

Groundwater Reconnaissance Visit to Yap State, FSM, May 2019

As part of the EU-funded Readiness to El Nino (RENI) project, a reconnaissance mission was undertaken to Yap, FSM between 15th and 17th May, 2019. The mission was essential to:

1. Establish the key hydrogeological needs to be addressed;
2. Gather relevant hydrogeological information from field areas, the Gagil-Tomil area;
3. Scope out the extent of field area and make logistic arrangements related the hydrogeological field assessment scheduled for September, 2019.

The mission was undertaken collaboratively between Yap State EPA and SPC. The SPC team included the project coordinator, Sean Kadannedg, and the water resources assessment (WRA) staffs Amini Loco and Anesh Kumar. Prior to the mission, there was an understanding that this mission, and the subsequent field assessment, will focus on the use of electrical resistivity to identify additional groundwater sources within the field area to reduce the impacts of severe droughts as recorded in 1998 and 2015. The mission proved that the assessment scope needs to be modified. Thus, this summary report presents some of the preliminary findings to inform the RENI Project Manager on the priority area(s) and proposed activities for the field assessment.

Situation Analysis

The water supply systems on Yap State Main Island has been severely affected during the 1998 – 2000 and 2015 – 2016 drought periods. These events resulted in varying impacts on the four (4) water supply systems on the Island, all which are managed and operated separately. The water supply authorities include the Southern Yap Water Authority (SYWA) Yap State Public Service Corporation (YSPSC), Gagil-Tomil Water Authority (GTWA) and Mapp Water Authority (MWA). Two of these water authorities, namely YSPSC and GTWA are currently utilising groundwater from the Gagil-Tomil aquifer (GTA), providing potable water to their respective municipalities. These competing interests and water use triggered questions around the capacity and sustainability of the aquifer to meet the water demands and considering the prolonged and severe dry conditions prevalent on the island.

The GTA has been previously mapped to be is composed of fractured and/or fissured volcanics that has number of perennial springs and now provides substantial groundwater since its initial drilling assessment in the 1980's. Two (2) adjacent valleys, namely Monguch and Eyab, 1 to 2 km apart have been developed for groundwater-fed water supplies. Operation in Monguch valley is undertaken by GTWA since the 1980's – the system currently has four (4) pumping bores, 2 of which are non-operation, to serve the neighbouring communities of Gagil and Tomil. The Eyab valley, on the other hand is managed by the Yap State Public Service Cooperation (YSPSC). The Eyab system has a total of 8 production bores (6 currently operational) and 5 monitoring wells (3 located in Monguch valley and 3 in Eyab) – these YSPSC bores were drilled after the 1998-200 droughts.



Figure 1: the GTA between the Eyab and Monguch valleys and currently equipped with water supply and monitoring bores.

Initial discussions with the Yap State EPA and the two (2) water authority's managers led to the understanding of the following needs and concerns:

- What are current impacts of the current pumping in each valley, with a view on extreme dry conditions?
- What is the extent of the GT aquifer?
- Can the systems be able to support the water needs during extreme conditions?
- Is the current pumping at Eyab vey causing drawdown impacts in the Monguch Valley? If so, what management strategies be adopted to ensure the continued and sustainable management of the aquifer as well as operation of both water supply systems?

Further, a visit was also conducted to the SYWA, upon the request from the EPA. It was clear from the authority that the current system is vulnerable to drought-induced low flow and as a consequent, two potential drill sites have been identified. Potential funding for the drilling activity has been identified with drilling likely to happen later in the year or early 2020. Thus, the authority has expressed interest in the possibility of having resistivity surveys around these sites, to determine the groundwater potential of these areas and to guide these infrastructural investments.

Rainfall and drought analysis

The 1949 – 2019 rainfall data, provided by the Yap Weather Service station located near the airport, show a mean monthly and annual rainfall of 257 mm and 3092 mm, respectively. The dry months are from November to April recording an average monthly rainfall of 189 mm, whilst 324 mm recorded for the rainy months. The influence of ENSO events is also been very well recorded in the rainfall data, with the average monthly rainfall falling below 80 mm for the dry months 1998, 2015 and 2016 – this is 30% of the monthly rainfall for all periods

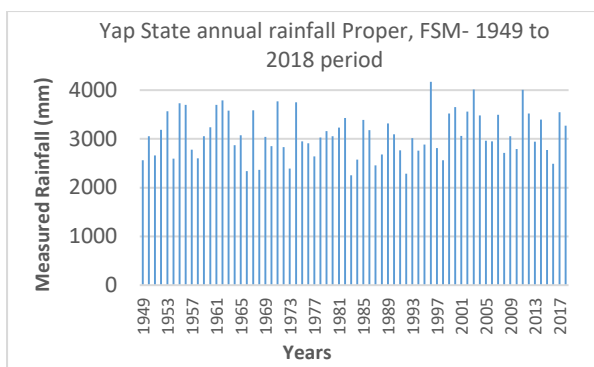


Figure 2: Annual rainfall for Yap Proper collected at the State International Airport from 1949 to 2018

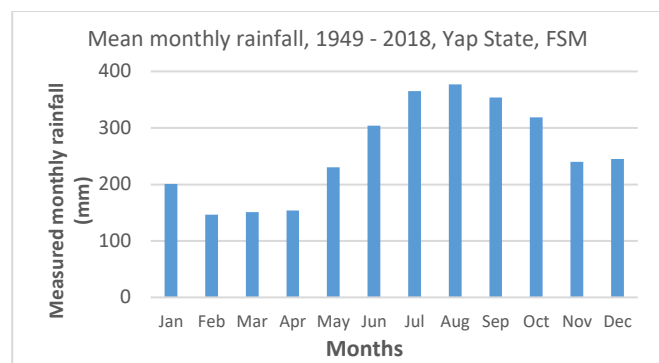


Figure 3: Average monthly rainfall for Yap Proper collected at the State International Airport from 1949 to 2018

Processing the historical rainfall datasets through the BoM’s Seasonal Outlook of Pacific Island Countries (SCOPIC) program, and using that the 6th months and 12 months percentile drought methods indicated 14 to 18 drought events in the island’s climate record, with the 1998 and 2015 El Nino events amongst the most severe. These suggested the recurrence of these events, with a possibility on increasing duration and intensity. This necessitate evidence-based water resources management strategies to be adopted, which will be relevant for areas like Gagil-Tamil, which is highly relied upon for water supply.

Water Supply information:

Based on Table 1 below, the GTWA system is designed to have around 550 m³/day, whilst the YSPC systems pumps around 300 m³ – these estimates are made on the basis of the 12 hours pumping at Moguch. It should be noted that the GTWA system has two (2) 200,000 L tanks to that needs to be filled on a daily basis whilst the YSPC has one tank to supplement the Yap central. Although, a number of pumps are non-operational, it is clear that groundwater abstraction is substantial and hence, concern on the capacity and sustainability of aquifers need to be further explored.

Table 1. Pumping well details in

Authority	Well	Status	Total depth (ft)	Design Discharge – GPM (L/s)	Diameter (inch)
GTWA (Monguch)	1	Non-operation	37	94 (6)	6
	2	Currently Operating	39		6
	3	Currently Operating	32	57 (3.5)	6
	4	Non-operation	50	60 (3.8)	6
YSPCS (Eyab)	2	Currently Operating	Unknown	50 (3.1)	6
	3	Currently Operating	Unknown	16 (1)	6
	4	Non operational	Unknown	Not in use	6
	5	Currently Operating	Unknown	21 (1.3)	6
	6	Currently Operating	Unknown	15 (0.9)	6
	7	Non-operation	Unknown	20 (1.2)	6

Recommended Approach for September Assessment

For the GTWA and YSPSC queries and challenges, the following is proposed:

1. Improve understanding of the aquifer and identifying new groundwater sources by conducting electrical-resistivity around the edges of Monguch and Eyab valleys to:
 - a. determine the thickness (depth), and extent off the Gagil-Tomil aquifer – this will aid the calibration and development of conceptual model to illustrate whether or not the Monguch and Eyab groundwater systems are hydraulically connected and
 - b. Identify potential drill sites outside the existing well fields and around the periphery of the catchment area to provide additional or emergency waters for the surrounding communities and/or to distribute pumping stress around the area.

Linked to these will be need to have good elevation data for the pumping stations, monitoring bores and ER survey lines – the use of R10 RTK GPS will be required.

2. Understanding the impacts of current pumping through:
 - a. Pumping tests in selected bores and check the impacts from nearby bores including monitoring bores – this will require a few pumps to be shut down and hence, some advance discussion and agreement with the authorities and communities will be needed on the possibility of reduced water supply for those number of days
 - b. Install CTD diver data logger in existing monitoring bores to establish the pumping impacts from existing pumping wells in the 2 valleys.
 - c. Undertake groundwater chemical sampling to gain insights on the recharge regime.
 - d. Use ultra-sonic flow meter to determine and/or verify abstraction data from the existing pumping stations. This will be assisted by authorities installing new and operational flow meters
3. Undertake consultation meetings with the different Water Authorities and surrounding communities on the preliminary results

For the SYWA, the request to run ER survey lines around two (2) sites already identified for drilling is secondary priority that is likely either late in the year or early 2020. Again, the benefits for undertaking this work will be to determine the groundwater potential and the viability of drilling to guide their planned groundwater development investment, as well as to demonstrate the value of undertaking ER survey in groundwater exploration which may be useful, not only for the authority, but for the Yap State and the whole of FSM.

Again, essential to all of these is the engagement of key stakeholders, including authorities and communities. It is important that preliminary information gained during the field survey be shared in an inclusive manner.

Thus, the following work plan options are proposed for September:

- a. Either a 11 field-working days (targeting the Sunday morning flights into Yap) program to cover both the Monguch and Eyab valleys around the Gagil-Tomil areas (70%), complete survey lines in SYWA (15%) and undertake stakeholders engagement (15%), OR
- b. An 11 field day program focussing on only on Gagil and Tomil area, including field survey and consultation and leaving the other activities for a later date or a future project.