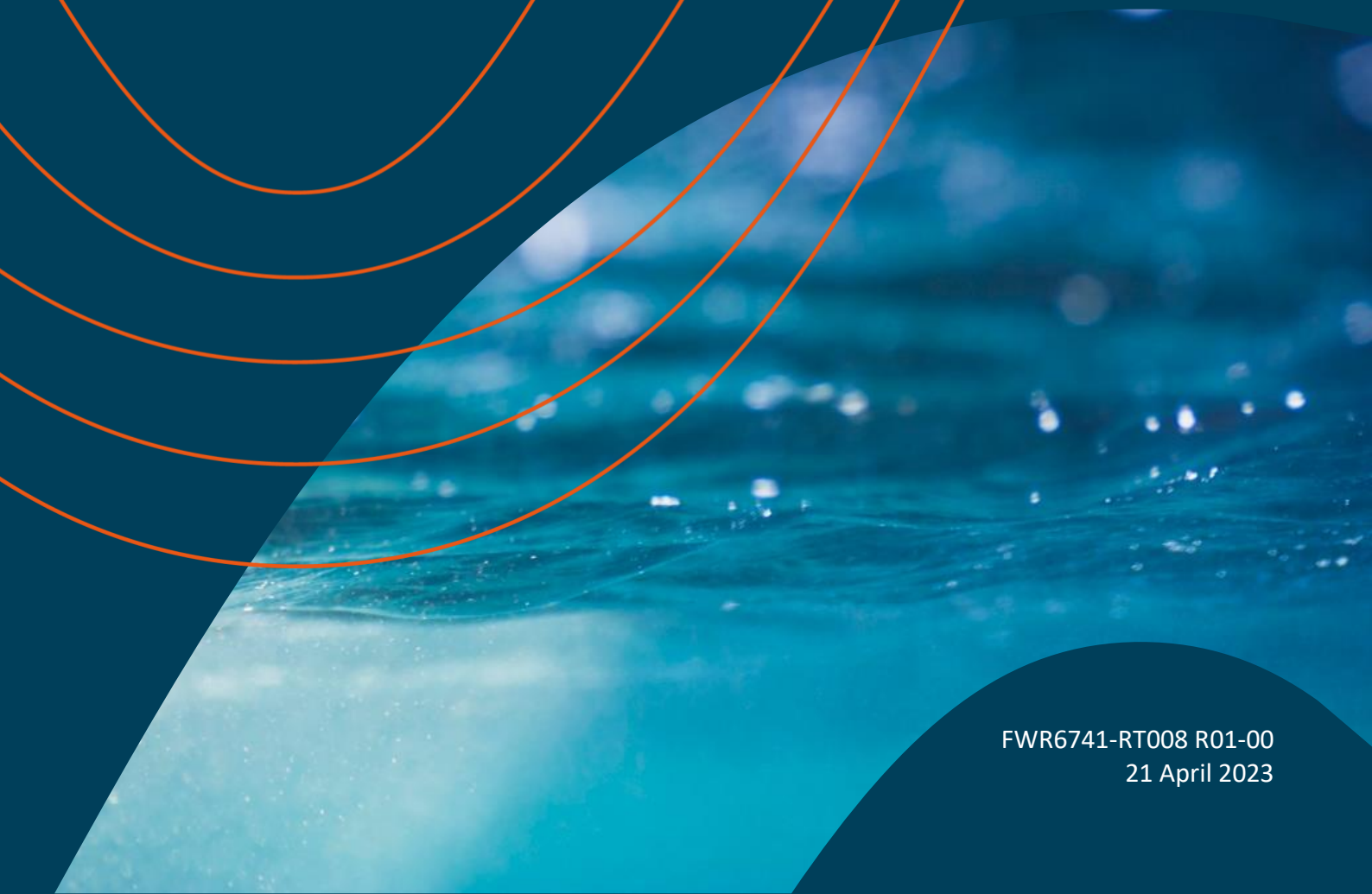
Groundwater monitoring for mapping aquifers in Belize as a tool for climate change adaptation planning

D 4.5 - Regional Groundwater Monitoring Meeting Report



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Contents

Appendices

Tables

Figures

1 Introduction

1.1 Project summary

The Belize National Hydrological Service and National Climate Change Office are executing a project to design a groundwater monitoring system for the management of aquifers in Belize, focusing on the New River watershed. The project commenced in October 2022 and will complete in August 2023. HR Wallingford Limited is leading the consulting team implementing the project and financial support is provided by the Climate Technology Centre and Network (CTCN).

This important project will help Belize to sustainably manage groundwater resources in the face of a changing climate and human pressures on the resource.

The main outputs include:

1. A communications plan and detailed work plan;
2. Stakeholder mapping and establishing a stakeholder working group;
3. An assessment of groundwater availability and demand, nationally and with a particular focus on the New River watershed;
4. Design of an integrated monitoring system that will enable Belize to manage groundwater resources in the priority area of the New River watershed;
5. Development of an implementation plan on the enabling factors for implementation, including financial, institutional setting and capacity building.

As part of Output 4 above, a virtual meeting was convened on 15th March 2023 which brought together groundwater monitoring specialists from across the region. Countries and participants were identified in consultation with the National Hydrological Service of Belize to provide a cross section of groundwater situations across the region. The meeting aimed to share experiences of the challenges and success factors for groundwater monitoring in the region, for the benefit of the participants and to feed lessons into the groundwater monitoring system design in Belize.

1.2 About this report

The report includes a record of the regional meeting, including the participants present; documentation of the key points made by each country's representative regarding their groundwater monitoring systems; and a summary of the discussion.

The authors wish to express their thanks and appreciation to all the meeting participants for joining the meeting and contributing to the discussions. Special thanks go to those participants who prepared and delivered presentations on their groundwater monitoring context from around the Caribbean region, and for kindly agreeing to share their presentations with this report.

2 Regional Groundwater Monitoring Meeting

2.1 Objectives

The Regional Groundwater Monitoring Meeting set out to achieve the following objectives:

- To identify and invite relevant countries to a virtual workshop to share experiences of groundwater monitoring in the Caribbean region with similar monitoring needs;

- To share information on the current status of groundwater monitoring, experiences and lessons learned.

2.2 Participation

Six countries attended the Regional Groundwater Monitoring Meeting. Countries represented were:

1. Antigua and Barbuda;
2. Barbados;
3. Trinidad and Tobago;
4. Guyana;
5. Jamaica;
6. St Vincent and Grenadines.

The participants' list is included in Section 2.4 of this report. Half of the participants present at the meeting were female.

2.3 Meeting structure

The Regional Groundwater Monitoring Meeting was held over a period of two hours and utilized a mix of presentations from each country and a focused discussion to gather input from the country representatives. The meeting agenda is included as Appendix 1 of this report.

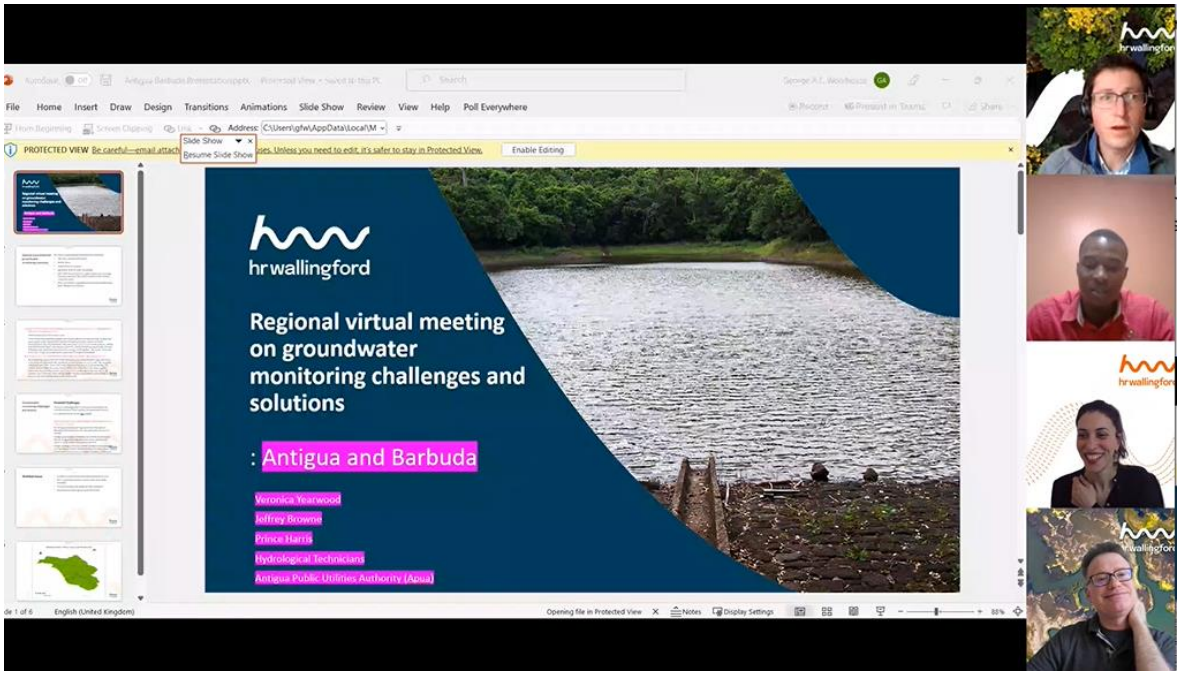

Figure 2.1: Participants from Antigua and Barbuda share a presentation at the meeting

2.4 Key points arising from the meeting

The following common themes emerged from the presentations and subsequent discussion sessions:

1. Countries range from having established groundwater monitoring programmes (such as Jamaica) to programmes at early stages (such as Saint Vincent and the Grenadines) or with attempts to re-establish monitoring in the case of Guyana. In some countries government agencies carry out monitoring independently, while in others

groundwater monitoring is carried out by the water utility, based on the specific institutional arrangements in each country and the status and independence of the utility from government.

2. A clear organisational mandate, based on appropriate legislation and regulation, for the organisation leading on groundwater monitoring is required. It is difficult to commence and sustain monitoring systems where this mandate is not clear and / or overlapping between agencies.
3. Coordination between organisations involved in groundwater monitoring is key, especially in situations where the water utility and government department with responsibility for water resources management are involved.
4. Funding for monitoring was cited as a perennial challenge, both for capital and operational aspects. Making use of existing private wells for monitoring is often required to minimise costs as well drilling for observation boreholes is expensive. This brings its own challenges of access arrangements and maintenance.
5. In monitoring system design a clear set of monitoring objectives are required in order to ensure that the performance of a monitoring system can be assessed. It is easy to fall into the trap of monitoring without a clear rationale which makes justification for monitoring difficult.
6. A good conceptual and numerical understanding of aquifer systems characteristics and behaviour is important to inform monitoring system design, this should include accurate data on groundwater exploitation, which is often lacking for private wells and agricultural groundwater use.
7. Jamaica raised three success factors based on the long history of monitoring groundwater:
    a. Persistence: Groundwater monitoring is a long term ambition and requires long term investment and a commitment to stick with it.
    b. Advocacy: Ensuring high level political support, and a strong mandate is important to secure sustained funding.
    c. Innovation: The ability to review and optimise the monitoring network, asking the question ‘is it fit for purpose?’ and looking for technological innovations and ways to monitor more cost effectively is important to maintain relevance and efficiency.

2.5 Meeting record

Date: 15th March 2023

Time: 8:30-10:30am CST (Belize), 10:30am-12:30pm AST, 2:30-4:30pm GMT (UK)

Location: Microsoft teams virtual meeting

Table 2.1: Attendees

Name	Organisation	Initials
Andrew Ball	HR Wallingford	ABL
Adrian Cashman	Independent Consultant (Barbados)	AC
Angela Franklin	Guyana Water Incorporated	AF
Anuradha Maharaj-Jagdip	Caribbean Water and Wastewater Association (focussing on groundwater in Trinidad and Tobago)	AMJ
Azucena Rodriguez Yebra	HR Wallingford	AZR
Emily Strathdee	HR Wallingford	ESD
Frank Grogan	Specialist Hydrologist, Hydrometeorological Service of Guyana	FG
Geoffrey Marshall	Water Resources Authority of Jamaica	GM
George Woolhouse	HR Wallingford	GFW

Name	Organisation	Initials
Gina Young	National Climate Change Office Belize	GY
John Bowleg	UNESCO Bahamas National Commission For Water Resources Management Unit - WSC	JB
Marisela Ricardez Garcia	CTCN representative for Latin America and Caribbean	MRG
Prince Harris	Antigua Public Utilities Authority	PH
Tennielle Hendy	National Hydrological Service Belize	TH
Veronica Yearwood	Antigua Public Utilities Authority	VY
Vialey Richards	Central Water and Sewage Authority (CWSA) St Vincent and Grenadines	VR

Table 2.2: Minutes

Item No.	Item	Action
1	**Welcome remarks** ● Welcome and introduction; ● Background provided by TH: Belize has previously focused on surface water management but over the past 10-15 years there has been a movement from surface to groundwater usage. In 2019 there was a major drought in the North of Belize – from which the New River is still recovering. The National Hydrological Service (Belize) wants to be more proactive rather than reactive in response to groundwater.	

2	**Background and objectives of the meeting**
	● Presentation by AZR to cover the background and objectives of the project, as well as the main aims of the meeting:
	  ● Who uses information from the groundwater monitoring system and why?
	  ● What needs to be in place for an effective and sustainable monitoring system?
	  ● Any other lessons or suggestions?	

3	**Presentations by the invited countries**
	
	Antigua and Barbuda – PH
	● Groundwater is used for potable water, reverse osmosis and agriculture. It can be the only source of domestic supply in some areas of the island (Claremont and Cades Bay);
	● Problems:
	  ● Saline intrusion;
	  ● Over extraction (due to shifting climatic patterns/ increasing population);
	  ● Decline in rainfall.
	● Monthly monitoring of observation and production wells and analysis in lab – since 1983;
	● Rainfall figures - good relationships with MET office;
	● Financial challenges:
	  ● Allocation of funds for necessary equipment and materials;
	  ● No funds for some areas.
	● Overcome financial challenges by setting up a budget, and make sure the programme is feasible and affordable. Working relationships with Antigua Meteorological Services and Caribbean Meteorological and Hydrological Institutes to exchange information;
	● Technical challenges:
	  ● Wells cannot always be monitored;
	  ● Funding have to be prioritised - would like to perform resistivity tests;
	  ● Not consistent with monitoring practices (not carried out as they would like);
	  ● Cannot always afford to maintain the wells.	

Item No.	Item	Action

Bahamas – JB

- The Bahamas are solely dependent on groundwater resources – lack surface water;
- They are heavily impacted by storms as the country is very flat. Storm surges result in saline intrusions. There is a history of over-pumping, salinisation, deforestation, squatting, land-based contamination and development;
- They had to move from dependence on groundwater (trying to protect and maintain these) and the use of Reverse Osmosis;
- Reverse osmosis in Jamaica still uses groundwater wells at depth (going through fresh water and brackish lenses) and returns brine into wells at a deeper horizon;
- They don't use marine water for reverse osmosis – for the inputs or outputs of water;
- 90% of desalinisation occurs in New Providence Island;
- Challenges include difficulty obtaining data. For example, they would like to expand the network of rainfall gauges across the country (with measurements taken by citizens) as currently only use gauges at airports with the MET department.

Guyana – FG

- Guyana is similar to Belize – as it is not an island, and has a coast line and shares boundaries with other countries;
- 90% of population lives around the coast, which depends on groundwater resources (although has additional resources);
- Challenges:
  - Contaminations from effluents and industries especially as the country develops;
  - Transboundary aquifers – for example, those shared with Suriname - data issue sharing / trust required;
  - Information can be outdated;
  - They have not started monitoring all the aquifers – and there is limited alternative resources at the coast;
  - There is no current monitoring network - but currently trying to resolve this;
  - Legislation and regulations are outdated in Guyana;
  - Funding.

Jamaica – GM

- In Jamaica the hydro-stratigraphy is based on geology knowledge. The majority of water resources are groundwater;
- Issues with pollution of groundwater:
  - Dundar contamination from historical sugar industry;
  - Saline intrusion;
  - Nitrate from sewage;
  - Caustic soda from the bauxite industry.
- As an authority they are responsible for managing 2200 wells that are monitored (monthly basis for groundwater level monitoring – not all wells are used for monitoring) in addition to surface water bodies. They don't own the wells:
  - This data is uploaded to their website on a quarterly basis;
  - They also have specialised project monitoring (over the past 3 years) – for example, with a focus in the Manchester region where there is increasing agricultural activity. They are continuing to monitor existing wells and are aiming to implement new wells in the area;
  - They used data loggers that took information every 15 minutes – but there have been some issues with this so these have been taken out;

Item No.	Item	Action

- Monitoring is informative and has been carried out for some time;
- Managed Artificial Recharge facility (water from irrigation canal which is then treated through sedimentation basis and wetland basis to try and recharge the aquifers - limited impacts so far).

- Challenges:
  - Issues around access to wells;
  - Lack of funding for groundwater exploration, equipment procurement and human resources.
- Overcome the challenges through:
  - Persistence;
  - Innovation;
  - Advocacy.
- Important to have a good understanding of geology and to communicate with institutes so they can advocate for groundwater resources.

St Vincent and Grenadines – VR

- Unique challenge of managing potable drinking water whilst experience volcanic eruptions;
- Groundwater, surface water, and rainwater harvesting are used for potable supply – groundwater is more reliable in the case of a volcanic eruption;
- On Mainland St Vincent, groundwater is monitored once a month, and in the Grenadine islands, groundwater is monitored every other month;
- Best practices:
  - To embark on feasibility studies by developing pilot boreholes and observation wells to facilitate the necessary pump test and groundwater studies;
  - Geological and hydrogeological knowledge of the island;
  - To design and establish a robust water quality and storage monitoring program;
  - Routine pilot borehole cleaning by stressing the aquifer;
  - Avoid over-pumping (saline intrusion prevention);
  - Conduct frequent buffer zone surveillance on activities surrounding the abstraction point to prevent seepage of contaminants into aquifer;
  - Establish a database for data storage and analysis that will assist with successive engineering planning and designs;
  - Capacity building (train personnel on relevant equipment use) – build into the plan training for people and the possibility of improvement of people's capacities.
- Groundwater monitoring technical challenges:
  - Limited access to technologies for continuous monitoring;
  - No installed technologies for real time monitoring;
  - Limited human resources and computational power to run in depth analysis and simulate modelling;
  - Impact of natural disasters such as floods and volcanic eruption.
- Groundwater monitoring institutional challenges:
  - Poor land zoning in Saint Vincent and the Grenadines (preventing aquifer contamination) e.g. Agrochemicals usage, inhabitation distances etc;
  - No established acts to mitigate against unauthorised groundwater abstraction (which leads to over-pumping);
  - Proper mandate for water resources management in SVG (presently under Water user's mandate).
- Groundwater monitoring financial challenges:

Item No.	Item	Action
	• Lack of finances required to conduct further studies and development of groundwater distribution network, monitoring and treatment technologies; • Limited finances for capacity building and maintenance. • Actions taken: • Develop and strengthen the capacity for integrated water management; • Assessment of groundwater potential and the option to improve water security; • Water security, adaptation to climate change measures and development of Disaster Risk Reduction (DRR) strategies. integrating them within national sustainable development strategies; • Successful conversion of the pilot borehole into a long-term production borehole. **Trinidad and Tobago – AMJ** • Most of the well fields are on the west of Trinidad where the population is located. Groundwater resources account for 28% of water resources in the country; • The groundwater network has 312 wells, with 276 in Trinidad and 36 in Tobago; • Groundwater is used for agriculture, industry / manufacturing and for municipal use; • Common issues include: • Saline intrusion; • Pollution; • Over abstraction; • Watershed degradation. • Originally there was limited monitoring in Trinidad and Tobago, but there is now a full network which is improving. Measurements are taken once a month manually, by staff trained when needed; • Data is stored on the National Water Resource Database (NWRD) which is GIS based – for internal use; • Issues: • The main issue is with data collection and quality analysis work; • Datasets are not long enough to establish trends; • Coastal zones are not well monitored; • No water quality sampling / monitoring. • Institutional challenges: • Management decisions are based on best available information; • Too reactive, not enough proactivity; • Need for development of human resources capacity and tools within the Water Resources Management Organisation to support an effective decision support system; • No official mechanism for stakeholder collaboration exists apart from stakeholder committees. • Financial challenges: • Limited finance / budget; • Low tariffs, low-cost recovery; • Groundwater considered low cost for maintenance so many wells abandoned due to collapse and disrepair. • Overcoming the challenges: • Requirement for one central, independent organisation and effective institutional structure to manage water resources; • Projects that are funded to fill gaps in data collection and storage.	

Item No.	Item	Action
4	**Q&A session** ● Question from ABL: Are observation boreholes in Antigua and Barbuda drilled by APUA or are they already in existence? PH – they are drilled by APUA; ● Question from AC: How does Guyana Hydromet liaise with Guyana Water Inc. with respect to monitoring groundwater? FG – this is work in progress, and they are trying to form an alliance (MOU – memorandum of understanding) to get data sharing policy. They have more data in the field so would be good for it to be less ad hoc and share information more; ● Question from AMJ: Are the unmonitored wells in use in Jamaica? GM - Most unmonitored wells are in use, some are abandoned. A few may be destroyed or otherwise cannot be found. We have a database of wells which keeps track of their current state and usage. Well verification is a major exercise that needs to be done on a regular basis	
6	**Wrap up** ● GWL – to circulate slides.	GWL

Appendices

A Meeting Agenda

Regional virtual meeting on Groundwater monitoring, challenges, and solutions

15th March 2023 at 8.30-10.30am CST (Belize), 10.30am – 12.30pm AST, 2.30 – 4.30pm GMT (UK).

AGENDA

1. **Welcome remarks**
2. **Background and objectives of the meeting**
3. **Presentations by the invited countries**
   a. Current status of groundwater monitoring systems
   b. Key institutional / financial / technical challenges and solutions for overcoming these
4. **Q&A session**
5. **Discussion session**
   a. Who uses information from the groundwater monitoring system and why?
   b. What needs to be in place for an effective and sustainable monitoring system?
6. **Summary and next steps**
7. **Meeting Closure**

Figure A.1: Meeting Agenda for Regional Groundwater Meeting (15th March 2023)

Source: HR Wallingford

B Presentations

Presentation slides attached as a separate pdf document.

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