarded to shark tank competition winner under the theme IwWM</i></p> <p>Number of documented best practices and lessons learnt and experience notes (https://drive.google.com/drive/folders/15Rj7s0nk4GgVSQVdRNWjT7-N8f-Wti0s?usp=sharing).</p>
<p><i>Knowledge management products such as perspective papers, and fact sheets developed</i></p> <p>Number of documented best practices and lessons learnt and experience notes: 2 (#)</p>

3.4. Lessons Learned

1. Ensuring Applicants Understand and Follow Criteria

Context Findings: While clear criteria and instructions were provided for scholarships and grant opportunities, many applicants failed to read or follow the guidelines, resulting in incomplete or non-compliant applications.

Recommendations:

Highlight key instructions prominently (e.g., bold text, bullet points, or a checklist at the start).

Include a brief “must-read” summary at the top of application forms or call notices to ensure critical details are not overlooked.

Require applicants to confirm they have reviewed the criteria and instructions, such as through a mandatory acknowledgment checkbox or pre-application questionnaire.

2. Lesson: Managing Limited Resources in Project Implementation

Context Findings: The planned collaboration with UWI to develop a course had to be revised due to insufficient funding and time constraints, requiring a shift to alternative training options.

Recommendations:

Prioritize cost-effective solutions, such as adapting existing courses or leveraging regional expertise and resources.

Focus on achievable activities that align with available time and budget, avoiding overly complex or resource-intensive plans.

Establish clear fallback options, such as partnerships with other institutions or shorter, targeted training modules, to ensure objectives can still be met.

3. Lesson: Enhancing Stakeholder Engagement Through Tailored Approaches

Context Findings: Despite using direct outreach methods such as emails, and leveraging existing networks, participation in some activities, like workshops, remained lower than expected.

Recommendations:

Assess stakeholder preferences and barriers to participation (e.g., timing, competing priorities, or technical access) to better align outreach and scheduling with their needs.

Consider smaller, more focused events for niche groups to increase engagement, rather than broad-scale activities.

Provide clear incentives or benefits for participation, such as certification, networking opportunities, or practical takeaways.

4. Lesson: Realistic Participant Targets and Expectations

Context Findings: Some targets, such as participant numbers, were overly ambitious for the available resources.

Recommendations:

Set smaller, more realistic targets that match regional capacity and available resources.

Prioritize quality of engagement over quantity by focusing on fewer but highly committed participants.

3.5. Next Steps

1. Turn Challenges into Learning Opportunities

Share lessons learned as case studies or quick-read reports to demonstrate transparency and encourage others to innovate within the region.

2. Prototype Before Full Rollout

Pilot new initiatives with a small group to refine the approach before expanding to a larger audience.

3. Bundle Activities for Efficiency

Combine related activities (e.g., workshops and training) into single events to maximize resource use and participant turnout.

4. Reward Participation with Practical Benefits

Offer meaningful, tangible incentives for participants, such as certificates or access to exclusive resources, to boost interest and engagement.

5. Tap Into Local Champions

Identify and empower individuals or organizations within the region to act as ambassadors who can promote initiatives and mobilise participants.

4. Focal point and national stakeholders

Name	Role in CReW+	Position and Organization	e-mail
Mr. Kerron Martinez	Key Regional Stakeholder	Programme Assistant Global Water Partnership-Caribbean (GWP-C)	kerron.martinez@gwp-caribbean.org
Ms. Simone Lewis	Key Regional Stakeholder	Regional Coordinator Global Water Partnership-Caribbean (GWP-C)	Simone.lewis@gwp-caribbean.org

Table 1. Focal points and stakeholders

5. Project implementing structure

Agency	Position	Contact	e-mail
Inter-American Development Bank (IDB)	Lead Implementing Agency	Rodrigo Riquelme Water and Sanitation Lead Specialist, INE/WSA	rodrigor@iadb.org
United Nations Environment Programme (UNEP)	Implementing Agency	Isabelle Van der Beck GEF International Waters Task Manager Water and Sanitation Division Ecosystems Division, Marine and Coastal Infrastructure and Environment Ecosystems Branch	isabelle.vanderbeck@un.org
	Project Coordination Group (PCG)	Pedro Moreo Mir Regional Coordinator	pmoreo@oas.org
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	Executing Agency	Bärbel Schwaiger Programme Director Sanitation for Millions Division Environment, Climate and Infrastructure	baerbel.schwaiger@giz.de

Agency	Position	Contact	e-mail
Secretariat to the Cartagena Convention (CAR/RCU)	Executing Agency	Christopher Corbin Programme Officer Pollution and Communications Sub-Programmes Cartagena Convention Secretariat Ecosystems Division	christopher.corbin@un.org
Organisation of the American States (OAS)	Executing Agency	Andres Sanchez Water Program Specialist Secretaría Ejecutiva para el Desarrollo Integral (SEDI) Departamento de Desarrollo Sostenible (DDS) Sección de Gestión Integrada de Recursos Hídricos (GIRH)	asanchez@oas.org

Table 2. Implementing structure

8. Annexes

8.1. Four (4) scholarships to professionals in IWWM and IWRM fields

TYC GIS Soluciones Integrales Training Departament

certifies that

Ivanna Odle

has successfully completed the course named:

QGIS Beginner to Advanced Level

held from September 12, 2022 to December 26, 2022.

This was a 140 hours online course. The candidate has fulfilled the attendance requirements and has successfully passed the examination.

The course covered the following topics:

Beginner Level

- Unit 1 - Introduction in QGIS
- Unit 2 - QGIS Tools, Accessing Tools and Functionalities
- Unit 3 - Handling Vector and Table Data in QGIS
- Unit 4 - Handling Raster Data in QGIS
- Unit 5 - QGIS Plugins
- Unit 6 - QGIS Integration with GRASS GIS
- Unit 7 - Map Creation in QGIS

Advanced Level

- Unit 1 - Relational Database Management Systems and Spatial Data
- Unit 2 - Spatial Analysis Using Vector Data
- Unit 3 - Basic Operations With Raster Data
- Unit 4 - Advanced Spatial Analysis with Raster Data
- Unit 5 - 3D Visualization
- Unit 6 - Route Analysis Using PgRouting
- Unit 7 - Python Programming Language
- Unit 8 - Lidar Data Management in QGIS
- Unit 9 - Development of a Cartographic Viewer in QGIS



**Santiago Pardini Hernanz
Training Manager**

Verified Certificate



A handwritten signature in blue ink, appearing to read "J. H. Slinger", with a horizontal line underneath.

Jill Slinger

Associate Professor

Faculty of Civil Engineering and Geosciences
Faculty of Technology, Policy and Management

Delft University of Technology

A handwritten signature in blue ink, appearing to read "Marcel Stive", with a horizontal line underneath.

Marcel Stive

Professor of Hydraulic Engineering

Faculty of Civil Engineering and Geosciences

Delft University of Technology

This is to certify that

Ginny Bijnaar

successfully completed and received a passing grade in

BwN101x: Engineering: Building with Nature

a course of study offered by DelftX, an online learning initiative of Delft University of Technology.



Verified Certificate

Issued September 22, 2022

Valid Certificate ID

[d29c1104ca194500affaa893383fd4ef](#)

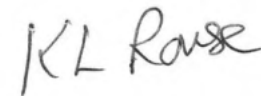
Certificate of Completion

aws 
Australian
Water School

Oclaya Verwey

for successfully completing the course

Python Essentials for water II



Karen Rouse

CEO, Water Research Australia
*Water RA are the custodians of the
Australian Water School*

Date

02/10/2022



This is to certify that

Tahira Khan

has completed the programme

Certificate in Wastewater Management

dated

November 7th – December 19th, 2022
Champs Fleurs, Trinidad

David Benny

INSTRUCTOR

David Benny

MPhil, MSc, BSc Environmental Engineering (UWI)

Dr. Robin R. Maraj

EXECUTIVE DIRECTOR

Dr. Robin R. Maraj

Hon. Bcomm (Ottawa), FABE (UK),
Hon D. Litt (Heriot-Watt)



5927984

8.2. One (1) workshop to collect information regarding the use of Treated Wastewater by the Agricultural, and landscaping sectors



Agricultural Society of Trinidad and Tobago

Report on Capacity Building Forums

Gregory C Reece
Chairman Projects Committee Agricultural Society of Trinidad and Tobago

Author's Note

The Agricultural Society of Trinidad & Tobago applied to the Global Water Project Caribbean for a grant to facilitate the Capacity Building forum's to be held between December 2022 and January 2023, these forums were designed to collect information regarding the use of Treated Waste Water by the Agricultural, and landscaping sectors. This was as a follow up to the development of a voluntary standard TTS 664-2022 for Domestic Wastewater Reuse.

The Agricultural Society of Trinidad and Tobago has been identified as the advocated body for all aspects of Agriculture in Trinidad and Tobago. Founded in 1894. In 1919 the Society became a statutory body by law. Act 1 of 1919 The Agricultural Society of Trinidad and Tobago Act. Chapter 63:01.



Report

This report gives a daily breakdown of the participation at the Six (6) Forum's held over the period of December 2022 to January 2023

Attendance

Session 1 Tuesday 10th January 2023 Bon Air/ St. Augustine Farmers

- 1.) Members of the ASTT Five (5) members
- 2.) Members of staff of the Ministry of Public Utilities Five (5) Members
- 3.) Minister of Public Utilities
- 4.) Members of staff of Water and Sewage Authority Two (2) Members
- 5.) Member of staff of the Water Resources One (1) member
- 6.) Farmers turn out Seventeen (17) Members
- 7.) Landscapers turn out Three (3) members.

Session 2 Thursday 12th January 2023 Malabar Farmers

- 1.) Members of the ASTT Five (5) members.
- 2.) Members of staff of the Ministry of Public Utilities Five (5) Members.
- 3.) Member of staff of The Water and Sewage Authority One (1) Member.
- 4.) Member of staff of the Water Resources One (1) member.
- 5.) Farmers turn out Fifteen (15) Members.
- 6.) Landscapers Four (4) members.



Session 3 Thursday 12th August 2023 Maloney Farmers

- 1.) Members of the ASTT Five (5) members
- 2.) Members of staff of MPU Five (5) members.
- 3.) Member of staff of Water and Sewage Authority One (1) member
- 4.) Member of staff of Water Resources One (1) member
- 5.) Member of staff of Bureau of Standards One (1) member
- 6.) Farmers turn out Five (5) members.

Session 4 Thursday 12th January 2023 Siparia / South Farmers

- 1.) Members of the ASTT three (3) members
- 2.) Farmers Turn out thirty-three (33) members.
- 3.) Landscapers turn out seven (7) members.
- 4.) Live streams turn out twenty-two (22) members

Session 5 Monday 16th January 2023 Tobago Farmers

- 1.) Members of the ASTT four (4) members.
- 2.) Members of staff of MPU virtually
- 3.) Members of staff of WASA two (2) members
- 4.) Members of the THA three (3) members.
- 5.) Farmers Turn out twelve (12) farmers.
- 6.) Landscapers turn out three (3) members.
- 7.) Virtual attendees ten (10) members.



Session 6 Wednesday 18th January 2023. Preysal Farmers

- 1.) Members of the ASTT five (5) members
- 2.) Members of staff of MPU virtually
- 3.) Member of staff of EMA one (1) member
- 4.) Member of staff of Water Resources one (1) member
- 5.) Farmers turn out twenty (20) members.
- 6.) Virtually ten (10) members

Note on Attendance:

The ASTT advertised on all social media platforms, as well as printed One Hundred (100) flyers for each session and had them distributed no less than two (2) days in advance.

The ASTT also had a loudspeaker go through the areas three days prior to each session, along with text messaging, e-mailing and calling farmers and persons involved in farming and landscaping in each area.

The turnout was lower than expected due to the natural factors that farmers do not turn out in large numbers, instead they usually rely on one-on-one contact with the ASTT and others for information and updates etc.

The President of the ASTT along with other members were in the fields as well meeting and talking to farmers individually about the program and getting feedback, this was the most successful as One Hundred and forty-three (143) farmers were reached during the two (2) week period.



We registered a total of three hundred and four (304) persons reached not including the staff members. With Two Hundred and Thirty-Three (233) or Seventy-Six point Six Five Percent (76.65%) being Male and Seventy-One (71) or Twenty Three point three Five Percent (23.35%) being Female.

Age Breakdown of Attendees				
Category	Male #	Female #	Total	Percent
18-34	53	4	57	18.75%
35-59	80	30	110	36.18%
60+	100	37	137	45.07%
Total	233	71	304	100%

Costing / Expenditure.

- 1.) The cost for the spaces were to a total of Three Hundred Dollars (\$300.00)
- 2.) Total Cost for Chairs and tables was Eighteen Hundred and Sixty Dollars (1,860.00)
- 3.) The Pa System costs totaled Seven Thousand Five Hundred Dollars (\$7,500.00)
- 4.) One Thousand Flyers were procured at a cost of Twelve Hundred (\$1,200.00) dollars.
- 5.) Fifty Snack plates were procured for each of the Six (6) sessions at a total cost of Eighteen Thousand Dollars (\$18,000.00)
- 6.) Miking (Loudspeaker) totaled Ten Thousand Eight Hundred Dollars (\$10,800.00)



7.) Two Reporters totaled Three Thousand dollars (\$3,000.00)

8.) Four Tickets to Tobago to host the Session in Tobago totaled Sixteen Hundred Dollars (\$1,600.00)

9.) Miscellaneous Expenses Four Hundred Dollars (\$400.00)

Total Costs to the ASTT for this event was Forty-Four Thousand Six Hundred and Sixty Dollars (\$44,660.00)

Income.

The ASTT was given a grant of Five Thousand United States Dollars equaling to Thirty-One Thousand Four Hundred Trinidad and Tobago Dollars (\$31,400.00) from GWPC the first tranche was received and the second after the report is handed in.

Session 1 Tuesday 10th January 2023

The session started with opening remarks from the chairperson for the session, after which welcoming remarks were brought by the councilor for Five Rivers.

Presentations were done by the Water and Sewage Authority (WASA) who did a presentation on the water treatment plants operations and the final product. The University of the West Indies (UWI) presentation focused on the development of the standard and how it affects the farmers as well as other industries targeted, both presentations were done as videos.

The President of the Agricultural Society of Trinidad and Tobago (ASTT) addressed the gathering on Agriculture and how it can benefit from the use of the treated wastewater as well as the benefits and challenges that the industry can face, he also spoke to the current state of



the industry and why those present should pay attention to this program and how it will benefit them.

The feature address done by the Minister of Public Utilities (MPU) Hon Marvin Gonzales, in his address he focused on the development of the sector, the current situation with treated wastewater as well as the plans moving forward.

Immediately after the feature address the session broke up into focus groups where the following questions were asked:

- 1.) Would you be willing to use the treated wastewater?
- 2.) What is your current means of collecting water?
- 3.) How would you like to access the treated wastewater?
- 4.) Would you be willing to pay for the treated wastewater?
- 5.) Are there any issues or concerns regarding the treated wastewater?
- 6.) Any other questions?

The answers were unanimous by all for each answer provided.

- 1.) Yes we would be willing to use the treated waste water
- 2.) The current means of collection amongst the farmers were harvesting rain water, pipe borne water, ponds, harvesting water from rivers, and drains, and having water truck delivered to them. The Landscapers all used pipe born water for their work.
- 3.) All farmers agreed that the easiest way to get the treated wastewater was to have it piped to them, however they would use from the riverine system and were willing to collect once the cost was not too high. The Landscapers were all in agreement to having access to it piped and to collecting at a collection point or having it delivered again once the cost factor was not too high.



4.) All were in agreement that they are willing to pay for the treated wastewater, they also agreed that the cost must be viable to them and not too high.

5.) The concerns stated were as follows:

- A.) The safety of use.
- B.) The consistency of the water quality.
- C.) The price to them.
- D.) The availability.
- E.) The continuity of delivery once started.
- F.) The time frame for the program to be rolled out.

These questions were all answered to the best of the facilitators ability and were noted here to pass on to the necessary authorities for consideration.

Session 2 Thursday 12th January 2023

The session started with opening remarks from the chairperson for the session, after which welcoming remarks were brought by Councilor Derrek La Guerre .

Presentations were done by the Water and Sewage Authority (WASA) who did a presentation on the water treatment plants operations and the final product. The University of the West Indies (UWI) presentation focused on the development of the standard and how it affects the farmers as well as other industries targeted, both presentations were done as videos.



The President of the Agricultural Society of Trinidad and Tobago (ASTT) addressed the gathering on Agriculture and how it can benefit from the use of the treated wastewater as well as the benefits and challenges that the industry can face, he also spoke to the current state of the industry and why those present should pay attention to this program and how it will benefit them.

Immediately after the address by Mr. Rampersad the session broke up into focus groups where the following questions were asked:

- 1.) Would you be willing to use the treated wastewater?
- 2.) What is your current means of collecting water?
- 3.) How would you like to access the treated wastewater?
- 4.) Would you be willing to pay for the treated wastewater?
- 5.) Are there any issues or concerns regarding the treated wastewater?
- 6.) Any other questions?

The answers were unanimous by all for each answer provided.

- 1.) Yes we would be willing to use the treated waste water
- 2.) The current means of collection amongst the farmers were harvesting rainwater, pipe borne water, ponds, harvesting water from rivers, and drains, and having water truck delivered to them. The Landscapers all used pipe born water for their work.
- 3.) All farmers agreed that the easiest way to get the treated wastewater was to have it piped to them, however they would use from the riverine system and were willing to collect once the cost was not too high. The Landscapers were all in agreement to



having access to it piped and to collecting at a collection point or having it delivered again once the cost factor was not too high.

4.) All were in agreement that they are willing to pay for the treated wastewater, they also agreed that the cost must be viable to them and not too high.

5.) The concerns stated were as follows:

A.) The safety of use.

B.) The consistency of the water quality.

C.) The price to them.

D.) The availability.

E.) The continuity of delivery once started.

F.) The time frame for the program to be rolled out.

These questions were all answered to the best of the facilitators ability and were noted here to pass on to the necessary authorities for consideration

Session 3 Thursday 12th January 2023

The session started with opening remarks from the chairperson for the session, after which welcoming remarks were brought by Councilor Derrek La Guerre.

Presentations were done by the Water and Sewage Authority (WASA) who did a presentation on the water treatment plants operations and the final product. The University of the West Indies (UWI) presentation focused on the development of the standard and how it affects the farmers as well as other industries targeted, both presentations were done as videos.



The President of the Agricultural Society of Trinidad and Tobago (ASTT) addressed the gathering on Agriculture and how it can benefit from the use of the treated wastewater as well as the benefits and challenges that the industry can face, he also spoke to the current state of the industry and why those present should pay attention to this program and how it will benefit them.

Immediately after the address by Mr. Rampersad the session broke up into focus groups where the following questions were asked:

- 1.) Would you be willing to use the treated wastewater?
- 2.) What is your current means of collecting water?
- 3.) How would you like to access the treated wastewater?
- 4.) Would you be willing to pay for the treated wastewater?
- 5.) Are there any issues or concerns regarding the treated wastewater?
- 6.) Any other questions?

The answers were unanimous by all for each answer provided.

- 1.) Yes we would be willing to use the treated waste water
- 2.) The current means of collection amongst the farmers were harvesting rainwater, pipe borne water, ponds, harvesting water from rivers, and drains, and having water truck delivered to them. The Landscapers all used pipe born water for their work.
- 3.) All farmers agreed that the easiest way to get the treated wastewater was to have it piped to them, however they would use from the riverine system and were willing to collect once the cost was not too high. The Landscapers were all in agreement to



having access to it piped and to collecting at a collection point or having it delivered again once the cost factor was not too high.

4.) All were in agreement that they are willing to pay for the treated wastewater, they also agreed that the cost must be viable to them and not too high.

5.) The concerns stated were as follows:

A.) The safety of use.

B.) The consistency of the water quality.

C.) The price to them.

D.) The availability.

E.) The continuity of delivery once started.

F.) The time frame for the program to be rolled out.

These questions were all answered to the best of the facilitators ability and were noted here to pass on to the necessary authorities for consideration.

Session 4 Thursday 12th January 2023

The session started with opening remarks from the chairperson for the session, after which welcoming remarks were brought by the Chairman of the Siparia Farmers Group.

Presentations that were done by the Water and Sewage Authority (WASA) who did a presentation on the water treatment plants operations. The University of the West Indies



(UWI) presentation focused on the development of the standard and how it affects the farmers as well as other industries targeted, both presentations were done as videos played and discussed by Mr. Rampersad.

The President of the Agricultural Society of Trinidad and Tobago (ASTT) addressed the gathering on Agriculture and how it can benefit from the use of the treated wastewater as well as the benefits and challenges that the industry can face, he also spoke to the current state of the industry and why those present should pay attention to this program and how it will benefit them.

Immediately after the address by Mr. Rampersad the session broke up into focus groups where the following questions were asked:

- 1.) Would you be willing to use the treated wastewater?
- 2.) What is your current means of collecting water?
- 3.) How would you like to access the treated wastewater?
- 4.) Would you be willing to pay for the treated wastewater?
- 5.) Are there any issues or concerns regarding the treated wastewater?
- 6.) Any other questions?

The answers were unanimous by all for each answer provided.

- 1.) Yes we would be willing to use the treated waste water
- 2.) The current means of collection amongst the farmers were harvesting rainwater, pipe borne water, ponds, harvesting water from rivers, and drains, and having water truck delivered to them. The Landscapers all used pipe born water for their work.



- 3.) All farmers agreed that the easiest way to get the treated wastewater was to have it piped to them, however they would use from the riverine system and were willing to collect once the cost was not too high. The Landscapers were all in agreement to having access to it piped and to collecting at a collection point or having it delivered again once the cost factor was not too high.
- 4.) All were in agreement that they are willing to pay for the treated wastewater, they also agreed that the cost must be viable to them and not too high.
- 5.) The concerns stated were as follows:
 - A.) The safety of use.
 - B.) The consistency of the water quality.
 - C.) The price to them.
 - D.) The availability.
 - E.) The continuity of delivery once started.
 - F.) The time frame for the program to be rolled out.

These questions were all answered to the best of the facilitators ability and were noted here to pass on to the necessary authorities for consideration.

Session 5 Thursday 12th January 2023

The session started with opening remarks from the chairperson for the session, after which welcoming remarks were brought by Assemblyman Sonny Craig of the THA.

Presentations were done by the Water and Sewage Authority (WASA) who did a presentation on the water treatment plants operations and the final product. The University of the West



Indies (UWI) presentation focused on the development of the standard and how it affects the farmers as well as other industries targeted, both presentations were done as videos.

The President of the Agricultural Society of Trinidad and Tobago (ASTT) addressed the gathering on Agriculture and how it can benefit from the use of the treated wastewater as well as the benefits and challenges that the industry can face, he also spoke to the current state of the industry and why those present should pay attention to this program and how it will benefit them.

The feature Address was done by Assemblyman and Assistant Secretary Division of Food Security Natural Resources, the Environment and Sustainable Development Nigel Taitt

Immediately after the address by Assistant Secretary Taitt the session broke up into focus groups where the following questions were asked:

- 1.) Would you be willing to use the treated wastewater?
- 2.) What is your current means of collecting water?
- 3.) How would you like to access the treated wastewater?
- 4.) Would you be willing to pay for the treated wastewater?
- 5.) Are there any issues or concerns regarding the treated wastewater?
- 6.) Any other questions?

The answers were unanimous by all for each answer provided.

- 1.) Yes we would be willing to use the treated waste water
- 2.) The current means of collection amongst the farmers were harvesting rainwater, pipe borne water, ponds, harvesting water from rivers, and drains, and having



water truck delivered to them. The Landscapers all used pipe born water for their work.

- 3.) All farmers agreed that the easiest way to get the treated wastewater was to have it piped to them, however they would use from the riverine system and were willing to collect once the cost was not too high. The Landscapers were all in agreement to having access to it piped and to collecting at a collection point or having it delivered again once the cost factor was not too high.
- 4.) All were in agreement that they are willing to pay for the treated wastewater, they also agreed that the cost must be viable to them and not too high.

The concerns stated were as follows:

- 1.) The safety of use.
- 2.) The consistency of the water quality.
- 3.) The price to them.
- 4.) The availability.
- 5.) The continuity of delivery once started.
- 6.) The time frame for the program to be rolled out.

These questions were all answered to the best of the facilitators ability and were noted here to pass on to the necessary authorities for consideration.

Session 6 16th January 2023

The session started with opening remarks from the chairperson for the session, after which welcoming remarks were brought by Mr. Suren Ramkissoon.



Presentations were done by the Water and Sewage Authority (WASA) who did a presentation on the water treatment plants operations and the final product. The University of the West Indies (UWI) presentation focused on the development of the standard and how it affects the farmers as well as other industries targeted, both presentations were done as videos.

The President of the Agricultural Society of Trinidad and Tobago (ASTT) addressed the gathering on Agriculture and how it can benefit from the use of the treated wastewater as well as the benefits and challenges that the industry can face, he also spoke to the current state of the industry and why those present should pay attention to this program and how it will benefit them.

Immediately after the address by Mr. Rampersad the session broke up into focus groups where the following questions were asked:

- 1.) Would you be willing to use the treated wastewater?
- 2.) What is your current means of collecting water?
- 3.) How would you like to access the treated wastewater?
- 4.) Would you be willing to pay for the treated wastewater?
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water truck delivered to them. The Landscapers all used pipe born water for their work.

- 3.) All farmers agreed that the easiest way to get the treated wastewater was to have it piped to them, however they would use from the riverine system and were willing to collect once the cost was not too high. The Landscapers were all in agreement to having access to it piped and to collecting at a collection point or having it delivered again once the cost factor was not too high.
- 4.) All were in agreement that they are willing to pay for the treated wastewater, they also agreed that the cost must be viable to them and not too high.
- 5.) The concerns stated were as follows:
 - 6.) The safety of use.
 - 7.) The consistency of the water quality.
 - 8.) The price to them.
 - 9.) The availability.
 - 10.) The continuity of delivery once started.
 - 11.) The time frame for the program to be rolled out.

These questions were all answered to the best of the facilitators ability and were noted here to pass on to the necessary authorities for consideration.

Outreach Sessions

Whilst these sessions were impromptu meetings held with farmers in the fields it was an easy way to reach the targeted audience with each farmer spending roughly ten minutes in discussions with the various ASTT members that were in the field. The same questions were



asked by the ASTT team after discussing the treatment process and the standard to the farmers.

The questions asked were:

- 1.) Would you be willing to use the treated wastewater?
- 2.) What is your current means of collecting water?
- 3.) How would you like to access the treated wastewater?
- 4.) Would you be willing to pay for the treated wastewater?
- 5.) Are there any issues or concerns regarding the treated wastewater?
- 6.) Any other questions?

The answers were unanimous by all for each answer provided.

- 1.) Yes we would be willing to use the treated waste water
- 2.) The current means of collection amongst the farmers were harvesting rain water, pipe borne water, ponds, harvesting water from rivers, and drains, and having water truck delivered to them. The Landscapers all used pipe born water for their work.
- 3.) All farmers agreed that the easiest way to get the treated wastewater was to have it piped to them, however they would use from the riverine system and were willing to collect once the cost was not too high. The Landscapers were all in agreement to having access to it piped and to collecting at a collection point or having it delivered again once the cost factor was not too high.
- 4.) All were in agreement that they are willing to pay for the treated wastewater, they also agreed that the cost must be viable to them and not too high.
- 5.) The concerns stated were as follows:



- A.) The safety of use.
- B.) The consistency of the water quality.
- C.) The price to them.
- D.) The availability.
- E.) The continuity of delivery once started.
- F.) The time frame for the program to be rolled out.

These questions were all answered to the best of the ASTT's teams' ability and were noted here to pass on to the necessary authorities for consideration.

Thank You

The Projects Committee of the ASTT wishes to take this opportunity to say thank you to the following Persons and institutions that assisted in making the Capacity Building Sessions a huge success. The committee apologises if any persons or institutions name is left out, the order of listing has nothing to do with importance of the person or institution.

- Permanent Secretary (Ag) Ministry of Agriculture Land and Fisheries Mrs. Goolabsingh
- Deputy Permanent Secretary Ministry of Agriculture Land and Fisheries Mrs. Sookdeo
- Ministry of Public Utilities
- The Minister of Public Utilities Hon Marvin Gonzales
- ASTT Secretary Ms. Vashti Persad and the ASTT Staff
- ASTT President Mr. Darryl Rampersad



- ASTT Committee of Management Member Suren Ramkissoon
- Projects Committee Chairman Gregory C Reece
- The University of the West Indies
- The Water and Sewage Authority
- The Water Resources Agency
- The Trinidad and Tobago Bureau of Standards
- The Environmental Management Authority
- All Farmers Associations
- ASTT Committee of Management Member Hansa Lalla
- ASTT Committee of Management Member Beesham Dookie
- ASTT Financial Member Khadijah Rashada
- The Tobago House of Assembly
- Councilor Derrek La Guerre
- The Bon Air West Community Centre
- The Media

REPORTING GUIDELINES

Grant Funding for Small-Scale Integrated Water and Wastewater Management (IWWM) Capacity Building Projects in the Caribbean

Global Water Partnership-Caribbean (GWP-C) in collaboration with the GEF CREW+ and the United Nations Environment Programme (UNEP) Cartagena Convention Secretariat/Caribbean Environment Programme (CEP).

FINAL PROJECT REPORT TEMPLATE

Date: WEDNESDAY 1st FEB 2023
Project Name: CAPACITY BUILDING SESSIONS FOR WASTE WATER REUSE
Grantee Name:
Grantee Contact Person:
Project Value: \$5,000.00 USD
Project Start Date: DECEMBER 1st 2022

1. Participants/beneficiaries

Number of females:

71

Number of males:

233

Number of children:

0

2. Capacity Building/Training

Number of females:

5

Number of males:

5

Number of children:

0

3. Budget and finance

Total Project Cost (USD): \$6,578.17

The amount received under this Agreement (USD): \$5,000.00

The amount received from other sources of funding (USD): -

In-kind Contribution (value USD): \$1,578.17

A. Summary of results achieved

B.

THE SESSIONS REACHED OUT TO 304 PERSONS SUCCESSFULLY COLLECTING DATA, AND BRINGING AWARENESS TO A CROSS SECTION OF PERSONS FROM THE AGRICULTURAL SECTOR, AS WELL AS THE LANDSCAPING, HOTEL, GUEST HOUSES, AND THE REGIONAL, AND CENTRAL GOVERNMENT THROUGH THE DELIVERY OF INFORMATION ON WASTE WATER, COLLECTION, TREATMENT AND THEN REUSE.

THE TECHNICAL DELIVERY WAS DONE BY THE WATER AND SEWAGE AUTHORITY (WASA) THE UNIVERSITY OF THE WEST INDIES (UWI) AND THE MINISTRY OF PUBLIC UTILITIES (MPU), AND THE TRINIDAD BUREAU OF STANDARDS (TTBS).

THE AGRICULTURAL SIDE OF THE PRESENTATIONS WERE DONE BY THE AGRICULTURAL SOCIETY OF TRINIDAD AND TOBAGO (ASTT).

THE QUESTIONS ASKED WERE ALL ANSWERED FAVOURABLY RESULTING IN BUY IN FROM ALL PARTICIPANTS AND THE WIDER COMMUNITIES.

Describe to what extent the objectives of the project were accomplished

THE OBJECTIVES OF THE PROJECT
WERE ALL SUCCESSFULLY ACHIEVED.

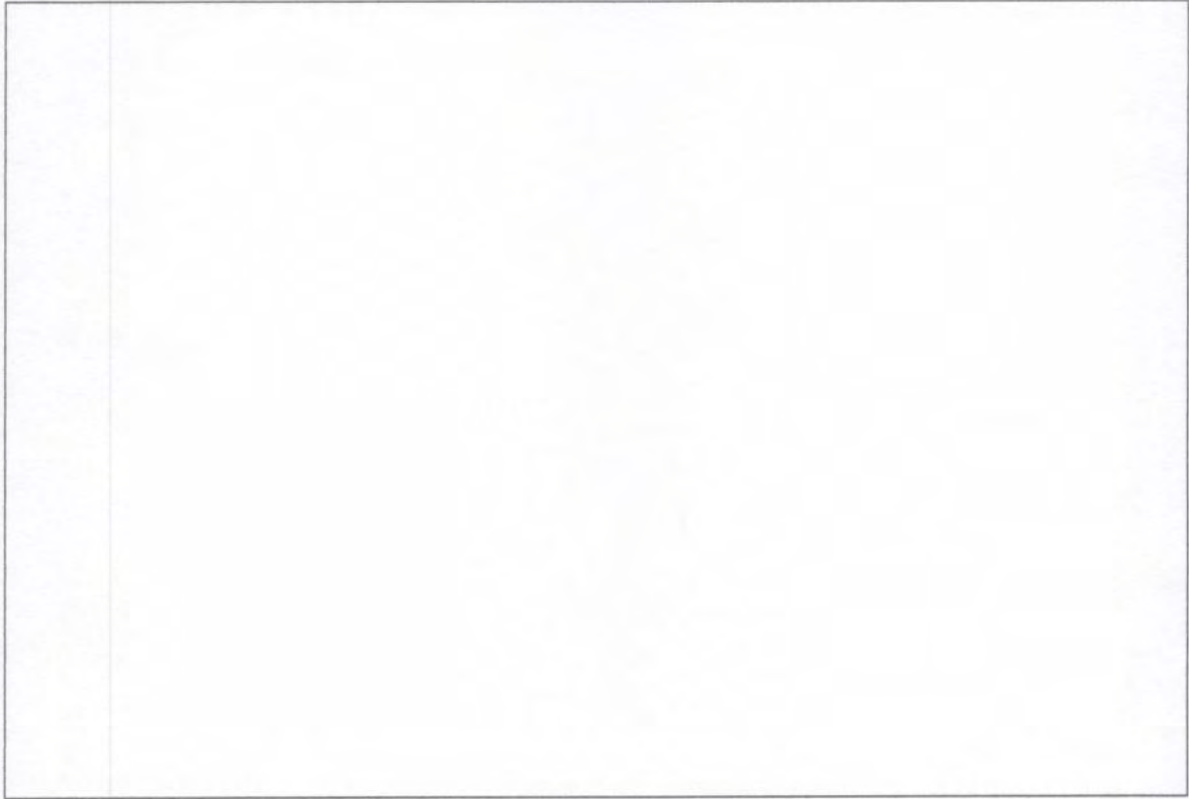
IN THAT THE EXPECTED NUMBER OF
FARMERS WERE SURPASSED AND THE
RESPONSE WAS OVERWHELMINGLY
POSITIVE.

THE INFORMATION WAS DISSEMINATED
AND RECEIVED.

C. Describe the immediate benefits received by the participants and/or the recipient communities

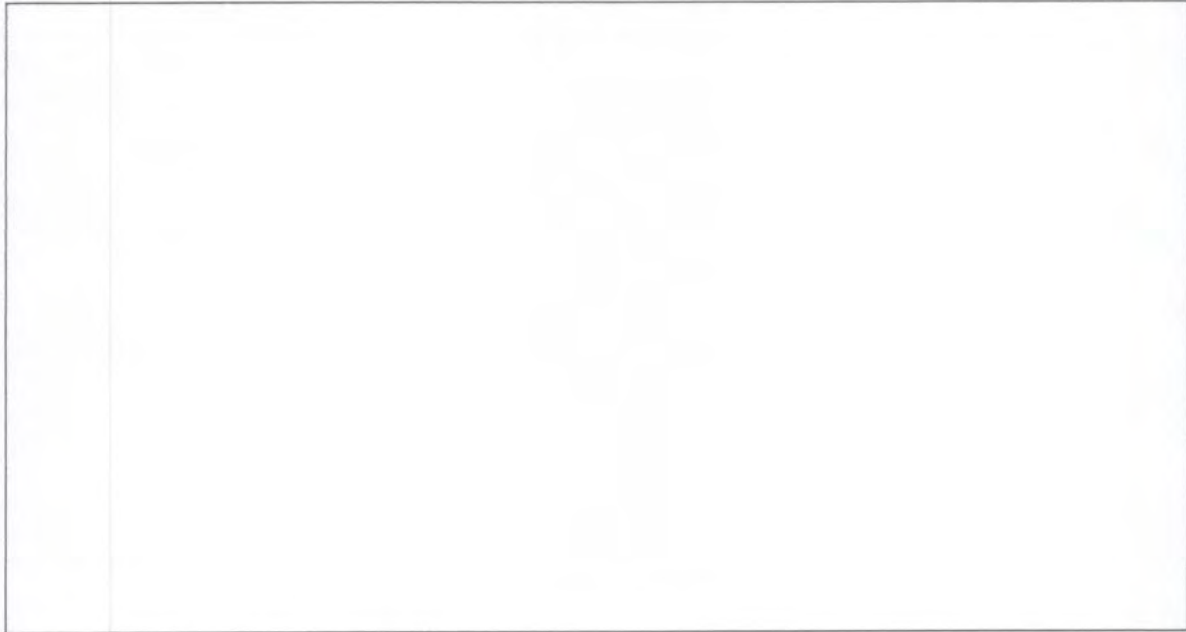
THE IMMEDIATE BENEFIT CAME FROM AWARENESS, CORRECT FACTUAL INFORMATION WAS SUPPLIED CLEARING UP MANY MISCONCEPTIONS AND GETTING BUY IN FROM A WIDE CROSS SECTION OF THE TARGETED AREAS.

SOME FARMERS ARE ALSO ACCESSING THE TREATED WASTEWATER AND ITS BY PRODUCTS SUCCESSFULLY WITHOUT FEAR OR MISCONCEPTIONS

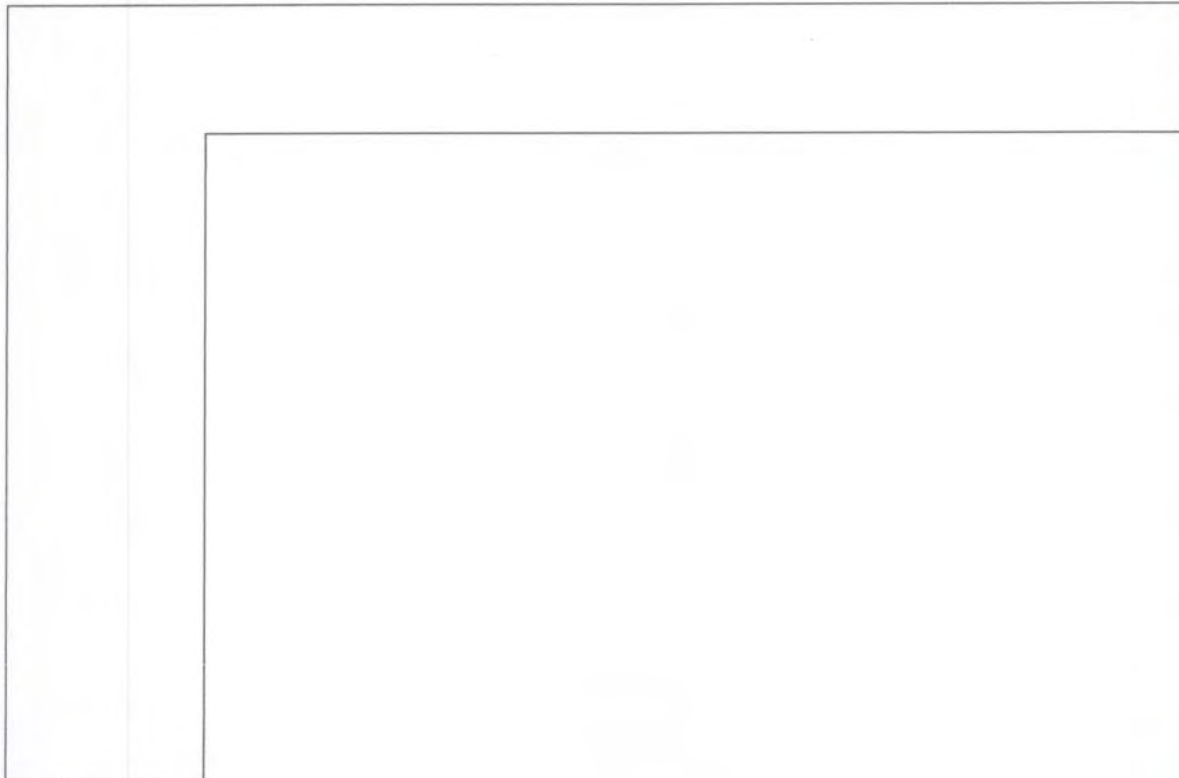


D. Describe long-term benefits

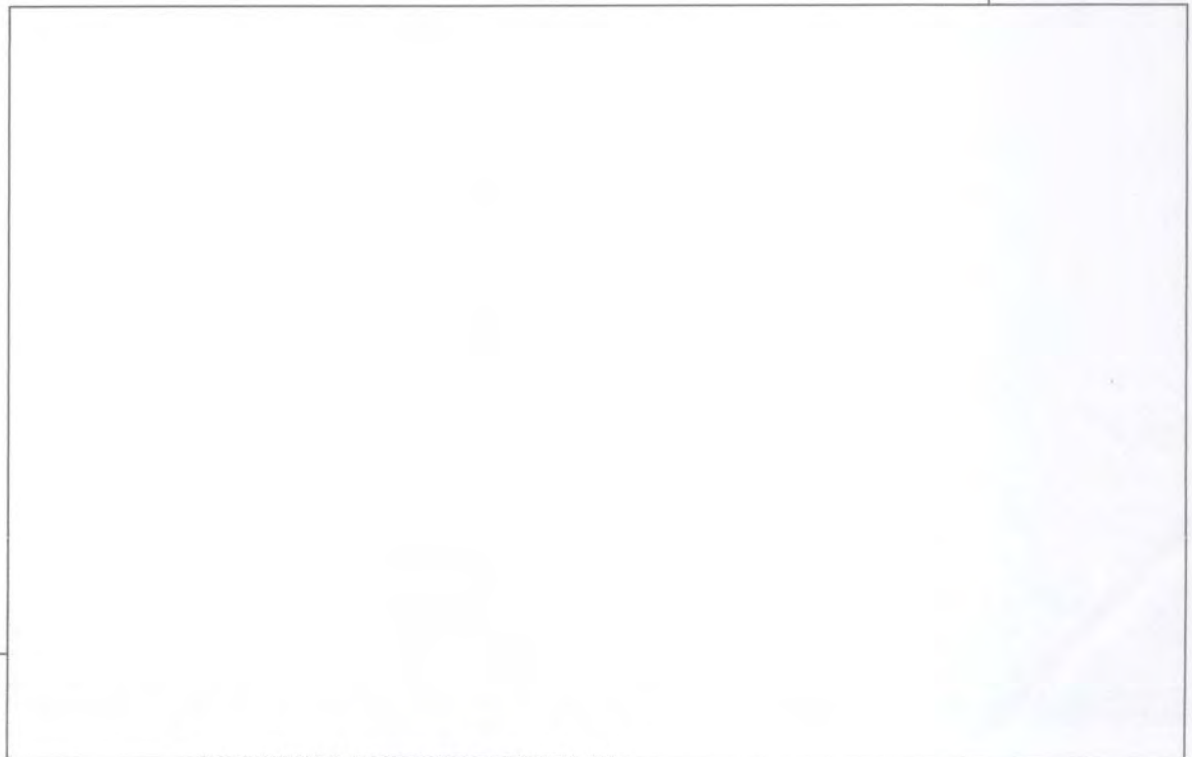
E. New Developments and unexpected difficulties during the implementation of the project



F. Actions taken to solve them



G.



Lessons learned

H. Description of other funding received for this project and how it was used

ALL OTHER FUNDING CAME DIRECTLY FROM THE AGRICULTURAL SOCIETY OF TRINIDAD & TOBAGO AND WAS USED TO FACILITATE AND ENSURE ALL GOALS WERE MET.

I. Final financial report template below

(Please double-click the icon below to access the final financial expenditure report to be completed and submitted with this form.)



FINANCIAL%20REPO
RTING%20TEMPLATE

J. List of accompanying documents

(Please list the accompanying documents related to the project's output; for example, publications, meeting reports, participants list, workshop reports, etc.)

K. Pictures and or videos on project implementation and completion.

Please utilize the following link to upload pictures and/or videos that document the progress of the project's implementation: <https://forms.gle/i3pNV2dpxTAiNQVt5>

Signature:

A handwritten signature in black ink, appearing to be 'G. C. R.' followed by a stylized flourish.

Date:

1-02-2023

Name and title of signing officer:

GABORY C. RICE
PROJECTS COMMITTEE
AST

8.3. One (1) workshop for integrated water and wastewater management in the Caribbean

TECHNICAL AND FINANCIAL REPORT

CAPACITY BUILDING FOR INTEGRATED WATER AND WASTEWATER MANAGEMENT IN THE CARIBBEAN.



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Acknowledgments

Project title:

INTEGRATED WATER AND WASTEWATER MANAGEMENT (IWWM)

Key words:

Summary

A deterioration of water quality has been evidenced in the main river basins of the country, mainly in those of the Pacific slope, an area where most of the population centers are located and where a high percentage of the population resides. This is more pronounced in rivers of metropolitan areas such as Curundú, which in turn presents a vehicular corridor, a protected area, an industrial area, low-income communities, and is channeled to its mouth along its course. The purpose of the study is to impact young university students' understanding of the importance of integrated water management and to promote integrated water and wastewater management planning from the local to the national level. Through the creation of the participatory action research group with the implementation of three training workshops for students. Achieving the formation of critical thinking, which allows linking the factors that influence water resources as a focal point within the implementation of projects. It is expected that this team will be in place for about 3 years in order to continue their training as students of hydrology, providing new knowledge in their careers and future professions water quality and more relevant the importance of caring for the basin.

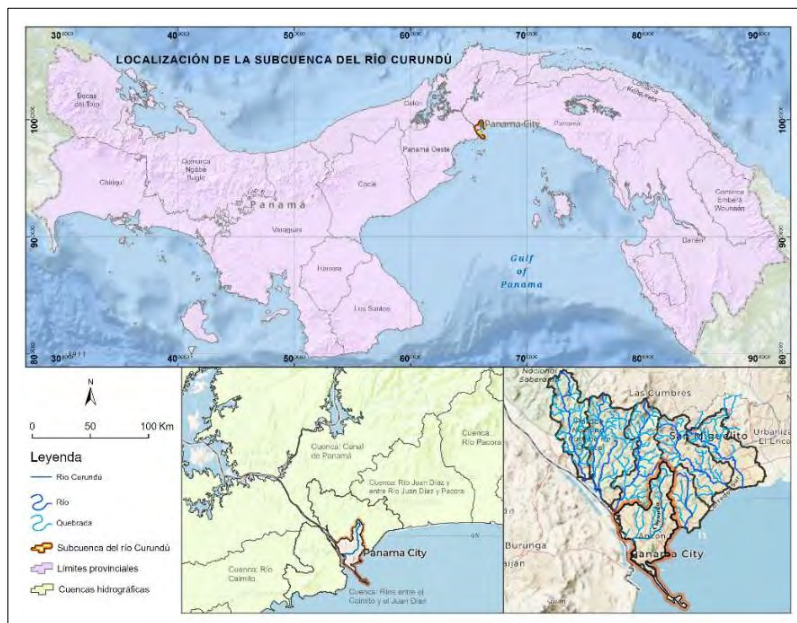


Figure 1: Location of the Curundú River sub-basin.

Benefits and main beneficiaries

Benefits: the creation of a research group trained in integrated watershed management will allow the dissemination of information on water quality and water quantity to groups of primary and university students.

In addition, equipment will be purchased to carry out on-site training in urban or rural areas.

The main beneficiaries are elementary school and university students, who are trained in integrated watershed management through the learning-by-doing technique.

The Metropolitan Natural Park and the UTP are among the beneficiaries. The former because it has become known as a living laboratory on watershed management issues, and the latter because it has acquired equipment that strengthens the training of young university students, who are key to environmental management in the region.

Impact expected

1. Number of UTP students, male and female, who have identified the risk of not applying integrated water and wastewater management in watersheds.
2. Number of people sensitized to the results of the project on integrated water and wastewater management in watersheds.
3. An 8-hour continuing education workshop coordinated by students trained in integrated water and wastewater management in watersheds.

Objectives of the project

Objective general

To impact young university students' understanding of the importance of integrated water management in watersheds by promoting tools to identify key issues and drive integrated water and wastewater management planning from the local to the national level.

The main points of contamination in the Curundú river basin are the following

Specific objectives

1. Create a group of 10 UTP students trained in the importance of integrated water and wastewater management in the Curundú River sub-basin.
2. Generate analytical capacity based on the understanding of the consequences of the lack of integrated water and wastewater management on biodiversity loss, landscape modification, economic and human losses in the impacted area.
3. Promote positive awareness of good integrated management in the Curundú River sub-basin within the UTP university campus.

1. Collaborators of the project

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D. in Agricultural Engineering with mention in water resources in agriculture. Civil and sanitary engineering. Researcher. Faculty of Civil Engineering, Technological University of Panama. Mainly in charge of the flood component, analysis of the environmental and socioeconomic dimension. Average monthly dedication: 25%.

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Master's Degree in Geography and Land Management - University of Costa Rica. Specialist in earth sciences. Bachelor's Degree in Geography - University of Panama.

E-mail: elias.lopez Experiences:

Consultant in Isla Del Rey, Village of San Miguel Arcangel, Pearl Archipelago

-Territorial organization

-Tourism planning

-Integrated coastal management

-Risk management and disaster mitigation Telephone:

- **Alexander Aguirre:**

Master of Science in Forestry Engineering with a true passion for nature Technical Assistant at Metropolitan National Park

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6743-4883

Creation and maintenance of field maps (reforestation, signs, streams, etc.) Creation, supervision and implementation of reforestation projects.

Flora and fauna registration. Site

inspections.

Support in nursery tasks (cleaning, seedling collection, inventory, etc.).

Dealer inspections within the park.

Assistance in educational programs on reforestation, forestry and environment.

• **Yarabí Vega**

Technician/Bachelor's Degree in Geographic Ecotourism E-

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2325552

Experiences:

Gamboa Rainforest Resort giving my service as an ecological tour guide.

Participation in the Metropolitan Natural Park in the area of Flora and Fauna Conservation, environmental education area and tour guide.

Panama Excurions, S.A. accounting assistant, dock assistant, reservation department, operations coordination assistant and other functions.

Volunteer Zummit Zoo and botanical garden, Metropolitan Park and ANAM. Currently working as PNMVolunteer Sea shepherd land Panama.

2. Methodology



Figure 2: Methodology diagram

2.1 Area of study

2.1.1 Selection of the area of study

Several points adjacent to the Curundú River were selected for the study, those that in alliance with the Metropolitan National Park were visited during the organization and development of the project. These points are located near residences, commercial premises and factories, being the water quality of the riverbed the focal point of the research.

2.1.2 Description of the area of study

The Curundú River basin flows in a northwest direction, has its source in the Ancón region, north of the Dr. Víctor Levi Sasso Campus of the Technological University of Panama. It is located at an altitude of 79.65 masl, within the coordinates 90 01'N, 790 32'W and 80 57' N, 790 33' W. The entire Curundú river basin constitutes 17.6 km, where the average annual temperature is 28° C and the average annual precipitation is 1740 mm (See Annex 1).

The area has a dry season that generally runs from December to April and a rainy season from May to November. However, the current El Niño phenomenon has affected these characteristics, as the dry season has extended into June.

This watershed has 1250 hectares, running from its source regions in the Camino de Cruces National Park through Panama City to its mouth in Panama Bay, where it discharges at a rate of 573.57 cm^3/s . As the Curundú River winds its way to the ocean pacific passes through the districts of Belisario Porras, Ancon, Amelia Dennis de Icaza, Bella Vista, Curundú, Calidonia and Betania and the neighborhoods of Curundú, La Locería, Dos Mares, Altos de Chase, Villa de las Fuentes 1 and 2, Calidonia, where it is crossed by a vehicular corridor, a protected area, an industrial area, marginal communities, and is channeled to its mouth.

Along the river there are discharge points for solid waste, hospital waste, untreated sewage, chemical and industrial waste, as well as changes in land use without land use planning increase the risk of loss of forest cover and contamination of the area's water resources, which, together with the impacts of climate change, aggravate the risk of loss of the sub-basin's hydrological functions. These risks increase urban vulnerability, affecting the quality of life of the inhabitants exposed to the consequences of biodiversity loss.(Medianero, E., & Samaniego, M.,2004) (Wilson, E. M. W., 2019).

Flora

The river is located in a life zone of Tropical Rainforest, around it you can find from bushes to trees that are at a height between 20 - 40 meters high,

such as: Anarcadiaceae, Moraceae, Sapotaceae, Annonaceae, Burseraceae, Cecropiaceae, Fabaceae, Rubiaceae, Tiliceae, Muntingiaceae, Meliaceae, Combretaceae, among others.

In contrast to the urban area and industrial regions surrounding the river in Panama City, its upper reaches are located in a region of tropical rainforest with savanna vegetation, grasslands such as espave, cuipo, barrigón, Panama and other plants.

Fauna

Regarding the fauna of the Curundú River basin, you can find lots of macroinvertebrates, fish, alligators, turtles, but these disappear as you drive towards the lower basin. Also in its leafy trees you can observe a great biodiversity from marmoset monkeys, single cats, squirrels, howlers, iguanas, birds and a wide range of insects.

2.2 First stage. Diagnosis of the site

2.2.1 Collection and analysis of data from studies.

For the development of the project, data from studies previously conducted in the sub-basin were collected and analyzed, using bibliographic search tools and geographic information systems (GIS) in order to build both visual and referential characteristics previously existing in the site, as a guide for further exploration.

2.2.2 Formation of a group of students

The methodology of participatory action research is a didactic strategy where two processes coexist: knowing and acting, which through sequential actions start from a situation capable of being solved with different resources or activities, allowing perfectionism and constant enrichment (Padrón Alvarez et al., 2022). In turn, it helps to understand and analyze reality in a better way, enhancing reflection, planning and implementation of actions aimed at continuous improvement and significant transformations of aspects that require change (Colmenares E., A., 2012).

We investigated how watershed degradation is addressed with the approach of each gender, male or female. What is their understanding of what integrated water and wastewater management is?

What are the evacuation ideas that each one has regarding the implementation of integrated water and wastewater management (Caprile, M., 2012).

2.2.3 Elements of analysis at field

The variables chosen for the analysis of the Curundú River sub-basin describe the physical-chemical behavior of water quality, being functional material for watershed planning and in turn for sustainable development focused on the equitable division of all the aspects that make it up, i.e. Environmental, Economic and Social.

The physical and chemical indexes are based on a mixture of parameters that provide information on nature in relation to its chemical characteristics and physical properties, providing information on the effects and risks to both humans and wildlife surrounding the surface water body. (Gil-Mora, J.E, 2022).

In order to provide a scenario, data were collected on physical parameters such as hydrogen potential, electrical conductivity, temperature, turbidity, and chemical parameters such as dissolved oxygen, nitrates, phosphates and biological oxygen demand.

A program of activities was developed in conjunction with entities of the Metropolitan National Park where equipment and inputs are used to determine some of the biological, physical and chemical parameters of the water within the park.

Finally, the first report is discussed with the results obtained in the first stage of the analyses comparing the biological, physical and chemical parameters of water quality with the values of the standard.

2.3 Second stage. Programming.

For the scientific study of the Curundu River basin, activities are organized for the analysis of water quality parameters in the middle part of the basin.

2.3.1 Description of study points

1-La Amistad Bridge

(Latitude: 660517, longitude: 995725)

This point is surrounded by commercial and residential areas that can be seen from this sample site. The water is relatively clear, although a certain amount of trash can be seen around this stretch of the river.

At the site, 2 wastewater discharges from the businesses located in the continuous plaza were observed.

It has a diverse vegetation with a wide solar penetration.

Point 2- La Alameda

(Latitude: 660421, Longitude: 995241)

This site is located in a purely residential area, where a direct discharge of water from existing sewage drains could be observed, approximately 6 meters from where the sample was taken. Also, traces of oil were observed in parts of the river.

Item 3- The Locería

(Latitude: 660504.80, Longitude: 994785.10)

At site 3, sampling took place around residential areas, where sewage discharges were observed from residential areas adjacent to this stretch of the Curundú River; however, it is presumed that the discharges do not come only from the residential area. In addition, it should be noted that there is fauna present at the site, which shows the tolerance capacity of some species to the existing fluids.

Some taller trees grew in the area, which allowed a higher sun penetration of 50% to 60%.

The garbage coverage observed was 40-50%, as there were parts of furniture and household appliances in the river, where contamination was visibly evident.

Item 4 - Old Veranillo

(Latitude: 660709.70, Longitude: 993944.20)

This point is surrounded by many houses and recreational areas. The water remains gray and opaque with a foul odor. A brown effluent is also attributed to the watercourse at this point, from a small tributary formed by a pipe from a factory near the site. Lower vegetation such as shrubs, grasses and a few trees were present in the upper reaches.

The closed margins caused erosion and sunlight penetration was 100%. Many large black birds were observed, as well as an abundance of insects.

This site has the most contamination from solid waste, which was distributed from larger pieces of wood, as well as a refrigerator, a stove and bags of garbage, obstructing the natural flow of the river.

2.3.2 Analysis of samples, texts and reports

Published information and scientific research conducted on the Curundú River were investigated in order to determine multitemporal variations in environmental factors, specifically the physicochemical characteristics of the river's waters.

2.3.3 Realization of workshops.

The training was divided into three workshops, attended by a group of students from the University of Panama's Water Resources program, personnel from the Metropolitan National Park, and students from the Technological University of Panama with careers related to water sciences, where the objective of training a multidisciplinary group was achieved, as well as complementing the knowledge of each expertise.

2.4 Third stage. Conclusions and proposals.

2.4.1 Negotiation and preparation of concrete proposals .

It was agreed to prepare, together with the administrative entities of the Metropolitan National Park, a proposal that includes information describing the diagnosis of the current state of the riverbed, the key actors for its management, and possible programs involving joint participation with civil society, such as the construction of the Integrated Action Program (PAI).

2.5 Integration of research objectives for the promotion of knowledge.

The integration of the results will be carried out by calculating the indicators of the research project with the integration of the RAP results and the contrast of an integrated water and wastewater management.



Figure 3: Sampled points of the Curundú River Basin.

3. Activities developed

3.1 Compilation of information

3.1.1 First meeting

It will be held on April 13, 2023 with Dionora Viquez, Director of the Metropolitan Natural Park, and her staff at its facilities.

The generalities of the project, objectives, scope, methodology, among others, were presented through a visual presentation in power point. After the presentation, a space was opened for the exchange of ideas to develop the topic.

Finally, the research group formally liaised with the national authorities to ensure their assistance and participation in the activities to be carried out throughout the project.

3.1.2 Second meeting

It will be held on April 19, 2023 at the facilities of the Metropolitan Natural Park where the research group, Engineer Alexander Aguirre and Yarabi Vega will attend.

The work team travels to the site by uber in the morning to the offices of the Metropolitan Natural Park in order to review background information on previous research conducted on the Curundú River within the park.

After the feedback from the professionals to the student trainers, there was an exchange of ideas, suggestions and information according to their knowledge and experience in their respective areas with respect to the project.

3.1.3 Third meeting

It will be held on April 26, 2023 at the facilities of the Metropolitan Natural Park where the research group, Engineer Alexander Aguirre and Yarabi Vega will attend.

The work team travels to the site by uber in the morning hours to the offices of the Metropolitan Natural Park to coordinate activities and review the equipment to be used in the next water quality monitoring of the Curundú River.

Finally, modifications are made to the schedule of activities for the start of field work.

3.2 Constitution of the Group PAR.

The Peer Group was formed through the collaboration of the Technological University of Panama; Magister Elías López, Dean of the Faculty of Engineering of the University of Panama (UP); and Dionora Viquez, Director of the Metropolitan Natural Park, who together convened students from these universities.

3.3 Introduction of elements of analysis

It is important to ensure that people have access to safe drinking water. In addition, monitoring water quality can help researchers predict and learn about the natural cycling of water in the environment, as well as determine human impacts in the process.

Through a meeting with the work team, physical and chemical parameters selected based on the use and disposition of the water quantity and quality equipment were unified for this study. These parameters were used as indicators of the presence of contaminants, as fundamental tools to determine the quality of the surface water of the Curundú River.

3.4 Beginning of the work of field

The research group in the morning hours of May 3, 2023 approaches the facilities of the Metropolitan Natural Park from the Technological University of Panama. Then, they go with the Engineer Alexander Aguirre to the lagoon located within the grounds of the Metropolitan Natural Park.

Upon arrival at the site, several water samples are collected from the lake and placed in containers; some samples are analyzed on site.

The remaining samples are brought to the laboratory of the Metropolitan Natural Park and analyzed using the necessary reagents and equipment.

Finally, the research group together with Engineer Alexander Aguirre held a discussion to exchange information on what was learned, experience gained and results obtained.

3.5 Submission and discussion of the first report

In the morning, the Research Group meets at the Rosendo Taylor Meeting Room of the Technological Faculty of Panama to discuss the first report of the diagnostic stage.

We begin by presenting the results of the analysis of the parameters obtained from the water sample collected in the Metropolitan Natural Park. These samples are then compared with the standard to determine if they are outside or inside the established range or value.

3.6 field work

A chronogram is made selecting the 4 days that the samples will be taken in 4 different points of the middle basin of the Juan Díaz River, being these:

- Point 1-La Amistad Bridge
- Point 2- La Alameda
- Item 3- The Locería
- Item 4 - Old Veranillo

The days selected for sample collection are Wednesdays of each week for four weeks, corresponding to Wednesdays, May 17, May 24, May 31 and June 7, 2023.

Departure at 7:30 am from the Technological University of Panama to the Metropolitan Natural Park. Upon arrival at the site, the equipment and supplies to be taken for the collection and analysis of the sample are prepared.

The research team is accompanied by the park ranger assigned to the Metropolitan Natural Park and Engineer Alexander Aguirre.

Upon arrival at Point 1-Puente La Amistad, the river is approached to collect the sample. The sample is placed in two containers, one container is analyzed on site and the other container is placed in the cooler. This is done successively at Point 2, Point 3 and Point 4.

After visiting the 4 points, we proceed to return to the Metropolitan Natural Park and analyze the parameters of the sample stored in the cooler at each point in the laboratory, and the results of each point are placed in a table.

This procedure was carried out during the 4 days assigned to collect the samples.

3.7 Text analysis and speeches.

The research team extracted the values obtained from the water quality parameters and created a table with the average values according to each parameter.

They grouped the average values of the four measured parameter points, corresponding to pH, nitrates, phosphates and dissolved oxygen and created a graph to analyze their results in comparison with the parameters of the maximum values.

They also grouped the average values of the four points of the measured parameters corresponding to conductivity, total dissolved solids, turbidity and created a graph and analyzed their results in comparison with the parameters of the maximum values.

3.8 Delivery and discussion of the second report.

The research team meets in the common area to perform the different analyses.

We proceed to extract the data for the year 2009 and 2017 from the published information and scientific research conducted in the Curundú River obtained in point 2.1 (Data collection); a table of the average values obtained in point 3.6 (field work) from the sampling at the 4 points is also made.

Then, a table is created including data from 2009, 2017 and 2023 (current) and an analysis is performed in comparison with the values of the standard.

3.9 Realization of workshops

3.9.1 Workshop 1

On Friday, June 30, 2023, the Research Group went to the facilities of the Technological University of Panama, for the subsequent transportation of the necessary supplies to carry out the activity in the facilities of the Metropolitan Natural Park.

Workshop 1 was attended by members of the PAR group made up of students from the Water Resources program of the University of Panama, staff from the Metropolitan National Park and students from the Technological University of Panama from the Civil Engineering, Environmental Engineering, Geological Engineering and Geomatics Engineering programs.

The workshop was subdivided by basing the training on:

- First section: Watershed management
- Second section: Water quality

This information was presented by the Hydrology of Forests and Urban Waters Research Group, and in turn, a discussion was held with the participants where a diversity of opinions was generated on the best way to manage a watershed and the importance of generating a baseline of the physicochemical status of a watercourse.

At the end of the workshop, the participants were offered lunch.

3.9.2 Workshop 2

On Wednesday, July 12, 2023, the Research Group went to the facilities of the Technological University of Panama, for the subsequent transportation of the necessary supplies to carry out the activity in the facilities of the Metropolitan Natural Park.

The workshop was subdivided by basing the training on:

- First section: Theoretical part on the procedures to perform the analysis of water quality parameters.

The research team was introduced to important concepts of water quality, sampling methodology and regulations in the Republic of Panama for the study of water quality.

- Second section: field work to obtain the sample.

The participants were divided into subgroups to perform the preparation of the measuring implements such as: Cooler, labeling and arm.

Staff from the Metropolitan Natural Park accompanied the group to part of the Curundu River that flows through its facilities. Next, collaborators from ITS Technologies demonstrated the instruments used to measure physicochemical parameters in the field.

Each subgroup performed the sample collection by the arm method, where the pipette method was used to obtain smaller parts of the original sample in sealed 25ml containers.

- Third section: Analysis of results

Back in the main room, each subgroup measured their chemical parameters with the kits provided by the research team, and then discussed and presented their results with the other groups, in order to achieve better learning retention by applying theory over practice.

Afterwards, group members are provided with lunch.

To conclude this workshop, the director of the Metropolitan Natural Park, Dionora Viquez, expressed her gratitude and encouragement to the workshop participants for being part of such an important project of the Universidad Tecnológica.

3.10 Construction of the Comprehensive Action Program (PAR).

Participatory action research (PAR) is a method in which two processes participate and coexist: to know and to act; therefore it favors social actors to know, analyze and better understand the reality in which they are immersed, their problems, needs, resources, capacities, potentialities and limitations; the knowledge of that reality allows them, in addition to reflect, plan and execute actions tending to improvements and significant transformations of those aspects that require changes; therefore, it favors awareness, the assumption of concrete and timely actions, empowerment, collective mobilization and the consequent transforming action" (Colmenares E., A., 2012)

3.11 The integration of the results will be carried out by calculating the indicators of the research project with the integration of the RAP results and the contrast of an integrated water and wastewater management.

1. Number of male and female students who have identified the risk of not applying integrated water and wastewater management in watersheds:

The call was made by Dr. Haydée Osorio Ugarte; Magister Elías López, Dean of the Faculty of Engineering of the University of Panama (UP); Licenciada Dionora Viquez, Director of the Metropolitan Natural Park to the students of the Technological University of Panama, students of the University of Panama and members of the Metropolitan Natural Park (See Annex 9, Table 5).

There were 26 people who identified the risk of not applying integrated water and water and wastewater management in watersheds; 18 students, 10 men and 17 women.

2. Number of people sensitized to the results of the project on integrated water and wastewater management in watersheds.

In addition to the 26 people who identified the risk of not applying integrated water and wastewater management in watersheds, we can mention the authorities of the Technological University of Panama, University of Panama, staff of the Metropolitan Natural Park, friends and relatives of all those members of the PAR group.

3. An 8-hour continuing education workshop coordinated by students trained in integrated water and wastewater management in watersheds.

Two workshops were held at the Metropolitan Natural Park, each lasting 5 hours, and a final event lasting 4 hours at the Rosendo Taylor Meeting Room of the Technological University of Panama.

4. Results of the stage

4.1 Compiled from Information.

4.1.1. First meeting

A space was opened for members of the Metropolitan Natural Park and members of the research group to express new ideas for the training of students interested in natural resources and to be carriers and disseminators of information.

To facilitate the development of the research, agreements were made between both parties where the director, Dionora Viquez, provided us with the facilities of the Metropolitan Natural Park, scientific equipment and the collaboration of its professionals.

Note: See Annex 1 (First meeting)

4.1.2 Second meeting

During this meeting, basic information was presented about the Metropolitan Natural Park and the research work and theses that have already been completed on its facilities dating back to 1990.

The research group receives information on the importance of water quantity and quality parameters, interpretation of parameter values and their importance (See Annex 1, second meeting).

4.1.3 Third meeting

The professionals of the Metropolitan Natural Park, Engineer Alexander Aguirre and Yarabí Vega, trained the work team in the handling of the water quantity and quality analysis equipment.

Note: See Annex 1 (Third Meeting)

4.2 Constitution of the group PAR

The constitution of the participatory action research group was created with students from the University of Panama (UP) from the Water Resources career and students from the Technological University of Panama from Civil Engineering, Environmental Engineering, Geomatics Engineering and Geological Engineering, thus forming a multidisciplinary group.

The trainers of the PAR Group on behalf of the Technological University of Panama was the Research Group and on behalf of the Metropolitan Natural Park were Engineer Alexander Aguirre and Yarabí Vega, thus training more trainers whose mission is to continue training more people and to continue training more trainers of trainers.

Members of the Participatory Action Group (See Annex 2).

4.3 Introduction of elements of analysis.

Sampling was carried out based on parameters that were previously selected by the work team according to the use and disposition of the water quality and quantity equipment, such as temperature, pH, conductivity, total dissolved solids, dissolved oxygen, nitrates and phosphates, which are basic indicators that allowed determining the contamination levels in the lagoon within the Metropolitan Natural Park and in the Curundú River.

4.4 Beginning of the work of field

The samples obtained were analyzed to determine the values of the different biological, physical and chemical parameters of the water within the Metropolitan Natural Park and compare them with the parameters of the standard.

The equipment and supplies were used by the research group in order to practice and to provide them with the knowledge and information obtained during the training in the different workshops.

4.5 Submission and discussion of the first report

The results obtained show that the parameters analyzed are fundamental to determine water contamination, so it was decided to use the parameters analyzed for sampling at different points in the middle basin of the Curundú River.

4.6 field work

During the days to be sampled, the tasks were distributed among the Research Group for the best performance at the time of sampling. Before starting the monitoring, cabinet work was carried out in which the containers were selected, washed and labeled. In addition, the equipment for the measurement of physical parameters was prepared, as well as the cooler with ice, sampling arm and materials for the subsequent cleaning of the equipment; it is worth mentioning that all the preparation was carried out in the facilities of the Natural Park during the 4 days stipulated for the point sampling.

Sample collection was carried out for four weeks and the research group was able to successfully complete it (Annex 3).

4.7 Text analysis and speeches.

A table was created with the average values according to each parameter (Annex 5, Table 1).

The maximum values presented mostly in point 4 of the Viejo Veranillo Sector are closely related to the unplanned development around the water body, given the existence of industries close to the watercourse, such as the brewery industry.

It is assumed that, being the highest point sampled in the basin in this study, the minimum values are proportional to point 1 of La Amistad Bridge.

Taking into account the classification for determining the good ecological status of rivers, according to the European Commission's Water Framework Directive 2000/60/EC, the maximum allowable values for the parameters are shown (Annex 5, Table 2).

The nitrate parameters are below the maximum value, without exceeding the 8 mg/L concentration, on the contrary, the phosphate values are well above the threshold value, being the highest at point 4 of Viejo Veranillo. Regarding pH, all values are within the range, so that it complies with the maximum and minimum values. Finally, a disproportion can be observed between the values obtained and the maximum value for dissolved oxygen, which are well below the recommended values.

In Annex 5, Table 1, Graph 1 and Graph 2, it can be seen that the point that most frequently presented higher values than the others was point 4, belonging to the sampling in the Viejo Veranillo sector, while for the minimum values, in some parameters, the lowest values correspond to point 1 of the La Amistad Bridge.

4.8 Delivery and discussion of the second report.

Within the Curundú River channel, despite the fact that not so many studies have been conducted, there is data from previous research conducted in 2009 for the Bay Sanitation Project conducted by the Ministry of Health and data provided by the Metropolitan National Park from 2017 (Annex 6, Table 4), both focused on physical-chemical parameters (Fernández, 2019).

Using these data, a comparison has been made to observe the changes that have occurred over the last 15 years (Annex 6, Graph 3 and Graph 4).

For pH values (Annex 6, Graph 3), despite remaining within the recommended ranges, a slight decrease is noted for the same. While the presence of dissolved oxygen has been relatively variable over time, having values of 0 ppm for 2009, 4.8 ppm for 2017 and 1.13 in 2017, this parameter determines the existing life capacity of the habitat, therefore, the lower the amount of dissolved oxygen, the lower the life capacity for aquatic species. (Cupil Díaz, Alan, 2015).

For the parameters of conductivity and dissolved oxygen, there has been a decrease in the first parameter and an increase in the second between 2009 and 2023, it is important to remember that these parameters are related to each other, since the higher the value for conductivity, the greater the presence of dissolved solids (Cupil Diaz, Alan, 2015).

4.9 Realization of workshops

4.9.1 Workshop 1

During the training, aspects such as the definition of "watershed", formation of a watershed, elements of a watershed, importance of studying watersheds, evolution of watershed management, world organizations focused on watershed management, watershed management in Panama, background of the Curundú River watershed were highlighted.

The first section provided general knowledge about general concepts of a watershed, elements of a watershed, its function within the ecosystem, the evolution of integrated watershed management and the main actors that finance watershed management studies.

The second part of the workshop focused on the presentation of the project developed by the Research Group, which showed the methodology applied, the characterization of flora and fauna, results obtained at each monitoring point and guidance on the relevance of the creation and implementation of a management plan in urban watersheds.

See Annex 7 - Workshop 1

4.9.2 Workshop 2

During the training, aspects such as definition of water quality, importance of water quality, Panamanian legal framework for taking samples for water quality analysis, types of parameters (biological, physical, chemical), measurements of the types of parameters, Panamanian legal framework for water quality in surface bodies, field workshop for demonstration of measurements and practical use of direct measurement equipment and kits were highlighted.

The objective of workshop 2 was to train the group formed in the collection and measurement of water quality, whose attendees were the members of the PAR group formed by students of the Water Resources career of the University of Panama, staff of the Metropolitan National Park and students of the Technological University of Panama from the careers of Civil Engineering, Environmental Engineering, Geological Engineering and Geomatics Engineering.

The collection of samples for each subgroup was done by the arm method, where the pipette method was used to obtain smaller parts of the original sample in sealed 25ml containers for the practice of chemical parameters (dissolved oxygen, phosphates, nitrates and turbidity) by means of field kits. Also, the original sample was used to measure physical parameters such as TDS, conductivity and pH.

See Annex 7 - Workshop 2

4.10 Construction of the Comprehensive Action Program (PAR).

Project collaborators were provided with information through the workshops held to provide information and identify people with organizational and participatory skills, characteristics of community leaders. These workshops will allow the linkage with the population for future training sessions in which the importance of the development of the social component and the use of equipment to be used during the project will be explained.

4.11 The integration of the results will be carried out by calculating the indicators of the research project with the integration of the RAP results and the contrast of an integrated water and wastewater management.

1. Number of male and female students who have identified the risk of not applying integrated water and wastewater management in watersheds:

Those who identified the risk of not applying integrated water and water and wastewater management in watersheds were 25 people from the Technological University of Panama, University of Panama, Metropolitan Natural Park and ITS Technologies company; 18 students, 9 men and 17 women.

All these people were integrated during the 6-month period of the project where they gained a great and important knowledge through the different trainings on the importance of applying integrated water and wastewater management in watersheds.

The deterioration of watershed functions has important negative consequences, mainly in the reduction of water quality and the loss of aquatic habitat and biodiversity; therefore, one of the practical trainings was to carry out sampling for the analysis of water quality parameters.

2. Number of people sensitized to the results of the project on integrated water and wastewater management in watersheds.

The Technological University of Panama and the University of Panama were among the main beneficiaries in raising awareness of the results of the project on integrated water and wastewater management in watersheds, since they now have trained students who are information bearers in order to disseminate and train others.

The members of the Metropolitan Natural Park who participated in this process and hosted the trainings and workshops, being an important part as trainees and trainers.

As the main mission of this project to train people to become trainers starting mainly by their environment, family, friends, colleagues, among others. Disseminate the information obtained to identify the risk of not applying integrated water and wastewater management in watersheds.

3. An 8-hour continuing education workshop coordinated by students trained in integrated water and wastewater management in watersheds.

Two 5-hour workshops were held in the Metropolitan Natural Park, the first one was composed of information on the risk of not applying integrated water and wastewater management in watersheds and the second workshop was to put this knowledge into practice, mainly in the analysis of water quality parameters where the contamination in the middle part of the Curundú River Basin is evident. This gives us an important warning that we must take measures to combat this contamination.

5. Dissemination strategy of project



Figure 4: Project disclosure

During the development of the integrated water and wastewater management project, the subject matter has been actively disseminated, making known its objectives and the importance of water resources as an important factor in the environment.

A WhatsApp group has been created with the members of the group in order to publish important information regarding the topic and for them to be information carriers for their classmates and community in general.

We participated in the SRI 2023 scientific open house event and in the climate change day 360: Communicating climate research and action, and we expect to present the progress of the ongoing project at the APANAC national scientific congress.

6. Conclusions and recommendations

The creation of the group trained on the importance of integrated water management in watersheds promotes positive knowledge about good integrated management in the Curundú River sub-basin. At the same time, it generates an analytical capacity to understand the consequences of the lack of integrated water and wastewater management on the loss of natural resources.

The group formed is able to identify the risk of not applying integrated water and wastewater management in watersheds and the importance of raising awareness. In addition to promoting responsibility to society for the proper management of natural resources. Therefore, they are able to transmit their knowledge and be trainers of future generations in the awareness of integrated water and wastewater management in watersheds.

Water contamination was detected at the points sampled in the upper, middle and lower parts of the Curundú river basin as a result of wastewater discharges from businesses located in the continuous square, water discharges from existing sewage drains, sewage discharges from residential areas bordering the Curundú river and discharges from the normal flow of the river.

Within the Curundú river basin there are two regions that are part of the National System of Protected Areas (SINAP) of the Ministry of the Environment. One of them is the Metropolitan Park, which is defined as a Natural Monument and carries out projects and actions for the protection of the water resource, which is why we are liaising with this institution for future projects and training, where they are provided with an optimal education on everything related to the environment and its surroundings.

It is recommended to continue the PAR group, where future environmental projects, thesis or field practice can be developed, generating researchers and professionals involved with the environment. In addition, the Metropolitan Natural Park recommends in conjunction with the research group Urban Forest and Water Hydrology the realization of an Integral Action Program for the Curundú River sub-basin, as an area of study of interest.

The activities planned for the next 3 years are as follows:

2024 - Installations of a basic network of camera traps associated with the baseline water quality established with the previous fund. These camera traps will be located in the protected areas adjacent to the Curundu watershed, the watershed analyzed in this project.

2025 - Expansion of the network of camera traps associated with water quality to a basic hydrological network for the association of water quantity as a determinant of the water quality - water quantity binomial.

2026 - Design of restoration actions based on the hydrology of the study watershed.

Camera traps, which are a tool that allows us to learn about biodiversity and detect stealthy or nocturnal species, will be very useful to learn about species activity patterns, estimate abundance and population densities.

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8. ANNEX

Annex 1: Collection of information

First Meeting



Figure 5: Members of the Metropolitan Natural Park and Research Team



Figure 6: Project Presentation



Figure 7: Brainstorming

Second meeting



Figure 8: Presentation of previous research



Figure 91: Research group



Figure 10: Engineer Alexander Aguirre: from the Metropolitan Natural Park

Tercera reunión



Figure 11: Adjusting the Schedule of Activities



Figure 12: Review of equipment and supplies



Figure 13: Handling equipment

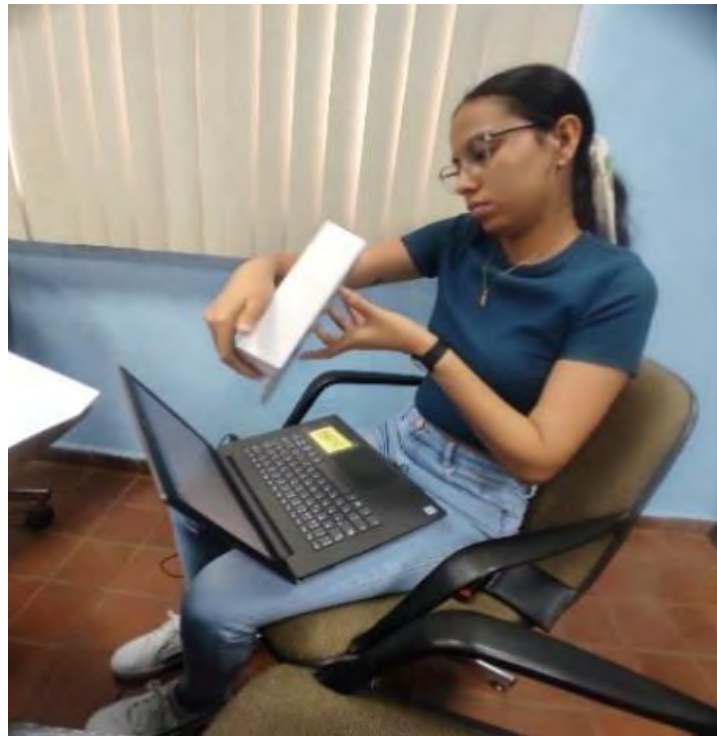


Figure 14: Inventory of equipment and supplies

Annex 2: Establishment of the Participatory Action Research Group



Figure 15: Participatory Action Research Group



Figure 16: Ms. Yarabí Vega (left), Ms. Alexander Aguirre (right)

Annex 3: Start of fieldwork



Figure 17: The research team on their way to collecting the samples



Figure 18: Sample collection



Figure 19: Samples analyzed on-site



Figure 20: Saving the analysis samples in the lab



Figure 21: Analysis of samples in the laboratory



Figure 22: Discussion of information

Annex 4: Fieldwork



Figure 23: On-site sample analysis



Figure 24: Water sampling at Point 1-La Amistad Bridge



Figure 25: Access to Point 2-La Alameda



Figure 26: Point 2-The Alameda



Figure 27: Point 3 - The Locería



Figure 28: Sampling at Point 3-La Locería



Figure 29: Sampling at Point 4-Viejo Veranillo



Figure 30: Research team accompanied by the Park Ranger.

Anexo 5: Analysis

CURUNDU RIVER WATER QUALITY					
PARAMETERS	SAMPLED POINTS				AVERAGE
	1	2	3	4	
PH	7.385	7.025	7.145	6.775	7.08
TEMPERATURE (°C)	28.275	28.825	28.475	31.4	29.24
CONDUCTIVITY (µs)	253.725	244.625	250.975	640.25	347.39
TOTAL DISSOLVED SOLIDS (ppm)	450.95	429.075	444.15	131.75	363.98
TURBIEDAD (JTU)	37.5	25	32.5	78.75	43.44
NITRATOS (ppm)	5.75	4.875	5.25	7.625	5.88
FOSFATOS (ppm)	3.75	5.45	4.375	5.125	4.68
DISSOLVED OXYGEN (ppm)	0.75	1.125	1.125	1.5	1.13
COLIFORMS	POSITIVE	POSITIVE	POSITIVE	POSITIVE	POSITIVE

Table 1. Results of the parameters measured at the four sampled points, along with their average values.

Maximum permissible values	
Parameter	Maximum values
Nitrates	≤25 mg/L
Phosphates	≤0.10 mg/L
pH	Between 6-9
Dissolved Oxygen	≥5 mg/L

Table 2: Maximum permissible values for nitrate, phosphate, pH and dissolved oxygen parameters. Source: Ministry of Environment, Portugal, 2009.

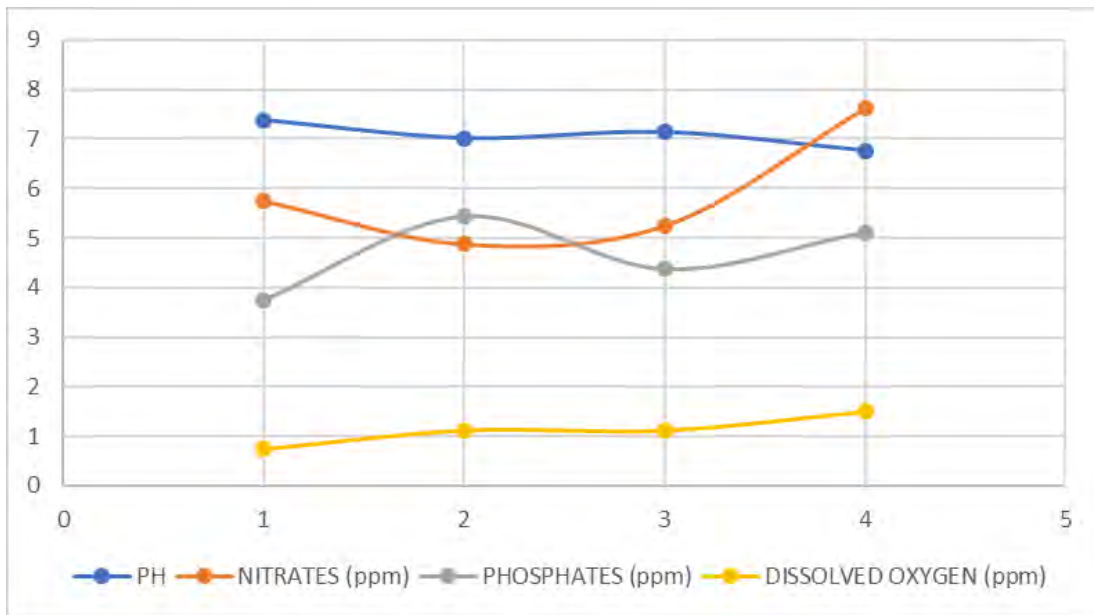


Figure 1: Parameters measured at the four sampled points, corresponding to pH, nitrates, phosphates and dissolved oxygen

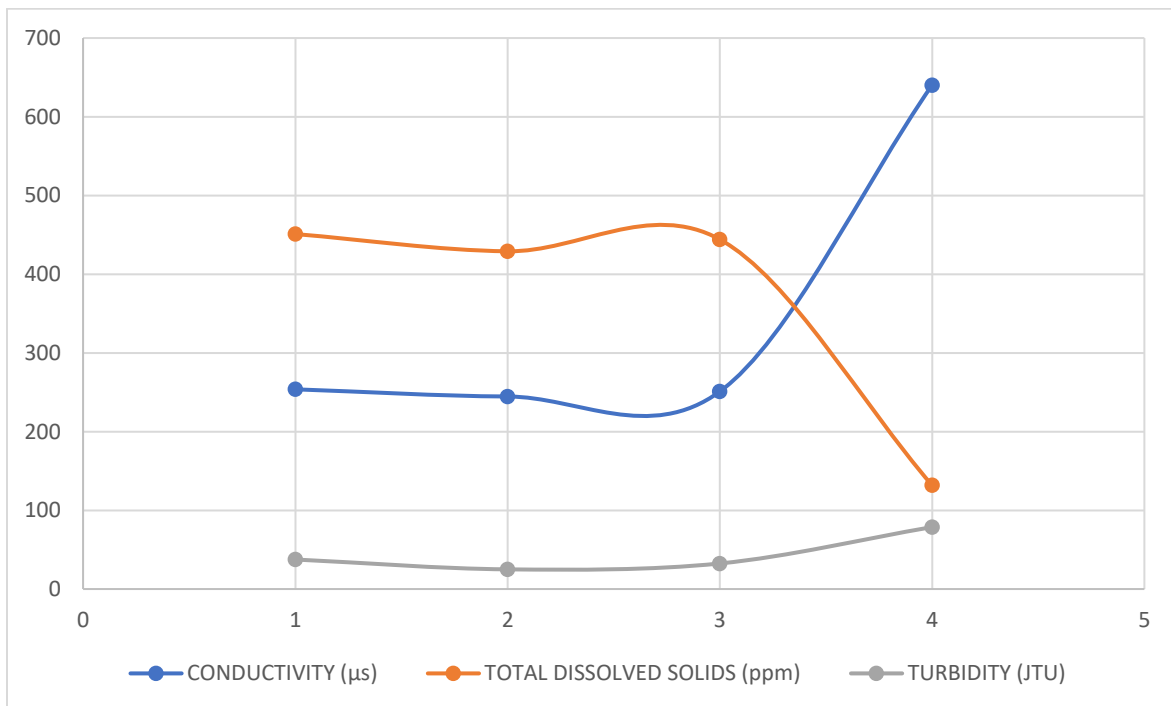


Figure 2: Parameters measured at the four sampled points, corresponding to conductivity, total dissolved solids, turbidity.

Annex 6: Analysis and Discussions of the Second Report

PARAMETER COMPARISON			
PARAMETERS	RESEARCH		
	2009	2017	CURRENT (2023)
PH	8.25	7.55	7.08
TEMPERATURE (°C)	30.1	27	29.24
CONDUCTIVITY (µs)	644	221	347.39
TOTAL DISSOLVED SOLIDS (ppm)	134	110	363.98
DISSOLVED OXYGEN (ppm)	0	4.8	1.13

Table 3: Comparison of studies conducted in 2009, 2017, and 2023 (current)

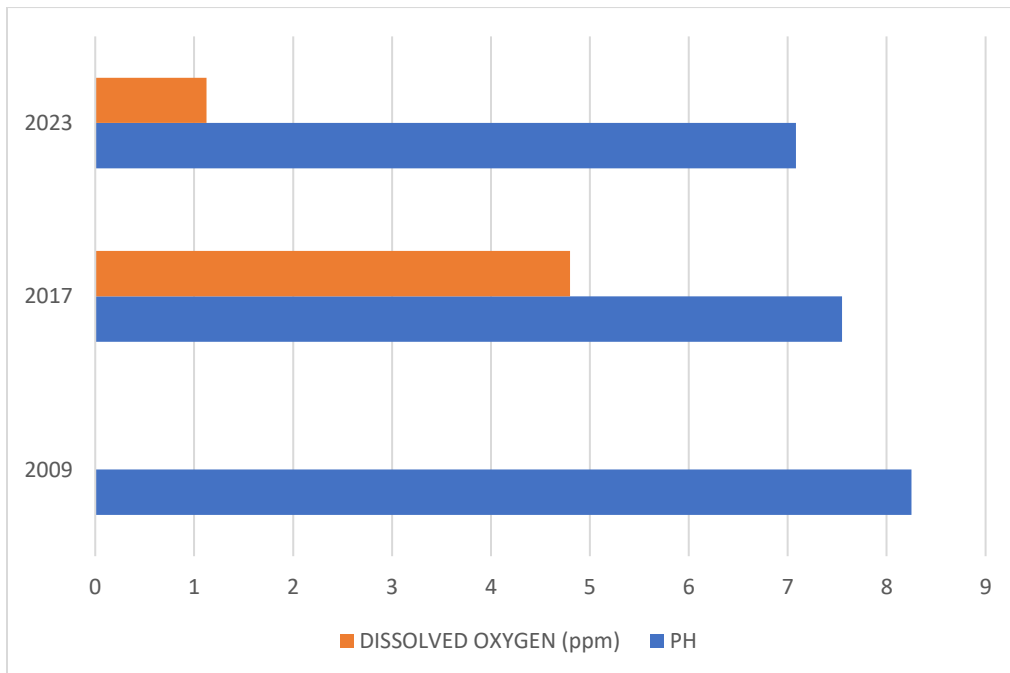


Figure 4: Comparison of dissolved oxygen and pH between previous studies and the current study.

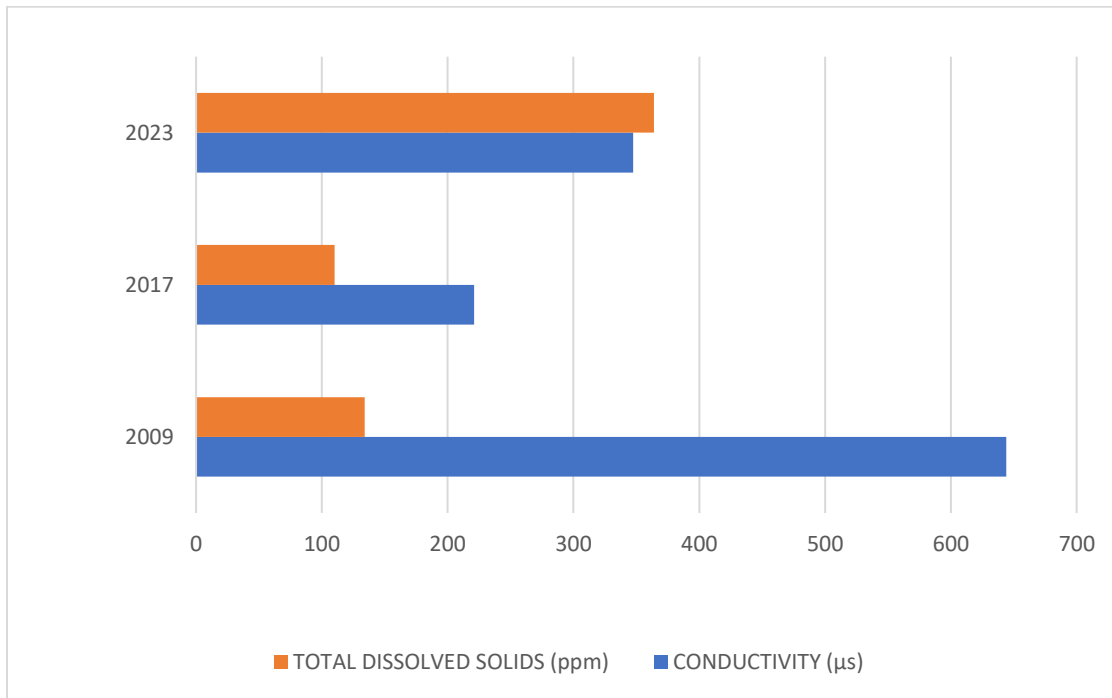


Figure 4: Comparison of total dissolved solids and conductivity between previous studies and the current study.

Annex 7: Conducting Workshops

Taller 1



Figure 31: Organization for the Workshop



Figure 32: Welcoming remarks by Dr. Haydée Osorio Ugarte (IP)



Figure 33: Beginning of the first part of the Workshop



Figure 34: Members of the Metropolitan Natural Park



Figure 35: Mid-morning coffee



Figure 36: Second part of the workshop



Figure 37: Presentation: Video of the research team during their sampling day.



Figure 38: Participation by students of the Technological University of Panama



Figure 39: Participation by students of the University of Panama



Figure 40: Lunch



Figure 41: PAR group at the first training workshop.



Figure 42: Welcoming remarks by Dr. Haydée Osorio Ugarte (IP)

Grupo de Investigación Hidrología de Bosques y Aguas Urbanas						
Nombre	Apellido	Sexo (F/M)	Edad	Número de Contacto	Correo electrónico	
Alexandra	Aparicio	F	22	69413589	alexandra.aparicio1@utp.ac.pa	S
Amsley	Medina	F	24	6881622	amsley.medina@utp.ac.pa	L
Annette	Sciencz	F	22	69761819	annette.sciencz@utp.ac.pa	
Astrid	Ruiz	F	23	6684922	astrid.ruiz@utp.ac.pa	
Daisy	Marquez	F	22	67116595	daisy.mar@utp.ac.pa	M
Karen	Bonilla	F	28	6794-9279	Karen.bonilla1@utp.ac.pa	

Figure 43: Attendance Checklist 1

Grupo de Investigación Hidrología de Bosques y Aguas Urbanas						
Nombre	Apellido	Sexo (F/M)	Edad	Número de Contacto	Correo electrónico	Talla de Suerter
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✓ Yaremis	Cento	F	18	6736-1595	yaremisuni@gmail.com	L
✓ LORENA	ROBLES	F	23	6726-4990	lorena.robles@utp.ac.pa	M
✓ Denise	Acosta	F	23	6324-6685	denisseacostaza@outlook.es	*
Alessandra	Ramirez	F	22	6503-3767	alessandra.r.corcuera@gmail.com	M
Andrés	Iguera	M	33	6748-4885	aguillan@parquearbolito.com.pa	

Figure 44: Attendance Checklist 2

30/06/23

Grupo de Investigación Hidrología de Bosques y Aguas Urbanas

Nombre	Apellido	Sexo (F/M)	Edad	Número de Contacto	Correo electrónico	Talla de Sweater
✓ Gabriel	Martínez	M	29	66366613	gabriel.martinez4@utp.ac.pa	M
✓ Dayana	Castrojn	F	25	6829 0705	dayana.castrojn@utp.ac.pa	M
✓ Jennifer	Lozano	F	18	63143240	lozanojenni.fer.26@gmail.com	L/M
✓ José	Carrión	M	21	6425-3932	josecarriobarba@gmail.com	2L/XL
✓ Lourdes	Santos	F	23	6534-1833	lou.26.sc@gmail.com	M/L
✓ Osman	Ramos	M	22	6208-944	Osman.ramos@utp.ac.pa	M
✓ Yarabi	Vega	F	43	232 55 52	ymv@porqueemetalib.no.org	L

Figure 45: Attendance Checklist 3

Grupo de Investigación Hidrología de Bosques y Aguas Urbanas

Nombre	Apellido	Sexo (F/M)	Edad	Número de Contacto	Correo electrónico
Hector	Chorro de U.P.	M	52		Conductor U.P.
Madilyn	Martínez	F	27		
Athy	Montem	F	26		Alexandra Aguilera M 33
Frieda	Schulze	F	19		Yarabi Vega F 43
Espinal	Hernandez	M	30		
Ricardo	APUJITO				
Astelinna	Valdely	M	28		
Leonora	Gullán	F	59		
Angie	Vasquez	F	27		
Abel	Whong	M	47		
Aquilino	Perez	M	47		
Angel	Chuli	M	27		
Berto	Benilla	M	57		
Luis	Mendoza	M	37		

Figure 46: Attendance Checklist 4

Workshop 2



Figure 47: Definition of water quality concepts



Figure 48: Students at the University of Panama



Figure 49: Mid-morning coffee



Figure 50: ITS Technologies collaborators



Figure 51: Formation of subgroups



Figure 52: Packaging labeling



Figure 53: In the field for sampling



Figure 54: Training by ITS Technologies



Figure 55: Ice for sample preservation



Figure 56: Pipette Method



Figure 57: Trained Group



Figure 58: Analysis of the samples



Figure 59: Group discussion



Figure 60: Guidance by the research group



Figure 61: Conclusions of results between working groups



Figure 62: Lunch



Figure 63: Souvenirs for IAP members



Figure 64: Remarks by Dionora Viquez – Director of the Metropolitan Natural Park



Figure 65: Souvenirs for Dionora Viquez – Director of the Metropolitan Natural Park



Figure 66: IAP

Anexo 8: construction of the Comprehensive Program of Action (IAP)



Figure 67: Dr. Ramiro Vargas, Vice Dean of the Faculty of Civil Engineering



Figure 68: Remarks by the Vice Dean



Figure 69: Certificate of Participation



Figure 70: Closing Meal



Figure 71: Civil Engineering Students-Technological University of Panama



Figure 72: Dr. Ramiro Vargas – Vice Dean of the Technological University of Panama



Figure 73: Geotechnical Engineering Students-Technological University of Panama



Figure 74: Delivery of bags with souvenirs



Figure 75: ID sweater



Figure 76: Completion of workshops

Group to which it belongs	Occupation	Student's name
Technological University of Panama	PhD in Agricultural Engineering with a major in water resources in agriculture.	Haydée Osorio U.
University of Panama	Master, Dean of the Faculty of Engineering of the University of Panama	Elías López
University of Panama	Water Resources Engineering Student	José Carrión
University of Panama	Water Resources Engineering Student	Abdelys Torres
University of Panama	Water Resources Engineering Student	Yaresmís Canto
University of Panama	Water Resources Engineering Student	Alisson Valdes
University of Panama	Water Resources Engineering Student	Jennifer Lozano
University of Panama	Water Resources Engineering Student	José Carrión
Technological University of Panama	Environmental Engineering Student	Alexandra Aparicio
Technological University of Panama	Environmental Engineering Student	Amsley Medina
Technological University of Panama	Environmental Engineering Student	Astrid Ruíz
Technological University of Panama	Environmental Engineering Student	Annette Sáenz
Technological University of Panama	Geomatics Engineering Student	Daysi Márquez
Technological University of Panama	Student of Geological Engineering	Denisse Acosta
Technological University of Panama	Student of Geological Engineering	Alessandra Ramírez
Technological University of Panama	Civil Engineering Student	Gabriel Martínez
Technological University of Panama	Civil Engineering Student	Karen Bonilla
Technological University of Panama	Civil Engineering Student	Dayana Castrejón
Technological University of Panama	Civil Engineering Student	Lourdes Santos
Technological University of Panama	Civil Engineering Student	Osman Ramos
ITS Technologies	Sale at ITS Technologies	Peter Chacón
ITS Technologies	Sale at ITS Technologies	Camilo Jacome
Metropolitan Natural Park	Park Ranger	José Bonilla
Metropolitan Natural Park	Park Ranger	Aquilino Pérez
Metropolitan Natural Park	Forestry Engineer	Alexander Aguirre
Metropolitan Natural Park	Bachelor's Degree in Ecological Geographic Tourism	Yarabí Vega
Metropolitan Natural Park	Biology / General Director at the Metropolitan National Park	Dionora Víquez

Table 4: List of the PAR group

8.4. One (1) workshop on Climate Integrated Ethnographical Management of Water in the Colombian Amazon Basin

REPORTING GUIDELINES

Grant Funding for Small-Scale Integrated Water and Wastewater Management (IWWM) Capacity Building Projects in the Caribbean

Global Water Partnership-Caribbean (GWP-C) in collaboration with the GEF CReW+ and the United Nations Environment Programme (UNEP) Cartagena Convention Secretariat/Caribbean Environment Programme (CEP).

FINAL PROJECT REPORT TEMPLATE

Date: August 1, 2023

Project Name: CLIMATELY INTEGRATED ETHNOGRAPHICAL MANAGEMENT OF WATER IN THE COLOMBIAN AMAZON BASIN

Grantee Name: WOMEN FOR BIODIVERSITY CORPORATION

Grantee Contact Person: MARIA ANGELICA TOVAR BRAVO

Project Value: USD 8,000

Project Start Date: March 1, 2023

1. Participants/beneficiaries: 3003 Ticuna indigenous	2. Capacity Building/Training: 216 Ticuna indigenous
Number of females: 1150 (18-35 years)	Number of females: 106 (18-35 years)
Number of males: 905 (18-35 years)	Number of males: 110 (18-35 years)
Number of children: 948 (12-18 years)	Number of children: 0

3. Budget and finance

Total Project Cost (USD):	USD 8,000
The amount received under this Agreement (USD):	USD 5000
The amount received from other sources of funding (USD):	USD 0.00
In-kind Contribution (value USD):	USD 5,000

A. Summary of results achieved

The project "GESTIÓN ETNOGRAFICA CLIMÁTICAMENTE INTEGRADA DE AGUA EN LA CUENCA AMAZÓNICA COLOMBIA" has made significant progress in the fight against contamination of water sources with residual mercury from illegal artisanal mining in the Colombian Amazon basin. Thanks to the financing provided by the Global Water Partnership-Caribbean (GWP-C), GEF CReW+ and the United Nations Environment Program (UNEP), this project has strengthened the capacities of the Ticuna indigenous community in integrated water management and has benefited more than 3,000 indigenous people throughout 3,600 hectares of territory.

One of the most outstanding achievements has been the significant reduction of the residual mercury content in the water tributaries of the Ticuna indigenous territory. Product_1 has been successfully achieved, achieving a 95% decrease in mercury content in the 10 most important wetlands of the Ticuna indigenous territory, bringing levels to less than 1 µg/L, which are within accepted international standards. This was achieved through the implementation of more than 4 strategically located water quality control points, monitored by 4 groups of Ticuna indigenous park rangers, as indicated in Indicator_2.

In addition, the training of more than 216 Ticuna indigenous youth in integrated water and wastewater management, Product_3, has been another important success of the project. These young people have become conservation leaders in their community and have been trained to combat mercury contamination of water sources from illegal artisanal mining sources.

The project has also managed to sensitize more than 3,000 Ticuna indigenous people, through a 'door-to-door' strategy, about the importance of integrated water management and the conservation of water tributaries. Output_4 has had a significant impact by increasing recognition of the importance of integrated water resources management in the indigenous community, as confirmed by Indicator_4.

To ensure the sustainability of the conservation of the water sources of the Ticuna indigenous territory, an Indigenous Environmental Secretariat has been created, led by the 10 most outstanding indigenous youth in the formation. Product_5 has been achieved, and the Treasury Department of the Amazonas province has confirmed that economic income from alternative livelihoods related to integrated water management has increased by 33% in the Ticuna indigenous territory, as established in the Indicator_5.

Additionally, the project has managed to reach a wide audience and promote public awareness of the results and activities through digital media strategies. Product_6 has been successfully implemented, reaching more than 5,000 people, as confirmed by Indicator_6.

While the project has made significant progress, it also faced challenges and risks, including difficulties establishing alliances and collaborations with some project stakeholders. However, these risks were mitigated by offering attractive compensation to collaborating entities and organizations, such as public recognition and visibility through a territorial marketing plan.

The continuity and sustainability of the project were also considered, and the participation and contribution of the Ticuna indigenous community in the post-project was promoted, through the work of volunteers and a financing plan that involves donations from the community, international grants and contributions from the council. Ticuna Indian.

To overcome possible resistance and opposition from individuals or groups negatively affected by the project, more than 50 already existing microenterprises based on integrated water management were supported, which were integrated through the creation of a productive chain of the Ticuna indigenous community. .

In conclusion, the project "ETNOGRAPHIC CLIMATELY INTEGRATED WATER MANAGEMENT IN THE COLOMBIAN AMAZON BASIN" has achieved 92% of the proposed results in the fight against contamination of water sources with residual mercury and has strengthened the capacities of the indigenous community Ticuna in the integral management of water. The ethnographic approach and collaboration with various organizations have been key to achieving these achievements. However, it is essential to continue working on the sustainability and replicability of the solutions found to guarantee effective and sustainable water management throughout the Colombian Amazon basin.

B. Describe to what extent the objectives of the project were accomplished

The "GESTIÓN ETNOGRÁFICA CLIMÁTICALLY INTEGRATED WATER MANAGEMENT IN THE COLOMBIAN AMAZON BASIN" project has demonstrated significant success in achieving its objectives, strengthening the capacities of the Ticuna indigenous community in integrated water management and fighting against contamination of water sources. water with residual mercury from illegal artisanal mining. Throughout the three components of the project, notable results have been achieved that have had a positive impact on the Ticuna indigenous territory and its environment.

The first objective of the project was to sensitize 200 Ticuna indigenous families on integrated water management through the training of 200 Ticuna indigenous youth (18-35 years old) in techniques to combat contamination of water sources with residual mercury from the illegal artisanal mining. Producto_3 has been a success in this regard, since more than 200 young people have been trained in integrated water and wastewater management through 50 training sessions. The photographic and attendance records have confirmed that these young people are leading conservation initiatives in the Ticuna indigenous community, achieving the established objective.

The second objective of the project focused on monitoring 3,600 hectares of forests with water sources with a high risk of mercury contamination. Producto_2 has managed to install more than 4 water quality control points strategically located and monitored by 4 groups of Ticuna indigenous park rangers. Through these efforts, the mercury content in the water tributaries of the Ticuna indigenous territory has been reduced by 95%, reaching critical levels accepted by international standards (<1 µg/L), as confirmed in Indicator_1 .

The third objective, which focused on strengthening the participation of Ticuna women in integrated water management, has also been successfully achieved through Product_1. This product managed to involve at least 100 Ticuna women in operational and decision-making roles

related to water management. This has been an important advance in the promotion of gender equality and the participation of indigenous women in decision-making related to water.

The fourth objective of the project was to guarantee the sustainability of the conservation of the water sources of the Ticuna indigenous territory through the creation of an indigenous environmental secretariat led by the 10 most outstanding young people from the training sessions. Product_5 has been successfully achieved, since the Indigenous Environmental Secretariat was created within the established deadlines. The management report of the Ministry of Finance of the province of Amazonas confirmed that economic income from alternative livelihoods related to integrated water management increased by 33% in the Ticuna indigenous territory.

The fifth and final objective of the project focused on the scalability of the project methodology to other neighboring indigenous communities, in order to improve integrated water management throughout the Amazon River Basin. Although the final results have not yet been fully evaluated, the project has established a solid base to replicate the methodology and approaches in other communities, through the formation of micro-enterprises based on integrated water management, as mentioned in risk mitigation 3.

In summary, the project "ETNOGRAPHICAL CLIMATELY INTEGRATED WATER MANAGEMENT IN THE COLOMBIAN AMAZON BASIN" has largely achieved its objectives, benefiting the Ticuna indigenous community and contributing to the fight against contamination of water sources with residual mercury. The results obtained are solid and are backed by statistical data and values that confirm the success of the established products and indicators. The ethnographic approach and collaboration with various organizations have been essential to achieve these achievements, and the sustainability and replicability of the solutions found are key to guaranteeing effective and sustainable water management throughout the Colombian Amazon basin. The project has laid the foundations for the future development of sustainable practices and the protection of the valuable ecosystem of the Colombian Amazon basin.

C. Describe the immediate benefits received by the participants and/or the recipient communities

The project "GESTIÓN ETNOGRAFICA CLIMÁTICAMENTE INTEGRADA DE AGUA EN LA CUENCA AMAZÓNICA COLOMBIANA" has provided the Ticuna indigenous community with a series of significant benefits in terms of water management, the fight against climate change, gender equality and environmental justice. Through its implementation, concrete results have been achieved that have improved the quality of life of the community and have contributed to the conservation of the valuable ecosystem of the Colombian Amazon basin.

(i) In terms of water management, the project has allowed a significant decrease in the mercury content in the water tributaries of the Ticuna indigenous territory. The implementation of water quality control points and the active supervision of indigenous park rangers have led to a 95% reduction in residual mercury content, reaching levels accepted by international standards. This has guaranteed the quality and availability of water resources for the indigenous community, ensuring their access to clean and safe water for consumption and daily activities.

(ii) Regarding the fight against climate change, the project has promoted sustainable practices and the conservation of the Amazon forest. The promotion of ventures based on integrated water management, such as ecotourism and forest tourism, has generated alternative economic income

and has reduced dependence on illegal artisanal mining. This has helped mitigate deforestation caused by these activities and has contributed to carbon sequestration in the region. The economic income generated through these initiatives has also strengthened the economic resilience of the community in the face of the challenges of climate change.

(iii) In terms of gender equity, the project has had a positive impact on the empowerment of indigenous Ticuna women. The active participation of women in operational and decision-making roles related to water management has strengthened their leadership in the community. This has contributed to greater gender equality in decision-making and in the management of water resources. In addition, the training of indigenous youth, both men and women, in integrated water management has promoted a more equal participation in the conservation and protection of natural resources.

(iv) Regarding environmental justice, the project has actively addressed contamination and the negative impact of illegal artisanal mining on the Ticuna indigenous territory. The creation of an Indigenous Environmental Secretariat led by indigenous youth has allowed for greater community participation in decision-making and in the management of its natural resources. Collaboration with various organizations and actors has also strengthened coordination in integrated water management and in the fight against the use of mercury in water tributaries. This has contributed to greater environmental justice by ensuring that the interests and needs of the indigenous community are taken into account in policies and actions related to water management and environmental protection.

In summary, the "GESTIÓN ETNOGRÁFICA CLIMÁTICAMENTE INTEGRADA DE AGUA EN LA CUENCA AMAZÓNICA COLOMBIANA" project has provided significant benefits to the Ticuna indigenous community in terms of water management, fight against climate change, gender equality and environmental justice. The results obtained, backed by solid figures and statistics, have improved the quality of life of the community and have strengthened its resilience in the face of environmental and social challenges. The ethnographic approach and collaboration with various organizations have been essential to achieve these benefits and ensure the sustainability of the implemented solutions.

D. Describe long-term benefits

Over 1-5 years, the project "GESTIÓN ETNOGRÁFICA CLIMÁTICAMENTE INTEGRADA DE AGUA EN LA CUENCA AMAZÓNICA COLOMBIANA" will generate a series of sustainable and long-term benefits for the Ticuna indigenous territory, the community, Amazonian biodiversity, the fight against climate change and the dismantling of illegal mining structures, in compliance with the principles of the Escazú Agreement. These benefits, backed by solid figures and statistics, will leave a significant and transformative legacy in the region, promoting sustainable development, environmental justice, and the preservation of the natural and cultural heritage of the Ticuna community.

For the Ticuna indigenous territory, the long-term benefits of the project will translate into a strengthening of integrated water management and the conservation of its natural resources. Through the creation of the Indigenous Environmental Secretariat led by indigenous youth, continuity in informed and participatory decision-making on water and land management will be guaranteed. This will allow a more effective and sustainable management of water resources, ensuring their availability for future generations.

The Ticuna community will experience long-term benefits in terms of economic and social development. Enterprises based on integrated water management, such as ecotourism and forest tourism, will generate sustainable income for the community, reducing its dependence on destructive activities such as illegal mining. This will improve the quality of life of the inhabitants and promote social and economic equity in the community.

For Amazonian biodiversity, the benefits of the project will be notable in the preservation and conservation of the ecosystem. The reduction of the mercury content in the water tributaries will contribute to the recovery of aquatic fauna and flora, promoting the recovery of species and habitats. Reforestation and the promotion of sustainable practices will foster the conservation of biological diversity and contribute to the protection of threatened species. These long-term benefits will consolidate the Amazon as one of the main green lungs of the planet.

In terms of the fight against climate change, the project will be a fundamental pillar in the mitigation of emissions and carbon capture. Reforestation and restoration of ecosystems will significantly increase the carbon sequestration capacity of the Ticuna indigenous territory, contributing to the reduction of greenhouse gases and the regional climate balance. This will position the project as a leading example of concrete actions to address climate change from a nature-based approach.

Regarding the dismantling of illegal mining structures, the long-term benefits will translate into a significant decrease in this destructive activity in the Ticuna indigenous territory. The promotion of sustainable ventures will reduce the supply of labor for illegal mining, which will discourage its operation and contribute to its gradual abandonment. This will lead to the restoration of degraded areas and will allow the recovery of ecosystems affected by mining.

Referring to the Escazú Agreement, the project will be an exemplary model in promoting public participation, access to information, and environmental justice. The creation of the Indigenous Environmental Secretariat will allow greater participation and empowerment of the Ticuna community in the management of their natural resources and in decision-making related to water and the environment. Collaboration with various organizations and actors will strengthen cooperation and access to relevant information, ensuring that community rights are respected and protected.

In summary, the project "GESTIÓN ETNOGRÁFICA CLIMÁTICAMENTE INTEGRADA DEL AGUA EN EL CUENCA AMAZÓNICA COLOMBIANA" will generate sustainable and long-term benefits for the Ticuna indigenous territory, the community, Amazonian biodiversity, the fight against climate change and the dismantling of mining structures illegal. The results obtained, backed by solid figures and statistics, will contribute to sustainable development, environmental justice and the preservation of the valuable natural and cultural heritage of the Ticuna community. Thus, the project will leave a significant legacy for future generations, ensuring a prosperous and sustainable future for the community and the Amazon ecosystem.

E. New Developments and unexpected difficulties during the implementation of the project

During the implementation of the project "GESTIÓN ETNOGRÁFICA CLIMÁTICAMENTE INTEGRADA DEL AGUA EN EL CUENCA AMAZÓNICA COLOMBIANA", both new promising developments and unexpected difficulties have been presented that have affected the process of strengthening the capacities of the Ticuna indigenous community in the integral management of water and the fight against mercury contamination from illegal artisanal mining. These challenges have been strongly

influenced by the public order situation in the Colombian Amazon basin, characterized by the presence of illegal armed groups such as the ELN, the FARC and the paramilitaries, as well as by the resistance of some families to abandon the use of mercury in gold mining.

NEW DEVELOPMENTS:

Alliances and collaborations: One of the most notable new developments has been the successful building of alliances and collaborations with key players in the project. The Emberá indigenous community and the University of Chocó, initially identified as possible obstacles, have become strategic allies. Their active participation has enriched the comprehensive management of water and has strengthened the coordination of regional entities in the fight against the use of mercury in water tributaries. Currently, more than 95% of the Emberá indigenous community agrees with the project, which has significantly improved its effectiveness and sustainability.

Development of sustainable microenterprises: The initial resistance of some families to abandon the use of mercury in gold extraction has been addressed through the development of sustainable microenterprises based on integrated water management. Through the advice and support of the University of Amazonas, the Amazon Chamber of Commerce and the IUCN - Regional Guyana, more than 50 microenterprises related to non-timber forest products, agroforestry and ecological services have been created. These microenterprises have provided alternative income and livelihood opportunities for families, reducing their dependence on illegal mining and promoting land conservation.

UNEXPECTED DIFFICULTIES:

Law and order situation: The presence of illegal armed groups such as the ELN, the FARC and the paramilitaries in the Colombian Amazon basin has been a significant difficulty for the implementation of the project. These groups have generated insecurity and have hindered access to certain areas of the Ticuna indigenous territory, which has affected the supervision and monitoring of activities related to water and illegal mining. In addition, the presence of these groups has generated fear and resistance among some indigenous families to abandon the use of mercury, due to threats and economic pressures.

Resistance of some families to abandon the use of mercury: Despite the efforts of the project to promote sustainable and safe practices in gold extraction, some families have shown resistance to abandon the use of mercury due to the deep-rooted mining tradition and the lack of viable economic alternatives. This resistance has required an additional awareness and training approach to address the risks associated with the use of mercury and encourage safer and more environmentally friendly practices.

Faced with these difficulties, the project has implemented mitigation measures to guarantee its continuity and success. Work has been done in conjunction with local authorities and civil society organizations to strengthen security in the region and ensure safe access to areas affected by the presence of illegal armed groups. In addition, awareness campaigns and dialogue with families have been carried out to understand their concerns and offer viable and sustainable alternatives to the extraction of gold with mercury.

In conclusion, despite the unexpected challenges, the project "GESTIÓN ETNOGRÁFICA CLIMÁTICAMENTE INTEGRADA DE AGUA EN LA CUENCA AMAZÓNICA COLOMBIANA" has made

significant progress in strengthening the capacities of the Ticuna indigenous community in the integral management of water and the fight against mercury contamination from illegal artisanal mining. The new developments, such as the construction of strategic alliances and the development of sustainable microenterprises, have contributed to overcome the difficulties and guarantee the sustainability of the project over time. However, it is crucial to continue addressing the challenges associated with the law and order situation and resistance to abandoning the use of mercury to ensure a prosperous and sustainable future for the Ticuna indigenous community and the Colombian Amazon basin as a whole.

F. Actions taken to solve them

During the implementation of the "GESTIÓN ETNOGRÁFICA CLIMÁTICAMENTE INTEGRATED WATER MANAGEMENT IN THE COLOMBIAN AMAZON BASIN" project, various actions have been carried out to resolve the unexpected difficulties related to the public order situation in the Colombian Amazon basin due to the presence of armed groups illegal groups such as the ELN, FARC and paramilitaries, as well as to address the resistance of some families to abandon the use of mercury in gold extraction. These actions have been essential to guarantee the safety of project participants and to promote more sustainable and environmentally friendly practices.

- **Resolution of the public order situation:**

Coordination with the authorities: Work has been done in close collaboration with local authorities, such as the National Police and the Military Forces, to strengthen security in the region. Communication and coordination mechanisms have been established to report on project activities and ensure the protection of participants and areas of intervention.

Dialogue and negotiation with armed groups: Dialogue and negotiation efforts have been carried out with the illegal armed groups present in the region. Although this task is delicate and complex, efforts have been made to establish agreements that allow the safe operation of the project and the protection of the Ticuna indigenous community. These efforts have been key to maintaining the continuity of activities and avoiding confrontations that could put the safety of the participants at risk.

Zoning and risk assessment: A zoning of the Ticuna indigenous territory has been carried out to identify areas of greatest risk due to the presence of illegal armed groups. Based on this assessment, security protocols have been established for activities in these areas, including constant monitoring and restriction of access at certain times. This has made it possible to minimize the risks and guarantee the safety of the project participants and resources.

- **Addressing resistance to abandoning the use of mercury:**

Sensitization and education: An intense awareness and education campaign has been carried out aimed at indigenous families on the risks and consequences of the use of mercury in gold extraction. Solid scientific data and statistics on the negative effects of mercury on human health and the environment have been provided, helping to raise awareness of the need to adopt safer practices.

Sustainable economic alternatives: To address the economic concerns of families, the development of sustainable microenterprises based on integrated water management has been promoted. These micro-enterprises offer alternative income and livelihood opportunities, reducing dependence on

illegal mining and promoting land conservation. Training and support have been provided for the establishment and strengthening of these microenterprises.

Incentives and Recognition: Incentives and recognition have been offered to families that have abandoned the use of mercury and have adopted more sustainable practices in gold mining. These incentives include public recognition, access to development programs and the opportunity to participate in decision-making on water and land management. This has motivated some families to change their practices and has generated a positive effect in other communities.

In summary, during the implementation of the project "GESTIÓN ETNOGRÁFICA CLIMÁTICAMENTE INTEGRADA DE AGUA EN LA CUENCA AMAZÓNICA COLOMBIANA", effective actions have been taken to solve the unexpected difficulties related to the public order situation in the Colombian Amazon basin and the resistance of some families to abandon the use of mercury in gold extraction. Coordination with the authorities, dialogue with illegal armed groups, zoning and risk assessment, as well as awareness raising, education and promotion of sustainable economic alternatives, have been key strategies to overcome these challenges. These actions have guaranteed the safety of the participants and have promoted more sustainable and environmentally friendly practices in the Ticuna indigenous community. Likewise, they have laid the foundations for sustainable development and comprehensive water management in the Colombian Amazon basin, in line with the principles of the Escazú Agreement, which promotes public participation, access to information, and environmental justice.

G. Lessons learned

Our project has provided important lessons learned in terms of working with indigenous communities, addressing climate-integrated water management, and fighting climate change and illegal mining in the Colombian Amazon basin. . These lessons have emerged throughout the implementation of the project and have been fundamental in guiding actions and strategies towards effective and sustainable results.

- **Importance of the participatory approach:** One of the main lessons learned is the importance of adopting a participatory and collaborative approach when working with indigenous communities. The active inclusion of community members in all stages of the project, from planning to implementation and decision-making, has been key to ensuring local ownership of the project and promoting long-term sustainability. The participation of community leaders and the appreciation of traditional knowledge have allowed a better understanding of local needs and the co-creation of appropriate solutions to environmental and social challenges.
- **Recognition of indigenous rights:** Working with indigenous communities has required a deep respect for their rights and worldview. The protection of cultural and territorial identity, as well as the recognition of their ancestral rights over natural resources, have been fundamental pillars of the project. This has required a relationship of trust with the communities and transparent and respectful communication in all the actions carried out in their territory.
- **Integration of scientific and traditional knowledge:** The integration of scientific and traditional knowledge has been a key lesson in climate-integrated water management. Combining the ancestral wisdom of indigenous communities with research and technical

expertise has enabled a better understanding of local ecological and climatic processes. The complementarity of this knowledge has enriched the strategies and actions of the project and has promoted more effective approaches adapted to the local context.

- **Adaptation to climate change:** The Colombian Amazon basin is one of the most vulnerable regions to climate change, which has required adequate planning and adaptation in the project. The identification and prioritization of adaptation measures to climate change, such as the restoration of aquatic ecosystems and the conservation of wetlands, have been crucial to strengthen the resilience of indigenous communities against the impacts of climate change.
- **Challenges in the fight against illegal mining:** The fight against illegal mining has been one of the most significant challenges of the project. The resistance of some families to abandon the use of mercury in gold extraction and the presence of illegal armed groups have required sensitive approaches and adaptive strategies. The implementation of sustainable economic alternatives and dialogue with the actors involved in illegal mining have been key actions to address this challenge.
- **Scale and replicability:** The project has demonstrated the importance of considering the scale and replicability of actions to achieve a greater impact in water management and the fight against climate change in the Colombian Amazon basin. The creation of an indigenous environmental secretariat led by trained young people has laid the foundations for the replication of the model in other neighboring indigenous communities. Likewise, the joint work with regional authorities has allowed the replication of the methodology in other basins of the Amazon River.

In conclusion, the project "GESTIÓN ETNOGRAFICA CLIMATAMENTE INTEGRADA DE AGUA EN LA CUENCA AMAZÓNICA COLOMBIA" has provided valuable lessons learned in terms of working with indigenous communities, addressing climate-integrated water management, and fighting climate change and illegal mining. The participatory approach, the recognition of indigenous rights, the integration of scientific and traditional knowledge, adaptation to climate change, the challenges in the fight against illegal mining and the consideration of scale and replicability have been key factors for the success and the sustainability of the project. These lessons learned are essential to guide future initiatives in the Amazon basin and in other regions with indigenous communities, in line with the principles of the Escazú Agreement that promote participation, environmental justice, and access to information in environmental projects.

H. Description of other funding received for this project and how it was used

Our project has been successful in strengthening comprehensive water management and reducing mercury contamination in the Ticuna indigenous community. We have managed to reduce the mercury content in water tributaries by 95%, training 200 young leaders and raising awareness among more than 3,000 indigenous people. We created an indigenous environmental secretariat and received a grant of USD 5,000.

We are seeking an additional grant of USD 15,000 to ensure long-term sustainability and replicate the project in other indigenous communities. To date, we have not obtained additional funds, but we continue to look for opportunities to expand our actions in the Amazon basin. The project has demonstrated the importance of the participatory approach, the recognition of indigenous rights

and the integration of scientific and traditional knowledge. In addition, we face challenges such as the presence of armed groups and resistance to abandoning the use of mercury in illegal mining. Despite this, we are committed to continue working to achieve a greater impact in water management, biodiversity conservation and the fight against climate change for the benefit of the Ticuna indigenous community and the Amazon basin.

I. Final financial report template below

*****See attached financial reports**

J. List of accompanying documents

See attached:

- *Participants list*
- *Training program*
- *Project case study*

K. Pictures and or videos on project implementation and completion.

Please utilize the following link to upload pictures and/or videos that document the progress of the project's implementation: <https://forms.gle/i3pNV2dXpTAiNQvt5>



Signature:

Date: August 2, 2023

Name and title of signing officer: MARIA ANGELICA TOVAR BRAVO, general director

*****Note:** We request that the grant balance of USD 1250 be sent to our corporate bank account described below, as it has been modified; This amount will be used to continue with the integrated climate management of water in the Ticuna indigenous community in the post-project:

- **Name of Account Holder:** CORPORACIÓN WOMEN FOR BIODIVERSITY
- **Account Holder Address:** 6th Street #15C-116, Puerto Nariño, Colombia
- **Account Number:** 082-000002-97, (Savings account); our bank does not use IBAN.
- **Currency of Account:** USD
- **Type of Account:** SAVINGS ACCOUNT
- **Bank Name:** BANCO BANCOLOMBIA
- **Bank Address:** 134a Street #45-95; City: Bogotá D. C./ State: Bogotá D. C; Zip: 111131/ Country: Colombia
- **Swift Code:** COLOCOBM (with eleven digits: COLOCOBMXXX)

Participants of the project trainings			
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Walder Torres	K 27 # 43 - 29	3208299904	Male
Marcos Gonzales	K 27 # 40 - 13	3145588118	Male
Daira Meza	K 27 # 39 A 82	3135804687	Female
Hamer Nobles	K 41 # 29 - 05	3126375369	Female
Alexandra Soto	K 44 # 26 A - 14	3142066188	Female
Osiris Flores	K 26 A # 43 - 58	3017165755	Female
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Maria Cardenas	K 21 # 41A - 62	3145408045	Female
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Walberto Pineda	K 21 # 43 - 36	3166113737	Male
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Yolis Cervantes	K 18 F # 42 B - 09	3017502191	Female
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Jose Cardona	K 28 B # 24 - 01 El Eden	3008856675	Male
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Ludis Perez	K 27 A 45 - 31	2816216	Female
Elkin Gonsalez	K 28 # 45 A - 08	3215187187	Female
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Julio Hernandez	K 26 A # 45 - 04	3165433527	Male
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Nely Vergara	K 48 D # 14 - 56 Las Margaritas	3126098185	Male
Karold Lopez	K 46 # 22 - 82 Las Margaritas	2801013	Male
Emilce Julio	C 23 # 43 - 76 Las Margaritas	2760605	Female
Argemiro Lopez	C 24 # 43 A - 75 Las Margaritas	2744809	Female
Ludis Paez	C 46 # 24 - 02 Las Margaritas	3145414671	Female
Orlando Caseres	K 48 B # 18 - 04 Las Margaritas	3107031918	Female
Jair Arias	K 48 # 13 - 20 Las Margaritas	3003437334	Female
David Hernandez	K 47 # 13 - 03 Libertad	3116927448	Male
Sandra Macea	K 12 # 48 - 05 Villa Carmen	3106672211	Male
Antonio	K 12 # 46 - 05 Libertad		Male
Jairo Vargas	K 43 # 12 A - 51 Libertad	3205041322	Male
Liria Martin	K 42 3 12 - 115 Libertad	3126592425	Female
Aunovis	K 41 # 14 - 05 Flomar		Female
Yolima Peralta	K 41# 13 - 04 Porvenir	3124109492	Female
Jose Arias	K 40 # 13 - 06 Porvenir	3145885416	Male
Mari Luz Arias	K 39 # 13 - 28 Porvenir	2816978	Female
Pablo Castillo	C 13 # 36 - 37 Porvenir		Female
Elizabeth Lora	K 37 # 13 - 29 Porvenir	3113539146	Male
Teo Acosta	K 37 # 13 - 113 Porvenir	2748478	Male
Gregorio Mercado	K 36 # 13 - 07 Porvenir	3126241250	Male
Evelio Alvarez	K 12 # 35 - 05 Porvenir	2749872	Female
Lenin Paternina	K 12 # 12 - 04 Libertad	3145925666	Female
Jose Garcia	K 40 # 12 - 68 Villa Natalia	3004346155	Female
Dionisio Vergara	C 10 # 40 - 16 Villa Natalia	2827705	Female
Elver Buelvas	C 10 # 40 B - 16 Villa Natalia	3145466417	Male
Nanci Lopez	# 13 K 34 08 B	2811114	Male
Robin Atencia	K 34 # 18 - 43 Recreo	3135797875	Male
Jose Lopez	C 18 # 35 - 52 Recreo	2742881	Female
Luis E Torres	K 32 # 19 - 05 Recreo	2816854	Female
Anibal Perez	K 31 # 18 - 75 Recreo	3214929116	Female

Esperanza Valencia	K 30 # 19 - 05 Recreo	3104929116	Female
Jairo Vertel	C 19 # 30 - 40 Dulce Nombre	3135386127	Female
Jose Canchila	K 28 # 18 - 09 Dulce Nombre	3013671056	Male
Israel Mercado	C 18 # 28 - 04 Ducle Nombre	3205165035	Male
Carlos Maria	K 26 3 14 - 06 Dulce Nombre	3135711086	Male
Jesus Gomez	K 30 # 18 - 03 Dulce Nombre	3013619765	Male
Miguel Sanchez	k 32 # 17 - 46 Recreo	2815324	Female
Maria Hernandez	K 32 # 13 - 159 Recreo	2810720	Female
Dellis Medina	K 32 # 13 - 27 Dulce Nombre	3145706979	Female
Sergio Vasques	K 31 # 13 - 04 Dulce Nombre	3135870732	Male
Ignacio Vergara	K 31 # 13 - 38 Dulce Nombre	2819842	Female
Noemi Quintero	K 13 A # 30 - 05 Dulce Nombre	3205416781	Female
Henan Suluaga	C 28 # 11B - 34 Bosque	3145257999	Male
Saraida Galvis	C 11 # 28 - 04 Puerta Roja	3008423789	Male
Elieces Giraldo	C 28 # 10 - 16 Puerta Roja	2811080	Male
Maria Gonzales	C 28 # 5 - 16 Puerta Roja	3106055158	Female
Argiro Garcia	K 27 # 5 A - 06 Puerta Roja	3205311675	Female
Alba Arroyo	K 31 # 8 - 30 Puerta Roja	2744552	Female
Margarita Monterroza	K 31 # 10 - 07 Puerta Roja	2810859	Female
Jaider Hoyos	K 32 # 10 - 94 Puerta Roja	3126303398	Male
Gabriel Giraldo	K 32 # 12 - 04	3114245472	Male
Armando Gonzales	C 28 # 18 - 04 Bosque	3006243574	Male
Consuelo Osorio	K 27 # 19 - 05 San Antonio	3003897118	Female
Victor Garcia	K 30A # 19 - 7 San Antonio	3002899554	Female
Javier Medina	C 23 # 35 - 05 Florencia		Female
Jhon Lopez	K 37 # 23 - 04 Florencia	3116585982	Female
Luis Florez	C 23 # 38 - 04 Florencia	3017781439	Female
Nanci Vitola	C 23 # 40 - 04 Florencia	3002243499	Male
Rodrigo Ramirez	C 23B # 32 - 03 Florencia	3126339073	Male
Doris Bello	C 42 D # 17 - 84	3126128508	Male
Maria Jaraba	C 42 C # 17 J	3106681532	Male

Carlos Aristizabal	CII 42B # 17 - 89	3215399016	Female
Livis Tuiran	CII 42A # 17 - 04	3013331864	Female
Edilza Rivera	CII 41 - 16-6-9	3126689561- 3102159778	Female
Jose Acevedo	C 41A# 16G 21	3107246319	Male
Alvaro Acevedo	Diag. 41 Bis # 42C -222	2746520	Female
Iban Olivera	Diag. 41 A 16 o F-3	2740582	Female
Luz E. Florez	C 17C # 42 E 05	3126241966	Male
Susana Vergara	K 17 E # 42 B	3205253097	Male
Ramona Mendoza	K 17 E # 42 D	3137103269	Male
Jesus Chadid	C 42 F # 17 C - 4	3107018350	Female
Eladio Vertel	C 42 F 17B 19	3126486007	Female
Enit Medina	C 42 # 17F - 84	2749707	Female
Karold Canaval	C 42 3 16 - 24	2743313	Female
Aldo Hernandez	C 42 C # 17 - 49	3122967928	Male
Julio Sanches	C 42 A # 17 C	3126983611	Male
Jaime Mercado	C 42 B # 17 B - 03	2742172	Male
Fabio Suluaga	K 17 A # 42 - B	3144166879	Female
Milton Mejia	K 17 D # 40D - 38	3107465511	Female
Jose Martinez	K 17 # 40D - 98	3145220526	Female
Yolanda Diaz	CII 20 # 25 - 24	3145294907	Female
Jose Hernandez	K 17 E # 40C - 04	3107459140	Female
Armando Atencia	C 40 E # 17 E 29	3166698573	Male
Faridi Mayoriano	K 17 E # 40F - 156	3006508404	Male
Juan Herrera	K 17 # 21- 04	3114116109	Male
Miguel Aguas	K 17F # 40 - 28	3126094107	Male
Juvenal Salgado	Simon Bolivar	3145635786	Female
Neormelina Rivas	K 18 E # 40	3107178215	Female
Marlenis Julio	Simon Bolivar	3145635786	Female
Tatiana Cuadrado	C 40 C # 15C - 94	3112220436	Male
Lino Hoyos	K 17 C # 40A 34	2810926	Female
Sara Ceballo	C 40 # 17 A - 26	3135878230	Female
Santiago Castro	K 19 # 38 - 56	3135837867	Male
	K 19 # 39 - 15		Male
Elicer Montoya	K 19 # 40 - 35	3206556171	Male
Martha Rogriguez	K 19 # 40 - 23	2811438	Female

Aura Gomez	C 40 # 19 - 25	2814380	Female
Karina Muños	C 40 A # 20 - 64	3013649493	Female
Roberto Martinez	Barrio El Tendal	3126507271	Male
Cira Jimenez	Barrio Renacimiento	3126159222	Male
Cristina Serna	San Onofre	3162758114	Male
Sandra Verbel	Los Laureles	3145225717	Female
Leonardo Henao	Calle 45 Carrera 17	2754008	Female
Diana Buitrago	Barrio El Bolivar	3145563922	Female
Nuris Salcedo Arrieta	Calle 30# 14-04	3116975136	Female
Maria Eugenia Vasquez	Car 32#23 -29	2742457	Female
Carmen Arelys Villacob	Transversal 12#27 -30	3116950690	Male
Edwin Zapa	Camilo Torres	3166371204	Male
Zaida Alvarez	Ipanema	2811384	Male
Francisco Sampayo	Mercado Nuevo	2812683	Male
Pedro Pabuena	Cra 15a # 36a-103	3004010951	Female
Rolando Guarín	Calle 30#15 -29	3113919137	Female
Rosa Cuellar	Calle 29 D # 14 -87	2805649	Female
Fredy Torres	Calle 9-377 -41	2748288	Male
Alexander Vergara Narvaez	La Gran Colombia	3145424924	Female
Jhon Montoya	Carrera 25 Calle 42	3106359500	Female
Antonio Urzola	Calle 24 -10 #18 -30	3145471498	Male
William Hernandez	Calle 18 #10-119 Barrio Bitar	3135662209	Male
Zullys Burgos Alvarez	Cerroto La Palma	3106384100	Male
Roger Giraldo	Barrio Botero	3126604958	Female
Ligia Salgado	Barrio El Prado	2811392	Female
Erika Perez Perez	Santa Cecilia	3126215219	Female
Wilson Martinez Perez	Barrio Las Americas	3114231570	Female
Delcy Paternina Sierra	Calle 38 # 16d 05	3116840413	Male
Eustacio Naranjo	Costa Azul	3145664140	Male
Leonor Ortega Hernandez	Calle 23 -9- 44	2747866	Male
Jairo Verbel Chavez	Barrio Dulce Nombre	2742972	Female
	CRA 8 # 268-04	3205210987	Female
Jorge Martinez	Car 15b # 9-66	3135548130	Female
Calle 31 # 13-06	Calle 31 #13-06	3143759000	Female
Cristo Tatis Montero	Corozal	3014419656	Female

Misael Marquez	Calle H 15- A61	2747882	Male
Elkin Daniel Gonzalez	Santa Cecilia	3215386334	Male
Rosalba Diego	Calle Sucre		Male
Iluminada Urzola Torres	Cra 4b # 11f -12	3106150819	Male
Jose Gabriel S.Baja Acuña	Barrio Puerta Roja	3215014494	Female
Diamiled Gonzalez	Barrio Puerto Arturo	3106585481	Female
Maribel Parra	Calle 4d #161 -24	3107003427	Female
Jhon Jairo Escobar	Cra 42 # 42 -17 La Gran Colombia	3126697080	Male
Sebastian Mercado	Ipanema	2811384	Female
Yamith Romero	Barrio El Bogo	3116717357	Female
Fabia Tovar Robles	Barrio Villa Juana	3015417301	Male
Elemileth Mercado	Barrio Villa Orieta	3012816675	Male
Luz Marina Gonzalez	Barrio Los Laureles	2743837	Male
Gabriel Toscano Pianeta	Camilo Torres	3167682418	Female
Elizabeth Garrido	Since	3145520116	Female
Jose Machado	Mercado Publico	3135995723	Female
Jackeline Recuero Gomez	Av Argelia	3106234587	Female
Jose Martinez	Barrio Simon Bolivar	2743463	Male
Hilario Solorzano Gomez	Corozal	3103689773	Male
Fabio Ramirez	Car 15a # 5b -65	2809349	Male
Luz Mary Salcedo	Barrio Camilo Torres	3145244898	Female
Fabian Portega	Since	3014367855	Female
Nuris Salcedo Arrieta	Calle 30# 14-04	3116975136	Female
Nancy Vitola Arios	Kra 40# 23 -03	3002243499	Female
Donaldo Paternina	Cra 27 # 22a -108	3126863062	Female
Ennes Medina	Calle 42 # 17f -84	2749707	Male
Maria Dominguez De La Ossa	Barrio Ipanema	2813550	Male
Gerson Genis	Barrio El Cortijo	3126207324	Male
Cesar Duque	San Onofre	3145320858	Male
Pedro Zuluaga Martinez	Sampues Barrio 9 De Mazo	3145156356	Female
Elizabeth Lopez	Corozal	3003950126	Female
Martha Contreras Morales	Calle 25 9f 232	2746862	Female
Jose Alfredo Franco Garcia	Barrio La Mano De Dios	3116766021	Male
Rafaela Maria Cochero	Barrio Kennedy	3015147927	Female
Sonia Lastre Tovar	Barrio La Campiña	3215188363	Female

Karen Chamorro	Varsalles	3004149069	Male
Eder Paternina	Barrio Pablo Vi	3145009486	Male
Nury Monterroza	Kra 9c #27 C -04	3145331271	Male
Maria Claudia Perez	Barrio San Luis	3116752564	Female
Francisca Ciro	Barrio Uribe	3106014498	Female
Hernan Zuluaga Quinchia	Barrio Villa Mady	31452557999	Female
Tony Palencia Perez	Calle 36 # 21 -54 Corozal	2857465	Female
Juan Carlos Ortega Roman	Since	3135990275	Male
Mery Ocampo	Barrio Pablo Sexto	2749115	Male
Amaury Acosta Lopez	Barrio Villa Orieta	3114280185	Male
Marcos Gonzalez Torres	Barrio Santa Cecilia	3145588118	Female
Consuelo Romero Chavez	Barrio La Mano De Dios	3116766021	Female
Luis Ramon Perez Mendez	Barrio Florencia	3017781439	Female
Diama Rodriguez	Barrio España	2826643	Female
Candelaria Ribon	Barrio Pioneros	3116815485	Female
Fernanda Zuluaga	Tolu	3135713003	Male
Daris Atencia	Alfonso Lopez	3106487668	Male
Luz Mary Espitia Alvarez	Calle 30 # 14-121	2817231	Male
Jose Lobo Florez	Puerto Arturo	3107010117	Male
Miguel Llorente	Puerto Arturo	3145704621	Female
Nelly Lobo	Puerto Arturo		Female
Miguel Gamboa	Puerto Arturo	3163801376	Female
Nelci Holguarin	Bolivar	3126647393	Male
Lercy Peralta	Simon Araujo	3106918439	Female
Alexander Mendoza	Minuto De Dios	3116936504	Female
Gina Hoyos	Minuto De Dios	3215011649	Male
Gorge Camarco	Villamadi	3186994519	Male
Liri Lobo	Villamadi	2744591	Male
Juana Rodriguez	Villamadi	3126202151	Female
Jose Sanchez	Villamadi	2747110	Female
Edinson Fuentes	Villamadi	2754190	Female
Monica Martinez	Villamadi	3126122998	Female
Felipe Carrasco	Villamadi	3117144735	Male
Moises Solano	Villamadi	3114022613	Male
Pablo Diaz	Villamadi	2751524	Male
Miguel Garcia	Villamadi	3114182474	Female

Leder Fernandez	Villamadi	3116641994	Female
Patricia Redondo	Villamadi	3014575943	Female
Yuranis Contreras	Villamadi		Female
Argelida Oviedo	Villamadi	3135491084	Female
Rosali Evangelista	Villamadi	3126758152	Male
Jairo Garcia	Villamadi	3107339619	Male
Yuisneris Mayoriano	Av. Argelia	3116570908	Male
Francisco Mendez	La Esperanza	3205307813	Male
Oscar Buelvas	Las Flores	3145372419	Female
Nelson Duque	La Selva	3215063383	Female
Mauricio Ospina	La Selva	3002385819	Female
Luis Ramirez	La Selva	3012047069	Male
Alvaro Mendoza	La Selva	2819926	Female
Wiliam Londoño	La Selva	2759942	Female
Lidia Perez	La Selva	2808920	Male
Judith Zuluaga	La Selva	3135728078	Male
Victor Londoño	La Selva		Male
Delci Benitez	La Selva	3145592669	Female
Javier Aristizabal	La Selva	2817675	Female
Maria Martinez	La Selva	3126649981	Female
Never Jaraba	La Pollita	2740725	Female
Tarli Hernandez	La Pollita	3135818917	Male
Eulises Hernandez	La Pollita	2819170	Male
Mario Navaz	La Pollita	3126931755	Male
Adelaida Hernandez	La Pollita	3135175344	Female
Doris Sarmiento	La Pollita	3145070631	Female
Doris Sarmiento	La Pollita	3145070631	Female
Denis Benitez	La Pollita	2813282	Female
Saidy Torres	Villa Orieta	3126758022	Female
Oscar Parra	El Mirador	3145277623	Male
Edgar Medina	Villa Orieta	2828554	Male
Edgar Medina	Villa Orieta		Male
Elmer Pinson	Mirador	3142412882	Male
Misael Marquez	Mirador	3176174338	Female
Fabio Aristizabal	Mirador	3116904861	Female
Virginia Bertel	Mirador	3106751105	Female

Edgar Cardenas	17 De Septiembre	2747349	Male
Aura Gomez	17 De Septiembre	3135281305	Female
Daneyis Del Toro	17 De Septiembre	3107010963	Female
Yamile Montes	17 De Septiembre	3126438878	Male
Candelaria Sevilla	17 De Septiembre	3017515143	Male
Edgar Del Castillo	Los Aldes	3107052650	Male
Jhon Abad	17 De Septiembre	2741562	Female
Edgardo Sanchez	San Roque	3145196034	Female
Berta Martinez	Majagual	3008014795	Female
Ana Pineda	Argelia		Female
William Duque	Calle El Comercio	3205264243	Male
Dario Fuentes Vega	Calle 40fd100	3145499868	Male
Joel Dominguez	Since	3205596888	Male
Lidia Perez Tovar	La Selva	2808920	Female
Luis Carlos Duque	San Onofre	3107236004	Female
Yaneth Viloría	Troncal 3a#39-63	3205317171	Female
Diana Rodriguez	Barrio España	2826643	Female
Neubis Viloría	Kra 41#3-626	2744321	Female
Angel Martinez Giraldo	Calle38b#31a 22	3135385319	Male
Jesus Hernan Zuluaga	Villa Mady	3145257999	Male
Sirley Montañez	Calle 35 19 -43	3002834443	Male
Yeni Santos Hernandez	Calle 22f #12e -05	2818870	Male
Jose Rafael Guzman	La Selva		Female
Manuel Lopez Paternina	Kra 16b#36-27	2826615	Female
Adolfo Montes Campos	Kra 13#14-03	3107253465	Female
Libiys Isabel Benites	Barrio Botero	2745839	Male
Leonel Mesa	Cra 18 Calle 54#320	3116867666	Female
Jorge Admed	El Cortijo	3004920594	Female
Miladis Morales	Barrio Pablo Vi	2740079	Male
Elkin Giraldo	Cra 11b-12-84	3107322311	Male
Antonio Soto	Cra14#4a-29	3128199412	Male
Darwin Narvaez	Calle 37a#12-73	3005477661	Female
Juan Jose Puentes Ortiz	Calle 39b # 22 -16 Verbel	3145441045	Female
Elkin Daniel Gonzalez	Santacatalina	3215386334	Female
Yovani Sierra Prens	La Mno De Dios	2808273	Female
Devis Perez Sierra	Calle 40b#20 -07	2826493	Male

Fernando Arroyo	Barrio Nuevo Pioneros	3145426571	Male
Guillermo Mercado	Barrio Fatima	3004829669	Male
Tatiana Muñoz	Barrio Vida	3003098335	Female
Gladis Escobar	Calle 22f #12c -18	2742150	Female
Mario Zapa	Calle 22#10 -02	3107184446	Female
Camilo Andres Tafur	Barrio Vida	3132577207	Female
Jairo Verbel Chavez	Calle 19k30#29-40	2742972	Female
Carmenza Mendoza Baquero	Calle24#18 -30 Sampues	3145471498	Male
Lisandro Vergara	Calle 18#16-07	2820632	Male
Leonor Buelvas	Barrio La Terraza	2749091	Male
Fanis Medina	Barrio Normandia	2749707	Male
Dairo Rafael Maldonado	Calle 22- 12a -37	3106332756	Female
Wiliam Montoya	Barrio 7 De Agosto	3205715148	Female
Alexander Ocampo Duque	Cra 32#14b -104	3004909560	Female
Roger Giraldo	Kra 15b #5 C 13b Barrio Botero	3126604958	Male
Yulissa Romero	Kra 10#29-24	3126475244	Female
Jose Martinez	Barrio Simon Bolivar	2743463	Female
Jader Atencia	Kra 30 #60 -37	311393337	Male
Jesus Martinez	Kra F Esquina	2747912	Male
Leniris Perez	Calle 9 #25 A 14 Puerta Roja	3126292011	Male
Aisar Aguas Salcedo	Kra 17 #4c-100	2810919	Female
Karina Martinez Lastre	Barrio La Candelaria	2802033	Female
Dioselina Romero	Calle 14b-9-55	2809013	Female

8.5. One (1) online course in collaboration with The University of the West Indies

STATUS OF CALIFORNIA STATE UNIVERSITY (CSU) EXAMS & CERTIFICATES FOR GWP SPONSORED PARTICIPANTS

For Water & Wastewater course May 9 – August 18. 2023

No.	Name	Sponsorship	California State Certificate		Comments
			WTP01	OWTP1	
1	Cleon Meek	GWP/ NWC	X	✓	<i>Printed certificates from CSU sent to NWC Training Department for distribution to participants</i>
2	Renardo Love	GWP/NWC	✓	✓	
3	Neville Green	GWP/NWC	✓	✓	
4	Oneil Bennett	GWP/NWC	✓	✓	
5	Troy Brown	GWP/NWC	✓	✓	
6	Derrick Brown	GWP/NWC	✓	✓	
7	Adrian Foreman	GWP/NWC	✓	✓	
8	David McCalla	GWP/NWC	✓	✓	
9	Bobby Jacobs	GWP	✓	✓	<i>Certificates emailed to GWP for distribution to participants.</i>
10	Jovon Clarke	GWP	✓	✓	
11	Alpha Donald	GWP	X	✓	
12	Harry Hillaire	GWP	✓	✓	
13	Makeda Matthew Bernard	GWP	✓	✓	
14	Melissa Livan	GWP	✓	✓	
15	Shervon Tyson Placide	GWP	X	X	
16	Kip Daniel	GWP	✓	✓	

Key: ✓ Certificate received X No certificate received

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

ALPHA DONALD


Has completed a program in

Operation of Wastewater Treatment Plants, Volume 1, Course A
Safety, Beginning Treatment, and Lagoon Systems

Earning 4.0 CEUs, January 2024
625959



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*


This is to certify that

BOBBY JACOBS

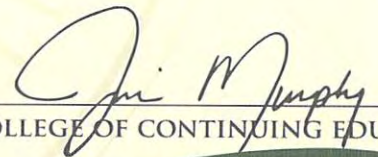
Has completed a program in

Operation of Wastewater Treatment Plants, Volume 1, Course A
Safety, Beginning Treatment, and Lagoon Systems

Earning 4.0 CEUs, January 2024
625967



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

BOBBY JACOBS

Has completed a program in

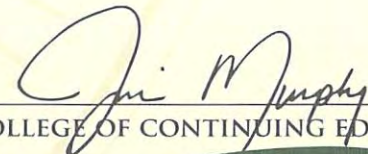
Water Treatment Plant Operation, Volume 1

Earning 9.0 CEUs, January 2024

625932



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
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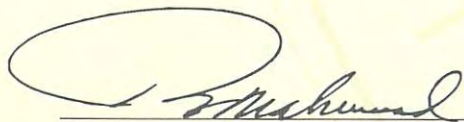
This is to certify that

HARRY HILLAIRE

Has completed a program in

Operation of Wastewater Treatment Plants, Volume 1, Course A
Safety, Beginning Treatment, and Lagoon Systems

Earning 4.0 CEUs, January 2024
625964



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

HARRY HILLAIRE

Has completed a program in

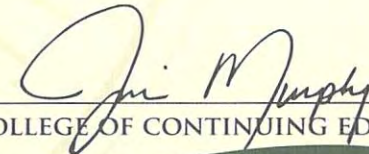
Water Treatment Plant Operation, Volume 1

Earning 9.0 CEUs, January 2024

625929



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

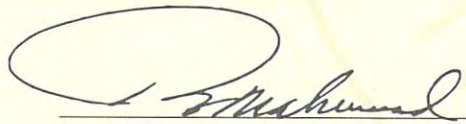
JOVON CLARKE

Has completed a program in


Operation of Wastewater Treatment Plants, Volume 1, Course A
Safety, Beginning Treatment, and Lagoon Systems

Earning 4.0 CEUs, December 2023

625957



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

JOVON CLARKE

Has completed a program in

Water Treatment Plant Operation, Volume 1

Earning 9.0 CEUs, October 2023
625922



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

KIP DANIEL

Has completed a program in

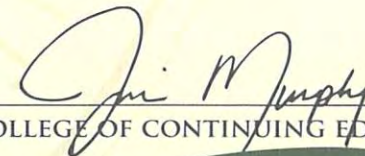
Water Treatment Plant Operation, Volume 1

Earning 9.0 CEUs, January 2024

625923



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

KIP DANIEL


Has completed a program in

Operation of Wastewater Treatment Plants, Volume 1, Course A
Safety, Beginning Treatment, and Lagoon Systems

Earning 4.0 CEUs, November 2023
625958



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DEAN, COLLEGE OF CONTINUING EDUCATION

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that


MAKEDA MATTHEW-BERNARD

Has completed a program in

Operation of Wastewater Treatment Plants, Volume 1, Course A
Safety, Beginning Treatment, and Lagoon Systems

Earning 4.0 CEUs, December 2023

625972



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

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in Cooperation with the College of Continuing Education*

This is to certify that


MAKEDA MATTHEW-BERNARD

Has completed a program in

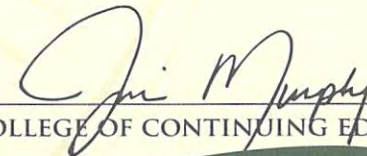
Water Treatment Plant Operation, Volume 1

Earning 9.0 CEUs, January 2024

625937



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This is to certify that

MELISSA LIVAN

Has completed a program in

Operation of Wastewater Treatment Plants, Volume 1, Course A
Safety, Beginning Treatment, and Lagoon Systems

Earning 4.0 CEUs, December 2023

625970



DIRECTOR, OFFICE OF WATER PROGRAMS



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CALIFORNIA STATE UNIVERSITY, SACRAMENTO

OFFICE OF WATER PROGRAMS

*College of Engineering and Computer Science
in Cooperation with the College of Continuing Education*

This is to certify that

MELISSA LIVAN

Has completed a program in

Water Treatment Plant Operation, Volume 1

Earning 9.0 CEUs, January 2024

625935



DIRECTOR, OFFICE OF WATER PROGRAMS



DEAN, COLLEGE OF CONTINUING EDUCATION

8.6. One (1) regional workshop for youth and journalists, focusing on wastewater management

PRO GRA MME 2022



"To Save the
Water...Let's
Talk About
Shit"

IWWM Youth Workshop

OPENING
CEREMONY

20.09.22

9:00 - 9:15

GWP - Caribbean

Facilitator: Kerron Martinez

WORKSHOP ZOOM REGISTRATION LINKS:

Sessions 1, 2, 5 & 6: <https://bit.ly/3BK30d9>

Sessions 3 & 4: <https://bit.ly/3Dnpj9E>

Time Zone: GMT/UTC - 4

20.09.22

SESSION 1 | 9:15 - 11:00

Context Setting: Integrated
Water and Wastewater
Management

Facilitator: Marle Reyes

27.09.22

SESSION 2 | 9:00 - 11:00

Innovative Technologies for
Wastewater Recycling: The
Use of Glass in Recycling of
Wastewater

Facilitator: Better2Earth

11.10.22

SESSION 3 | 9:00 - 11:30

Failure in WASH: The Youth
Experience

Facilitator: Liz Smith

18.10.22

SESSION 4 | 9:00 - 12:00

Training in Communications

Facilitator: Liz Smith

01.11.22

SESSION 5 | 9:00 - 12:00

Presentation of Final
Product

Facilitator: Liz Smith

22.11.22

SESSION 6 | 9:00 - 12:00

Presentation of Final
Assignment Videos -
Journalist Workshop
(Optional)

Facilitator: Liz Smith

"To Save the Water...Let's Talk About Shit"

IWWM Youth Workshop

Programme Breakdown



20.09.22

OPENING CEREMONY | 9:00 - 9:15

Facilitator: Kerron Martinez

Speakers:

- GWP-C -Simone Lewis (Regional Coordinator)
- UNEP- Christopher Corbin (Acting Coordinator Cartagena Convention Secretariat)
- CReW+ Pedro Moreo (PCG)

SESSION 1 | 9:15 - 11:00

Facilitator: Marle Reyes

Context Setting: (15 minutes) | Presenter: Pedro Moreo

Wastewater Management and Sanitation in the Caribbean (including Governance Frameworks for Wastewater Management (national, regional and global) (15 minutes)

Presentation 1: (30 minutes) | Presenter: Cartagena Convention Secretariat based on SOCAR and Nutrients Strategy

- Snapshot of Wastewater Management Issues in the Caribbean – Drivers and Pressures
- Wastewater Pollution – State and Impacts
- Governance Arrangements to improve wastewater management and sanitation, including promoting the use of treated wastewater and biosludge – Responses
- (Implementing solutions for Integrated Water and Wastewater Management (IWWM) – Responses)

Q&A Session (15 minutes)

Presentation 2: (15 minutes) | Presenter: GWP C –Mr. Miguel Montoute

Treated wastewater reuse and its benefits in the region's increasingly water scarce environments. Circular Economy, Waste as a Resource and one of the tools to adapt to Climate Change.



Presentation 3: (15 minutes) | Presenter: GWP-C--Dr Peters

Examples of collective action for IWWM, what went right, what went wrong, and what can be learned from it.

Q&A (15 minutes)

27.09.22

SESSION 2 | 9:00 - 11:00

Innovative Technologies for Wastewater Recycling: The Use of Glass in Recycling of Wastewater

- Glass recycling community approaches (30 minutes)
- Glass recycling technology for wastewater management (30 minutes)

Break (10 minutes)

Porous alpha glass recycling technology for agriculture development (30 minutes)

Q&A (30 minutes)

Innovative technologies for wastewater recycling: Plastic recycling

Facilitator: Better2Earth

11.10.22

SESSION 3 | 9:00 - 11:30

Failure in WASH: The Youth Experience

- WASH Case Studies (30 minutes) | Presenter: GWP-C
- Youth and Innovation in IWRM (15 minutes) | Presenter: GWP-C Shark Tank Winner 2020

Q&A (15 minutes)

Break (5 minutes)

- How can young people become more involved in IWWM? (10 minutes) | Presenter: Jamilla Sealey

Panel Discussion: Topics: Lessons learned from young advocates involved in IWWM.

- Why do youth voices matter in IWWM? (40 minutes)

Panelists: Jamilla Sealey, Minerva Gonzales, Jheuel Carter Guy, Keisha-Ann Belle, Amana Hosten, Akil Crichlow

Break (5 minutes)

Interactive activity and sharing (30 minutes)

Facilitator: Liz Smith



18.10.22

SESSION 4 | 9:00 - 12:00

Training in Communications

- Training topics will include but not be limited to the selection of the appropriate platform(s) for the target audience.

Assignment

Facilitator: Liz Smith

01.11.22

SESSION 5 | 9:00 - 12:00

Presentation of Final Product

Facilitator: Liz Smith

WORKSHOP GUIDELINES

Attendance:

You will be required to register via Zoom to attend this workshop. Kindly note the different links required for the respective sessions below.

- Sessions 1, 2, 5 & 6: <https://bit.ly/3BK30d9>
- Sessions 3 & 4: <https://bit.ly/3Dnpj9E>

Participants must attend all Sessions (unless listed as "Optional") and complete an Exit Survey prior to receiving their Certificates.

- Participants who opt to complete the Workshop Assignment will receive a **Certificate of Completion**
- Participants who opt not to complete the Workshop Assignment will receive a **Certificate of Participation**

Participants are welcome to attend the final session of the Journalist Communications Workshop carded for Tuesday 22nd November, 2022 from 9:00AM to 12:00PM (Optional). Journalists will be showcasing IWWM videos created for their Final Assignment.

Journalists will also be invited to attend the final session of the Youth Workshop.

E-mail	First Name	Last Name	Gender	Age	Country	Education	Area of Study	How would you rate your level of skill/capacity in communications and storytelling?	How would you rate your level of familiarity/knowledge of mainstream media and social media platforms?	Which of the following statements best describe your main objective for participating in this workshop?	What outcomes do you expect from this workshop?
aria.goodridge10@gmail.com	Aria	Goodridge	Female	21	Barbados	Bachelor's Degree	Energy and Electronics	2	2	Contribute to changes or improvements in my community	I expect to be exposed to the issues surrounding water
waynelletaylor@yahoo.com	Waynelle	Collymore-Taylor	Female	32	Barbados	Master's Degree	Natural Resource and Environmental Management - Economics and History, Architecture	3	4	Gain new knowledge/further my knowledge	I expect that the knowledge being shared at the workshop will gain more knowledge about wastewater management
jaogj_@hotmail.com	Jabari	Jones	Male	27	Barbados	Bachelor's Degree	social communication & Digital Media	3	4	Raise my awareness on a particular issue	I would like to learn about the wastewater management and
xiramahovy@hotmail.com	Xiara Mahovy	Paulino FrÃ- as	Female	20	Dominican Republic	Bachelor's Degree	Environmental and Atmospheric Science	4	4	Advocate for changes or improvements at policy level	To share knowledge gained from my experience
amana.hosten@gmail.com	Amana	Hosten	Female	31	Grenada	Master's Degree	Biology minor in microbiology	3	3	Share gained knowledge and/or skills	To learn more about wastewater systems, how to sensitive/
amieshapersaud@gmail.com	Amiesha	Persaud	Female	30	Grenada	Bachelor's Degree	Biology	3	3	Contribute to changes or improvements in my community	To familiarize myself with these topics
lionia_sap@hotmail.com	Lionia	Price	Female	21	Grenada	Bachelor's Degree	General Biology	3	4	Gain new knowledge/further my knowledge	To be able to advocate for safe and reliable water supply on
Koolest_rp@gmail.com	Reesca	Pope	Female	32	Grenada	Bachelor's Degree	Environmental Science	3	3	Contribute to changes or improvements in my community	I hope to have a better understanding of my role in
benitadavis00@gmail.com	Benita	Davis	Female	27	Guyana	Bachelor's Degree	Bachelor of Science (Chemistry)	3	4	Advocate for changes or improvements at policy level	Increase my knowledge basic, that can possibly lead to change
melissalvan2010@yahoo.com	Melissa	Livan	Female	28	Guyana	Bachelor's Degree	Water quality management	3	4	Gain new knowledge/further my knowledge	I just completed an introductory level Water Quality Management
nazemasattar@gmail.com	NAZEMA	SATTAR	Female	22	Guyana	High School	Environmental Studies	2	2	Contribute to changes or improvements in my community	The outcomes align with all 6 options/options as objectives for
nikitalacruz21@gmail.com	Nikita	Bagot	Female	26	Guyana	Bachelor's Degree	Engineering	3	3	Advocate for changes or improvements at policy level	Interactive sessions
shahadhusain995@gmail.com	shahad	husain	Male	26	Guyana	Associate's Degree	Environmental Science	4	3	Share gained knowledge and/or skills	Highlight the problems in WWTF to specific countries and
garridoshannon@gmail.com	Shannon	Garrido	Female	24	Guyana	Bachelor's Degree	Geography	3	4	Contribute to changes or improvements in my community	An interactive engagement and deepened stakeholder
arhwolmersvip@gmail.com	Adrian	Henriques	Male	34	Jamaica	Bachelor's Degree	BSc Political Science, MSC International Public and	3	5	Gain new knowledge/further my knowledge	Waste water management is very important to the region
mario.galbert15@gmail.com	Mario	Galbert	Male	23	Jamaica	Bachelor's Degree	Geology	4	5	Advocate for changes or improvements at policy level	I expect to meet and get an opportunity to network with
petaharris08@gmail.com	Peta-Gay	Harris	Female	26	Jamaica	Master's Degree	Public Health	3	4	Contribute to changes or improvements in my community	Improvement of knowledge/contributions to
cgaston_6@hotmail.com	Chantal	Gaston	Female	32	St. Lucia	Bachelor's Degree	sociology, economics, business	4	4	Advocate for changes or improvements at policy level	I expect this workshop to be interactive and very informative
coslens2@gmail.com	coslene	Simon	Female	21	St. Lucia	High School	Marketing	1	2	Gain new knowledge/further my knowledge	The further my knowledge on the topic and to develop/identify
kashardaniel@gmail.com	Kashar	Daniel	Female	32	St. Lucia	Bachelor's Degree	Geoscience	4	4	Contribute to changes or improvements in my community	I expect that after this workshop I will be able to combine what I
gustazeeuw325@gmail.com	Augusta	Zeeuw	Female	25	Suriname	Bachelor's Degree	Sociology/ climate change	5	4	Contribute to changes or improvements in my community	to get more knowledge Integrated Water and
sanishaautar@gmail.com	Sanisha	Autar	Female	22	Suriname	High School	Biodiversity Conservation and Sustainable Development in the Renewable Energy Technology and Environment Science and	2	4	Gain new knowledge/further my knowledge	Gaining new knowledge and improve my ability to
akilcrichlow898@gmail.com	Akil	Crichlow	Male	25	Trinidad and Tobago	Master's Degree	Biology and Environmental and Natural Resource Management	3	5	Advocate for changes or improvements at policy level	I expect to broaden my perspective about this topic and
alsandriaalvada@gmail.com	Alsandria	Alvada	Female	29	Trinidad and Tobago	Master's Degree	Mechanical engineering	3	3	Gain new knowledge/further my knowledge	I hope to be able to learn more about media in order to bring
sharinagerald@gmail.com	Sharina	Gerald	Female	30	Trinidad and Tobago	Bachelor's Degree	Natural resources and the environment	3	4	Advocate for changes or improvements at policy level	a better understanding on water and waste management
mekialjames9@gmail.com	Mekial	Jmaes	Male	26	Dominica	High School		4	2	Contribute to changes or improvements in my community	I expect to gain knowledge on how to contribute to changes in
stevensonetienne.se@gmail.com	Stevenson	Etienne	Male	26	Haiti	Bachelor's Degree		4	3	Contribute to changes or improvements in my community	

8.7. One (1) regional workshop on Shit Flow Diagrams (SFD) diagrams

International Online Training Programme on Preparation of Shit Flow Diagram (SFD) for Caribbean Countries



Part A (Online): 21-28 March, 2022 | Part B (Virtual): 29 March-1 April, 2022

Course Coordinators:

Dhruv Pasricha, CSE | Persis Ramirez, GWP-C

Agenda

TIME (AST)	SESSION	TRAINER
Day 1: 29 March, 2022		
07:30 – 07:45	Participants' Welcome, About the training, About CSE	DP
07:45 – 08:15	<ul style="list-style-type: none"> About GWP-Caribbean Context-setting: Issues and challenges Need for SFD in the Caribbean 	PR / SL
08:15 – 09:00	<ul style="list-style-type: none"> Reflections of Part A India's SFD Journey Why do we need SFD? 	DP
09:00 – 09:20	Break	
09:20 – 10:30	<ul style="list-style-type: none"> How to read an SFD? Getting versed with SFD terminologies (Including brainstorming exercises) 	HY
Day 2: 30 March, 2022		
07:30 – 07:50	Reflection Session	DP & HY
07:50 – 09:00	<ul style="list-style-type: none"> Data collection for SFD Report SFD Data sources Group exercise on Data Collection 	HY
09:00 – 09:20	Break	
09:20 – 10:30	<ul style="list-style-type: none"> Analysing SFD Data Estimating WW and FS generation in cities SFD Reports 	HY
Day 3: 31 March, 2022		
07:30 – 07:50	Reflection Session	DP & HY
07:50 – 09:00	<ul style="list-style-type: none"> How to generate the SFD Graphic? What's new with SFD? Context Adapted SFD 	HY & SA
09:00 – 09:20	Break	
09:20 – 10:30	DIY Exercise on Preparation of SFD for hypothetical town	DP & HY
Day 4: 1 April, 2022		
07:30 – 08:30	DIY Exercise on Preparation of SFD for hypothetical town	DP & HY
08:30 – 09:00	Group presentations for DIY Exercise	DP & HY
09:00 – 09:20	Break	
09:20 – 09:45	Feedback, closing and way forward	DP
DP: Dhruv Pasricha; HY: Harsh Yadava, SA: Sarim Ansari; PR: Persis Ramirez, SL: Simone Lewis		

First Name	Surname	Email Address	Gender	Age (in years)	Contact Number	Country	Name and Address of your current organisation	Letter sent	Your designation in the organisation	Category of your organisation
Fane	Austin	wcaustin@wsc.com.bs	Female	26	2428247449	Bahamas	Water and Sewerage Corporation, #38 Thompson Boulevard	Yes	Graduate Engineer	Government
Henrea	Curry	henrea_lorele@hotmail.com	Female	38	242333198	Bahamas	Water & Sewerage Corporation, #38 University Drive, Nassau, Bahams	Yes	Graduate Engineer	Government
Barett	Clarke	ianclarke290@gmail.com	Male	41	1242457223	Bahamas	Water & Sewerage Corporation Thompson Boulevard	Yes	Sewer Engineer	Government
Hugo	Rancharan	hugo.rancharan@bwal.com.bz	Male	46	6341440	Belize	Belize Water Services Limited	Yes	Belize Water Services	Government
Andrew	Cutkelvin	andrew.cutkelvin@bwal.com.bz	Male	41	6059774	Belize	Belize Water Services Limited	Yes	Belize Water Services	Government
Vanessa	Tore	vanessa.tore@gobiernu.cw	Female	51	+59995128443	Curaçao	Committee for Integrated Water Management of Curaçao	Yes	Government of Curaçao	Government
Hypolite	Austrie	h.austrie@dowasco.dm	Male	44	17672751150	Dominica	Dominica Water and Sewerage Company Limited	Yes	Sanitation Supervisor	Government
Ivanira	Izidoro Da Costa James	ijames@dowasco.dm	Female	57	+17672552950	Dominica	Dominica Water and Sewerage Limited	Yes	Operations and Maintenance Manager	Government
M. Vanya	David	vanyamrhadavid@gmail.com	Female	63	6147520	Dominica	Dominica National Council of Women (DNCW) C/o 43 Hillsborough Street Roseau	No	President	Civil Society/NGO
Marion	Clyne	adminmanager@grenadaports.com	Male	49	4734493269	GRENADA	Grenada Ports Authority, St. Georges, Grenada.	No	Manager - Administration	Government
Damani	Bruno	damani_bruno@yahoo.com	Male	33	+14734102394	Grenada	National Water & Sewerage Authority	No	Hydraulic Organization	Government
Keron	Martinez	keron.martinez@wp-caribbean.org	Male	33	14734054441	Grenada	Global Water Partnership-Caribbean, The Windward Islands Research & Education Foundation (WINDREF)	No	Programme Assistant	Civil Society/NGO
Rabicia	Niles	rabicia98.niles@gmail.com	Female	23	5926417939	Guyana	Ganges Street Sophia Georgetown Guyana	Yes	Environmental Officer 1	Government
Elon	Sooknaran	esooknaran@epguyana.org	Male	38	5926191335	Guyana	Environmental Protection Agency - Ganges Street, Georgetown, Guyana.	Yes	Public Infrastructure, Transportation and To	Government
Karen	Watson	kwatson@epguyana.org	Female	40	5926488148	Guyana	Environmental Protection Agency, Ganges Street, Sophia, Georgetown	Yes	Senior Environmental Officer	Government
Jodian	Pinder	pinder88@yahoo.com	Female	33	8764175929	Jamaica	North East Regional Health Authority/ St. Mary Health Department/St. Ann, JWI	No	Public Health Officer	Government
Soshanna	Mussenden	smussender05@gmail.com	Female	34	18767999793	Jamaica	Aqua Treat Solutions 3 Fairfield Estate, Montego Bay	No	Managing Director	Industry / Consultant
Patrick	Reece	tmbercon@yahoo.com	Male	64	+18769908837	Jamaica	Civ-Tech Engineers Limited, 203 Eltham View Drive, Spanish Town P. O., St Catherine, Ja W. I.	No	Prncpal Engineer and CEO	Industry / Consultant
Kenaud	Ryan	kenaud.ryan@mul.ms	Male	49	+446644912538	Montserrat	Bradex	No	Manager Water & Waste Water Division	Government
Vigan	Daway	vigan.daway@mul.ms	Male	42	+16644955113	Montserrat	Montserrat Utilities Limited	Yes	Network Supervisor	Government
David	Henry	dekanoute@gmail.com	Male	28	+17582843223	St. Lucia	ReThink Youth, High Street, Canaries, St. Lucia	No	Founder & President	Civil Society/NGO
Miguel	Montoute	Miguel.Montoute@govt.lc	Male	32	17582859645	St. Lucia	Water Resource Management Agency	Yes	Water Resource Specialist	Government
Gabriel	Kirby	gkirby@cvsavg.com	Male	30	7844914498	St. Vincent and the Grenadines	Central Water and Sewerage Authority	Yes	Engineer	Government
Khadjah	Tyrell	greenenviro.tt@gmail.com	Female	42	18684993200	Trinidad & Tobago	Green Enviro TT - 1-67 Mountain View Terrace, Upper Mendez Drive Champs Fleurs	No	Project Coordinator	Civil Society/NGO
Delena	Indar	delena.indar@gmail.com	Female	34	18686202337	Trinidad & Tobago	N/A	No	Consultant	Industry / Consultant
IAN	CONSTANTINE	iconstantine@govt.tc	Male	51	16492467446	Turks & Caicos Islands	Government of Turks and Caicos Islands	No	Capital Projects Coordinator	Government



SFD Lite Report

Mahdia Guyana

This SFD Lite Report was prepared by CSE, GWP-Caribbean,
Mayor and Town Council of Mahdia-Environmental Health Department (MTCMEHD)
and Global Environment (GE)

Date of production/ last update: 24/08/2022

1 The SFD Graphic

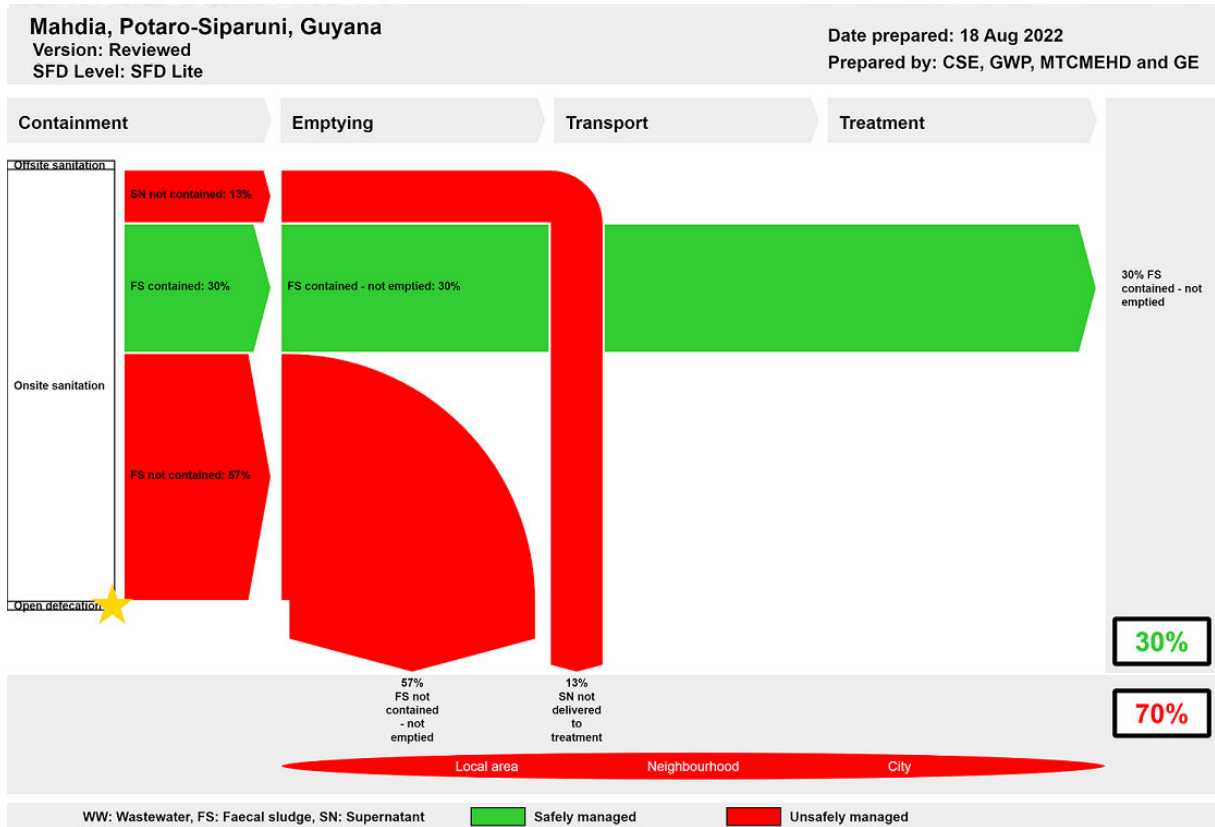


Figure 1: SFD Graphic for Mahdia.

2 SFD Lite information

Produced by:

- This report has been made as part of an International Online Training on Preparation of Shit Flow Diagram (SFD) for Caribbean Countries conducted by Centre for Science and Environment (CSE) in partnership with Global Water Partnership (GWP)- Caribbean from 21/03/2022 to 2/04/2022 and compiled as part of SFD Promotion Initiative (SFD-PI) Project (Phase 3) funded by Bill and Melinda Gates Foundation (BMGF). Further, the report was compiled by Ms Rabicia Niles.
- Special appreciation to Ms Kimberly Jacobs, Environmental Health Officer of Mahdia, Mr Andre Phillips, Statistician at the Bureau of Statistics and all residents who participated in the surveys and Key Informant Interviews. Special thanks to Mr Harsh Yadava (CSE) and Mr Dhruv Pasricha for their patience and support during the preparation of this SFD graphic.

Collaborating partners:

- Centre for Science and Environment (CSE), New Delhi, GWP-Caribbean, Mayor and Town Council of Mahdia-Environmental Health Department (MTCMEHD). Financed by: Global Environment (GE). Co-implemented by: The United Nations Environment Programme (UNEP) and the Inter-American Development Bank (IDB).
- Co-executed by: The Caribbean Environmental Programme (CEP)-UNEP, the German Agency of International Cooperation (GIZ), and Organization of American States (OAS).

Date of production: 24/08/2022

3 General City Information

Mahdia is located in Administrative Region (8) - Potaro Siparuni of Guyana and is also near the centre of the country with an altitude of 415 m and elevation of 1,360 m. The town is approximately 203 km for the country's capital city Georgetown (Figure 2). It was officially declared Guyana's tenth town in October 2018 and is the Regional Administrative Centre of Region (8). The town is mostly known for its gold and diamond operations which is its main economic activity and as such attracts both local and foreign immigrants who benefits from obtaining wealth through mining. The town is divided into three constituencies; namely Central Mahdia, Seven Miles and the Airstrip¹.



Figure 2: Map of Mahdia (Source: Mayor and Town Council Mahdia/2022).

With a population of 4,200 residents at approximately 842 households within the township, the major water supply to households are private catchments/rain water and spring/river and pond water². Separate houses detached and flats/apartments/condominiums are identified as the major types of households by dwelling within the town³.

For the purposes of this report, the town's geographical coordinates are: 5°16'N 59°9'W. The topography within 3 kilometres of the town contains only modest variations in elevation, with a maximum elevation change of 124 metres and an average elevation above sea level of 106 metres (Figure 3). And the area within 3 kilometres of the town is covered by trees (94%).

The town has two artisanal wells; however, residents still depend on rainfall and water from the Salbura Falls as it major water source³.

Only moderate quantities of fresh groundwater are available from igneous and metamorphic rocks at depths from 10 to 300m². Meagre to very small quantities of fresh water is available

¹ Bureau of Statistics Guyana, Population Housing Census (2012), [Available from: https://statisticsguyana.gov.gy/wp-content/uploads/2019/10/2012_Preliminary_Report.pdf]

² World Population Review. Available from: <https://worldpopulationreview.com/countries/guyana-population>

³ KII, 2022; Interview with Ms. Kimberly Jacobs (Environmental Health Officer, Ministry of Health Guyana)

from igneous dikes and andesitic flows at depths ranging from 3 to 150m. It has a tropical rainforest climate with heavy rainfall year-round, and the daily mean temperature is 26.5°C, while the average annual rainfall is 140 mm⁴.

Table 1: Population Growth rate of Mahdia (Source: Rabicia/org./2022)¹.

Census Year	Population	Source
2002	1,617	Population housing Census 2002
2012	3,017	Population housing Census 2012
2022	4,200	World Population Review (Estimated)



Figure 3: Aerial Map of Mahdia (Source: Bing Map/2022).

⁴ Weather Spark [Accessed August 18 2022]. Available from: <https://weatherspark.com/y/28934/Average-Weather-in-Mahdia-Guyana-Year-Round>

4 Service outcomes

All sanitation systems available in the town are classified as onsite systems (there is no sewerage network⁵). The main types of toilet facilities are flush toilets linked to lined and unlined pits, ventilated pit latrines and traditional pit latrines with and without slabs⁶.

Table 2 summarises the sanitation systems in use, as well as estimates of the population connected to each system. For the onsite sanitation systems it shows the proportions of each from which faecal sludge is then emptied, transported to treatment and treated.

Mahdia, Potaro-Siparuni, Guyana, 18 Aug 2022. SFD Level: SFD Lite

Population: 4200

Proportion of tanks: septic tanks: 100%, fully lined tanks: 50%, lined, open bottom tanks: 100%

Containment						
System type	Population	FS emptying	FS transport	FS treatment	SN transport	SN treatment
	Pop	F3	F4	F5	S4e	S5e
System label and description	Proportion of population using this type of system (p)	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
T1A3C6 Fully lined tank (sealed) connected to an open drain or storm sewer	25.0	0.0	0.0	0.0	0.0	0.0
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	15.0	0.0	0.0	0.0		
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	15.0	0.0	0.0	0.0		
T1B10C6 Containment (septic tanks, fully lined tanks, partially lined tanks and pits, and unlined pits) failed, damaged, collapsed or flooded - connected to open drain or storm sewer	5.0	0.0	0.0	0.0	0.0	0.0
T2A6C10 Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	30.0	0.0	0.0	0.0		
T2B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	10.0					

Table 2: SFD Matrix for Mahdia (Source: Rabicia/2022).

⁵ KII-I, 2022; Interview with Mr Rensforde Joseph (Sanitation Manager, Sanitation Department-Guyana Water Incorporated GWI).

⁶ KII, 2022; Interview with Ms. Kimberly Jacobs (Environmental Health Officer, Ministry of Health Guyana).

4.1 Onsite Sanitation systems (OSS)

Containment:

The town is classified as a non-sewered sanitation system⁷. Key Informant Interviews (KIIs-1,2,3, 2022), field observations, focus group meetings (FDG1, 2022), sample Household (HH) survey records as well as census information from the Bureau of Statistics Guyana indicated that 100% of the population is dependent on Onsite Sanitation Systems (OSS). Household onsite sanitation systems includes; fully lined tanks (sealed) connected to an open drain (T1A3C6), lined tanks with impermeable walls an open bottom, no outlet or overflow (T1A4C10), lined pit with semi-permeable walls and open bottom, no outlet or overflow (T1A5C10), unlined pit, no outlet or overflow where there is a significant risk of groundwater pollution (T2A6C10), containment that failed, damaged, collapsed or flooded connected to open drain or storm water (T1B10C6) and pits, never emptied but abandoned when full and covered with soil, no outlet or overflow, where there is a significant risk of groundwater pollution (T2B7C10). Figure 4 shows a pipe connected from a toilet to an open drain.

Septic tanks (ST) are not prevalent in town as there is no private or public desludging company or a treatment plant⁸. However, unlined pits with no outlet or overflow (commonly referred to as pit latrines, Figure 5) utilized by (30%) of HHs and fully lined tanks (Figure 6) connected to an open drain utilized by (25%) of HHs, are popularly used within the town. There is no consensus on the size of fully lined tanks or unlined pits which are usually constructed based on the household size and purpose of use. Public and shared toilets (Figure 7) throughout the town are non-sewered and connected to fully lined tanks. Figure 8 and Figure 9 show the housing settlement and a household connected to a lined pit, respectively.

Emptying and transport:

There are no public or private desludging tankers operating within the town, and therefore emptying and transport is not practised. When tanks and pits fill up, households use other methods, for example the fully lined tanks constructed of concrete, blocks and water-tight mortar floorings (T1A3C6) are emptied through pipes leading to an open body of water/drainage canal, which is not a safe method of disposal.

Most of the tanks and pits are not emptied but abandoned when full and covered with soil. This method is considered safe when the groundwater used for drinking is not polluted, and it is estimated that 30% of the population use lined tanks and pits systems where there is no or only a 'low' risk (T1A4C10 = 15% and T1A5C10 = 15% on Table 2). However, this method is only safe while there is space for households to cover full tanks pits and replace with new ones. In areas where housing density is increasing, alternative safe solutions will need to be found that may include safe emptying, transport and treatment before reuse or disposal.

Treatment:

The town has no private or public faecal sludge treatment facilities.

⁷ KII-I, 2022; Interview with Mr Rensforde Joseph (Sanitation Manager, Sanitation Department-Guyana Water Incorporated GWI)

⁸ FGD-1, 2022; Focus Group Discussion with Deputy Regional Chairman of Mahdia Mr Peter Ramotar.

4.2 SFD Graphic

The outcome of the SFD graphic shows that only 30% of the excreta flow is classified as 'Safely Managed' while 70% of all excreta flow is classified as 'Unsafely Managed' (Figure 1).

The unsafely managed excreta originate from: Supernatant (SN) not contained- not delivered to treatment (13%) and faecal sludge (FS) not contained- not emptied (57%).

The safely managed excreta is all from the lined tanks and pits that are not emptied but abandoned when full and replaced. These are in an area where there is a low risk of groundwater pollution. However, this method is only safe while there is space for households to cover full tanks and pits and replace with new ones. In areas where housing density is increasing, alternative safe solutions will need to be found that may include safe emptying, transport and treatment before reuse or disposal.



Figure 4: Pipe connected to Open Drain (Source: Rabicia/EPA./2022).



Figure 5: Unlined Pit with permeable wall and open bottom (Source: Rabicia/EPA./2022).



Figure 6: Fully Lined Tank (Source: Rabicia/EPA./2022).



Figure 7: Shared Community Toilet (Source: Rabicia/EPA./2022).



Figure 8: Housing Settlement (Source: Rabicia/EPA./2022).



Figure 9: Household connected to a Lined Pit (Source: Rabicia/EPA./2022).

5 Data and assumptions

Considering the World Bank (2018) Country Report and World Population Review (2022), as the baseline data for all stages of the sanitation chain, updates were also made based on data collected from: field visits through KIIs, FGDs, field observations and secondary sources made available by relevant stakeholders. However, some data required to complete this SFD graphic was not readily available. Thus, some data were not up to date and the following assumptions were made based on information received from primary survey in developing the SFD graphic:

- Assumptions were made on the percentage of citizens using the various types of onsite sanitation services based on information received from the Environmental Health Officer⁹.
- 80% of water supplied is wastewater generated.
- The proportion of faecal sludge in septic tanks, fully lined tanks, and lined, open bottom tanks are considered 100%, 50%, and 100% respectively as per the guidance given in the Frequently Asked Questions (FAQs) in the Sustainable Sanitation Alliance (SuSanA) website.
- Based on observations, containment systems present in Central Mahdia, a congested area of the town, are in close proximity to the river and creek where groundwater level is high which poses a significant risk to groundwater contamination.
- The town has no private or public transportation system for the emptying and treatment of faecal sludge. Thus, values for variables F3, F4 and F5 for all sanitation systems were set to 0%. Similarly, values for variables S4e and S5e for systems T1A3C6 and T1B10C6 were also set to 0%.

⁹ KII, 2022; Interview with Ms. Kimberly Jacobs (Environmental Health Officer, Ministry of Health Guyana)

6 List of data sources

Reports and literature

- 1) World Population Review. [Accessed August 20 2022] Available from: <https://worldpopulationreview.com/countries/guyana-population>
- 2) Geo-Ref.net [Accessed August 20 2022]. Available from: <http://www.geo-ref.net/en/guy.htm>
- 3) World Bank, 2018. Country Report. [Accessed 16 August, 2022]. Available from: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>.
- 4) Weather Spark [Accessed August 18 2022]. Available from: <https://weatherspark.com/y/28934/Average-Weather-in-Mahdia-Guyana-Year-Round>
- 5) Bureau of Statistics Guyana, Population Housing Census (2012), [Accessed August 20 2022]. Available from: https://statisticsguyana.gov.gy/wp-content/uploads/2019/10/2012_Preliminary_Report.pdf

Key informant interviews (KII)

- 6) KII-1, 2022; Interview with Mr Rensforde Joseph (Sanitation Manager, Sanitation Department-Guyana Water Incorporated GWI).
- 7) KII-2, 2022; Interview with Ms. Kimberly Jacobs (Environmental Health Officer, Ministry of Health Guyana).
- 8) KII-3, 2022; Interview with Ministry of Public Health Officers.

Focus group discussions

- FGD-1, 2022; Focus Group Discussion with Deputy Regional Chairman of Mahdia Mr. Peter Ramotar.

Field Observations

- Random household surveys.
- Observations of containment systems.
- Visit to fully lined tanks supernatant discharge pipelines into drainage.
- Observation of various toilet facilities.

Mahdia, Guyana, 2022

Produced by:

Rabicia Niles, Environmental Officer,
Environmental Protection Agency, Guyana

Editing:

CSE, Harsh Yadava

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SFD Promotion Initiative





SFD Lite Report

Saint Mary Jamaica

This SFD Lite Report was prepared by
CSE, GWP-Caribbean and Saint Mary and Global
Environment (GE)

Date of production: 11/10/2022

1 The SFD Graphic

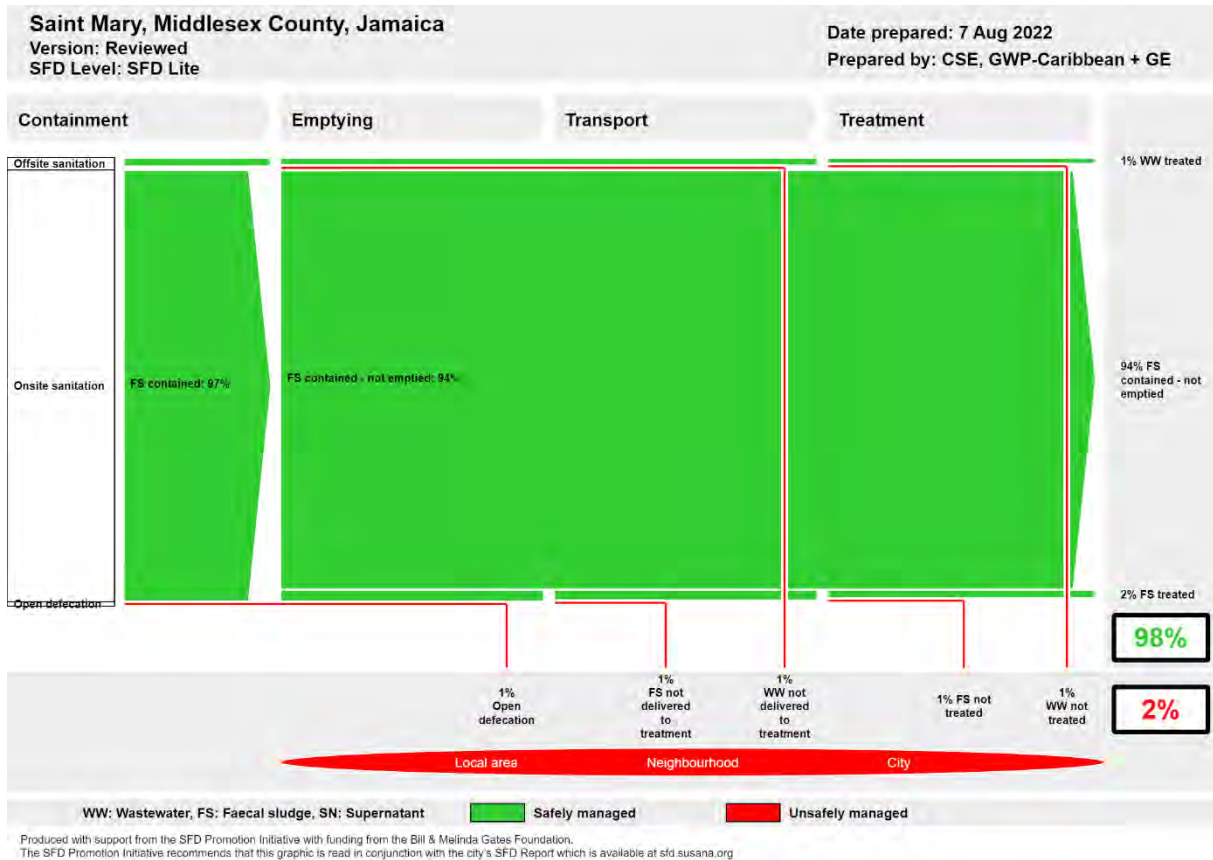


Figure 1: SFD Graphic for Saint Mary.

2 SFD Lite information

Produced by:

-This report has been made as part of an International Online Training on Preparation of Shit Flow Diagram (SFD) for Caribbean Countries conducted by Centre for Science and Environment (CSE) from 21/03/2022 to 2/04/2022 and compiled as part of SFD Promotion Initiative (SFD-PI) Project (Phase 3) funded by Bill and Melinda Gates Foundation (BMGF). Further, the report has compiled by Ms. Jodian Pinder.

-Special thanks to all the persons who participated in key informant interviews (KIIs) and surveys and special thanks to Mr. Harsh Yadava (CSE) for his invaluable inputs and support while preparing the SFD graphic.

Collaborating partners:

Partnership:

- Centre for Science and Environment, New Delhi, GWP-Caribbean, Saint Mary Municipal Corporation (SMMC). Financed by: Global Environment (GE)

Co-implemented by: The United Nations Environment Programme (UNEP) and the Inter-American Development Bank (IDB) and Co-executed by: The Caribbean Environmental Programme (CEP)-UNEP, the German Agency of International Cooperation (GIZ), and Organization of American States (OAS).

Date of production: 07/08/2022

3 General City Information

Saint Mary is a rural parish¹ located on the Caribbean island of Jamaica. The geographical coordinates of Saint Mary are latitude 18°09' north and longitude 77°03' west. Saint Mary is the fifth smallest parish on the island and its capital is Port Maria. The parish is located on the north eastern coast of the island and has an area of 611.3 km². Jamaica is divided into three counties namely Cornwall, Middlesex and Surrey. Saint Mary is situated in the county of Middlesex and is separated into three constituencies; specifically Western, Central and South Western Saint Mary (Figure 2).



Figure 2: Map of Saint Mary⁷.

The parish is bordered by the parish of Portland in the East, Saint Ann parish in the West, and parts of Saint Catherine and Saint Andrew parishes in the South. The topography is primarily mountainous, rising up to almost 4,000 feet at the highest point with 13% of its area having slopes below 10 degrees². The average rainfall for the parish is 2,057.4 mm per year. Saint Mary has warm temperatures year round ranging between 30°C and 32°C³.

The soil types that are found in the parish are predominately limestone on the western side and shale rock on the eastern side. The Rio Nuevo River, Wag Water and White Rivers are the three (3) main rivers in Saint Mary².

The National Water Commission (NWC) is the main supplier of water in Saint Mary. The NWC supplies approximately 139 million gallons (526 million litres) of water per month in Saint Mary. NWC currently has 26,000 accounts in the parish. Thus, 71% of the parish’s water is supplied by the NWC (KII-4, 2022)⁴. Other suppliers includes the Saint Mary Municipal Corporation (stand pipes, storage tanks and distribution into homes), private supplies and community supplies (open streams, wells, entombment). The amount of water supplied by ‘other suppliers’ is unknown (KII-2, 3, 2022)⁵.

Table 1 shows the population growth of Saint Mary in the past three decades.

Table 1: Population growth rate.

Census Year	Population	Growth Rate (%)	Source
1991	108780	2.6	Census 1991
2001	111466	1.89	Census 2001
2011	113615	1.9	Census 2011
2019	115090	1.28	STATIN
2022	146120	-	Estimated

As per the population and housing census conducted by the statistical institute of Jamaica (STATIN) 2011, Saint Mary had a population of 113,615 persons living in 36,530 dwelling with an average of 3.1 persons per household⁶.

According to STATIN post censual data collected in 2019, the total population increased to 115,090 (based on the number of births and deaths that occurred during that period)⁶. The year 2021 was slated to be census year in Jamaica but due to the COVID-19 pandemic this was postponed until September 2022. It is against this background that the researcher estimated the population in 2022 based on cross examination of information received during Key Informant Interviews (KIIs) to be 146,120 persons with an average of 4 persons per household.

¹ Parish is the smallest unit of a local government constituted in rural area.

² The Jamaica Information Service (JIS); <https://jis.gov.jm/information/parish-profiles/parish-profile-st-mary/>

³ Climate and average monthly weather in St. Mary, Jamaica; weather-and-climate.com)

⁴ KII Mr. Richard Williams (Regional Director North East NWC) and Mr. Neville Braham, North East NWC

⁵ KII with Mrs. Patricia. Smith-Warren Water and waste water quality Public Health Inspector and Mr. Brandon Myles, SMMC

⁶ The Statistical Institute of Jamaica (STATIN); https://statinja.gov.jm/Demo_SocialStats/PopulationStats.aspx

⁷ Map of Saint Mary sourced from <https://www.jamaica-land-we-love.com/st-mary-jamaica.html>

4 Service outcomes

Saint Mary , Parish, Jamaica, 7 Aug 2022. SFD Level: SFD Lite

Population: 146120

Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

Containment						
System type	Population	WW transport	WW treatment	FS emptying	FS transport	FS treatment
	Pop	W4b	W5b	F3	F4	F5
System label and description	Proportion of population using this type of system (p)	Proportion of wastewater in sewer system, which is delivered to decentralised treatment plants	Proportion of wastewater delivered to decentralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C4 Toilet discharges directly to a decentralised foul/separate sewer	2.0	90.0	80.0			
T1A2C5 Septic tank connected to soak pit	3.0			90.0	90.0	80.0
T1B11 C7 TO C9 Open defecation	1.0					
T1B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow	94.0					

Table 2 : SFD Matrix.

The SFD matrix (Table 2) was used to generate the SFD graphic shown in Figure 1. It was recognised that 98% of the excreta and wastewater (WW) is classified as safely managed while the remaining 2% is classified as unsafely managed. The safely managed excreta comprises 1% wastewater from the sewer system which is delivered to treatment and treated, 2% faecal sludge from septic tanks which is delivered to treatment and treated, and 94% faecal sludge in pits of various types, which are not emptied but safely abandoned, covered and replaced when full. While the latter method is considered safe (assuming groundwater used for drinking is not polluted), it is only safe while there is space for households to cover old pits and replace with new ones. In areas where housing density is increasing, alternative safe solutions will need to be found that may include safe emptying, transport and treatment before reuse or disposal.

The unsafely managed excreta generated from Onsite Sanitation Systems (OSS) and offsite systems is determined to be 2%, consisting of wastewater delivered to treatment but not treated (1%); wastewater not delivered to treatment (1%); FS not delivered to treatment (1%), FS delivered to treatment but not treated (1%) and people practising open defecation (1%).

Overview on technologies and methods used for different sanitation systems through the sanitation service chain is as follows:

4.1. Offsite systems

Sewerage network and conveyance systems:

Based on field observations, KIIs-1, 2, 6, 8, 2022 and records from the Saint Mary Health Department (SMHD) it was determined that 2% of the population is connected to offsite systems (decentralised sewerage systems, T1A1C4). The National Water Commission (NWC) has primary responsibility for sewerage services in Saint Mary. The excreta generated from the households (HHs) in the parish reaches the Sewage Treatment Plants (STPs) via gravity feed (through sewer laterals). There are two sewage treatment plants that are operated by the NWC in Saint Mary (Figure 3 and Figure 4). These sewage treatment plants are located in Stockholm Park, Highgate and Boscobel (KIIs-2, 4).

The STPs have a capacity of approximately 189,270,590 Million Litres per Day (MLD) each and treats between 189,270,590 to 264,978,826 MLD of wastewater. Mechanical technology, which includes oxidation ditches, mound and aeration tanks are being utilized at these sewage treatment plants. Chlorine and liquid alum are used in the treatment process. For the purpose of this research, it was assumed that 90% of wastewater is delivered to the sewage treatment plants of which 80% is treated.

Treatment:

It was assumed that 80% of wastewater received is treated at the national effluent standards. This assumption was based on information received during the interview with parish official who mentioned that the status of the effluent discharged fluctuates periodically because the plants are old, not being properly maintained and are being overloaded (KII-2, 2022). Thus, compliance with the country's effluent discharge standards are not always achieved by the operators. With regards to Faecal Sludge (FS), after treatment, drying beds are used to store FS. Some of the treated FS is also trucked to dumpsites (not sanitary landfills) outside of the parish.



Figure 3: Treatment (Source: Jodian/Org./2022).



Figure 4: STP, operated by NWC (Source: Jodian/Org./2022)

4.2. Onsite Sanitation Systems (OSS)

Containment:

The majority of the parish is non-sewered. Based on KIIs-1, 2, 6, 8, 2022, sample Household (HH) surveys records from the Saint Mary Health Department and field observations, 94% of the population is dependent on OSS. Most of the HHs have water carriage system attached to soak pits (*locally called as absorption pits*) while others have conventional pit latrines, pour flush and Ventilated Improved Pit latrines. Therefore, the most popular type of OSS utilized by HHs are pits, used by 94% of the population, that have never been emptied but abandoned when full and covered with soil (T1B7C10) . These pits have no outlet or overflow. It must be noted that all the pits have open bottoms. Currently lined pits with semi-permeable walls are in prevalent practice compared to unlined pits which were more prevalent about 30 years ago (KII-8). The pits currently used are 6-12 feet (1.8 - 3.6 metres) deep and constructed with reinforced walls. Masons line the pits with stones and create a ring beam to ensure that the walls do not collapse.

The use of 45 gallon (170 litre) drums to line pits is steadily gaining popularity among the lower socio economic class. Persons use both plastic and metallic drums (KII-2, 8).

Figures 5, 6, 7 and 8 show examples of OSS in Saint Mary.



Figure 5: Pour flush latrine
(Source:Jodian/Org./2022).



Figure 6: Soak pit (Source: Jodian/Org./2022).



Figure 7: Broken sewer pipe leading to soak pit (Source: Jodian/Org./2022).



Figure 8: Pit latrine (Source: Jodian/Org./2022).

More Septic Tanks (ST) are being constructed in Saint Mary because under the law only building plans that have proposal to construct secondary and tertiary systems to manage excreta are being approved. This is observed especially in the coastal areas and areas with very a high water table. It was determined that septic tanks connected to soak pits (T1A2C5) is being utilised by 3% of HHs in Saint Mary (Figure 9 and Figure 10). These septic tanks typically have two chambers and are built from concrete or sold as plastic precasted. The dimension varies for septic tanks constructed with cement while the precasted STs have standardised sizes. HH surveys revealed that septic tanks are emptied on average every two years but this is heavily dependent on the size of the household and septic tank. Septic tanks observed in Saint Mary are mostly connected to tile fields and reed beds. For the purpose of this SFD graphic, all such types of infiltration systems are categorized as soak pits (KII-2, 5, 7, 8).



Figure 9: STs connected to soak pit (Source: Jodian/Org./2022).



Figure 10: Precast plastic ST (Source: Jodian/Org./2022).

Public Toilets (PTs):

The Saint Mary Municipal Corporation (SMMC) operates eight public toilet facilities throughout the parish (markets and transportation centres) that are non-sewered (Figure 11). The PTs includes system tanks connected to soak pits. Most of the buildings are in need of minor to moderate repairs (field observation, 2022). There are twenty nine seats and three urinals in all PTs. Separate seats are available for both men and women. Fees ranging from \$30 to \$50 Jamaican dollars (USD 0.20 - 0.33) are charged at public toilets facilities located in transportation centre and markets while some of the sanitary conveniences are utilized for free. The FS from septic tanks is removed by private operator's mechanical desludging vehicle which are emptied daily at a co-treatment plant in St. Ann (KII-3, 2022).



Figure 11: Public toilet operated by SMMC (Source: Jodian/Org./2022).

Emptying:

OSS as mentioned before are emptied only if the containment is a septic tank. These tanks are mechanically and manually emptied by private desludging vehicles and workers. There is only one registered private desludging company that is based within Saint Mary. However, during field observation and KIIs, it was noted that other private cesspool operators are contracted to empty FS from HHs, restaurants, institutions and hotels in the parish. An operator receives on average 15 requests per month for emptying of septage. The cost to clean a septic tank varies and is based on the distance of the HH, the number loads and whether or not the workers have to manually clean the septic tanks (due to sanitary napkins disposed of inside the tanks, etc.). As per septic tank cleaner survey, it was stated that Personal Protective Equipment (PPE) is provided. The frequency of emptying septic tanks depends on the size of the tanks and the size of the HH. Based on KIIs, it was estimated that on average septic tanks are desludged between 18 months and 2 years. However, it can be less. Hence, variable F3 was set to 90%. The SMMC does not own a desludging vehicle and so PT, HHs and other entities hire private operators to remove FS (KII-1, 3,5,7,8, 2022).

Transport and Disposal:

Subsequent to emptying the septic tanks, the desludging vehicles discharge the septage at a sewage treatment plant in Saint Ann. Since FS/WW is transported and disposed of outside of the city, it is hard to monitor these private operators (Figure 12). However, it must be noted that the last report of an operator discharging FS in an unauthorized manner in Saint Mary was 10 years ago (KII-2, 5, 2022). As per the septic tank cleaner survey, it was established that operators log their daily activities, showing some form of accountability. It was also noted that these operators are aware of the law and try their best to obey the law as they do not wish to tarnish their company's name. Hence, variable F4 was set to 90% and F5 was set to 80% as it is being co-treated at the sewage treatment plant.



Figure 12: Septage haulage vehicle (Source:Jodian/Org./2022).

4.3 Open Defecation

The area is not open defecation free. It was determined through KIIs and surveys conducted by the Saint Mary Health Department-Environmental Health unit that open defecation is being practised by approximately 1% of residents. Reports (complaints) are still being made at the Saint Mary Health Department and SMMC with regards to residents who practise '*parachuting*' (open defecation). HHs that use sink holes or any other inappropriate method for disposal of their excreta which pollutes the environment are also categorised as open defecation. Lack of funding is a challenge to provide HHs with a latrine facility to marginalized communities.

Informal settlements or squatter settlements are dispersed across Saint Mary. These areas are usually densely populated. Most of these squatter settlements are formed as a result of persons wanting to be close to towns or because they have been displaced. Persons squat on lands that are both government and privately owned. Even though these settlements are informal, most of the HHs have access to potable water and acceptable excreta disposal systems (KII-1, 2022). It must also be noted that efforts are being made to regularise some squatter areas. Some of the HHs that do not have a suitable excreta disposal system were accounted for in the percentage that practice open defecation.

4.4 Ongoing and proposed sanitation projects

As mentioned before, the NWC has primary responsibility for sewerage services in Saint Mary⁵. The sewage treatment plant operator survey revealed that plans have been made for the total rehabilitation of Stockholm Park Sewage Treatment plant. Numerous housing developments are in the emerging phase and are proposed to have decentralised sewage systems. Recommendations have been made by the SMHD for a central sewerage system to be constructed in Saint Mary, especially for areas where the water table is very high. Some housing developments have incomplete systems and the owners are working persistently to have the systems completed (KII-2, 4, 2022).

4.5 Risk of ground water pollution

Very little data with regards to groundwater pollution were received during this research. The SFD groundwater risk estimation tool was used to assist in determining the risk for groundwater pollution in Saint Mary as being low. Based on field observations and information gathered from KII sources, it was estimated that less than 25% of the sanitation facilities are located <10m from groundwater sources and less than 25% of the sanitation facilities are located uphill of the groundwater source.

A percentage greater than 25% of drinking water is produced from groundwater sources. However, currently, soak pits construction are only permitted by the competent authorities where the highest groundwater level is 1.2 m from the bottom of the pit. Soak pits are also not allowed in areas whose landscape is underlain by limestone which has been eroded by dissolution, producing ridges, towers, fissures, sinkholes and other characteristic landforms⁸.

The parish has mostly surface water sources which includes rivers above and underground resurfacing as springs. Numerous underground caverns also facilitate springs. Therefore, because of the geological structure of Saint Mary groundwater sources are very few. Areas along the coast or in river valleys are the only places where the sinking of wells for groundwater is allowed (KII-1, 2, 2022). Thus, Saint Mary is categorized as low risk for groundwater pollution.

⁸Ministry of Health and Wellness Minimum Requirements for Waste Water Treatment Systems and Excreta Disposal Management in Jamaica, Volume 3 Section 4, 2007.

5 Data and assumptions

Some of the data required to complete this SFD graphic were not readily available. However, triangulation of data collected from the different authorities, field visit, KIIs, published and unpublished reports aided with the final SFD graphic and report. Some of the data were not up to date, so assumptions were made based on information received from the primary survey.

- Assumptions were made about the percentage of the population that use both onsite and offsite sanitation systems based on records kept by Public Health Officers in each district, field visits and the data collected from the census 2011.
- It was assumed that 90% of WW was transported to STPs and 80% of WW was treated in order to get a true picture of the SFD graphic for the parish.
- It was assumed that the risk for groundwater pollution is low because of the topography of the parish, soil type and the fact that most of the population live below the top of the water source. Laboratory results also showed low levels of sodium and nitrate in water. Low cases of gastrointestinal diseases have been reported in the parish.
- It was assumed that desludgers transport faecal sludge outside of the parish to be treated even though there is no monitoring system. No reports have been made about FS being disposed of improperly.
- Due to the age of the system, leakage and poor maintenance of STP, it was assumed that some WW escapes treatment.

6 List of data sources

Reports and literature

- Climate and average monthly weather in St Mary, Jamaica; weather-and-climate.com
- District Status Registers, SHMD-environmental health unit
- Map of Saint Mary sourced from <https://www.jamaica-land-we-love.com/st-mary-jamaica.html>
- Ministry of Health and Wellness Minimum Requirements for Waste Water Treatment Systems and Excreta Disposal Management in Jamaica, Volume 3 Section 4, 2007; <https://websitesearch2020.nepa.gov.jm/Development-Invest-Man/Volume%203%20-%20Infrastructure,%20Utilities%20and%20Communication/Section%204%20-%20Waste%20Water>
- NWC Development Manual, Volume 3 Section 3, 2007; <https://w.nwcjamaica.com/uploads/document/Draft%20St.%20Mary%20WS%20PLan%20-%20October%2012%202011.pdf>
- The Jamaica Information Service (JIS); <https://jis.gov.jm/information/parish-profiles/parish-profile-st-mary/>
- The Statistical Institute of Jamaica (STATIN); https://statinja.gov.jm/Demo_SocialStats/PopulationStats.aspx
- Water Resource Authority, Jamaica, 2022; <https://www.wra.gov.jm/>
- WRA Water Quality Atlas Jamaica, 2019.

Key informant interviews (KIIs)

- KII-1, 2022; Interview with Mr. A.P Brown (Public Health Expert).
- KII-2, 2022; Interview with Mrs. Patricia Smith-Warren (Water and waste water quality Public Health Inspector).
- KII-3, 2022; Interview with Mr. Myles (SMMC).
- KII-4, 2022; Interview with Mr. Neville Braham and Mr. Richard Williams (NWC).
- KII-5, 2022; Miss Shayna. Lyons/Mr. Mark Lyons (Hydromax).
- KII-6, 2022; Public Health Officers at the local Health Department.
- KII-7, 2022; Hardware operator, Highgate.
- KII-8, 2022; Masons.
- KII-9, 2022; Sewage treatment plant attendant operated by NWC.

Field observation

- Random households surveys.
- Survey of Public toilets.
- Visit to Sewage Treatment Plants and its outlet/discharge point.
- Observation of septic tanks.
- Observation of desludging trucks on the field.
- Observation of pits (all types if applicable).



Source: WRA Water Quality Atlas Jamaica, 2019

SFD Promotion Initiative



SFD Saint Mary, Jamaica, 2022

Produced by:

Mrs. Jodian Pinder

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8.8. One (1) regional science communication workshop targeting journalists with a focus on IWWM

PROGRAMME 2022



"Changing the Rhetoric...The Media's Role in Saving the Water"

IWWM Journalist Communications Workshop

OPENING CEREMONY

20.09.22

9:00 - 9:15

GWP - Caribbean

Facilitator: Kerron Martinez

WORKSHOP ZOOM REGISTRATION LINKS:

Sessions 1, 2, 5 & 6: <https://bit.ly/3BK30d9>

Sessions 3 & 4: <https://bit.ly/3LgSHjd>

Time Zone: GMT/UTC - 4

20.09.22

SESSION 1 | 9:15 - 11:00

Context Setting: Integrated Water and Wastewater Management

Facilitator: Marle Reyes

27.09.22

SESSION 2 | 9:00 - 11:00

Innovative Technologies for Wastewater Recycling: The Use of Glass in Recycling of Wastewater

Facilitator: Better2Earth

12.10.22

SESSION 3 | 9:00 - 11:00

Covering IWWM and Making Pitches to Editors

Facilitator: Liz Smith

13.10.22

SESSION 4 | 9:00 - 12:00

Training in Communications

Facilitator: Liz Smith

01.11.22

SESSION 5 | 9:00 - 12:00

Presentation of Final Product - Youth Workshop (Optional)

Facilitator: Liz Smith

22.11.22

SESSION 6 | 9:00 - 12:00

Presentation of Final Assignment Videos

Facilitator: Liz Smith



Presentation 3: (15 minutes) | Presenter: GWP-C--Dr Peters

Examples of collective action for IWWM, what went right, what went wrong, and what can be learned from it.

Q&A (15 minutes)

27.09.22

SESSION 2 | 9:00 - 11:00

Innovative Technologies for Wastewater Recycling: The Use of Glass in Recycling of Wastewater

- Glass recycling community approaches (30 minutes)
- Glass recycling technology for wastewater management (30 minutes)

Break (10 minutes)

Porous alpha glass recycling technology for agriculture development (30 minutes)

Q&A (30 minutes)

Innovative technologies for wastewater recycling: Plastic recycling

Facilitator: Better2Earth

12.10.22

SESSION 3 | 9:00 - 11:30

Covering IWWM and Making Pitches to Editors

- Making pitches about IWWM, how to make editors, radio show hosts, podcasts, bloggers etc interested in IWWM (20 minutes)

Presenter: Alonso Miranda

Q&A (10 minutes)

- Why IWWM should matter to the media? (20 minutes)

Presenter: Liz Smith

Q&A (10 minutes)

Break (10 minutes)

- Do's and don'ts covering IWWM and lessons learned from a journalist's perspective (20 minutes)

Presenter: Juan Fernando Lara

Panel Discussion: Sharing of experiences by participants (30 minutes)

Facilitator: Liz Smith



13.10.22

SESSION 4 | 9:00 - 12:00

Training in Communications

Assignment

Facilitator: Liz Smith

22.11.22

SESSION 5 | 9:00 - 12:00

Presentation of Final Assignment Video

Facilitator: Liz Smith

WORKSHOP GUIDELINES

Attendance:

You will be required to register via Zoom to attend this workshop. Kindly note the different links required for the respective sessions below.

- Sessions 1, 2, 5 & 6: <https://bit.ly/3BK30d9>
- Sessions 3 & 4: <https://bit.ly/3LgSHjD>

Translation/Interpretation will be provided for sessions including foreign presenters.

Participants must attend all Sessions (unless listed as "Optional") and complete an Exit Survey prior to receiving their Certificates.

- Participants who opt to complete the Workshop Assignment will receive a **Certificate of Completion**
- Participants who opt not to complete the Workshop Assignment will receive a **Certificate of Participation**

Participants are welcome to attend the final session of the Youth Workshop carded for Tuesday 01st November, 2022 from 9:00AM to 12:00PM (Optional). Youth will be showcasing IWWM products created for their Final Assignment.

Youth will also be invited to attend the final session of the Journalist Communications Workshop.

E-mail	First Name	Last Name	Gender	Age	Country	Are you currently a journalist?	If yes, are you an independent journalist or affiliated with a specific organization?	If you selected "Affiliated" above, please state the name of your organization	How would you rate your level of knowledge in Integrated Water and Wastewater Management?	Which of the following statements best describe your main objective for participating in this workshop?	What outcomes do you expect from this workshop?
xiaramahovy@hotmail.com	Xiara Mahovy	Paulino FrÃ-as	Female	18-34	Dominican Republic	Yes	Affiliated	Instituto TecnolÃgico de Santo Domingo (INTEC)	2	Contribute to changes or improvements in my community	I would like to learn about the wastewater management and what
brenphil.2022@gmail.com	Brenda	Phillip	Female	35-65	Grenada	No	Independent		4	Improve my work performance	To be able to better deliver the information and technology learned
gennil_reuben@hotmail.com	Gennil	Reuben	Female	35-65	Grenada	No	Affiliated		2	Gain new knowledge/Further my knowledge	My expectations are two-fold: Enhance my knowledge on water & increased awareness and knowledge that can improve my work at the
minabooker143@gmail.com	Mina	Booker	Female	18-34	Grenada	No	Affiliated	Communications Assistant at the Ministry of Agriculture Lands	1	Gain new knowledge/Further my knowledge	To understand water management to be able to provide information to
Tricia@triciasimon.com	Tricia	Simon	Female	35-65	Grenada	Yes	Independent		3	Gain new knowledge/Further my knowledge	It is my expectation that the workshop would have tons of knowledge, expertise, adaptation and implementation of information
lashana.gomes2019@gmail.com	Lashana	Gomes-Cornelius	Female	35-65	Guyana	No	Affiliated	I previously worked as a Journalist with MTV News Update Channel	3	Advocate for changes or improvements at policy level	I expect to further my knowledge in journalism and Wastewater
r.johntaylor1@yahoo.com	Ronald	Taylor	Male	18-34	Guyana	Yes	Independent		3	Advocate for changes or improvements at policy level	I am an investigative journalist, and the owner and Creative Director of
scoticia04@gmail.com	Scoticia	Hendrickson	Female	18-34	St. Kitts and Nevis	Yes	Affiliated	ZIZ Broadcasting Corporation	3	Gain new knowledge/Further my knowledge	Increased awareness and understanding of Integrated Water
admin@untoldstories.tv	Dale	Elliott	Male	35-65	St. Lucia	Yes	Independent		2	Share gained knowledge and/or skills	Get more information, documentation and networking connections with experts in the field
larisap2002@yahoo.com	Larisa	Kydd	Female	35-65	St. Vincent and the Grenadines	Yes	Independent		3	Gain new knowledge/Further my knowledge	To gain new knowledge and apply in to my field of work. Knowledge is Stakeholders collaboration
st.leeflang@grungrontapu.org	Steven	Leeflang	Male	35-65	Suriname	No	Affiliated	Grun Grontapu Foundation	2	Contribute to changes or improvements in my community	An opportunity to gain knowledge and skills to better advocate and
leandataitt@gmail.com	Leanda	Taitt	Female	35-65	Trinidad and Tobago	Yes	Independent		2	Contribute to changes or improvements in my community	A better understanding of the subject in order to effectively communicate
Zanarafique4@gmail.com	Reezana	Rafique	Female	18-34	Trinidad and Tobago	No	Independent		5	Advocate for changes or improvements at policy level	I wish to update my knowledge pool on what's going on in the water
akelmeade@gmail.com	Akel	Meade	Male	18-34	Trinidad and Tobago	Yes	Independent		3	Advocate for changes or improvements at policy level	
aliciaaquin@hotmail.com	Alicia	Aquin	Female	35-65	Trinidad and Tobago	No	Independent		3	Advocate for changes or improvements at policy level	
k.stjean@dowasco.dm	Kimani	St Jean	Female	35-65	Dominica	Yes	Affiliated	Dominica Water and Sewerage Co. Ltd. and Lion Caribbean	3	Share gained knowledge and/or skills	
pasmarcus@gmail.com	Dwight	Sampson	Male	18-34	Montserrat	Yes	Independent		3	Gain new knowledge/Further my knowledge	

8.9. Seven (7) National Videos on Wastewater Management (Barbados, Saint Lucia, St. Vincent and the Grenadines, Suriname and Trinidad and Tobago)

<https://www.gwp.org/en/GWP-Caribbean/WE-ACT/news-page/News-and-Activities/gwp-c-iwmm-video-series/>

8.10. Two (2) grants to young Caribbean innovators to water-related projects

<https://www.gwp.org/en/GWP-Caribbean/WE-ACT/news-page/News-and-Activities/finalists-from-jamaica-and-trinidad-and-tobago-deliver-winning-pitches-in-the--2022-young-caribbean-water-entrepreneurs-shark-tank-competition/>

8.11. Two (2) papers in Wastewater Management in the Caribbean: 1) A Jamaica Case Study and 2) A Toilet Paper

Wastewater Management in the Caribbean: A Jamaican Case Study



This Perspectives Paper was prepared by Dr. Arpita Mandal and Stephanie Parker. It is intended to galvanise discussion within the GWP-C network and the larger water and development community.

About Global Water Partnership-Caribbean

The Global Water Partnership-Caribbean (GWP-C) vision is for a water secure Caribbean.

Our mission is to support Caribbean countries in the sustainable management of their water resources at the community, national and regional level.

GWP-C is 1 of 13 Regional Water Partnerships of the Global Water Partnership (GWP). It was established in 2004 to foster the application of Integrated Water Resources Management (IWRM) in the Caribbean region. IWRM is the coordinated development and management of water, land, and related resources, in order to maximise economic and social welfare without compromising the sustainability of ecosystems and the environment.

Any organisation with an interest in water sustainability in the region, can become a GWP-C Partner. GWP-C currently has over 100 partners in more than 20 Caribbean countries. These include water management agencies, water user associations, private water management agencies, government institutions, academic and research institutions, private sector companies, non-governmental organisations, community-based organisations, civil society organisations, youth organisations, regional agencies, consultancy firms, among others.

This Perspectives Paper was prepared by GWP-C Technical Committee (TEC) member Dr Arpita Mandal¹, in collaboration with Ms Stephanie Parker².

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Cover Image: Ivan Bandura on Unsplash

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Introduction

Water resources globally are under stress with increase in populations, impacts of climate change and inefficient management of water and sewage systems. The Small Island Developing States (SIDS) of the Caribbean are of no exception and are disproportionately more exposed to water stresses than continental countries owing to their unique physical, demographic and economic factors, limited natural internal water resources (Box 1), increasing water demand due to urbanisation, more rapid late-stage industrialization, and poor sewage treatment (Chase, 2012). In 2010, the United Nations adopted Resolution 64/292, which recognised “the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights”. Despite being a human right, many nations and communities in developing countries do not have the facilities to support this right. The effects of compounding factors poses challenges for Caribbean SIDS in meeting their Sustainable Development Goals (SDGs) Goal 6 (Clean Water and Sanitation). Comprehensive and sustained wastewater management in combination with sanitation and hygiene is central to improved human health, food security, economic development, decent work, and poverty reduction. The Caribbean has certainly achieved progress towards universal access to clean water with an average 97% of populations in 25 Caribbean countries having access to at least improved drinking water. However, access to basic sanitation services is only at 89% coverage on average for most countries but with up to 64% of the Haitian population having no access to basic sanitation services (World Bank, 2023). As the type of urbanization typical in the Caribbean accelerates, the spread of unplanned communities, increased abstraction of limited water resources outpaces the environmental replacement of water resources. Coupled with existing insufficient water and wastewater infrastructure, there has been increased stress not only on surface and underground water resources, but also on water utilities to provide the infrastructure for the delivery of water services. Six of 16 Caribbean countries for which data were available are water stressed according to the Falkenmark Indicator, each having less than 1,700 m³/year/capita internal renewable water resources; and four of these have less than 1,000 m³/year/capita and are thereby deemed water scarce (Falkenmark, 1989; World Bank, 2023).

Improper wastewater management poses threats to water resources, human and ecosystem health through pollution and proliferation of disease vectors and associated pathogens. It also has adverse impacts on agricultural and marine-based food systems by degradation of ecosystems. Efficient wastewater management can provide immediate, intermediate, and long-term co-benefits to health services, water and food security, industry, and ecosystems (Montoute & Peters, 2022). Therefore, seeing wastewater as a resource has cross-cutting multi-dimensional advantages across all sectors, including tourism, agriculture, and aquaculture – all of which are cornerstone economic activities within Caribbean societies. Notably, wastewater management has been considered an integral part of Integrated Water Resources Management (IWRM), specifically highlighted in Sustainable Development Goal Target 6.3 (SDG 6.3), which seeks to improve water quality and reduce untreated wastewater, by aiming to cut half of the proportion of untreated wastewater by 2030 (United Nations, 2018; Roopnarine et al., 2019).

This paper aims to review the challenges and opportunities associated with wastewater management, with a view to highlighting areas for improving implementation of sustainable wastewater management practices applicable in the Caribbean, with special reference to Jamaica. The paper looks at the existing wastewater management system in Jamaica along with an overview of the policies and governance frameworks that are in place to support efficient wastewater treatment and management.

Box 1. Special Characteristics of Small Island Developing States

- Small size – limited natural resource endowment; high import content.
- Limited institutional capacity and small manpower resource base.
- Limited scope for economies of scale
- Demographic factors: out-migration resulting in brain drain; rural-urban pull resulting in population concentrations in narrow coastal strips.
- Insularity and remoteness, leading to high transport costs.
- Proneness to natural disasters, which threaten the survival of some small islands; large damage per unit of area and costs per capita.
- Unique and fragile ecosystems with low level of resistance to outside influences.
- Entire island is a system of highly integrated ecosystems and sub-ecosystems.
- High vulnerability to the impact of global warming and rising sea level.
- Over-dependence on donor funding for capital projects.
- Access to funding is limited.

Box 1. Special characteristics of SIDS (Chase, V., 2012. *Integrated Water Resources Management Planning Approach for Small Island Developing States*. UNEP)

Key Features of Integrated Wastewater Management

Wastewater is any water whose quality has been affected by anthropogenic influence, which encompasses effluents from domestic, agricultural, industrial, or municipal processes including run-off, partially or untreated sewage, and leachates (Tchobanoglous, Burton, & Stensel, 2003). Wastewater management involves both effective mechanisms of collection as well as treatment, disposal, or reuse of wastewater from generating sources. The efficiency of processes involved in wastewater treatment and disposal/reuse operates according to policy guidance, infrastructural capacity, and regulatory action and intervention. The absence and deficiencies of these can have a significant impact on water security, the environment, and public health (Akpor & Muchie, 2011; Cashman, 2014). Three main facets are required to operate in tandem during wastewater management: (1) processing facilities, inclusive of collection, treatment, disposal and reuse infrastructure and services systems (2) regulatory bodies, which covers public and private sector organizations responsible for maintenance, policy enforcement, and implementation/oversight according to agreed national standards during processing, and (3) policy framework, which gives regulators and service providers the institutional arrangements and standards, and overall capacity and tools to manage processes and equipment during wastewater treatment, disposal and reuse.

Liquid and sewage effluents can be classified as greywater (typically from washing, bathing, and kitchen activities) or blackwater (typically from toilets or facilities designated for excreta). Generally, liquid waste is

deemed hazardous, such as those from some industrial processes, certain medical or biological waste, and are often governed by local regulations that control or restrict the quantity, composition and level of contaminants that may be discharged. Charges may be levied on industrial waste producers based on criteria such as toxic content, quantity, and quality.

Wastewater collection systems consist of buried pipelines connected to residential and commercial waste drain systems which convey liquid and sewage waste via pumps, rising mains, valves, screens, and associated infrastructure to treatment systems. For residential and commercial grey and blackwater, there are two main types of systems for handling wastewater treatment: decentralized systems and centralized systems. Decentralized systems, which are the more common type of system used in older urban communities, refer to onsite or near site wastewater collection and treatment that are managed at or close to the point of generation, while centralized systems refer to the use of extensive piping systems (sanitary sewers) that convey residential, commercial or industrial wastewater to central wastewater treatment plants (Crites & Tchobanoglous, 1998; Pasciucco, Pecorini, & Iannelli, 2022), after which, treated wastewater may converge with stormwater runoff in urban drainage systems (combined sewers).

Decentralized systems are typically inclusive of shared and improved sanitation facilities connected to septic tanks, pit latrines or composting toilets. These systems can promote proper treatment of wastewater and may be the most cost-effective way to ensure correct wastewater disposal into the environment, especially where there is limited availability of resources for connecting domestic effluent to centralized systems. However, decentralized systems are more susceptible to near source pollution and improper wastewater handling and disposal as responsibility and maintenance of these systems is normally at the private or municipal levels (United Nations, 2015). This promotes fragmented and inconsistent enforcement of safety regulations.

Centralized systems tend towards more uniformity in treatment standards as well as greater potential to ensure efficiency after wastewater processing. The use of centralized systems is more conducive to institutionalizing the utilization of wastewater as a resource. That said, if these systems are not properly maintained, they fail to safely treat wastewater resulting in the release of partially treated wastewater into runoff flows, coastal ecosystems, and underground drainage systems. This is an ongoing issue in the Caribbean as poorly maintained and insufficient pipe networks and infrastructure exacerbate issues related to surface and groundwater pollution. While there has been a shift from traditional systems to more centralized systems in urban and industrialized areas in developed countries, this has been slow in progress in developing countries, partially related to general SIDS issues (outlined in Box 1) as well as local constraints of which funding could be a significant one.

Wastewater Management Coverage in the Caribbean

The coverage of wastewater disposal and treatment facilities in the Caribbean has changed, mostly for the better, since the early 2000s with an overall increase in access to improved sanitation services. On average around 97% of populations within 15 Caribbean countries have access to improved waste disposal facilities (World Health Organization, 2022) wherein, 54% of households utilize septic tank facilities, 20% use improved latrines, and 25% utilize the facilities connected to sewer networks (Figure 1). The WHO/UNICEF Joint Monitoring Programme - JMP (2021) also indicated that there has been an average increase of 6.2% in the proportion of populations connected to sewer networks from 2016 to 2019 and a 3.9% decrease in the proportion connected to septic tanks. This could be, in part, the result of policies mandating sewer network connections within newer urban developments as Caribbean governments implement actions in support of SDG targets, and urban population growth.

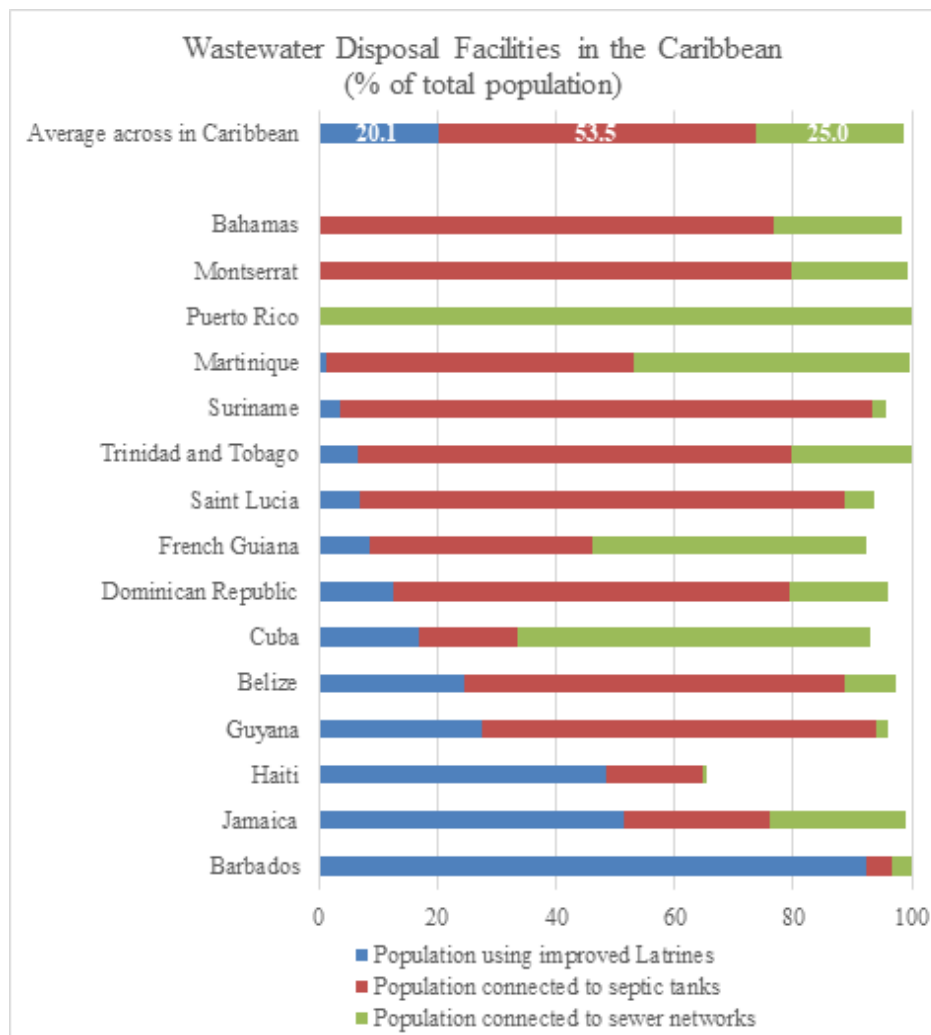


Figure 1. Proportion of population using certain waste disposal mechanisms in several Caribbean countries. Sourced from WHO/UNICEF Joint Monitoring Programme (JMP) 2021 (World Health Organization, 2022) and retrieved from UNICEF Data Warehouse

Apart from septic tanks, another metric of importance within the Caribbean setting, particularly for older urban and rural communities is the use of improved latrines connected to in-situ waste and wastewater disposal facilities which can be considered a form of decentralized systems. Data collected for Cuba, and Suriname (2 of 3 countries for which data were available) showed that 20% and 24% of their populations, respectively, utilized in-situ waste disposal facilities in 2019, while close to 1% used off-site waste treatment in Cuba and none utilized this method in Suriname (World Health Organization, 2022). Visualization and mapping of disposal and treatment usage can point out locations vulnerable to improper disposal and water contamination associated with poor upkeep of certain facilities. The main challenge comes from the lack of maintenance. Proper periodic cleaning (desludging) of the septic tanks, pit latrines, and pit privies needs to be carried out. Failure to de-sludge results in poor effluent quality. A further issue with on-site disposal is that septic tanks built on soils which are not very permeable results in poor adsorption of the contaminants by the soil resulting in soil contamination and if the groundwater levels are high, leading to groundwater contamination.

As noted earlier, having connections to sewer networks does not necessarily equate to safely treated wastewater. The Findings of the 2021 Joint Monitoring Programme (JMP) have further indicated that in four Caribbean countries, within the subset of populations with facilities connected to sewerage, there is only 14.3% of progress in minimum level of treatment of secondary wastewater treatment (WHO 2022). This is based on wastewater treatment plant design and categories defined in System of Environmental-Economic Accounting (SEEA) and the International Recommendations for Water Statistics (WHO, 2021). Primary level of treatment only requires that the effluent is screened (removal of larger material) and kept away from further human contact (WHO, 2021). This fails to remove harmful bacteria and contaminants in effluent. Additionally, the vast majority utilizing sewer connections practice long ocean outfalls method to the sea. The implications of only using primary level treatment in conjunction with ocean outfalls means that pollutants in the effluent are carried to marine ecosystems. This results in high coliform concentrations and low dissolved oxygen levels in coastal waters. Assessments conducted by GEF-CReW and UNEP that indicate 85% of wastewater entering the Caribbean Sea remains untreated. This has largely contributed to degradation and loss of over 80% of living coral in the past two decades (ECLAC & CDCC, 2015).

Targets for policy and management interventions tend to focus on resource protection and water supply, and several governments across the Caribbean have focussed on improving their water resource management policies, especially to maximize existing resource capture and storage. These are in the process of being refined even further to meet SDGs towards universal access to water and sanitation services. In the region, wastewater management is normally included under the umbrella of water management, and thereby, delegated to regulators and state-owned enterprises (SOEs) charged with providing utilities and sanitation services using an integrated water resource management (IWRM) system (Medina, Kullmann, & Felter, 2021). IWRM governance frameworks, through prioritization of more sustainable practices and oversight, should ensure that (1) adaptive strategies are implemented in regard to infrastructure, behaviour, management, and government, (2) there are iterative and targeted assessments of resources, assets and hazard probability for the as needed restructuring and capacity building, (3) there is development and implementation of data collection networks to improve evidence-base for policy design, and (4) there is mainstreaming of development planning (ECLAC & CDCC, 2015).

Apart from recognising the importance to human and environmental safety, the argument for wastewater reuse has received much attention with the implementation of development goals and there are numerous approaches proposed on how best to address these transitions in the Caribbean. The overarching principles critical to any approach however, remains the sustainability of periodic maintenance management, and the implementation of locally-appropriate strategies that respect the local environment, climate and resources (ECLAC & CDCC, 2015). A consistent feature noted in some approaches – such as, the circular economy (Montoute & Peters, 2022), nature-based approach (Corbi et al., 2021), and climate adaptation approach (Medina et al., 2021) – has been the potential of wastewater reuse to supplement strained water resources while meeting environmental considerations. A look at water withdrawals in the Caribbean provides an indication of which category of water withdrawal places the highest burden on internal water resources and hence potential contribution to wastewater discharge. It also suggests where there may be a need for targeted wastewater reuse strategies to reduce dependence on existing resources. On average as per data available for the 16 Caribbean countries in 2019, municipal activities account for the largest water withdrawals at 41.4%, followed by the agricultural sector at 41% and finally the industrial sector at 17.6% (FAO, 2019). These proportions vary vastly depending on the country with some of the larger or more agrarian economies like Guyana and Belize having disproportionately high agricultural withdrawals than more industrialized/tourist-centric economies like Trinidad and Tobago and St. Vincent and the Grenadines.

The potential for reuse would be of particular importance to the more water stressed countries like Antigua and Barbuda versus water abundant countries like Suriname.

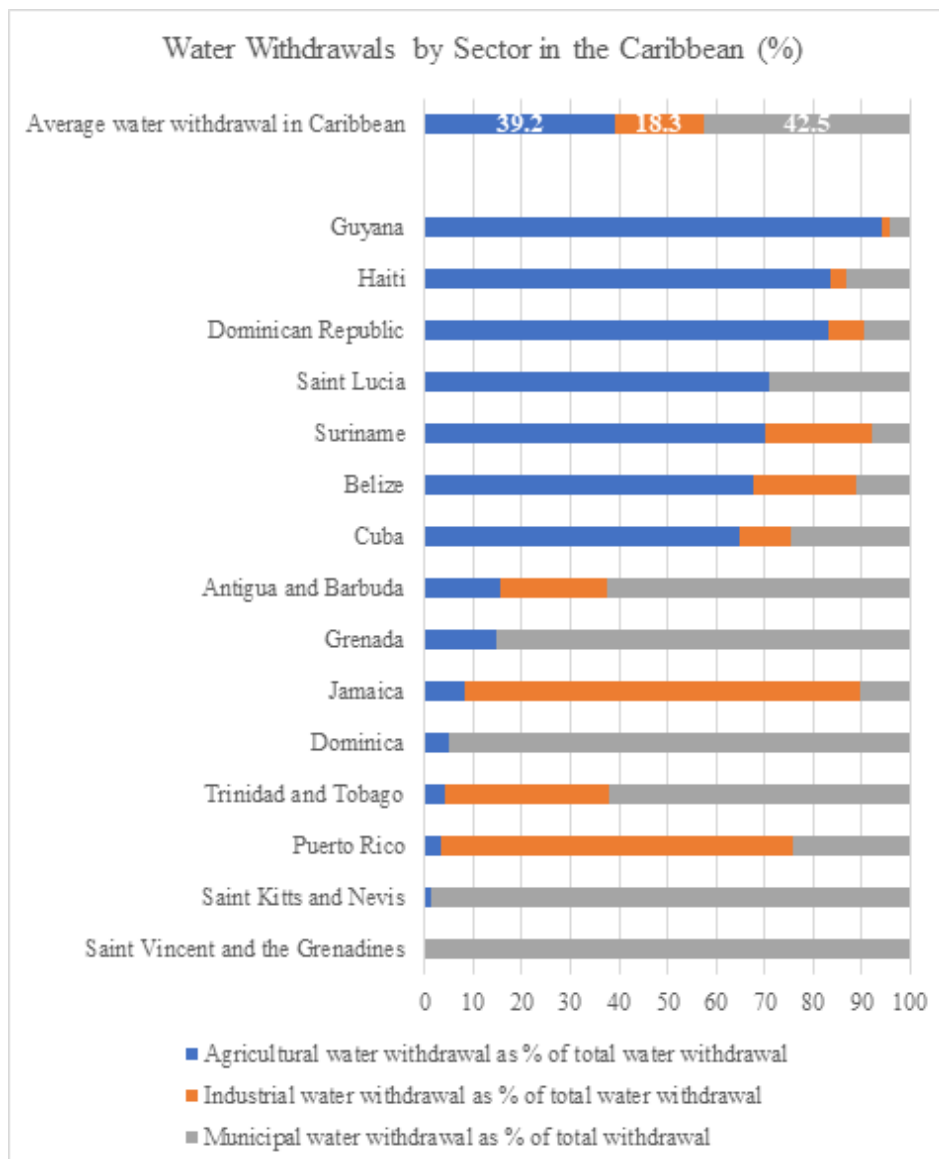


Figure 2. Sectoral water withdrawals as a proportion of total water withdrawals in several Caribbean countries in 2019. Sourced and retrieved from the Food and Agriculture Organization (FAO) database.

Issues in the Approaches to Wastewater Disposal and Reuse

Numerous “failures” in wastewater management stem from a lack of coordination in defining the desired output after wastewater treatment. There are now a broad range of methods, such as aerobic, anaerobic, and physicochemical processes, that can be used to treat effluents from the standard of simply removing gross solids to the standard of having potable water (United Nations, 2015). The challenges arising from this are that since there are many different standards applied to water treatment for different entities, communities, and administrative units, there is little uniformity in the end product after wastewater treatment – attaining primary, secondary or tertiary level of treatment. Not only does this confound control of quality of water

disposed but, also presents obstacles in reforming management approaches to adopt wastewater reuse systems.

It is important to note that not all wastewater generated from residential and commercial activities becomes conveyed to treatment systems. In fact, in the Caribbean, most assessments have shown that the majority of wastewater remains uncollected for treatment – a pre-emptive indicator of inefficient wastewater management in the contemporary sense, where environmental considerations and reuse potential are included in developmental goals. Pertaining to SDG 6.3.1 [Proportion of safely treated domestic water flows], data were only available for two Caribbean countries (Cuba and Suriname) and showed that around 76% of wastewater generated domestically remained unsafely treated or untreated in 2020. This represents a major shortfall in collection systems that are consequences of limited infrastructural networks, lack of forward planning for the built environment, and limited capacity of service providers. This lack of pertinent indicator data also serves to highlight gaps in data collection which hinder holistic assessments of wastewater management and failure to monitor progress towards water and sanitation SDG targets in the Caribbean.

In many cases the push has been to transfer water management strategies applied in the higher-income countries to the Caribbean. In an analysis of the three major governance paradigms associated with water resource management that was popularized in the last century, Belmar et al (2016) postulated that the paradigm most suitable for the governance structures in SIDS, like the Caribbean, would be the adaptive management paradigm. This concept acknowledges social-ecological systems perspectives, multi-scalar, governance partnerships and iterative planning, which are features vital in developing policies in the small-economies where civil service agencies do not have the luxury of being politically neutral and there is less chance of maladaptation (Belmar, McNamara, & Morrison, 2016). The Caribbean countries may need to examine the suitability of iterative management with room for re-evaluation over smaller timeframes. This is based on the consideration that much effort has been put into designing policy based on the integrated water management paradigm despite lacking the top-bottom governance rescaling needed for management at the watershed management level. For the Caribbean, the risk of maladaptation of wastewater management must be circumvented through adaptive evaluation and local awareness.



Wastewater Management Coverage and Approaches in Jamaica

In Jamaica, the public supply of drinking water and sewage treatment falls under the responsibility of the National Water Commission (NWC), while regulation, control and management of water resources are the duties of the Water Resources Authority (WRA). Figure 3 shows the existing wastewater treatment plants in the island operated by the NWC and Figure 4 shows the location of the 187 wastewater treatment plants that are monitored by the Environmental Health Unit under Ministry of Health. The NWC operates a fairly large number of plants in the island and accounts for 90% of the sewage handled and collected in major urban areas in the parishes of Kingston and St Andrew, St Catherine and St James. As per the GEF CREW 2015 report there are 306 sewage treatment plants in the island with 67 of them operated by the NWC.

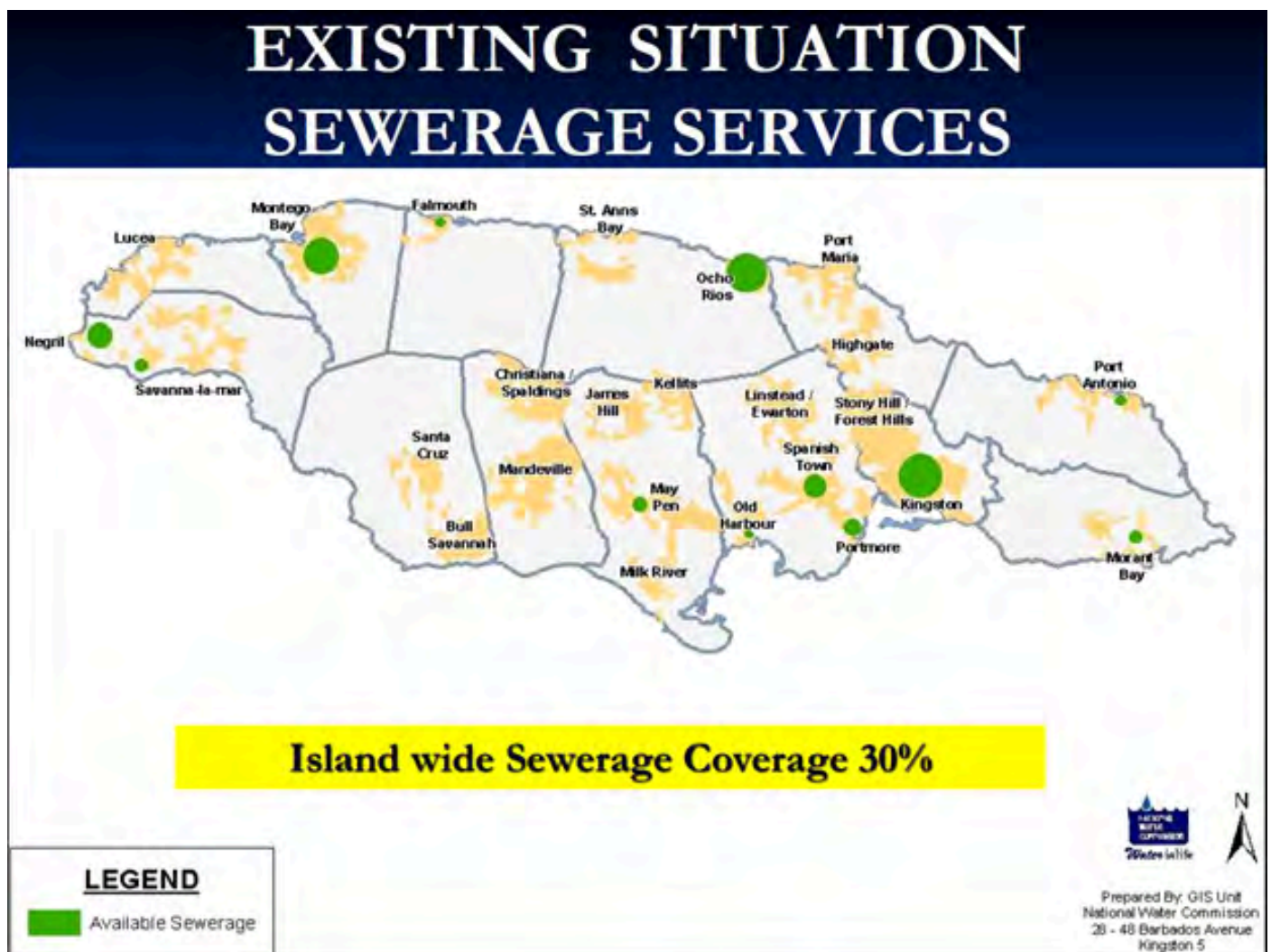


Figure 3. Islandwide Coverage of Sewerage system in Jamaica. GEF CREW Report 2015.

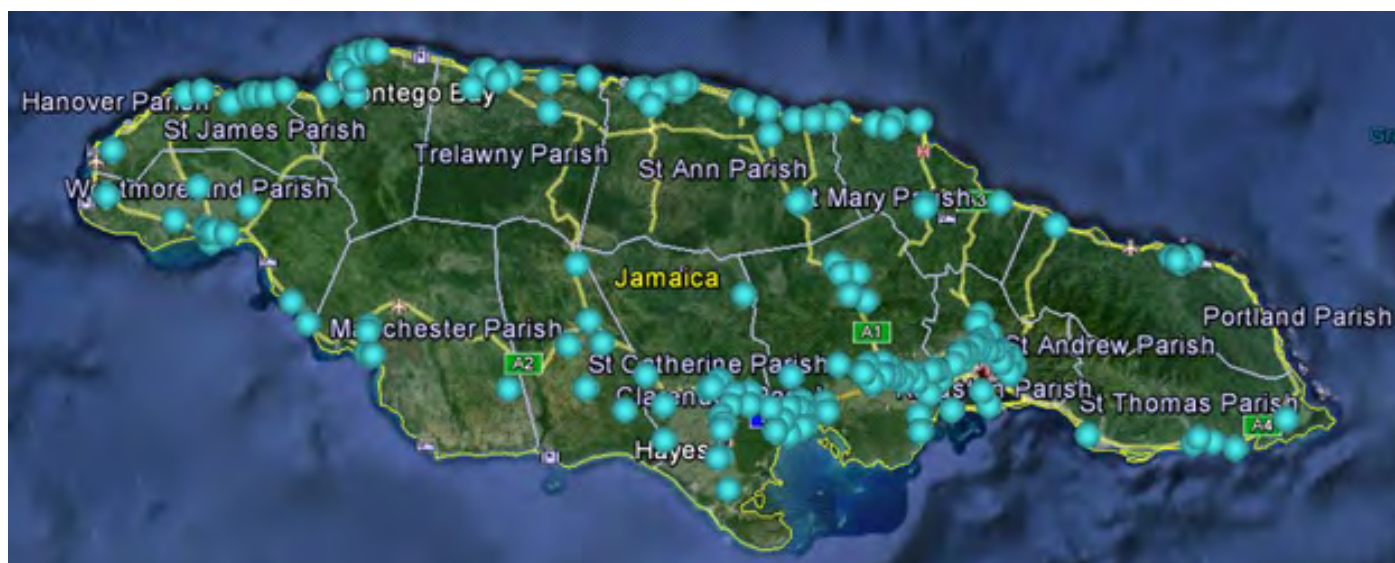


Figure 4. Location of 187 major Wastewater Treatment Plants in Jamaica (GEF CREW Report 2015).

Other satellite departments, agencies and SOEs are responsible for water supply to rural communities and agricultural irrigation, like the National Irrigation Commission and parish councils, however, NWC has the sole responsibility for wastewater treatment. The regulatory services of the WRA are supported by the National Environment Planning Agency (NEPA) and the Office of Utility Regulations (OUR). Policy and institutional initiatives, guided by SDGs, have been articulated through the revised National Water Sector Policy and Implementation Plan 2019, the Water Sector Plan, and Vision 2030 Jamaica – National Development Plan. Renewed focus has been made clear in revised strategic plans that have as their main outcomes, that all households will have access to improved sanitation, and technical solutions and institutional arrangement will be reformed to support universal access. In terms of goals of the National Water Sector Policy 2019 which relate to wastewater, only one of 13 objectives explicitly refer to effective wastewater management. Most objectives have implicit benefits that carry over to wastewater management. As explicated in Voluntary National Reviews (VNR), these objectives have guided advancements in sustainable development of mandate to provide clean water and sanitation. However, the assumption of implicit improved wastewater management may prevent outright prioritization of all components of wastewater management. The revised policies seek to target the most relevant challenges faced by Jamaica in water management, such as, high non-revenue water, high energy consumption, and poor storage and infrastructural capacity. The guidance principles around the latest iteration of the National Water Sector Policy are sustainability and intergenerational equity, efficiency, integrated water resource management (IWRM), universal access, gender and vulnerable groups responsiveness, and stakeholder participation (Government of Jamaica, 2019). From the legislative perspective, the *Town and Country Planning Act (1958)*, *National Water Commission Act (1963)*, *Watershed Protection Act (1963)*, *Public Health Act (1985)*, *Office of Utilities Regulation Act (1995, 2015)*, and *Public Bodies Management and Accountability Act (2001)* provides the legal framework for wastewater management activities in the country. Together, these acts govern the provision of secure sanitation conditions through development orders, the operation of wastewater services, the provision of national standards for waste disposal, the enforcement of regulations around sewerage and related utilities, and the financial accountability by which delegated public entities are held (Government of Jamaica, 2019). No act is dedicated solely to wastewater management in Jamaica. While the previously mentioned acts contain laws for effluent treatment, disposal and management, this fragmentation exacerbates the control and delegation issues around the subject matter.

According to the 2021 JMP, 51.3% of households in Jamaica use improved latrines while 24.8% are connected to septic tanks and 22.8% are connected to sewer networks. Compared with the findings of the 2017 JMP, there has been a 6.5% increase in the use of improved latrines from 2015, a 3.4% increase in connections to septic tanks, and a 3.6% increase in sewer connections (SALISES, 2018). One of the major issues to water security that overlap with wastewater management is water pollution. Around 10% of surface and groundwater quality in Jamaica has been affected by inadequate disposal and treatment from domestic, commercial, and industrial activities (Government of Jamaica, 2019). Extensive use of absorption pits and poorly maintained septic tanks have led to nutrient and faecal pollution of many aquifers and watersheds, while leachates from unsealed limestone pits for bauxite/alumina discharge and dunder from rum distilleries have contributed to severe degradation of 4 of 26 watershed management units in Jamaica (Government of Jamaica, 2019). Most recent inventories of wastewater treatment plants in Jamaica have shown that around 97 plants are in operation by the NWC (Medina et al., 2021) up from 71 in 2015 (Silva, 2015), though there may be vast differences in capacity and efficiency of said operations from plant to plant. The largest treatment plants in the island are the Soapberry, Greater Portmore, Negril, Montego Bay, and Ocho Rios plants which handle 60% of sewage collected (Silva, 2015). A benchmarking study assessed the performance of SOEs with primary water supply and sanitation functions in the Caribbean (Medina et al., 2021). The study found that focus on the provision of utilities (water supply services), along with limited financial capacity and poor maintenance has resulted in inadequate coverage of wastewater handling responsibilities (Medina et al., 2021). The NWC, as the sole SOE responsible for both water and sewage services in Jamaica, meets the criteria for risk of underperformance based on inadequate cost recovery and inadequate focus on maintenance (Government of Jamaica, 2019). It is noteworthy however, that the Soapberry Treatment Plant remains the only plant in the Caribbean that treats wastewater to a tertiary level (Silva, 2015). The success of this plant has been the result of a public-private partnership between the NWC and the Central Wastewater Treatment Company which sees to operations with a 75,000 m³/day capacity. Current efforts are underway to further increase the capacity and recycling capabilities of the Soapberry Treatment Plant while reducing energy consumption with outfitting of renewable technologies through a US\$85 million project with the Development Bank of Jamaica. This proves that similar PPP procurement models are effective within the wastewater landscape of Jamaica; an opportunity which has been highlighted by the government with emphasis on economic programs to boost investor confidence within the sector (Government of Jamaica, 2019).

Apart from public or semi-private agencies, wastewater treatment and reuse has been undertaken by private companies in Jamaica, either independently or guided by government campaigns encouraging wastewater reuse (Government of Jamaica, 2022). The operations undertaken at the wastewater treatment facility of the Jamaica Broilers Ethanol Dehydration Plant provide one such example of private sector treatment which has led to overall reductions in water usage across production facilities in the company (Jamaica Broilers Group, 2006, 2016). The bauxite industry is one of the largest and most water intensive industries in the country. Campaigns and reuse initiatives have also focused on encouraging and institutionalizing wastewater recycling in bauxite companies (Government of Jamaica, 2022; Silva, 2015). Through these efforts, there has already been a reduction in water withdrawals by the industry (Government of Jamaica, 2022).

The tourism sector drives a significant portion of the nation's economy bringing in approximately US\$3.3 billion in 2022 (Government of Jamaica, 2023), yet poses significant threats and challenges to the environment and accounts for high amounts of water withdrawals each year (Silva, 2015). In 2022, there were 3.3 million visitor arrivals to Jamaica, and current trends suggests that this will continue to increase (Government of Jamaica, 2023). Initiatives have been aimed at promoting water recycling in the tourism sector especially focusing on the six main destination hubs that receive the higher numbers of tourists. In response to pressures on water demand owing to influx of visitors to the island, several resort areas have

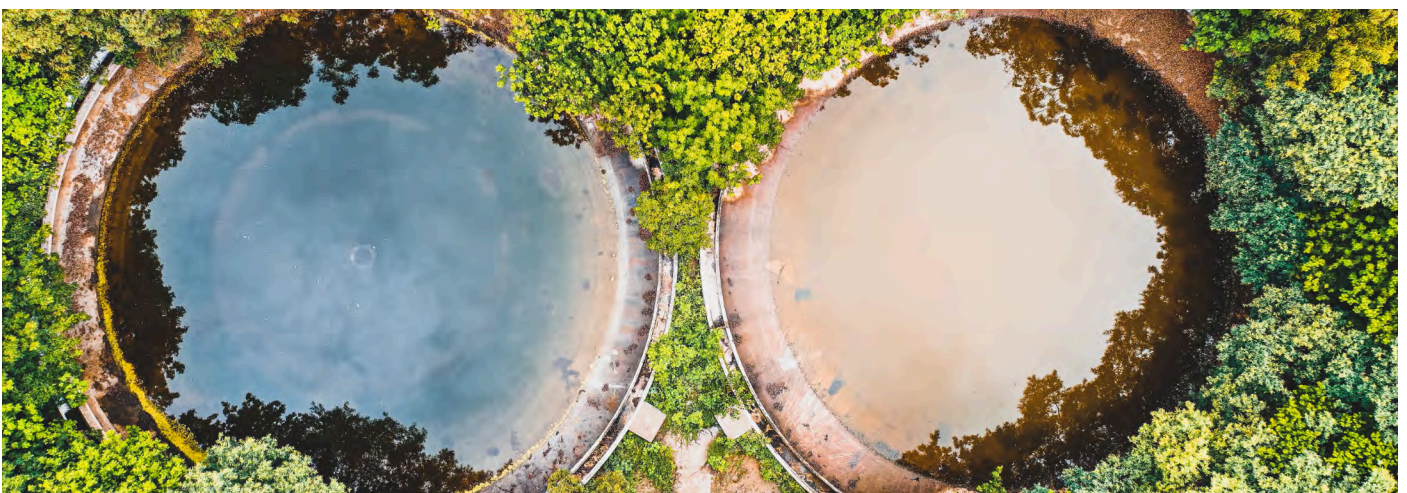
used recycled water for outdoor recreational activities like for irrigating golf courses. Environmental tests conducted by the WRA have noted that coastal water near hotels that have wastewater treatment plants are of better quality than those without, where biochemical oxygen demand (BOD), total coliforms (TC), and faecal coliform (FC) content are significantly lower than other hotel adjacent beaches (Silva, 2015).

From the domestic and municipal perspective, which account for around 10% of the total water withdrawal in Jamaica (FAO, 2019), several housing developments have wastewater treatment plants and utilize recycled wastewater for outdoor maintenance tasks (Silva, 2015). Efforts to improve coverage in rural areas and smaller communities have been undertaken through projects by the Rural Water Supply Limited. Externally funded projects such as the GEF CReW and GEF CReW+ focus on implementing small scale solutions in the Caribbean based on an Integrated Water and Wastewater Management approach that targets the institutional level planning, sustainable financing, nature-based design, and data sharing and knowledge management. Of note, this has been articulated through manuals entitled, 'Training Manual on Water Use Efficiency (WUE) in Agriculture' and 'Training Manual on Aquaculture for Caribbean Small Island Developing States (SIDS)' that articulates strategies inclusive of water budgeting and production waste management in water-based food production systems which was noted to have particular relevance to Jamaica (Creary, 2020). Furthermore, the CReW project, in partnership with NWC, commenced the design and implementation of three wastewater conveyance systems to replace decommissioned wastewater treatment plants in Acadia, Bay Farm Villas and Hughenden, and divert effluent to the Soapberry Treatment Plant (SALISES, 2018).

Evidence suggests that while more progress needs to be made in improving wastewater management, especially to improve treatment beyond primary and secondary levels according to national and international standards, there have been key advances in connectivity of sewerage for urbanized areas in Jamaica. With a broadening of the scope of wastewater management, there may be a need to consider appointing a separate entity with wastewater treatment responsibilities, or at least revamping the capacity of the NWC and WRA to boost efficiency and coverage of their operations, especially in non-urbanized areas. While the institutional arrangements and policy framework exist to guide the path to water and sanitation developmental targets, the nation struggles with limited capacity of existing infrastructure, inadequate oversight and poor maintenance and equipment upgrading (Government of Jamaica, 2019) which are steadily lagging in the face of urban population growth. That said, the privately-run operations and funded projects have eased the pressure off overburdened SOEs. The use of locally appropriate systems, such as community level treatment plants and properly maintained absorption pits where, and the Bio-digester technologies developed by the Scientific Research Council has benefited Jamaica and provided more access to sanitation services. These are more apt in the Jamaican context than systems directly mimicking systems from larger more developed counterparts, as can be seen from the establishment of package plants in rural areas where the construction of centralized systems would be too costly and disruptive. Legislation mandates connections to sewer networks in residential developments within 90 meters of NWC sewerage systems (NWC, 2023), and WRA has restricted new building permits for premises planning to utilize absorption pits in the Corporate Area (Foster, 2010). These policies will facilitate the transition to systems conducive to the public regularization of wastewater recycling, and plans for increasing the number and capacity of treatment plants steer the country towards much needed reductions in discharge of unsafe wastewater. The concern, however, is that Jamaica is subject and highly susceptible to stressors like the global energy crises and economic recessions, which are compounded by the uncertainties associated with shifts away from climate precedents resulting in longer droughts, more intense extreme weather, as well as threats of potential geophysical disasters like earthquakes. The pace of building resilience in all sectors, including and especially water and sanitation, needs to be accelerated to withstand, and ensure timely recoveries from, internal and external shocks.

Takeaways for Jamaica Wastewater Management

1. The legal and institutional framework exists to support sustainable wastewater management in Jamaica. However, fragmented legislation with caveats for location- and condition-specific delegation in the maintenance of wastewater and sanitation services/regulations confound the enforcement of acts and policies surrounding treatment quality, system siting, and coastal and watershed pollution. The result is a complex chain of command that is slow to engage and limited in investigative capacity owing to inadequate cost recoveries. Focus must be placed on consolidating wastewater legislation to make clear the responsibilities from the community level upwards. This must be paired with informative and wide-reaching public campaigns to increase awareness of public and private consequences and reporting structures. Limited enforcement of acts has severely impacted human and environmental health. Urgent focus has to be given to increasing the scope, frequency and parameters of water quality tests and environmental assessments to ensure timely regulation and attract heavy corrective fees for fl grant offenders.
2. The coverage of waste disposal facilities in Jamaica has increased over the past 10 years. While commendable, the pace must be accelerated to meet 2030 targets. Forward planning must involve siting of disposal facilities based on hydrogeological, socioeconomic, and environmental factors such as distance from rivers, dominant economic activity and income level of communities, and underground aquifers and fl ws, to ensure the use of locally appropriate facilities within community context. Climatic shocks have been identified as events to which we are vulnerable; planning must account for the resilience of structures and renewed focus must be given to maintaining infrastructure and technical knowledge of all associated ministries, departments, and agencies (MDAs) and SOEs. Current coverage of sewerage facilities by the NWC stands at around 30% of the population with the majority of wastewater pipelines concentrated within the corporate areas of KMA and Montego Bay. NWC has plans to increase connectivity and conveyance to treatment plants, however, these must also be accelerated to across corporate areas as well as communities above shallow aquifers or with other characteristics that heighten vulnerability to pollution.
3. The contribution of private sector and PPPs in improving wastewater management has been particularly visible for several industries like tourism and bauxite, and the most successful and wide-reaching example of remains the Soapberry Plant. Given the limitations of MDAs and SOEs from the maintenance and capacity standpoint, continued exploration and expansion of similar collaborative projects can be beneficial, especially if guided by principles in the 2019 National Water Sector Policy and Vision 2030.



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Caribbean

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A Toilet Paper



This Perspectives Paper was prepared by the Global Water Partnership - Caribbean Technical Committee Chair, Dr Adrian Cashman. It is intended to stimulate discussion within the GWP-C network and the larger water and development community.

About Global Water Partnership-Caribbean

The Global Water Partnership-Caribbean (GWP-C) vision is for a water-secure Caribbean.

Our mission is to support Caribbean countries in the sustainable management of their water resources at the community, national and regional level.

GWP-C is 1 of 13 Regional Water Partnerships of the Global Water Partnership (GWP). It was established in 2004 to foster the application of Integrated Water Resources Management (IWRM) in the Caribbean region. IWRM is the coordinated development and management of water, land, and related resources, in order to maximise economic and social welfare without compromising the sustainability of ecosystems and the environment.

Any organisation with an interest in water sustainability in the region can become a GWP-C Partner. GWP-C currently has over 100 partners in more than 20 Caribbean countries. These include water management agencies, water user associations, private water management agencies, government institutions, academic and research institutions, private sector companies, non-governmental organisations, community-based organisations, civil society organisations, youth organisations, regional agencies, consultancy firms, among others.

This Perspectives Paper was authored by GWP-C Technical Committee (TEC) Chair, Dr Adrian Cashman.

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Purpose of the Paper

In 2002, two psychologists conducted an experiment in which they asked people, among other things, to rate their understanding of everyday objects such as the toilet on a scale of 1 to 7, and then elaborate on what they knew. Surprisingly, very few people could do it (Rozenblit & Keil, 2002). If we realise that we don't know as much as we think we know, even about everyday objects and how they work, it may just make us that bit more curious (Harford, 2020). In essence, that is what this paper is about – stimulating the reader's curiosity. There is a remarkably vast and varied literature on all things lavatorial, which would be impossible to cover in such a short space. We have no intention of trying but hope to touch on a sufficiently diverse range of topics to pique your interest in sanitation, history and health.

Our unifying thread is that toilets and sanitation practices form part of a system. To realise a change or development in one area requires change and innovation across supporting components; the household flush toilet would not have taken off if there hadn't been a water supply.

A further assumption is that toilets, and by extension sanitation practices, are at the intersection of technology, culture, economics, health and history. How sanitation is practised in particular places at particular times can tell us a great deal about society and the human condition. And it can be approached from many different perspectives. While sanitary engineers might think that they have a monopoly on the subject, a cursory Google search turns up numerous avenues of exploration. The most obvious might be the archaeology and history of sanitation across different cultures and continents, but we could also find ourselves gaining insights from French novelist Victor Hugo's classic 1862 novel, *Les Misérables*, through to research in linguistics and disability studies (LaCom, 2007). More recently, the COVID-19 pandemic has accelerated interest in the surveillance of sewage as a means of monitoring public health and informing targeted responses.

In this paper, we consider the growing interest and importance of toilets and sanitation, and global initiatives aimed at raising awareness. With that as a backdrop, we provide an abbreviated history of toilets covering observed practices across a selection of countries and civilisations. The point is not to replicate the countless books and articles that deal with the history of sanitation and toilets, but rather to illustrate the diversity of practices. Along the way, we will touch on human coprolites and apes, farmers' almanacs and compost, and the technological nexus that has enabled some present-day sanitation practices. Finally, we ask where all this is taking us – what is the future of sanitation in a rapidly warming world, and what is the future of the sit-down flush toilet?



Introduction

Sustainable Development Goal 6 seeks to "ensure availability and sustainable management of water and sanitation for all". The goal has eight targets to be achieved by 2030, with progress measured by eleven indicators. The two targets relevant to our discussion of toilets are Targets 6.2 and 6.3.

Target 6.2 focuses on ending open defecation and providing access to sanitation and hygiene by 2030. Its only indicator, 6.2.1, has two parts: "the proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water". A safely managed sanitation service is: "use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite" – in other words, separating excreta from human contact.

Target 6.3 focuses on improving water quality, wastewater treatment, and safe reuse by 2030; specifically, it requires halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse. Indicator 6.3.1, the one relevant to this paper, addresses the proportion of domestic and industrial wastewater flows safely treated.

For both targets to be achieved, facilities are needed to provide the means of collecting and transporting waste away from the point of use, and systems must be in place to ensure that these are properly managed. In other words, technology, economics, social acceptability, and governance arrangements need to come together. The dysfunction of any one of these aspects jeopardises the others.

Sanitation is immensely important to both individual and societal well-being. According to the World Health Organisation (WHO), diarrhoeal disease, commonly associated with poor sanitation, was responsible for the deaths of 297,000 children under 5 years old in 2019 (WHO, 2022). The total of diseases attributable to diarrhoea in all age groups equates to 73 million disability-adjusted life years (DALYs)¹. Taking into account the additional health burden associated with malnutrition caused by diarrhoea and other 'neglected' tropical water-, sanitation- and hygiene-related diseases, over 1 billion people are, and constitute a further, health burden of 19 million DALYs (WHO, 2019). Improving access to water and sanitation is one of the most cost-effective ways of addressing ill-health, malnutrition, and loss of productivity. Evidence suggests that every 1 US\$ invested in sanitation yields some 5.50 US\$ in benefits – lower health costs, greater productivity, and fewer premature deaths (Hutton, 2012).

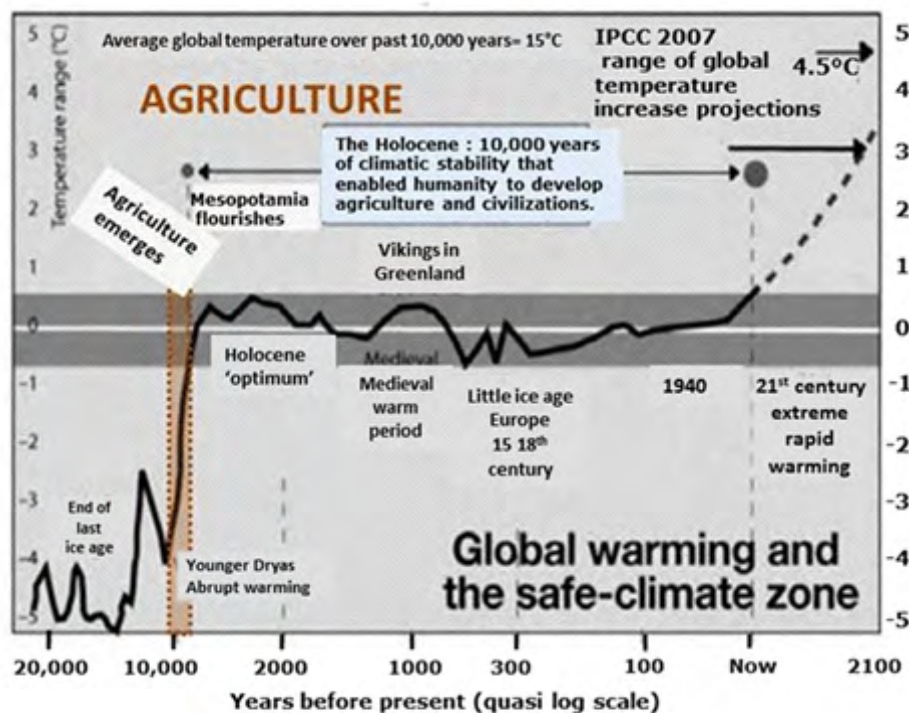
In addition to these health benefits, addressing sanitation needs can lead to the potential recovery of water and nutrients, the expansion of renewable energy, and the potential mitigation of water scarcity through the reuse of treated wastewater, particularly in areas that will be affected by climate change – after all, wastewater is, on average, 99% water! These potential uses for 'wastewater' will increasingly impact how wastewater system components are designed and operated. It might even be argued that we are returning to ways in which societies previously viewed human waste – not as a waste but as a resource.

¹ The overall burden of disease is assessed using the disability-adjusted life year (DALY), a time-based measure that combines years of life lost due to premature mortality (YLLs) and years of life lost due to time lived in states of less than full health, or years of healthy life lost due to disability (YLDs). One DALY represents the loss of the equivalent of one year of full health. Using DALYs, the burden of diseases that cause premature death but little disability (such as drowning or measles) can be compared to that of diseases that do not cause death but do cause disability (such as cataract causing blindness). Source: World Health Organization <https://www.who.int/data/gho/indicator-metadata-registry/imr-details/158>

Agriculture and the Urban Revolution

Modern human dispersal out of Africa, which led to the spread of *homo sapiens* across the globe, is thought to have taken place about 75,000 years Before Present (BP) (Armitage, et al., 2011). although there is still much speculation around the date. Irrespective of exactly when, the human population is thought to have numbered between 1,000 and 10,000 people. These people lived in small groups of hunter-gatherers at extremely low population densities, moving around as nomadic extended family bands. Under these conditions, the disposal of human waste would not have been an issue.

The major change that eventually led to development of sedentary societies, and the need for systems of waste disposal, occurred during the Holocene period, around 12,000 years BP, when a transition to warmer temperatures and a relatively stable climate made environmental conditions favourable for agriculture (Zahid, Robinson, & Kelly, 2015).



Global warming and the safe climate zone
Carbon Equity

Figure 1: Global temperatures and the rise of civilisations

Source: <http://www.climate-change-knowledge.org/civilization>

The origins of agriculture and the move to a more sedentary way of life are still not fully understood although they are thought to have occurred independently in different parts of the world at around the same time: Central America, South America, Asia, Africa and the Levant. There was no single factor which would have triggered the transition, but the domestication of crops and animals allowed for a more reliable food supply and, with it, a move towards more permanent settlements. And agriculture provided the basis for the growth

of urban centres. At around 10,000 BP, the human population was probably between 5 and 15 million people, although whether agriculture led to accelerated growth of the population is contested. Archaeological evidence for the growth of permanent settlements, suggesting a transition from a village-centred agrarian society to an urban-rural centred society, exists in various parts of the world. The earliest evidence is from the Levant at around 6,000–5,000BP (May, 2013). At around this time, it would seem that irrigated agriculture spread in what has been called the “hydraulic revolution”, in places such as the Nile Valley, Mesopotamia, the Yangtze Delta and the Indus Valley.

The production of food surpluses and storage, and settlements had a profound effect on the organisation of human society. It allowed the rise of large, dense sedentary and stratified societies as stored food surpluses can feed non-food producing specialists, such as scribes and artisans (Diamond, 1997). Urban centres became trading and manufacturing hubs, focal points for administration and education, as well as centres of culture and creativity. They also gave rise to division of labour and the development of different social and economic classes. Another feature tended to be shared communication, such as language, writing and counting systems, and ideas – all of which support the infrastructure needed for technology, trade, cultural exchanges and government. The hydraulic revolution took this a step further: in an economy reliant on irrigation, labour had to be mobilised to construct, operate and maintain the management of water infrastructure. This technological and social organisation revolution, it has been suggested, enabled the evolution of state-like organisations (Wittfogel, 2011).

Box 1: Why don't chimpanzees use toilet paper?

Most animals don't wipe after defecation, generally because they have not developed the ability. This also suggests that there has been no evolutionary pressure to do so. Although some mammals clean themselves by licking, it is not a route that hominids have gone down.

So why do humans wipe between their buttocks after a “number two”? One of the characteristics that distinguishes humans (*homo sapiens*) from other primates is our upright stance and bipedal motion – we walk upright. As with many evolutionary adaptations, the development implies compromises, although the benefits outweigh the downsides. The upright posture means that our anus is tightly sandwiched between two mounds of flesh that are our buttocks. As a result, faecal residue might stay around the anus, and accumulated residue along with moist conditions could cause infections to occur. This would be a particular hazard for females, due to the proximity to the vagina and urethra.

There are further complications associated with diversity in human diets. Humans have a varied diet and cook food – a practice that also has had its own evolutionary impact on our physiology. As a result, human excrement has diverse forms: hard, soft, dry, runny, etc., which can contribute to health hazards. At some stage, hominids evolved behaviours to mitigate the hazards, through wiping or washing to remove faecal residue. Unlike many of us who use sit-down toilets, our ancestors would have squatted during defecation, as many still do in various parts of the world. This puts less strain on the human system – think about it – and allows smoother evacuation of the bowels, which also alleviates the need for wiping. We won't know when the wiping (or washing) behaviour began, but we do know that as hominids have developed, so cultural behaviours, taboos and norms associated with defecating also developed.

So wiping and washing behaviours are products of human physiology, diet and culture, and differentiate us from other members of the primate family.

Why is Human Waste a Problem?

An unwanted consequence of domesticating animals and having concentrated human populations in close proximity is that it provides ideal conditions for the spread of diseases. People in a sedentary society, especially where they are densely packed together, such as in cities, tend to live amid their own sewage. Such closeness shortens disease transmission pathways, contaminates drinking water and provides living conditions for disease-transmitting pests such as rats and mosquitos. Trade routes play a role too, in allowing infections to be transported between population centres, spreading diseases. Urban centres are thus ideal for maintaining crowd diseases (Diamond, 1997, p.206). The crowd diseases that we are familiar with today evolved from diseases present in animals with similar characteristics of large, dense populations – mainly social animals such as cattle, sheep, poultry, and pigs. Unfortunately, it was these same animals that were ideal for domestication, thereby providing a reservoir of diseases that could be transferred to humans via an intermediate vector. The proximity of domesticated animals to human settlements has provided the conditions that allow crowd diseases to cross the species barrier. Large quantities of animal and human excrement not only host diseases but also harbour intermediate disease vectors (Wolfe, Dunavan, & Diamond, 2012). However, it is only through the development of modern medicine that we have gained a better understanding of how diseases are transmitted and the health threat that excrement poses.

Box 2: Bristol Stool Chart | Source: Dynamic Nutrition Sdn Bhd, 2022

The **Bristol Stool Chart** is a medical aid designed to classify faeces. It was devised by doctors in the Bristol Royal Infirmary, England, and based on the bowel movement of nearly 2,000 people.

What Does Your Shit Tell You?

[MILD CONSTIPATION]
CATERPILLER TYPE SHIT
 Caterpillar-shaped but lumpy

[LACKING FIBER]
AMOEBAS TYPE SHIT
 Separate hard lumps, like marble (Hard to Pass)

[NORMAL]
SAUSAGE TYPE SHIT
 Like a sausage but with cracks on its surface

[MILD DIARRHEA]
SOFT SERVE TYPE SHIT
 Fulffy pieces with ragged edge, a mushy stool

[CONSTIPATION]
MARBLE TYPE SHIT
 Separate hard lumps, like marble (Hard to Pass)

[NORMAL]
SNAKE TYPE SHIT
 Like snake (smooth & Soft)

[DIARRHEA]
WATERY TYPE SHIT
 Watery, no solid pieces. Entirely Liquid

Of more immediate concern, especially for urban dwellers, is the sheer volume of shit that can build up. According to an article by Mindy Weisberger (2018), studies in the United States show that an average adult produces about 400–500 grams of faeces per day, of which 70% are solids. Over the course of a week, that's 2.8 kg per person. Sumer, one of the oldest cities of the ancient world, in modern-day Iraq, was home to some 40,000 people in 2800BCE – ignoring the very different human physiology and diet, that's an accumulation of over 100 tonnes of shit each week. So what did they do with it all? There is some evidence of cylindrical drainage pits in a few houses, but they were the exception, so a lot of it would have ended up on the streets, along with household and other waste (McMahon, 2016). Apart from making any excursion outside your house an unpleasant experience, the accumulation of such large amounts of waste would have created quite a stink.

Even before the modern understanding of germs and pathogens, a widespread belief has associated bad odours with sickness and disease, causing people to become ill. This was the result of attributing causality to the co-occurrence of disease and bad odours, because the smell was perceptible whereas the germs were not. This belief still persists. Studies for the US military found that everyone tested was averse to odours associated with faecal or human waste products (Dalton, 2003). Not only are these odours highly recognizable, but that they are universally repellent and believed by many to be a potential source of disease. It may be that the prevention of odours was one of the reasons behind the adoption of sanitation systems. Even so, the build-up of waste would also have been both unpleasant and hazardous.

Passing in the Past – What Was Done About Human Waste

The emergence of urban areas and the range of economic activities that underpinned them also gave rise to social and wealth stratification. Archaeological investigations provide examples of high-status homes and buildings. While burial or open defecation may have been an acceptable practice among nomadic and rural communities, as people congregated together in closer proximity, those means of disposal would have become more problematic. And presumably, higher-status individuals and households would want to distance themselves from the unpleasant nature of excrement. So what were the sanitation practices in ancient times? Archaeological records from around the world provide numerous examples of how different civilizations and societies have dealt with sanitation – the treatment and disposal of human excreta and sewage. We discuss some briefly in the following sections.

India

The Indus Valley Civilization, also known as the Harappan Civilization, was located in modern-day Pakistan and flourished between 3300–1300BCE. The Harappan cities were noted for their urban planning, which, it has been suggested, indicated a high degree of municipal governance, which prioritised hygiene and religious ritual. The city remains of Mohenjo-Daro contain the Great Bath, which may have been a large, public bathing and social area. Excavations have revealed remains of what appear to be latrines connected to wastewater drainage and rubbish collection systems. Individual homes drew water from wells, while wastewater was seemingly directed to covered drains on the main streets; some houses appear to have been equipped with private bath-toilet areas. Even the smallest homes on the city outskirts are believed to have been connected to the system, further supporting the conclusion that cleanliness was a matter of great

importance. According to Antoniou et al. (2016), these remains in the ancient cities of Harappa and Mohenjo-Daro in the Indus Valley are among the earliest known multiple lavatories flushed with water and attached to a sewage system. They date from the mid-third millennium BCE. The toilets at Mohenjo-Daro were apparently only used by the affluent classes. Most people would have squatted over old pots set into the ground or used open pits (Rizvi, 2011).

Mesopotamia

Mesopotamia, the land of the Tigris and the Euphrates rivers, in modern-day Iraq, was one of the earliest centres of agriculture and city-based civilizations. All the archaeological evidence suggests that ancient Mesopotamians from the fourth millennium BCE had the technology and the ability to build sewerage pipes to transport waste from buildings. However, how to interpret the archaeological evidence is another question. Some experts suggest that it indicates the existence of sewers and wastewater drainage systems, albeit associated with royal zones within cities. Others have pointed out that the gradients of these systems would not have been sufficient to transport waste (Margueron, 2013) and that these systems probably managed rainwater. Waste was probably disposed of in cesspits – for which there is extensive evidence.

Relatively few toilets have actually been identified and have tended to be in the bathrooms of houses which are larger than average size (George, 2015). Examples from two-storey houses show the toilet was located under the stairs. The toilets were connected to cesspits constructed from baked clay pipes and stacked on top of each other. Bitumen appears to have been used as a natural sealant on the floors of bathrooms and as caulking for pipes. As for the toilets themselves, both squat and seated versions were present. For the squat toilets, brick supports were provided to stand on and give some elevation off the floor. Examples of seat toilets indicate that they were built with baked bricks and coated with bitumen, with a slot through the middle. Margueron (2013) has questioned this interpretation, pointing out that a civilization is unlikely to have adopted two different solutions. So that although there may be some evidence of a sanitation system, this would not have been a flush-away system.

Minoan Civilization

The Minoans of Crete (3200–1100BCE) are credited with the first flushing human waste management system, which was achieved by pouring water into a conduit. Minoan expertise in hydraulics may have developed because of the climate and the very low availability of water, which may have spurred innovation. The Minoans developed a quite advanced water supply, drainage and wastewater management system to handle organic waste. Evidence of systems of stone drains and large sewers – large enough for people to walk through – have been found at many Minoan sites. Excavations on Crete have provided evidence of indoor toilet facilities, mostly inferred from the existence of sewer connections from buildings to outside central sewerage and drainage lines. Traces of stone or wooden seats, and in one case, the remains of a clay tube, were found just outside the door of the room in which the seats were found. It is thought that water was poured through a hole in the floor immediately outside the toilet door, while an under-floor channel linked the hole with a vertical clay pipe under the lavatory seat. The toilet consisted of a wooden seat with an earthenware 'pan' and a rooftop reservoir, as a source of water. The toilet could be flushed even during a rainless period, either by an attendant outside the lavatory, or by the user. It is generally believed that water was poured into toilets to flush them, hence the claim that these are the oldest flush toilets (Antoniou et al., 2016).

China

The Chinese character for “toilet” goes back some 2000 years. It was originally associated with a pigsty because toilets were built next to pigsties, in order to channel human waste there for the pigs (Wangyun, 2018). Around 500BCE better off people who lived in urban areas began to integrate toilets into homes and an interesting north-south divide emerged (Newitz, 2016).

Northern China often suffered from water shortages, so squat toilets were more common, as this allowed night soil to be stored. Night soil collectors would collect human waste from toilets and sell it to farmers in the countryside, who then would spread it on their crops. In southern China,

sitting toilets were more common. Whether in northern or southern China, most people didn't have such facilities in their homes and just went about their business in the streets (Carr, 2017).

Box 3: Origin of the word “lavatory”

The oldest Latin word for toilet is thought to be *lavatrina*, which covers the concept of both bathing facility and toilet. By the 3rd century BCE the term *balineum* began to be used to indicate a separate, private bathing structure while *latrina* – a contraction of *lavatrina* – became associated with a public toilet. By the 1st century BCE, *forica* was being used to denote a large multi-seat lavatory with an open plan. (Koloski-Ostrow, 2015, p.40).

Classical Greece

In Classical Greece, archaeological evidence is supplemented by the written record, and therefore provides a more nuanced picture. The comedies of Aristophanes are the main ancient sources about the terminology of the sanitary structures in ancient Greece. The excavated evidence shows that the Greeks had reverted to using cesspits as well as clay containers, which are also referred to in written sources (Antoniou et al., 2016). Small sewage ducts made of clay or lead have been found leading to cesspits outside buildings. Clay vessels with an anatomical shape and no base have also been unearthed, which suggests that they were used either over cesspits or over some other receptacle collecting the sewage. Typical features of an ancient Greek lavatory included a water channel, a duct below floor level, a bench-type seat with keyhole openings, and a sewage duct by an outer wall running along the street or beside buildings. In addition, the lavatory area contained receptacles for cleaning sponges, used as the equivalent of toilet paper. Generally, in private residences, lavatories had more than one position, although the customs around their use are unclear. During the Classical Greek period, we also see the emergence of public toilets, with similar features and design, which could be used by many people at the same time. This practice went on into the Roman Era (Antoniou et al., 2016).

The Roman Era

Much has been written about Roman-era sanitation due to a diverse wealth of physical and written evidence across a wide range of geographical settings. It has been suggested that public latrines were introduced into the Roman world from around the second century BCE from the Greek Hellenistic world. The process may

have been a result of trade and Rome's wars of expansion involving both contact between merchants and travellers and returning army veterans (Koloski-Ostrow, 2015). The Greek public latrines would have been viewed as an improvement on Romans' basic facilities, which would have spurred the adoption and introduction of public latrines. The provision of public latrines, along with bathing as a social practice became a feature of Roman culture and identity and was disseminated across the Roman world. It seems that, initially, public latrines were associated with marketplaces as a way of trying to ensure that defecation, urinating and the general fouling of an area were limited to specific places. Over time, the public settings expanded, and latrines were increasingly associated with other public facilities such as fora, theatres and bathing facilities (Koloski-Ostrow, 2015). Although increasingly included as part of these structures, they were still hidden away, probably for aesthetic reasons – smell, flies and mosquitos.

Excavations have indicated that early public latrines were modest affairs in terms of materials and decoration. With Rome's increasing wealth during the Republican and Imperial eras, public latrines became increasing lavish, with more design features reflecting changes in taste and ideas, and a more prominent feature of the planning of public spaces and facilities. Alongside city authorities, elites invested part of their wealth in extravagant projects, including public buildings, baths and latrines. Increasingly, these became a feature of open communal living, associated with expanding urban populations – the Roman distinction between the public and the private was quite different from modern-day understandings (Koloski-Ostrow, 2015). While the wealthy and political elites lived in individual homes and villas, the majority of urban populations lived in multi-storey building complexes with limited access to water, washing, and waste disposal. Roman towns would have been foul, stinking, fly infested places, in which all kinds of waste accumulated, contributing to poor health and high mortality rates. The provision of public facilities such as latrines, fountains and baths were not built because of pressure to improve conditions but were intended to increase prestige and foster political patronage (Koloski-Ostrow, 2015). In Rome itself, and other towns, increased provision of public facilities was facilitated by ensuring copious supplies of water. Indeed, without the emphasis on improving water supplies, the provision of public facilities could not have expanded to the extent that it did. Furthermore, as water supplies increased, so wealthy citizens used them to incorporate more water-using amenities in their properties: toilets, gardens, fountains, baths, ponds and other washing facilities (Stamper, 2021).



Figure 2: Roman toilets | Source: Stamper, 2021

The archaeological evidence for standard toilet features is strong. Across the Roman world, irrespective of the number of seats in a facility, the spacing was 300mm or thereabouts, the same as for public theatres.

The toilet seat itself consisted of a keyhole opening for defecating and a slot for wiping the backside. The shallow trench at the foot was for washing off the sponge stick used to wipe the backside. Beneath the toilet seat was the sewer channel for waste flushed with water. These public, multi-seater toilets were located near, or over, a sewer, which allowed the waste to be washed away in channels lined with concrete. The source of water for flushing could have come from overflow from public baths or fountains. The facilities had a reasonable degree of ventilation to prevent the build-up of odours but were poorly lit.

Recent thinking suggests that the public sewers were not built to take away waste but functioned as drains to handle excess rainfall, overflows from baths and fountains, and to minimise flooding. The flow from fountains and baths would not have been enough to clear the waste deposited in them; in fact, both literary and physical evidence indicates that waste deposits built up and had to be cleaned out periodically. The main task of sewers was to transport waste away from where it was a nuisance, or impeded economic activity and industry, to somewhere else. According to Koloski-Ostrow (2015), the focus of Roman hygiene was on the removal of visible waste rather than its safe disposal. The archaeological evidence suggests that the use of cess pits and urine pots by households was widespread but that connection to public sewers was limited. There are good reasons



Figure 3: Flush toilets – Roman style

for this. First, human and animal waste was widely used in agriculture and therefore had value. Urine was used in a variety of processes, from tanning to toothpaste, and was at one stage taxed by the Emperor Vespasian (Nair & Sriprasad, 2010). Second, connecting toilets to a public sewer brought with it hazards, such as the buildup of flammable gases, and backflow of sewage during flooding. The evidence for sewers is not as extensive as it would be if they had been considered an integral part of waste management. It is doubtful whether Roman engineers understood much about the principles of sanitary engineering e.g. self-cleaning flows and velocities – which stands in contrast to their water supply expertise. As Koloski-Ostrow (2015) puts it, sewers appear to have been a last resort to the problems of waste removal in Roman towns and urban areas.

Roman sanitation practices demonstrate some interesting points. The first is that the technology available had a determining impact on the way in which water was supplied and regulated. Although the Romans had valves that could regulate flows, it seems that maintaining a flow of water was important. Furthermore, written evidence does not suggest that water shortages were an issue; the estimated average volume of water used per person in Rome was between 750–1000 litres per day. This also meant that excess water supplied had to be removed – hence the sewers operating as drains – and labour was needed to perform various tasks such as the cleaning of sewers. Warfare, and the taking of defeated opponents as slaves, provided such a pool of labour but as this source declined, the use of free labourers was considered more cost effective. This, coupled with the fact that human and animal waste was a valuable product, provided little incentive to drive technological change. The legal and administrative arrangements governing the management of waste and

sewers was somewhat ad hoc, with responsibilities changing frequently. So while the impression persists that the Romans were excellent hydraulic engineers with a well-developed system of water supply governance, their stewardship of waste management did not meet the same threshold. Lastly, we see that the customs around water management became part of Roman culture and how they would define themselves.

The Rise of Technology – Putting the Pieces Together

Essentially, there was very little improvement in Europe in the approaches to and provision of sanitation from the middle of the first millennium CE until what has been called the Age of Enlightenment, starting around 1700 CE (Tulchinsky & Varavikova, 2014).

At a basic level, toilets facilitate urinating and defecation and provide a way of separating people from their waste through some form of transfer, from one place to another. The smooth functioning of a toilet requires the bringing together of a host of interconnected components, both technical and organisational. Each component is reliant on other components, and a breakdown in the harmony between them can have public health consequences. We can think about toilets, particularly flush toilets, and their functioning, by considering what is required for them to function satisfactorily as a system:

- With some notable exceptions, flush toilets need a supply of water to remove and transport the waste products away;
- The toilet itself must be engineered to store and control the flushing of water;
- The toilet should be accessible, convenient and comfortable to use;
- The toilet should not be unpleasant or unsafe to use, e.g. it controls odours;
- The provision of installation and maintenance services is necessary;
- The infrastructure to transport and dispose of waste is also essential;
- The different components should meet a set of generally accepted standards of service;
- The person or body benefiting should be in a position to afford the above; lastly
- A person or body may wish to exercise choice over some of the above aspects.

In other words, the toilet as a fixture lies at the intersection of engineering, technology, economics, culture, organisation and institutions. And, as might be expected, there are different ways in which each of these requirements can be met (or not). We can gain some appreciation of how the different components have emerged by considering the evolution of sanitation in England, and in particular London, through the development of the flush toilet.

Water Supply

Up until the 16th century CE, Londoners got their drinking water from wells, springs and rainwater. Some obtained water from the Great Conduit, run by city authorities, which consisted of a lead pipe from a spring to a large cistern. “Keepers of the Conduit” controlled access and gathered fees from those who could pay,

who were granted permission for a household connection. Over time, the Great Conduit was extended, and other sources incorporated. In 1582, with the support of the City of London, a pumped water supply was installed, powered by undershot waterwheels in the arches of London Bridge. This was known as the London Bridge Waterworks and in 1592 was joined by another pumping station, also backed by the City of London. Supply from the London Bridge Waterworks was intermittent and so water was distributed across the city on a weekly schedule (Tomory, 2015).

In 1613, a water supply scheme, New River, was commissioned, which brought water to London via a 68-km waterway. The New River scheme was promoted by an entrepreneur, who obtained a patent and water rights, as well as investment, from the king. In 1619, the New River Company, incorporated by letters patent took over and was one of the first joint-stock companies in England, and remained in existence for nearly 300 years as a private company. The New River Company supplied water via a network of wooden pipes, and as with the Great Conduit, an additional fee was levied for a supply via lead pipes into homes that could afford it. Water was available for a few hours a day. The Great Fire of London, in 1666, destroyed much of the wooden and lead water piping (Tomory, 2015).

From the mid-17th century onwards, an increasing number of new, private waterworks were set up, supplying the expanding urban area. Some were established by an act of parliament while others were issued with letters patented by the Crown. Although the Acts of Parliament which created the water companies encouraged them to compete for customers, the companies quickly realised that this would not be profitable. As a result, from the 1800s, the various companies agreed amongst each other to set boundaries within which each would operate. In 1852, Parliament passed the Metropolis Water Act, which sought to regulate the provision of water supplies and set standards such as the requirement that water be “effectually filtered”. The revised Metropolis Water Act of 1902 nationalised the private water companies by compulsory purchase and established the Metropolitan Water Board, which became responsible for London’s water supply (“London water supply infrastructure”, 2022).

Thus, over a period of more than 500 years, the provision of water supplies was expanded from a situation where only a privileged few had household connections, to almost universal household coverage. At the same time, supplies were transformed from intermittent and irregular to continuous supplies, and from water of doubtful to wholesome quality. This was brought about by technological advances, the ability to finance and operate schemes, organisational developments, and regulation.

The Water Closet

Credit for developing the first flush toilet is commonly attributed to Sir John Harrington in 1592, who was the godson of Queen Elizabeth I. Two were built, one of which was installed in Richmond Palace, outside London, and required 34 litres per flush. That said, Harrington claimed that 20 people could use it between flushes. However, all this did was confirm that a toilet without a sewer was just a fancy chamber pot! With the advent of the Industrial Revolution and advances in manufacturing, a series of incremental advances paved the way for the development of the flush toilet. The advances were based around improvements to existing chamber pots, otherwise known as commodes, and aimed to make the removal of the urine and faeces more ‘convenient’. In other words, design and innovation followed on from an existing form (Museumfacts, 2022).

In 1775, a watchmaker called Alexander Cummings developed an S-shaped pipe which could go under a toilet basin and could contain foul odours. Two years later, Samuel Prosser invented and patented a plunger

closet, which unfortunately was not able to fully clear waste deposits. In 1778, Joseph Bramah patented (though he did not develop) a hinged flap valve to seal the bottom of the basin bowl. In 1790, a ballcock to regulate the filling of cisterns was devised by a Mexican priest, José Antonio de Alzate y Ramírez. In 1853, the symphonic flush was thought up by Joseph Adamson, and improved upon by George Jennings. Various improvements in design followed but the basic features of a cistern containing water for flushing, a toilet bowl on which to sit and distribute the flush, and a waste pipe to convey the waste away had been established by the early 19th century (Museumfacts, 2022).



Figure 4: Advertisement for a toilet

In 1848, the British government decreed that all new houses should have either a water closet or an ash-pit privy – a form of composting toilet. However, the arrangements for the removal of solid and liquid waste remained inadequate. One effect of the decree was to increase groundwater pollution, as properties still relied on cess pits, or the services of night soil operators, or the open sewers, which drained into streams and rivers, such as the Thames (Tomory 2015, 2017).

At the Great Exhibition held in London in 1851, the aforementioned George Jennings pursued the organisers to allow him to install his Monkey Closet in the retiring rooms there – effectively the first public flush toilets (‘George Jennings’, 2023). “Spending a penny”, which was the price to use the facilities, came with a clean seat, towel, comb and shine. The financial success of the venture led to the provision of public conveniences, initially only catering for men¹.

¹ The popularity of the term “spending a penny” most likely dates from the 1890s when public lavatories fitted with penny coin-operated locks were first established by British local authorities.

Box 4: Using “the crapper”

The expression “crap” predates Thomas Crapper but the use of “*the crapper*” as a synonym for toilet is thought to date to 1917/18 when American servicemen in Europe saw the name on the toilet bowl and took the expression back to the States.

In 1861, Thomas Crapper, who had three patents¹ related to the improvements of toilets, was commissioned to install lavatories in Westminster Abbey, Buckingham Palace and Windsor Castle. Crapper's flushing toilets were elegant, reliable and water-efficient – three qualities that helped them spread. This use by the monarchy helped to dispel the notion that indoor toilets were unhygienic, and contributed to the improvements in sanitation. His other innovation, from 1870, was to open a showroom to display his company's wares (Historic England, 2022; Sullivan, 2021). From 1885, Thomas Twyford revolutionised the water closet when his company built a trapless, one-piece ceramic toilet. A ceramic toilet was unique, as up to that point, toilets had been made from metal and wood.

The uptake of flush toilets, we might conclude, was a result of advances in technology and manufacturing, regulatory requirements and marketing. The incorporation of toilets into homes influenced the design and layout of homes. Whereas in the past, doing one's 'toilet' was something that could be carried out in the bedroom – or for the wealthy, in the dressing room – now separate provision had to be made for the toilet's installation and use.

The Bidet

In many parts of Europe, a bidet is still an integral part of bathroom furniture. In essence, it is a low-level washbasin, which is used for washing legs, genitalia, inner buttocks and anus. It is not known who invented the bidet, but historians agree that they appeared first in France in the 17th century CE as a bedroom hygiene tool ("Bidet, 2023). From these beginnings, the bidet has gradually become a bathroom fixture in many countries. In the beginning, its use was confined to the aristocracy, before becoming more widespread in more recent times. In France, bidets were regarded as a 'civilized way' of preparing for sex, or rinsing off afterwards. Today, some bidets have taps that pour warm water into a basin; some have a basin that can be plugged and filled with water; others have a nozzle that is pointed upwards for washing the nether regions. And the design has morphed alongside that of the toilet, with the bidet's functions being incorporated into the toilet, as will be seen later.

Toilet Paper

Adoption of the flush toilet brought with it associated challenges: how were people using toilets to clean themselves after defecating? (Blakemore, 2020) For the Greeks "three stones are enough to wipe". The Romans used sponges on a stick to clean themselves; the sponge was then washed off in a container filled with salt water or vinegar water. Evidence suggests that this was the opposite of hygienic and contributed to the spread of infections, such as roundworm (Preskar, 2022). Analysis of the contents of cesspits across the Roman world suggests that they would have suffered from a variety of intestinal infections.

By the early 14th century CE, the Chinese were manufacturing toilet paper at the rate of 10 million packages of 1,000 to 10,000 sheets annually. In the 1390s, thousands of perfumed paper sheets were produced for the Hongwu Emperor's imperial family. However, even though paper making spread out from China, paper was an expensive commodity.

The first commercially packaged factory-made toilet paper was probably created in the United States in 1857 (Toilet Paper History, 2023); it was called "therapeutic paper" and was medicated with aloe, with the name of

¹ His advertising laid false claim to some patents he did not have and some inventions (such as the syphonic flush) that were not his. One of his innovations was the modification of the S-bend to the modern U-bend.

the manufacturer on every sheet. Although 500 sheets cost 50 cents, the venture was apparently not a commercial success. The United States led the way in developing toilet paper, although perforated toilet paper on a roll appears to have been invented at the same time on both sides of the Atlantic in 1879. In 1885, Oliver Hewlett Hicks patented packages of toilet paper and the manufacturing process.

In the United States, it is said that during the 19th century CE, sheets from mail order catalogues were torn off and used. When the catalogues began using glossy paper, rural America switched to using the Farmer's Almanac, which was often nailed to the wall, leading the company to pre-drill the legendary "hole" into their publication in 1919.

No one company had a monopoly on the production of toilet paper. Toilet paper manufacturers therefore needed to find ways to market and promote their products to increase sales, which led to the adoption of new approaches to marketing. In 1928, the Hoberg Paper Company introduced a brand called Charmin. The packaging showed a woman in profile and the advertising campaign featured the homeliness of the product, whereas previously toilet paper had been advertised as a medicinal or luxury product. In many ways, the packaging and marketing of toilet paper is as important as the toilet paper itself.

Sewers

As noted above, although authorities pushed the adoption of the water closet, dealing with the volume of waste produced lagged far behind. By the 1850s, 2.5 million people were living in London. The waste they produced went into storm sewers and from there into the Thames. The result was that instead of flying out to sea, the stinking excreta stayed put. In the 1830s, epidemics of cholera, typhoid, and influenza prompted the government to launch an investigation into sanitation. In 1842 the report *The Sanitary Conditions of the Labouring Population* was produced, which showed a direct link between poor living

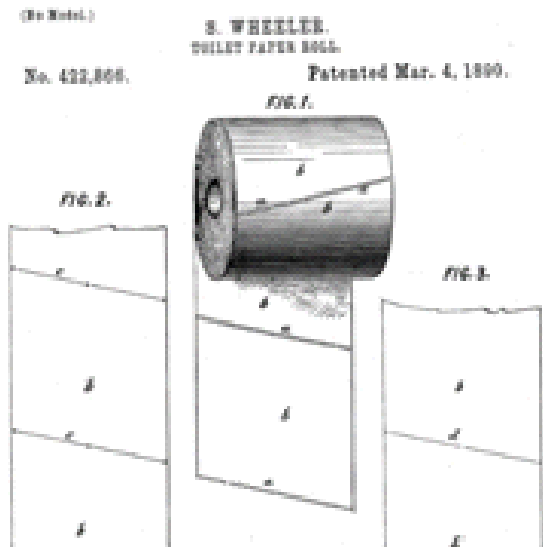


Figure 5: Perforated toilet paper

Box 5: The selling points of toilet paper | Source: Doctorow, 2010

A popular product from the 1870s was 'Bromo Paper', which came in packs of about 500 individual sheets inside a solid card box. Every sheet had a distinguishing watermark of 'Bromo' so that counterfeit versions could be easily spotted. This toilet tissue had been awarded the highest prize at the Paris Exposition in 1878 and every pack proudly bore reproductions of both sides of the medal to prove it. The paper contained the "disinfectants and curatives" which would "...render its use not only a positive preventive of that most distressing and almost universal complaint, the Piles, but also a thorough deodorizer and disinfectant of the water closet"

conditions and disease and life expectancy. It led to institutional changes such as the Public Health Act of 1848, establishing a General Board of Health. In the 1850s, miasma theory – the idea that diseases were spread due to unhealthy or polluted vapours rising from the ground, or from decomposed material – was widespread and had influential supporters. Deadly concentrations of miasmata, especially near the Thames, were used to explain the spread of epidemics such as cholera, which had arrived in Britain in 1830.

During the 1848/49 outbreak, anaesthetist John Snow was able to demonstrate the spread of cholera through water. However, his findings were overshadowed by belief in the miasma theory of transmission. Partly in response to the epidemics in London, the Metropolitan Commission of Sewers was brought into being by an Act of Parliament in 1848. It set about surveying the capital's estimated 200,000 cesspits, insisting that all cesspits should be closed and that house drains should connect to sewers and empty into the Thames. This latter recommendation only made matters worse and contributed to "The Great Stink" of 1858. The Commission was absorbed into the Metropolitan Board of Works on 1 January 1856.

The "Great Stink" of 1858 proved to be a turning point, but not because of entirely altruistic reasons. Previous proposals to modernise the sewer system had been rejected on the grounds of cost. However, the proximity of the members of parliament to the stench from the Thames combined with the belief in miasma theory contributed to their fears that they were at heightened risk of catching cholera, which prompted them to act. The Chief Engineer of the Metropolitan Board of Works, Joseph Bazalgette, was given responsibility for the work ("Joseph Bazalgette", 2023). Between 1859 and 1865 an extensive underground sewerage system was designed and constructed. It consisted of a system of feeder and interceptor sewers and incorporated some of London's 'lost rivers' on both sides of the Thames to convey sewage downstream to two wastewater works. The low-level interceptor sewer was incorporated into the Thames Embankment and allowed new roads, public gardens and space for London Underground lines to be constructed. The sewer was opened in 1870. In creating the Embankment the flow of the Thames was also altered from a slow to a fast-moving body of water.

The construction of the London sewer system is notable for a number of reasons (Jackson, 2014). It resulted in a marked improvement in public health, and allowed a greater number of Londoners to benefit from a water supply in the home, including indoor toilets. The potential of technological advances was realised, such as in the use of cement in construction. The creation of the Embankment provided spill-over economic and development opportunities for businesses and investors. The growing appreciation of the benefits of sewers impacted town planning, particularly in the provision of

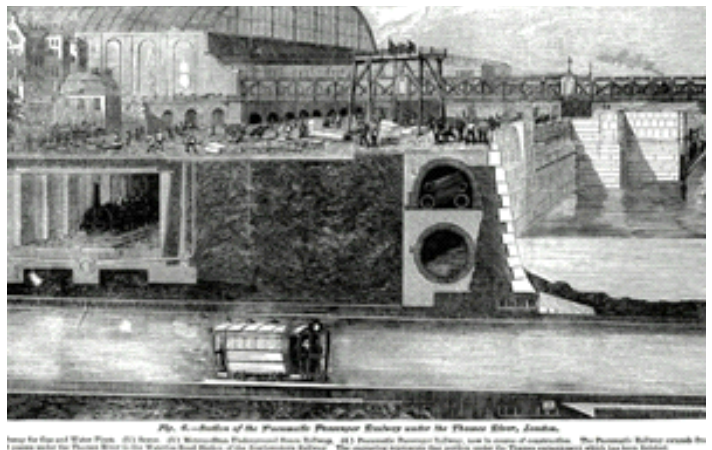


Figure 6: London's Thames Embankment



Figure 7: Terraced housing in London with outdoor toilets – the collector sewer ran down the back of the houses.

back-to-back terraced housing. However, this also served to reinforce social stratification in which the working classes were provided with outdoor toilets whereas housing for the more affluent included indoor toilets. It wasn't until the 1960s that indoor toilets were retrofitted into working-class terraced houses. Two points can be inferred from the above. First, science and engineering are seldom by themselves enough to spur advances – a large degree of self-interest on the part of decision makers is often called for. Second, the ways in which services are provided can serve to reinforce socio-economic hierarchies.

Dry and Composting Toilets

As the global population grows, and water becomes scarcer, composting or dry toilets, which use precious little, if any, water, have attracted increasing attention. Unsurprisingly, such toilets have been around for millennia in some shape or form, from glazed terracotta urns used in ancient China, which were used to collect night-soil (King, 2004), to more recent container-toilets developed in Haiti, here in the Caribbean (Remington et al., 2016). So what are composting toilets and how do they work?

Box 6: Monitoring sewage for diseases

In August 2022, the United Kingdom's Joint Committee on Vaccination and Immunisation recommended that all children below the age of nine years in London should receive a booster dose of polio vaccine. The advice followed the detection of 116 polio viruses from 19 sewage samples in London. The level and genetic diversity of the viruses indicated that transmission was taking place in several parts of London and although no cases had been diagnosed in the population, vaccination was recommended as a precautionary measure. A further result was that wastewater surveillance was expanded to assess the extent of transmission and identify localised areas of concern.

Sampling sewage as a surveillance measure is not a new idea and in fact it is one that has been used to track polio from the early 20th century. However, it was the COVID-19 pandemic which really spurred interest in the approach. It has been realised that monitoring and testing wastewaters can be a powerful tool to predict the spread and peaks of infection and identify new variants of diseases. The challenge is data analysis and interpretation, and its integration into public health systems. Wastewater surveillance has the potential to become a powerful tool to monitor public health and inform responses. But as with any new tool, there may be a dark side.

As US-based Greywater Action (n.d) explains:

“In a modern-day composting toilet, faeces and toilet paper compost with a “bulking agent”, such as sawdust, leaf litter, bark mulch or dried coffee granules, which covers the faeces to create air gaps for aerobic bacteria to break down the material. This process is the same as for a household food waste compost. If urine is included in the compost, more sawdust is added to soak up excess liquid. Toilet paper can be disposed of with the solid waste – preferably unbleached recycled paper as it degrades more easily.”

Composting toilets are often used in non-arid areas with easy access to the types of bulking agents mentioned above. The finished product is a moist humus similar to garden compost, which makes a valuable soil conditioner. Another adaptation is to divert urine out of the toilet (making a dry toilet) and dilute it with water (three parts urine to five parts water). This forms a fertilizer rich in nitrogen, potassium and phosphorus (Randall & Naidoo, 2018).

In areas with arid climates, dry toilets are preferred, in which ash or lime mixed with dry soil are added to create a dehydrating environment for breaking down and killing off pathogens. Toilet paper, which cannot be added to a dry toilet, is usually burned or buried. Pathogens typically die off more quickly in the dry, high pH environment of a dry toilet. The finished product, which resembles instant coffee granules, can be used as a soil amendment (Greywater Action, 2023). Good ventilation is needed whichever the type of toilet, both to help prevent odour and to aid decomposition.

The Arborloo

The Arborloo, or tree toilet, is a popular, simple, low-cost version of a moveable composting toilet widely used in parts of the rural Global South, from Zimbabwe (where it was pioneered) and various countries in Sub-Saharan Africa (Herbert, 2010), to the Philippines, in Asia (Sayre, 2010), and Haiti, here in the Caribbean (Kramer et al., 2011).

In its simplest form, the Arborloo is a shallow pit, topped by a movable slab, ring beam (made from cement and or bricks) and housing, for privacy (made from cement and/or bricks). After defecation, soil and wood ash is added to the pit, both to mask the odour and accelerate the composting. When nearly full, the pit contents are levelled off and covered with a 15cm-layer of topsoil (if available) and left to compost. In the meantime, a new pit has been dug, and the slab, ring-beam and housing are relocated. At the start of the rains, or immediately, if water is available, a sapling is planted in the topsoil, protected from animals, and watered. Thus, over time, the household is provided with shade trees and potentially extra produce, depending on what is planted (Morgan, 2004). The risk of groundwater contamination, however, is still present, tree or no tree.

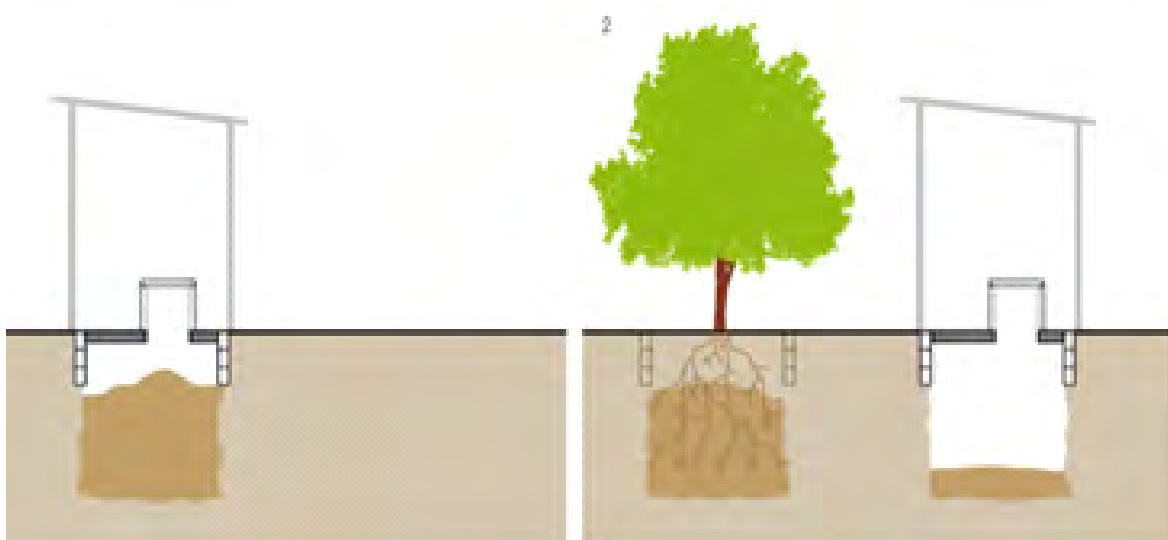


Figure 8: The Arborloo (tree toilet) | Source: Tilley et al., 2014

Sustainable Organic Integrated Livelihoods (SOIL), an award-winning non-profit organisation working in Haiti, has gone on from designing composting toilets to developing a community-wide sustainable EcoSan system, Ekolay, in some of the country’s deprived urban areas. It involves collecting and transporting the waste from container urine-diverting composting toilets (UDTs), eventually transforming it into agricultural-grade compost (www.oursoil.org).

The Pros and Cons of Composting Toilets

The advantages and disadvantages of composting and dry toilets vis-à-vis modern flush toilets in any given situation will depend on a range of contextual factors, such as climate, income levels, available space and infrastructure, availability and cost of materials, level of political commitment, cultural (including religious) attitudes with regard to human waste, inclusive community participation, perceived benefits, etc.

That said, the pros and cons can roughly be summarised as follows:

Table 1: Advantages and disadvantages of composting toilets

PROS	CONS
<ul style="list-style-type: none"> • Huge savings on domestic water consumption. • Water cost savings where water is metered. • Low energy requirement. • Can help plant growth where compost can be used as soil amendment. • Reduced need to buy fertilizers. • Can be installed even where there is no water source. • Simple technology to install in rural areas of LICs where there’s no wastewater infrastructure. • Can help keep pathogens out of surface and groundwater. 	<ul style="list-style-type: none"> • Considerably more maintenance for householder than standard flush toilet. • Can be more odorous. • If poorly maintained can lead to serious odours, insects and health hazards. • If the composting process does not function properly (insufficient aeration, non-conductive temperature), the resultant compost can be a health hazard. • Can involve extra costs, such as waste collection, if the end product can not be spread on soils in the immediate vicinity. • Special permits may be needed for installation. • Can be difficult in urban areas to access the necessary mulch, leaf litter, sawdust. • Need to overcome public resistance.

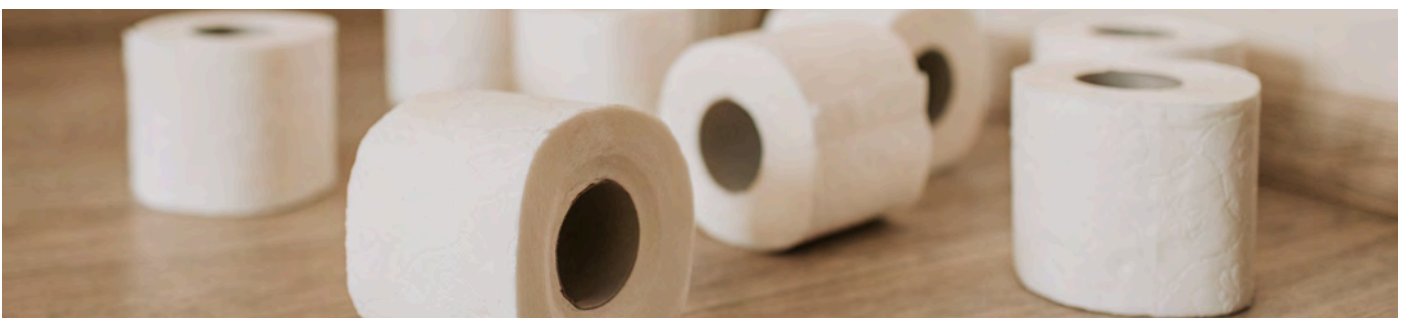
Sources: Anand & Apul, 2014; Langergraber & Müllegger, 2005; Tilley et al., 2014

The Japanese Toilet

The Japanese toilet differs significantly from those in most western countries, even though they do the same job of removing your waste in a hygienic, efficient way. But these appliances go above and beyond simple waste disposal. While the Japanese were the first to take toilet technology to the next level, inevitably they have spawned imitators. However, toilets that incorporate advanced features are generically referred to as “Japanese toilets”. These toilets are equipped with an array of additional features that set them apart from the basic loo. They first started to have added features in the 1980s and by the mid 2010s over 80% of Japanese households had a toilet with additional features. The defining feature is the incorporation of the bidet, or nozzle, to aid washing the anus and genitals, all without needing to stand up. As a result, the appliances are not marketed as toilets, but as “washlets”. From the incorporation of the basic bidet feature in Japanese toilets/washlets, the range of features appears to be limited only by imagination. The heated seat is one such feature. Some incorporate a mild soap for rinsing and cleaning; others control the water temperature and even allow a choice of a steady or a pulsating water stream. More features include a blow-dry system, air deodorizing, speakers to play music, glow-in-the-dark options, an air-conditioned toilet rim for hot summer months, and even massagers built into the toilet seat itself. Most incorporate a control panel system, sometimes built into a small handheld remote control (Szczygiel, 2016, 2017).

It gets even better, as some of the functions have been automated. Some models have an automatic lid that lifts when its proximity sensor determines someone is standing close to the toilet. Some go further, with the lid raising only if it senses that someone is facing away from the toilet, e.g. preparing to sit down, but the sensor will lift both the lid and the seat if someone is facing the toilet, e.g. standing to pee. Most of these toilets' built-in bidets also have proximity sensors, so the stream will automatically shut off if the user stands up. Top-of-the-line models collect and analyse data on when and how often the toilet is used. Some models take things further by having the hand basin connected to the toilet so that the water from the hand basin flows into the toilet cistern for flushing, increasing water use efficiency. Many Japanese toilets have features designed to keep them clean. These include automatically rinsing the toilet bowl before use, while the most advanced models use ultraviolet light after a toilet is used, to disinfect the bowl (Sealy, Marsh & Aguro, 2018).

There are, however, drawbacks: the built-in features need electricity to function, which can cause problems due to safety rules and regulations that require the separation of appliances that use water from those that use electricity. Another reported issue is that overzealous use of the bidet function can eliminate ‘good’ bacteria, leading to irritation and skin sensitivity. It has been argued that Japanese toilets are more environmentally friendly than the ‘bog standard’ toilet. The argument runs something like this; even though they increase electricity use – most western toilets use no electricity – they eliminate the need for toilet paper, thus reducing the demand for wood pulp and deforestation. And, although such toilets use more water, this is more than offset by the volume of water used in the manufacture of toilet paper. So, on balance, they are more environmentally friendly (Feenstra, 2022).



What Next – The Future of the Toilet?

Reality Check in the Caribbean

Within the Caribbean, with the exceptions of Dominica and Haiti, countries report that over 90% of their populations have access to improved sanitation, meaning flush toilets. However, when we consider how few are connected to a centralised sewer system, the picture changes dramatically. At around 30%, Trinidad and Tobago has the highest percentage of the population connected to a sewerage system, followed by Jamaica, at 20%. According to the Global Environmental Facility CREW+ (United Nations Environment Programme (UNEP), 2020), 70% of the Caribbean’s population lack access to safely managed sanitation and hygiene:

“80% of wastewater is discharged into the environment without any treatment as a result of weak legislation, political, and regulatory frameworks and lacking financial means to maintain the infrastructure”.

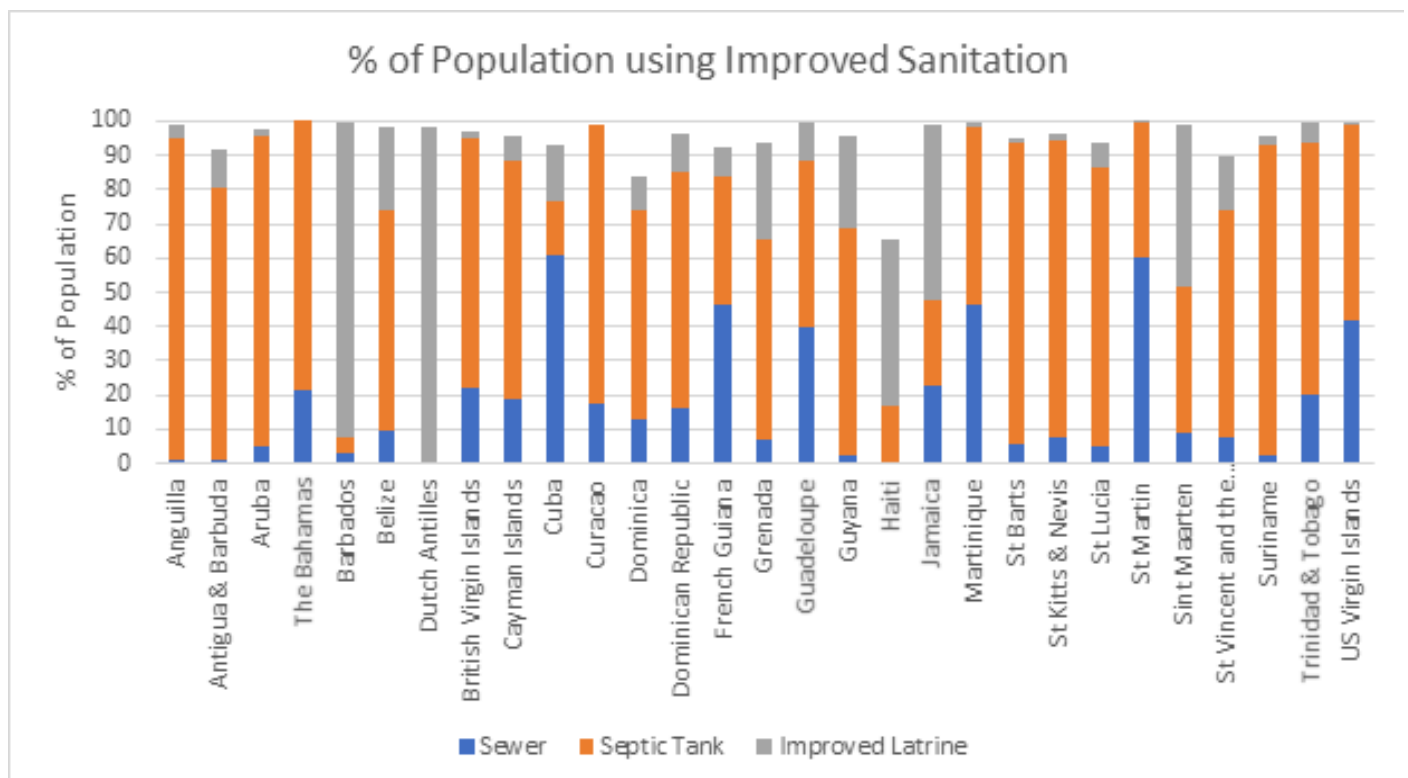


Figure 9: Percentage of population using Improved Sanitation in the Caribbean | Source: Author’s own calculations

Governments and water utilities across the Caribbean are faced with a dilemma. Although sections of their populations lack access to improved sanitation as they may still rely on pit latrines, the majority have some form of indoor toilet. Yet this very improvement in access unaccompanied by an adequate regime of collection, treatment and disposal is creating an environmental problem and recalls the situation in London, described above, during the early part of the 19th century CE. For example, poorly designed and maintained septic tanks have contributed to groundwater pollution. Studies of Kingston Jamaica’s Liguanea aquifer have demonstrated that it is not suitable for potable use, as it is polluted with nitrate contamination, due to years of improper sewage disposal (Mandal et al., 2020; Water Resources Authority (WRA) Jamaica, 2022). Other

examples include Barbados (Cashman, 2014). Arguably, the situation will worsen as climate change begins to affect water security. There is a growing realisation that something needs to be done, yet the scale of the task facing governments and societies is daunting. How to raise the millions of dollars in funding required to put the infrastructure in place? How to create the capacity to operate the infrastructure? And how to afford to repay and maintain the infrastructure when set against other competing needs? These are questions to which there are no easy answers. Although many creative ideas, papers and reports have been produced, suggesting what funding is required and how these funds can be made available, progress is painfully slow.

Box 7: Reinventing the toilet

In 2011, the Bill and Melinda Gates Foundation embarked on a challenge to “reinvent the toilet”. Up until 2018, the foundation had spent US\$200 million developing toilets that don't need water or sewers and use chemicals to turn human waste into fertilizer. The foundation is expected to spend the same amount again before the toilets are viable for widespread distribution.

The Future of Toilets

The point has been made that the toilet as we know it has evolved as a result of innovation and improvements, and is contingent on a host of supporting developments across disciplines, as well as cultural acceptance. These developments include advances in materials technology and manufacturing processes, engineering design, economic growth, public health concerns, town planning, regulatory requirements, marketing opportunities and advertising, and the list could go on. So looking to the future, what might it hold for the further development of toilets?

The challenges, and hence the potential innovations, may be thought of in two parts. The first concerns the toilet itself, and the second the supporting environment – in the sense that the environment captures the sanitation elements touched on above. For the toilet itself, future interest will continue to be on the improvement and extension of its functionality. In other words, there is unlikely to be a radical change until toilets as we know them are replaced by some other mechanism. In the case of the supporting environment, the toilet is but one part of a system to serve people's sanitation needs; in addition, the necessary infrastructure and institutions need to be established. This is a big task. Although these are essential components – as we have seen through history – exploring them is beyond the remit of this paper.

As for the toilet itself, three trends are emerging: improving the efficiency and effectiveness of water use; resources recovery; and extension into personal health care.

Efficiency and Effectiveness

Improving the efficiency and effectiveness of water use entails reducing the volume of water used to flush away urine and faeces. Toilet water use is a major contributor to household water use, making up between

20% and 30% of overall consumption. Over time, the volume of water used per flush has decreased. Before the 1980s, approximately 26 litres were being used per flush, but gradually this has reduced to around four litres per flush while achieving the same result. At the same time, advances, such as dual-flush systems, have come onto the market, also as a means of conserving water, along with product certification schemes, such as the US WaterSense labelling. Recent designs have reduced the volume even further to two litres per flush while still achieving the same level of performance. The requirements to reduce water use have become embedded in national product standards; Barbados, for example, is looking to allow the importation of efficient water-use products, according to specifications by the National Standards Institution. A further step is the waterless toilet concept, which is of particular interest where access to a water supply is problematic. One solution, which has been around for a long time, is the composting toilet, as discussed above.

Box 8: The Arumloo – Interview with the developer, Jonny Harris (<https://arumloo.com>)

What's the inspiration for the Arumloo toilet?

The Arumloo is inspired by the arum lily, the elegant white flower that incorporates a natural vortex to bring insects into the heart of the flower and promotes pollination. Both the form and function of the arum lily has been mimicked in the Arumloo, to enable beautifully efficient bathrooms.

What's the operating principle? How does it work?

The Arumloo rimless toilet looks and feels much like a conventional flush toilet. The design incorporates a vortex shape bowl to provide the path of least resistance for efficient cleaning of the pan. This circular flow path continues through the trap to effectively clear waste from the toilet.

How did you get started and how many prototypes have you gone through?

We started developing the product in 2015. Our early prototypes included a flush discharge directly into the water seal to clear waste. This worked well; however, to achieve the target performance of flushing on less than two litres, we quickly realised that the flush water needed to clean the bowl before it cleared the waste. By 2017, we had incorporated biomimicry into the design of the toilet and realised that the arum lily held the key for our desired flush performance. Since this time we have been working on refining the design to align with the manufacturing process.

How much water does it use?

The Arumloo is able to effectively clear waste with a two-litre flush, and urine and small amounts of paper with one litre. Based on average usage patterns, this gives us an average flush performance of 1.3 litres.

That doesn't seem a lot; is it effective in flushing away?

The toilet is very effective. It is not acceptable to us that a toilet should be flushed twice to clear toilet paper trapped in the bowl. The vortex design effectively clears waste from the bowl and through the water trap.

What's been the biggest challenge?

As a small start-up company, our biggest challenge has been to finance the development of the toilet and to align the design with the manufacturing process. This has added three to four years to the development timeframe, which has been frustrating when we know that we have an excellent product that is much needed to enable water efficient sanitation.

Does the arum toilet comply with any international standards?

The toilet has been successfully tested against several flush performance standards, confirming the water efficiency of this low flush toilet. The toilet complies with all requirements for the initial target markets in Southern Africa and East Africa. We are currently in the process of adapting certain design elements, to ensure that the toilet complies with specific requirements for toilets in the EU and other parts of the world.

What next?

We are busy developing additional versions of Arumloo, including a wall-hung version and a toilet for the European market. These should be available in 2023. We have been prototyping a package ecological wastewater treatment plant as a back-end treatment solution for the toilet. This will also be available in 2023.

The work of the Bill and Melinda Gates Foundation has aimed to develop solutions for populations living where there is little or no access to a water supply. Several approaches have been developed (Bill and Melinda Gates Foundation, 2023). One approach has been to modify a conventional toilet but replace the use of water with a barrier material lining in the bowl, which is collapsed and twisted, sealing the waste and compressing it into the bottom of the container.

Other waterless versions use chemical processes, or the use of nanofiltration, to convert waste to water and ash. For public toilets, there is the option of including waterless urinals. These work in one of three ways: by having some form of microbiological cartridge that treats the urine, a liquid barrier system, or a valve barrier system. It is likely that low-flush toilets using water will be with us for the foreseeable future. The roll-out and uptake of waterless appliances is likely to face many challenges, such as cost, social acceptability, manufacturing capabilities, and plumbing services expertise.

Resource Recovery

An extension of water-use reduction is the growing interest in resource recovery, which in some ways harks back to historical perceptions of human waste as a resource. Resource recovery can take place either 'on site', or the place where the waste has been transported. The on-site resource recovery approach tends to apply to toilets that are not coupled up to a water system, from which water can be reclaimed, waste composted and, in some cases, energy produced. The reclaimed water would be used for secondary (non-potable) purposes, whereas the composted waste would be taken away and used in agriculture, for example. This model will necessitate a new and different ecosystem to support and facilitate its functioning. Although advancing the technology would not be a problem, rolling out this form of resource recovery practice at the individual level is likely to be a greater challenge because it will require institutional support and development.

Resource recovery after collection is already being promoted at different scales, servicing small cluster developments through to towns and cities. In some cases, this is being done by upgrading or replacing existing wastewater treatment facilities, recovering and reusing the treated wastewater primarily for non-potable purposes. Beyond water recovery, there are opportunities to generate energy from biogas and apply the resultant dried sludge to soils, to recover heat from the water treatment process, and also recover nutrients, such as nitrates and phosphates. Obviously, as the range of recovery processes increases, so too does the complexity and cost. Scale and location are also important considerations. What might work and be financially viable in an urban setting may well not be viable at a community level. It's also worth pointing out that for some of the resources, the recovery technology may not have matured sufficiently to engender confidence. In the Caribbean, as for many other regions, resource recovery beyond water is largely at the conceptual stage, and the region will be looking at advancements elsewhere, in order to leapfrog the development and implementation processes.

However, this is not to say that the Caribbean is sitting around doing nothing. Several initiatives are putting in place the building blocks that would underpin resource recovery. These are not primarily in engineering or technology but relate to creating the necessary regulatory environment – again highlighting that successful implementation depends on advances across many different spheres. One of the weaknesses in the water sector has been with respect to water quality and related public and environmental health concerns. Gradually, this is being addressed in various Caribbean countries with the development of water quality standards and regulations governing the treatment and reuse of water for various purposes and applications. We would expect that this will spread across the Caribbean and hopefully include some degree of regional

collaboration and uniformity. At this stage, it is too much to expect the development of standards addressing other forms of resource recovery. This is partly because water regulation – beyond simply water quality – impacts other sectors, and needs to be tied in to building standards and planning requirements. Building developers respond to market forces and what they provide depends on what they are required to provide, what a client is prepared to pay for, and the profit they can make. In such instances, planning and regulation have an important role to play. Barbados's planning system, for example, has been moving towards creating a regulation-led demand for the provision of wastewater systems in new developments. The government also recognises that addressing the associated costs will entail involving the financial sector. Maybe in the future, the toilet will itself be the resource recovery system, doing away with all the infrastructure we presently associate with wastewater collection and treatment. But even then, there will have to be a supporting ecosystem – we can only speculate on what that might look like.

Personal Health Care

What is perhaps more likely in the near future is that the toilet itself will become integrated into the provision of personal medical care. We have become familiar with the idea of the analysis of sewage providing useful insights into the prevalence of COVID-19 even before it was detected by public health surveillance systems. We are familiar with the medical profession testing our urine for blood sugar levels and faeces for bacteria. In this article, we have seen how analysis of the contents of cesspits has shone a light onto the state of health of past human societies. There is already thinking around the idea that toilets could one day become mini laboratories capable of analysing urine and faeces, which along with other health monitoring devices, could infer the state of a person's health and

deliver personalised health care. Incorporating sterilising technology (e.g. ultraviolet lights) into toilets could provide protection against harmful micro-organisms. Exciting as these possibilities are, they raise ethical questions which up to now we have not worried about. What might be the privacy and confidentiality concerns associated with such new technological innovations? Could they be used in coercive ways that would be inimical to democratic freedoms?

It is worth remembering that history is littered with examples of failed innovations and products that have not caught on. One of the common reasons is failure to recognise the role and importance of the presumed beneficiary and what they think. Technology is only one part of the equation: context, community, culture and the customer are equally, if not more, important.

Box 9: The role of culture

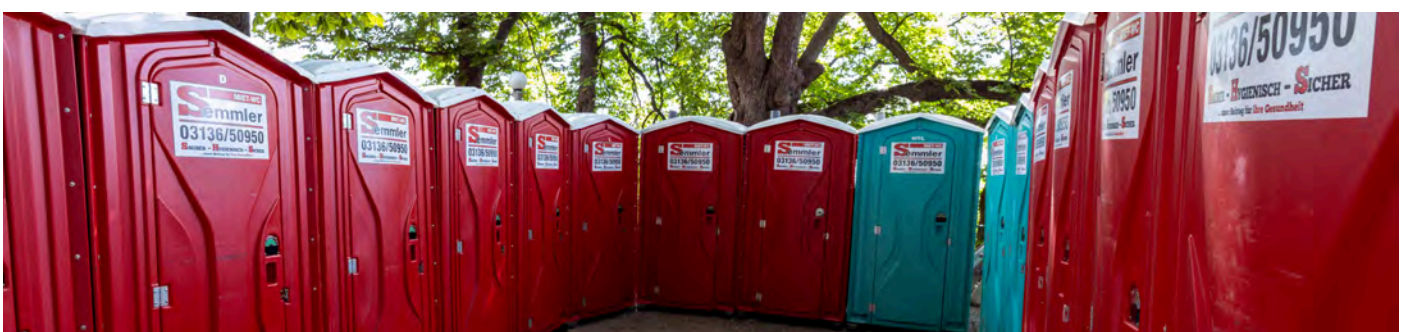
Culture is important to shaping practice and facilities. In several Latin American countries toilet paper is placed in a bin alongside the toilet and not flushed away. Originally this was to avoid clogging of the small sized pipes but has now become accepted practice. In some cultures and religions water is used to clean the anus either by having a vessel called a lota or by having a bidet spray nozzle or hose attached to the sides of the toilet.

Coming to the End

Over the preceding sections, we have put forward the notion that the toilet constitutes a central point at which different water-related services intersect; where water supply arrangements and wastewater management come together, coexist and then deviate. We have also developed the idea that technologies, institutional arrangements and regulation do not suddenly appear, but are the products of processes of innovation and improvement, and responses to opportunities and changing circumstances. What drives these processes? Is the adoption of technological solutions, institutional arrangements and regulations driven by epistemic communities of knowledge-based experts who help decision-makers to define the problems they face and identify various policy solutions (Cross, 2013)? Alternatively, does change normally proceed incrementally, due to the inertia of institutional cultures and practices, vested interests, and the bounded rationality of individual decision-makers? In this case, policy change happens when the equilibrium can no longer hold in the face of changing conditions, or changes in public opinion (Levinthal, 1998). Or is it a combination of the two?

In the natural world, one animal's waste becomes a resource input for another organism, a circular approach. Yet humans have, with some exceptions, adopted a linear approach in which human urine and excreta are considered to be waste. The toilet is the most visible manifestation of this approach; it is designed to provide a convenient and comfortable way to take away our liquid and solid by-products. As we have illustrated, a toilet can achieve this in many different ways, whether by focusing on performance, like the Arumloo toilet, or as an immersive experience, like the so-called Japanese toilets. From this, we can see that the toilet has been transformed from being a basic appliance to a socio-cultural artefact.

But this narrow emphasis on a toilet's form obscures more urgent, broader questions around function. We are entering a world of increasing water scarcity (Global Commission on the Economics of Water, 2023), including for the Caribbean, where changes in rainfall patterns and a drying climate will disrupt water resources and supplies. Under these circumstances, can we continue to use large volumes of drinking-grade water just to flush our waste away? Perhaps for some, better water-endowed countries the answer may be "yes". But for many countries in the Caribbean, changing conditions are going to force a fundamental rethink of function. The relative equilibrium which has characterised the provision of water and sanitation services will have to be punctuated, and the 'stickiness' in the system challenged (Repetto, 2006). Treated water reuse is likely to become an urgent imperative. We will have to seek new answers to questions about what water and sanitation services should look like, how they should be delivered, and who benefits. This implies: a rethink of the economics of water and investment choices, governance arrangements, and the role of the public private and third sectors, and the technology and what we want it to deliver. The toilet of tomorrow is going to have to deliver more than a hygienic environment, a warm seat and a clean bum.



Glossary

BCE	Before Common Era
BP	Before Present
CE	Common Era
DALYS	Disability-Adjusted Life Years
Km	Kilometres
SDG	Sustainable Development Goals
UDT	Urine Diverting Toilets
UNEP	United Nations Environment Programme
WHO	World Health Organisation

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