

March 24, 2023

MEMORANDUM

FOR : The Regional Executive Director
DENR, MIMAROPA Region

THRU : The ARD for Technical Services
DENR, MIMAROPA Region.

FROM : The OIC, PENR Officer
Oriental Mindoro

SUBJECT : **FIRST QUARTERLY REPORT ON DATA VISUALIZATION
AND ANALYSIS GENERATED BY THE SCIENCE-BASED
REAL-TIME WATERSHED MONITORING INSTRUMENTS
FOR CY2023**

Submitted is the first quarterly report on the analysis of data generated from the science-based real-time watershed monitoring instruments installed in Mag-Asawang Tubig River Watershed and Bongabong River watershed.

Based on the data analysis, the microclimate condition plays a significant role in the AWS data. The built-up area (Macatoc-Automated Weather Station) has less rainfall and high solar radiation while in the mountainous area (DA-Automated Weather Station) has more rainfall and less solar radiation. The Mag-Asawang Tubig River watershed is currently in draining trend at a rate of 9.4 mm/day. There is non-agreement of data between the volumetric moisture content and the precipitation in Macatoc-AWS station that shows a data problem in our database.

Data problem of the database must be investigated further with the help of technical expert from the DENR Central Office. Data analysis will be further improved once the repair of Automated Water Level Monitoring Station in Abaton bridge, Barangay Parang, Calapan City, Oriental Mindoro is completed.

Attached is the analyzed data for information and record.

ALAN VALLE



DENR PENR02303000101



March 24, 2023

MEMORANDUM

FOR : The Regional Executive Director
DENR, MIMAROPA Region

THRU : The ARD for Technical Services
DENR, MIMAROPA Region

: The OIC, PENR Officer
Oriental Mindoro

FROM : PENR Personnel
DMITS

SUBJECT : **FIRST QUARTERLY REPORT ON DATA VISUALIZATION
AND ANALYSIS GENERATED BY THE SCIENCE-BASED
REAL-TIME WATERSHED MONITORING INSTRUMENTS
FOR CY2023**

Respectfully submitting the first quarterly report on the analysis of data generated from the science-based real-time watershed monitoring instruments installed in Mag-Asawang Tubig River Watershed and Bongabong River watershed.

The data generated in the automated weather station (AWS) located in a built-up area greatly differs from the AWS located in a mountainous area. The latter has lesser solar radiation and more precipitation while the earlier has more solar radiation and less precipitation. Aquifer recharge is also visible after every rainfall event. Data was correlated to determine the direct relationship between factors. This further exposes the data problem such as the soil moisture versus rainfall in Macatoc-AWS. Correction of the data problems encountered is necessary with the help of a technical expert from the DENR Central. The flooding expectance will be analyzed once the repair of the Automated Water Level Monitoring Station in Abaton bridge, Barangay Parang, Calapan City, Oriental Mindoro is completed.

Attached is the analyzed data from January 1 to March 21, 2023 for information and record.

JACKSON A. BELLEN

Database Manager IT Specialist

INTRODUCTION

Watershed plays a vital role in the existence of mankind. It collects water in the form of precipitation, convey downstream as surface water in the form of runoff or river baseflow, store in the aquifer as groundwater for future use. Watershed is a complex system made up of interconnected ecosystems. From the ridge to the reef, each ecosystem plays a role in the overall condition of the watershed. Thus, it is vital to monitor the watershed regularly. Science-based methodology monitoring is a necessity to understand these systems and processes and how they interact with each other as influenced by physical, biological, socioeconomic and political factors. Physically, one way of monitoring and managing watersheds scientifically is through setting up of stationary watershed monitoring instruments. It is utilizing the Internet of Things (IoT) to collect data in a given time interval and sent to the cloud database for repository.

The stationary watershed monitoring instruments are important since its data can contribute to the projects of the Department of Environment and Natural Resources (DENR) such as in sustainable upland development, flood mitigation, landslide and erosion control, and coastal management. It is in a way to have historical data on the watershed itself. In MIMAROPA Region, the pilot watershed monitoring instruments were installed within the Mindoro Island, particularly within Mag-Asawang Tubig River Watershed and Bongabong River Watershed. Mag-Asawang Tubig River Watershed were installed with one (1) Automated Water Level Monitoring Station (AWLMS), one (1) Groundwater Monitoring Station (GWMS), and two (2) Automated Weather Stations (AWS). Meanwhile, one AWS were installed within Bongabong River Watershed.

Mag-Asawang Tubig River Watershed is an important watershed in the region since it is included as one of the Priority Critical Watershed Supporting National Irrigation System (NIS) per Memorandum of the Forest Management Bureau (FMB) dated 29 January 2020. Covering an area of 42,706 hectares (River Basin Control Office, 2021), it provides irrigation water to low lying areas such as rice field in the municipalities of Victoria and Naujan. The watershed covers the municipalities of Naujan, and Victoria in Oriental Mindoro and Sablayan in Occidental Mindoro.

The AWLMS Mag-Asawang Tubig watershed was installed in Abaton Bridge, Barangay Parang, Calapan City. The GWMS was installed in the Mindoro State University (MinSU) compound, Barangay Alcate, Victoria. One AWS was installed at the upper portion of the watershed, specifically in the Department of Agriculture – Regional Integrated Agriculture Research Center (DA-RIARC) Compound, Barangay Alcate, Victoria. On the lower portion of the same watershed is another AWS located at Macatoc Elementary School, Barangay Macatoc, Victoria, Oriental Mindoro.

On the other hand, one AWS was installed Bongabong River Watershed, specifically in DENR CENRO Roxas Ranger Station, Barangay Hagan, Bongabong, Oriental Mindoro.

Bongabong River Watershed is one of the most important watersheds in Oriental Mindoro. It covers an area of 55,114 00 hectares, located at the south-central part of Mindoro Island, covering the Municipalities of Bongabong, Bansud, Gloria, and Mansalay of Oriental Mindoro and Sablayan of Occidental Mindoro. One of the major functions of this watershed is its role in irrigating several hundred hectares of rice fields in the low-lying areas in the municipality of Bongabong. Bongabong River is also the source of water for domestic use of several barangays and residents along the perimeter of the watershed.

The locations of the five (5) instruments installed within the two (2) watersheds in the island of Mindoro are shown in Figure 1 and Figure 2.

The data coverage of this report is from January 1, 2023 to March 21, 2023. The data stored in the cloud database (Zentra cloud) is in a 15-minute interval. Creating 96 records per day per instrument/sensor. Data was summarized using Microsoft Excel to have a daily average, maximum, minimum and total in the case of solar radiation. . R-Studio software was used to create wind rose diagram, while ArcGIS was used to build the maps presented in this report.

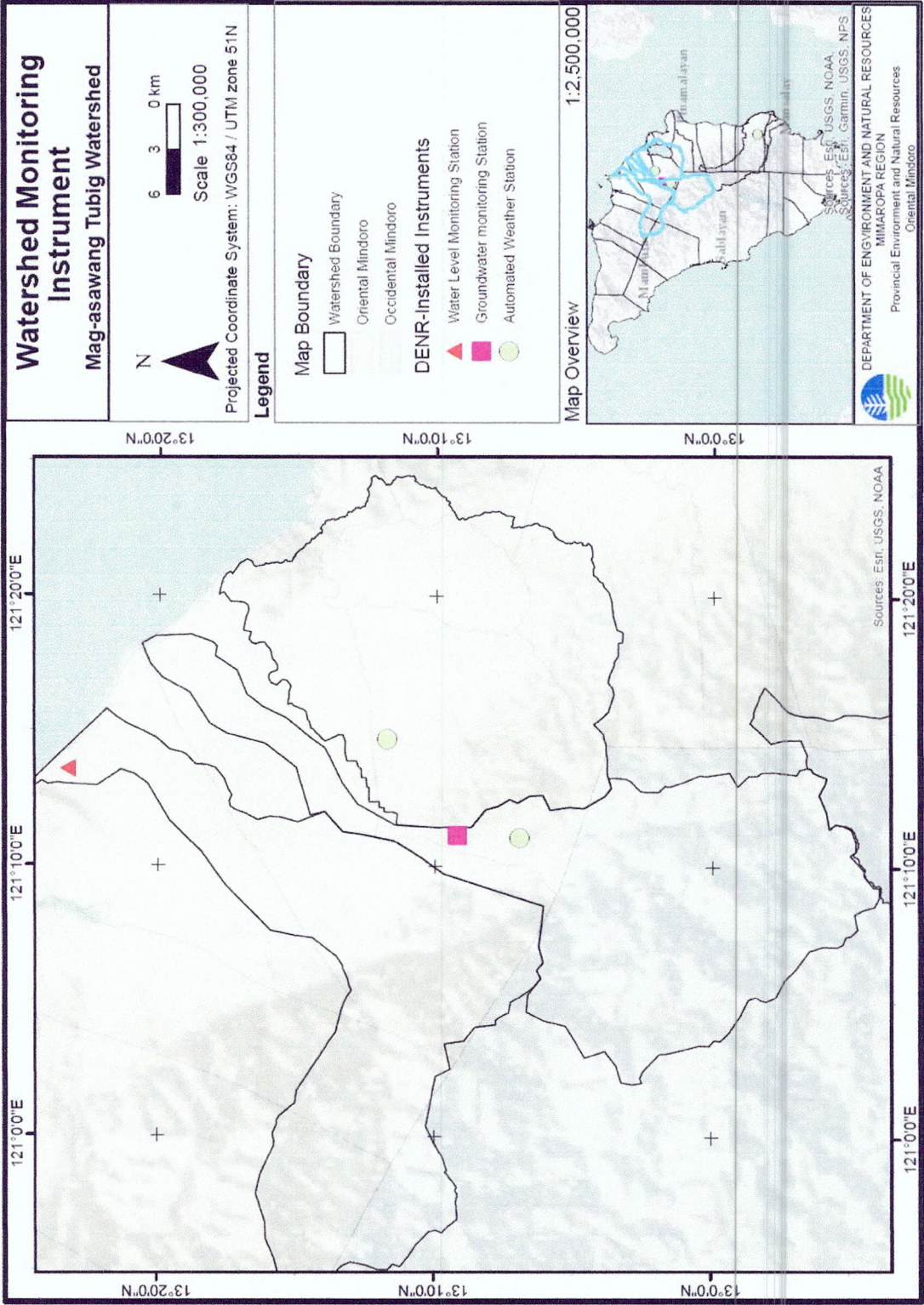


Figure 1. Map of Mag-Asawang Tubig River watershed with four (4) installed monitoring instruments.

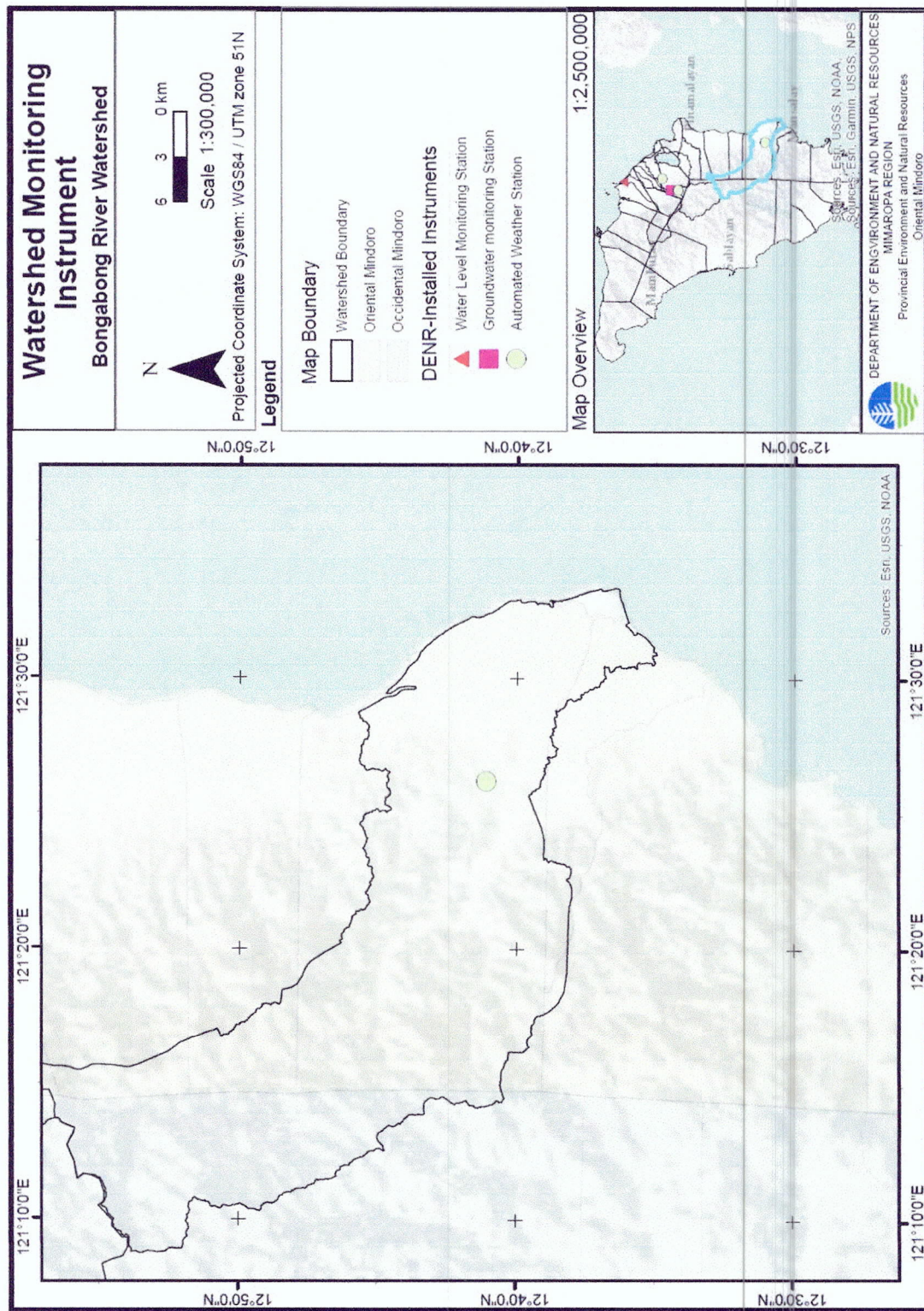


Figure 2. Map of Bongabong River watershed and the location of the installed AWS station.

Table 1. Location and function of installed Watershed Monitoring Instruments in Mindoro Island.

No.	Instrument	Purpose	Location, Coordinates and Watershed	Date Installed	Status
1	Automated Water Level Monitoring Station (AWLMS)	- This is a solar-powered setup device composed of an Advanced remote Data Acquisition Unit using STORM3 datalogger - It has a non-volatile memory capable of storing approximately one year of data with 5Ah gel-type battery as backup power supply, GSM module capable of sending data in a configurable time interval (set at 15 minutes) and a water level sensor. - The device monitors and transfers in real-time the water level data of Mag-asawang Tubig Watershed in Oriental Mindoro	Abaton Bridge, Barangay Parang, Calapan City, Oriental Mindoro. Lat 13.3881566° N Lon 121.2262129° E Mag-Asawang Tubig Watershed	January 2019	New battery was installed but the charging system was malfunctioning. Procurement of solar panel and charge controller is on process
2	Ground Water Monitoring Station (GWMS)	- This is a solar-powered setup device composed of an Advanced remote Data Acquisition Unit using Meter ZL6 data logger. - It has a non-volatile memory capable of storing approximately one year of data, six (6) rechargeable AA NiMH batteries as backup power supply, it has a built-in 4G data communication capable of sending data in a configurable time interval (set at 15 minutes) and a Conductance, Temperature and Depth (CTD) ground water sensor. - The device monitors and transfers in real-time the groundwater level data of Mag-asawang Tubig Watershed in Oriental Mindoro	MinSU Compound, Barangay Alcate, Victoria, Oriental Mindoro. Lat 13.1534589° N Lon 121.1857142° E Mag-Asawang Tubig Watershed	May 22, 2019	The instrument is in good condition and has a complete data in the Zentra cloud database

3	Automated Weather Station (AWS) - Macatoc	- This is a solar-powered setup device composed of an Advanced remote Data Acquisition Unit using Meter ZL6 data logger. - It has a non-volatile memory capable of storing approximately one year of data, six (6) rechargeable AA NiMH batteries as backup power supply, it has a built-in 4G data communication capable of sending data in a configurable time interval (set at 15 minutes) and a microclimate sensor. - The device monitors the wind speed, direction and gustiness, the solar radiation, air temperature and humidity, rain volume and intensity, barometric air pressure, and soil volumetric moisture content of the support surface of Mag-Asawang Tubig Watershed in Oriental Mindoro.	Macatoc Elementary School, Barangay Macatoc, Victoria, Oriental Mindoro. Lat 13.1963115° N Lon 121.2452662° E Mag-Asawang Tubig Watershed	May 22, 2019	One 10HS sensor is not functioning. Maximum RH values exceeds 100%
4	Automated Weather Station (AWS) – DA Victoria	- This is a solar-powered setup device composed of an Advanced remote Data Acquisition Unit using Meter ZL6 data logger. - It has a non-volatile memory capable of storing approximately one year of data, six (6) rechargeable AA NiMH batteries as backup power supply, it has a built-in 4G data communication capable of sending data in a configurable time interval (set at 15 minutes) and a microclimate sensor. - The device monitors the wind speed, direction and gustiness, the solar radiation, air temperature and humidity, rain volume	DA-RIARC Compound, Barangay Alcate, Victoria, Oriental Mindoro. Lat 13.1160894° N Lon 121.1843336° E Mag-Asawang Tubig Watershed	May 22, 2019	The anemometer has no data. One 10HS sensor is damaged and the other one gives negative values The ECRN100 is damaged in its outer casing

		and intensity, barometric air pressure, and soi volumetric moisture content of the support surface of Mag-Asawang Tubig Watershed in Oriental Mindoro.		Station is water-logged
5	Automated Weather Station (AWS) - Hagan	This is a solar-powered setup device composed of an Advanced remote Data Acquisition Unit using Meter ZL6 data logger. - It has a non-volatile memory capable of storing approximately one year of data, six (6) rechargeable AA NiMH batteries as backup power supply, it has a built-in 4G data communication capable of sending data in a configurable time interval (set at 15 minutes) and a microclimate sensor. - The device monitors the wind speed, direction and gustiness, the solar radiation, air temperature and humidity, rain volume and intensity, barometric air pressure, and soi volumetric moisture content of the support surface of Mag-Asawang Tubig Watershed in Oriental Mindoro.	CENRO Roxas Ranger Station, Barangay Hagan, Bongabong, Oriental Mindoro. Lat 12.6981016° N Lon 121.3720359° E Bongabong River Watershed May 21, 2019	The station is good except for one 10HS sensor with negative values

DATA ANALYSIS

Summarized daily data is attached in the Annexes in this report.

A. Mag-Asawang Tubig River Watershed (MATRW)

Table 2. Summary of the data collected for the First Quarter of 2023 for Mag Asawang Tubig watershed

Parameter	No. of Instruments Installed	Period Covered	Average	Max	Min
Rainfall (mm)	2	Jan. 1 – Mar 21, 2023	18.8	139.2	0
Air Temperature (°C)	2	Jan. 1 – Mar 21, 2023	24.6	32.5	18.9
Relative Humidity (%)	2	Jan. 1 – Mar 21, 2023	97.27	109.8*	52.3
Wind Velocity	2	Jan. 1 – Mar 21, 2023	Please see attached wind rose in Figure 3		
Wind Direction	2	Jan. 1 – Mar 21, 2023			
Solar Radiation (W/m ²)	2	Jan. 1 – Mar 21, 2023	9,326	24,630	1,875
Streamflow Level (mm)	1	Jan. 1 – Mar 21, 2023	AWLMS under repair		
Streamflow Temp(°C)		Jan. 1 – Mar 21, 2023	No data available		
Groundwater Level (mm)	1	Jan. 1 – Mar 21, 2023	8,511	9,300	7,518
GW Conductivity (μS/cm)	1	Jan. 1 – Mar 21, 2023	0.23	0.27	0.20
Soil Moisture (% vMC)	4***	Jan. 1 – Mar 21, 2023	13.0	80.2	(-11.0)**

*RH exceeded 100%

** Negative MC value by the 10HS sensor

*** 2 stations x 2 sensors

Two data problem is shown in Table 2, the maximum relative humidity (RH) is greater than 100% and the negative moisture content in 10HS soil sensor. The datasheet of the 10HS sensor from the Meter company states that negative value is when the sensor is in the air but when placed in a soil column it must be positive. In the problem of relative humidity, about 42% of the daily averaged RH data from the 2 AWS stations exceeded 100%.

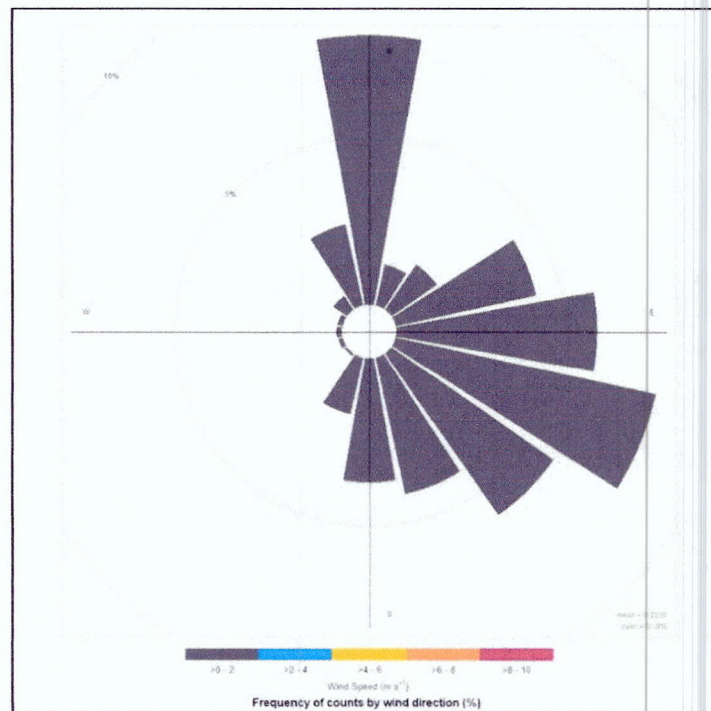


Figure 3. The wind rose of Macatoc-AWS station in MATRW.

Shown in Figure 3 is the prevailing wind in Macatoc station. Two pronounced directions can be seen, the North and the East-Southeast. The maximum wind speed is below 2 m/s while average wind speed is 0.23 m/s and the calmness is 51.9% (no wind movement).

The DA-AWS station has no data for wind speed and direction in the Zentra cloud for this quarter. Upon site monitoring and inspection, the ZL6 datalogger has no data coming from the Davis Cup anemometer when the logger is connected to the Zentra Utility app, the instrument was not functioning. The anemometer was also tried in the Macatoc-AWS station but still no data in the ZL6 logger.

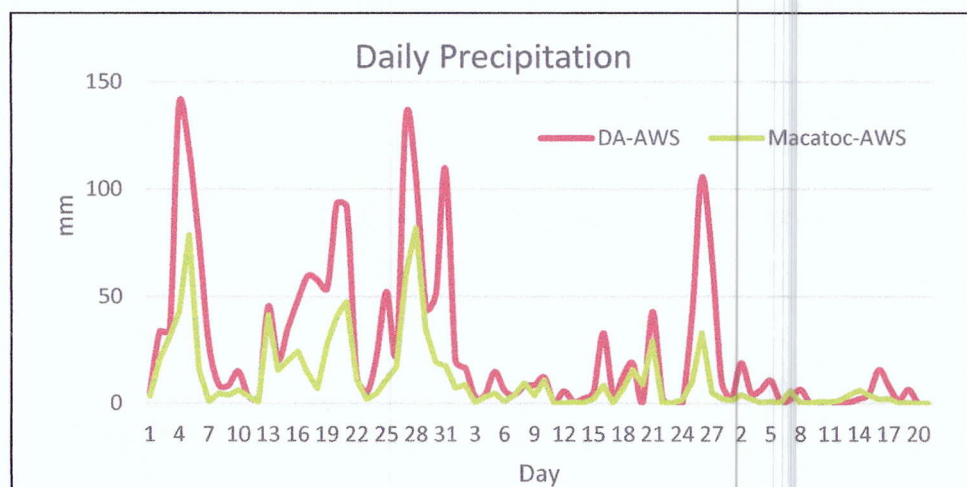


Figure 4. Daily precipitation of Macatoc-AWS and DA-AWS in MATRW.

The precipitation in Macatoc-AWS and DA-AWS are shown in Figure 4. The DA-AWS station received more rainfall compared to the Macatoc-AWS station of about 1,160 mm, a good amount of water supply for the watershed. The precipitation in Macatoc station is about 44% that of the DA station.

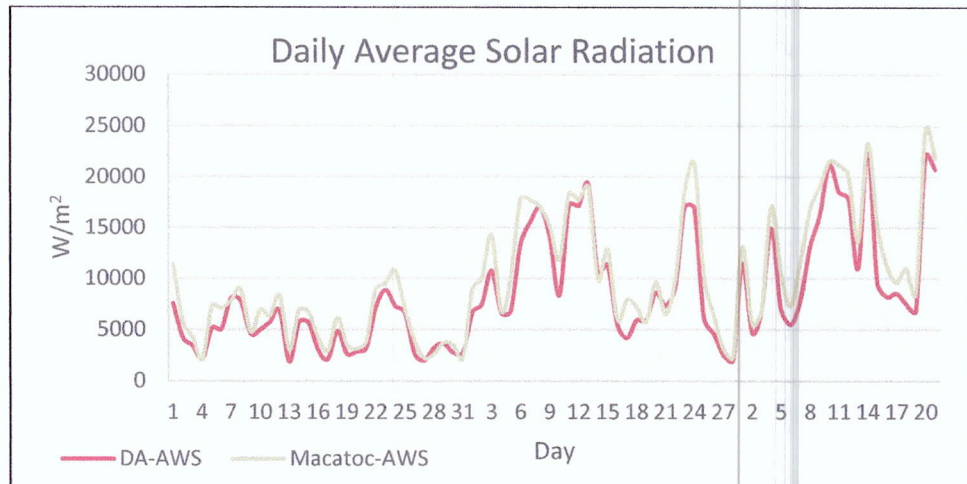


Figure 5. Daily average solar radiation of Macatoc-AWS and DA-AWS in MATRW.

Figure 5 shows the average solar radiation of Macatoc-AWS and DA-AWS. Contrary to precipitation, the DA-AWS received less solar radiation than of Macatoc-AWS station. This is due to the difference of microclimate conditions of the two stations, Macatoc station is in built-up area while the DA station is a mountainous area.

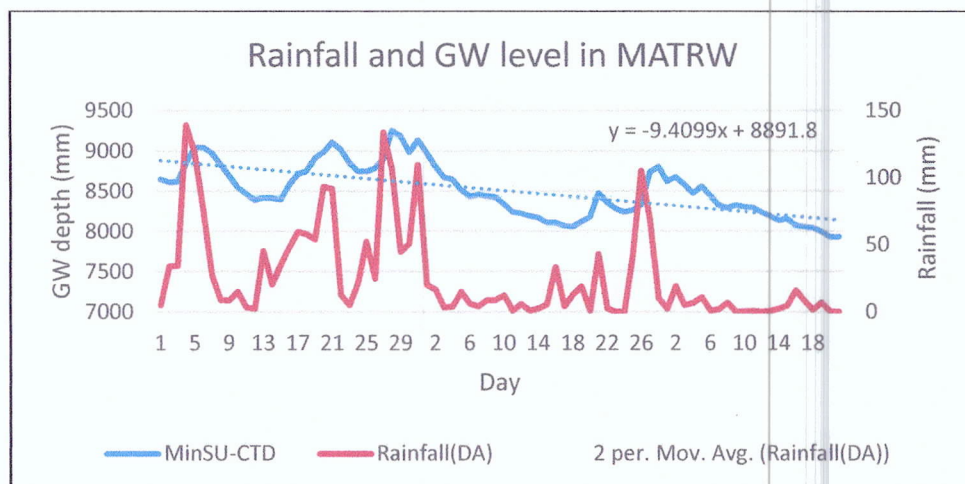


Figure 6. Average daily rainfall and groundwater level in MATRW.

In Figure 6 is the graph between the groundwater level in MinSU-Groundwater Monitoring System (MinSU-GWMS) and the rainfall in the DA-AWS station which is just few kilometers upstream. The aquifer recharge can be seen after every rainfall event. In terms of groundwater level, there is a lowering trend of groundwater in the rate of 9.4 mm/day for this quarter.

The correlation coefficient is 0.616 between the groundwater level and the precipitation. The groundwater movement is one reason for this correlation value. It takes time for groundwater to travel in the aquifer thus in some point, groundwater level in increasing even after the rainfall event.

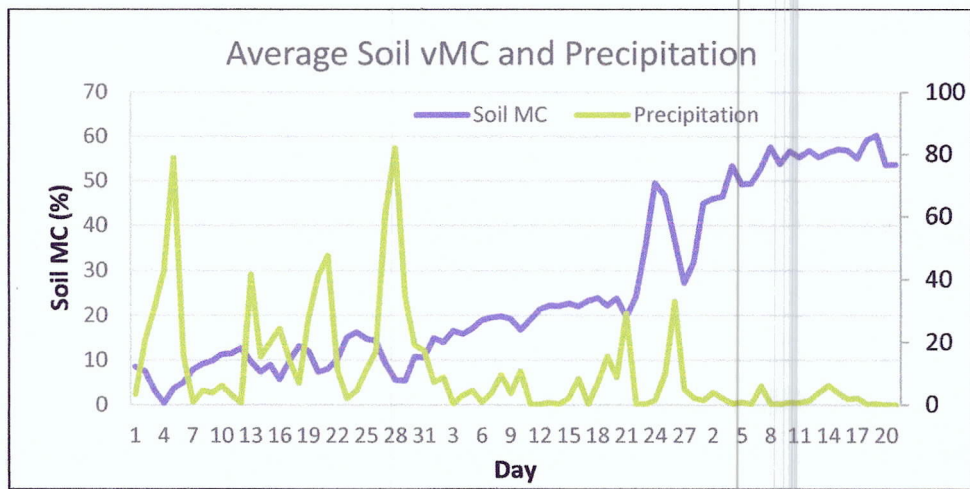


Figure 7. Average soil moisture content vs. precipitation in Macatoc-AWS station.

The relation between the soil moisture and the rainfall in Macatoc-AWS is shown in Figure 7. It is expected that the soil moisture has a positive correlation with the rainfall but the graph suggests the other way. The correlation coefficient is -0.49 of the two factors, this data must be scrutinized in the succeeding quarter as to the sensor value is at fault or there might be other physical factors contributing to this situation.

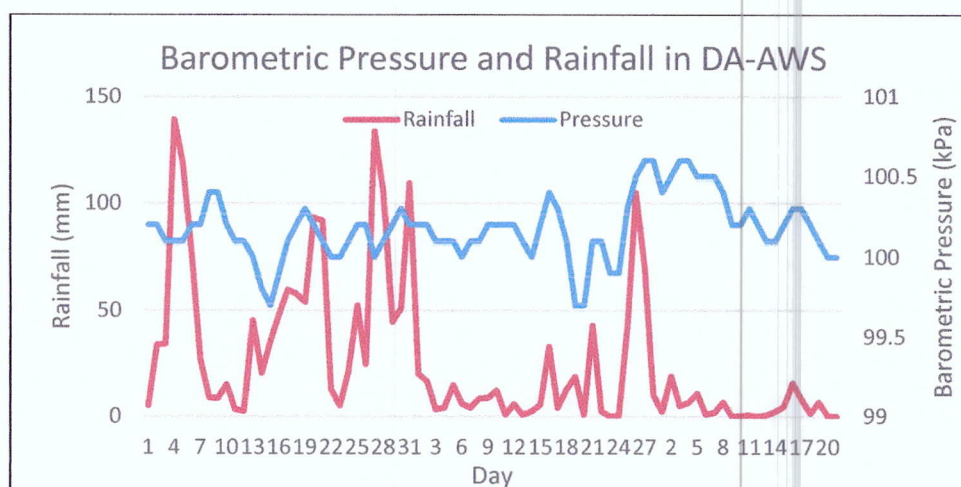


Figure 8. Barometric pressure vs rainfall in DA-AWS station.

Figure 8 is the relation between rainfall and barometric pressure in DA-AWS. The correlation coefficient is -0.014 which suggest that no established relation between the two factors in the current data format. A moving average might add relation to these factors and will be tested in the succeeding reports.

The relation between the rainfall and flooding cannot be established yet in this quarter since the Abaton-AWLMS has an on-going repair on the charging system. Purchasing of the solar panel and solar charge controller is on-going while new battery is already in the PENR office ready to be installed.

B. Bongabong River Watershed

Below is the summarized data of the sole DENR AWS station installed in the Bongabong River watershed. The averaged daily data can be found in Annex D.

Table 3. Summary of the data collected for the First Quarter of 2023 for Mag Asawang Tubig watershed.

Parameter	No. of Instruments Installed	Period Covered	Average	Max	Min
Rainfall (mm)	1	Jan. 1 – Mar 21, 2023	5.6	56.4	0
Air Temperature (°C)	1	Jan. 1 – Mar 21, 2023	25.2	35.2	19.3
Relative Humidity (%)	1	Jan. 1 – Mar 21, 2023	82.0	93.1	50.7
Wind Velocity	1	Jan. 1 – Mar 21, 2023	Please see attached wind rose in Figure 9		
Wind Direction	1	Jan. 1 – Mar 21, 2023			
Solar Radiation (W/m ²)	1	Jan. 1 – Mar 21, 2023	15,031	26,493	4,328
Soil Moisture (% vMC)	2*	Jan. 1 – Mar 21, 2023	3.5	13.8	(-26)**

*1 station x 2 sensors

** Negative MC value by the 10HS sensor

The Bongabong-AWS station also experiences the negative minimum volumetric moisture content. The whole record of 10-cm depth soil moisture sensor has negative values as shown in Annex D.

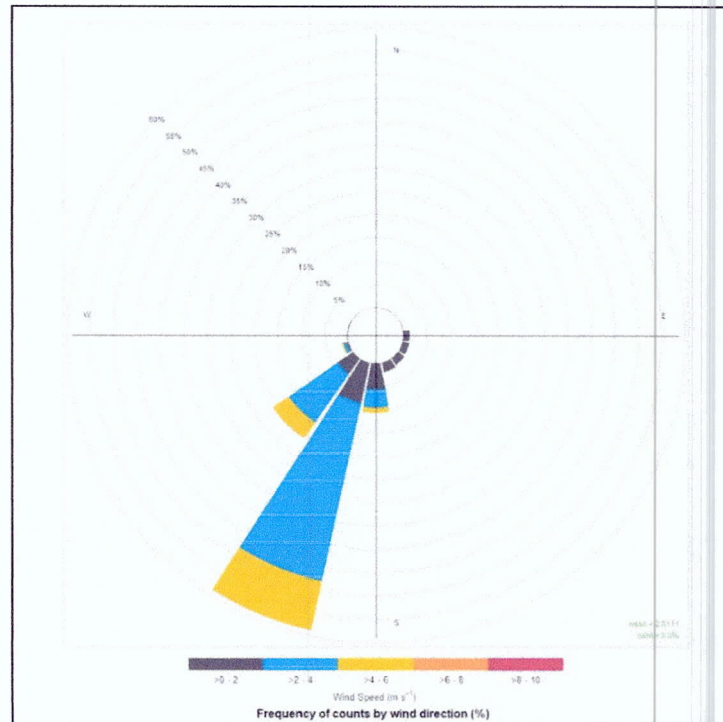


Figure 9. The wind rose of Bongabong-AWS station.

Figure 9 shows the wind rose of Bongabong-AWS station with prevailing wind blowing to the South-Southwest direction. The maximum wind speed in the station is between 4 to 6 m/s while the average wind speed is 2.1 m/s. The wind calmness is only 0.3% due to the location of the station overlooking the Bongabong river near the Lisap bridge.

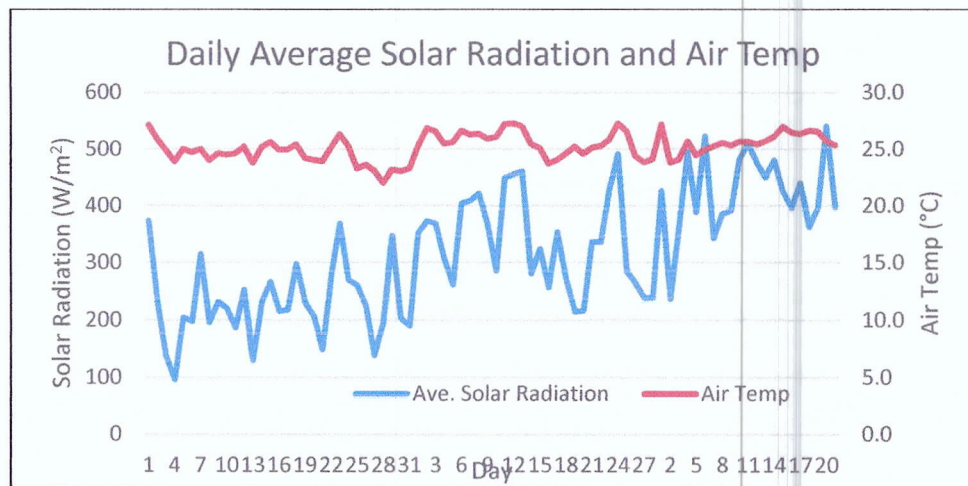


Figure 10. Daily average solar radiation vs. average air temperature of Bongabong-AWS station.

Shown in Figure 10 is the relation of solar radiation and air temperature in Bongabong-AWS station. It can be noted that there is an increasing trend in the daily total solar radiation for this quarter while no visible increasing/decreasing trend on the average air temperature. The correlation coefficient of the solar radiation and air temperature is 0.665, not so strong positive correlation. In most increase solar radiation there is also increase in air temperature.

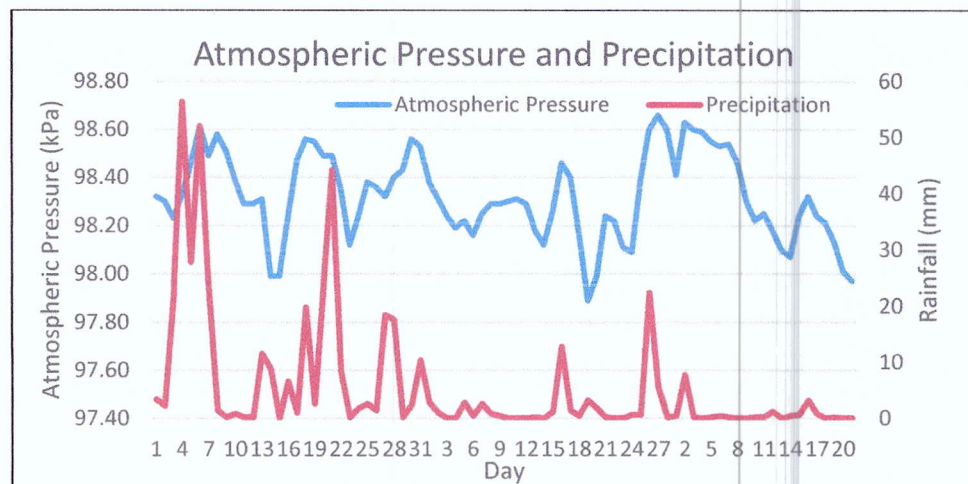


Figure 11. Daily average atmospheric pressure vs daily precipitation of Bongabong-AWS station.

Shown above (Figure 11) is the atmospheric pressure versus rainfall in Bongabong-AWS station. The correlation coefficient of the two factors is 0.306, which is a weak positive correlation.

SUMMARY AND CONCLUSION

In summary of this first quarter report, the difference in the microclimate conditions of the DA-AWS station and Macatoc-AWS station has greatly affected the climatic factor values. This

gives a wider scope on the watershed condition of the Mag-Asawang Tubig River watershed (MATRW). The draining trend in the aquifer storage of the MATRW is attributed lesser amount of rainfall in the watershed. As can be seen the report of March, even a greater discharge rate was observed. The soil moisture and rainfall in Macatoc-AWS should be further investigated as to the source of error, either the soil sensor or other factors interfering the reading of the 10HS sensor. The reactivation of the Abaton-AWLMS will be a great help in the analysis of the MATRW. a cumulative rainfall value will be determined of a flooding might occur during a rainfall event.

Several sensors were noted with data problem such as the negative soil moisture in the 10HS sensor, the relative humidity more than 100 percent, non-functional sensor/instrument such 10HS sensor and Davis Cup Anemometer. The correction of the above data problem will greatly contribute to the data reliability.

RECOMMENDATIONS

As for recommendation, a visit of a technical expert from DENR Central Office is necessary to ratify the above-mentioned data problems. Replacement of non-functional sensors/instrument is also recommended have a complete data in our database.

Moreover, the height of the anemometer must be increased to avoid the interference of the wind resistance like buildings such as in the Macatoc-AWS station.

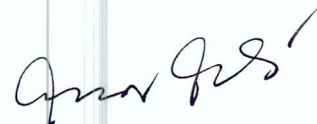
Lastly, the Zentra cloud is a powerful tool in data analysis and data visualization (presented in a live demo by Meter company personnel through video conference). It requires an admin capability to modify the data representation. Zentra cloud capability can be maximized and a great help to the DMITS personnel/data processor if admin privilege will be granted.

Prepared by:



JACKSON ABELLEN
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Noted by:



AMOR D. ASI
SVEMS/Chief CDS

ANNEXES

A. DA-AWS Daily averaged data								
Date	Total Solar Radiation (W/m ²)	Rainfall height (mm)	Rainfall intensity max (mm/hr)	Air Temp (°C)	Relative Humidity (%)	Atmospheric Pressure (kPa)	%MC 10 cm	%MC 30cm
1/1/2023	7545.3	5	24	25.6	99.2	100.2	4.3	0
1/2/2023	4190.8	33.8	72	25.22	100.8	100.2	-15.1	0
1/3/2023	3437.3	34.2	72	24.81	101.1	100.1	-10.6	0
1/4/2023	2094	139.2	96	24.15	101.2	100.1	-35.8	0
1/5/2023	5154.3	118.8	156	24.66	101	100.1	-24.1	0
1/6/2023	5073.4	76.2	108	24.4	100.9	100.2	-30.9	0
1/7/2023	8071.6	27.2	84	24.63	97.9	100.2	-23.4	0
1/8/2023	7810.7	8.8	36	23.42	98	100.4	-2.4	0
1/9/2023	4597.4	8.4	24	22.99	99	100.4	-15	0
1/10/2023	5005.8	15	60	23.66	99.9	100.2	-18.9	0
1/11/2023	5740.3	3.2	24	23.6	98.8	100.1	-15.7	0
1/12/2023	6845.4	2.4	24	24.03	98.6	100.1	-2.6	0
1/13/2023	1875.2	45.4	60	23.13	101.8	100	-26	0
1/14/2023	5684.6	20.4	36	23.66	100.9	99.8	-18.7	0
1/15/2023	5660.9	35.2	84	24.05	100.8	99.7	-18.6	0
1/16/2023	3001.6	48.2	48	24.13	102.3	99.9	-2.9	0
1/17/2023	2125.2	59.6	36	23.75	102.6	100.1	1.1	0
1/18/2023	4842.5	57.8	60	24.41	102.2	100.2	-4.8	0
1/19/2023	2634.6	54	36	23.5	102.4	100.3	-0.2	0
1/20/2023	2876.8	93.4	60	23.56	102.6	100.2	5.5	0
1/21/2023	3169.7	91.8	72	23.52	102.6	100.1	4.9	0
1/22/2023	7054.5	12.6	72	24.66	100.9	100	-2.8	0
1/23/2023	8863.3	5	24	25.06	99.8	100	-6.3	0
1/24/2023	7299.4	21.4	36	24.43	98.5	100.1	8.7	0
1/25/2023	6614.1	52.4	60	22.79	100.1	100.2	1.9	0
1/26/2023	2609.3	24.6	36	22.25	102.1	100.2	5.1	0
1/27/2023	1973	133.6	420	22.7	102.6	100	-9.9	0
1/28/2023	3242.3	106.2	36	21.85	102.4	100.1	3.6	0
1/29/2023	3648.1	44.6	24	21.47	102.4	100.2	7.5	0
1/30/2023	2727	51	36	22.08	102.6	100.3	7.9	0
1/31/2023	2758.1	109.4	36	22.7	102.7	100.2	-4.9	0
2/1/2023	6637.8	20	36	23.92	101.7	100.2	-15.9	0
2/2/2023	7474.1	16.6	84	25.22	101.2	100.2	-20.4	0
2/3/2023	10763.4	3.2	96	25.35	98	100.1	-6.3	0
2/4/2023	6596.8	4	24	23.51	100.1	100.1	-33.4	0
2/5/2023	6811.4	14.8	36	23.8	100.2	100.1	-30.3	0
2/6/2023	13360.8	6	36	25.58	97.2	100	-30.5	0
2/7/2023	15588.4	4	24	25.82	97.5	100.1	-3.3	0
2/8/2023	16978.1	8.4	60	25.58	95.8	100.1	-21.1	0
2/9/2023	14096.6	8.6	24	24.45	97.8	100.2	-11.2	0
2/10/2023	8333	12.2	36	24.47	99.7	100.2	-26.6	0
2/11/2023	17235.8	0.8	12	25.89	96.3	100.2	-31.3	0
2/12/2023	17155.6	5.8	48	25.76	95.5	100.2	-33.8	0
2/13/2023	19237.3	0.8	12	25.34	95.2	100.1	-38.3	0
2/14/2023	10557	2.4	12	24.12	97.1	100	-36.3	0
2/15/2023	11354.2	5.4	24	23.81	96	100.2	-39.3	0
2/16/2023	5424.2	33	60	22.71	100.1	100.4	-42.3	0
2/17/2023	4202.7	4	24	22.28	99.5	100.3	-41.3	0
2/18/2023	5936.8	12.8	24	23.38	98.7	100.1	-37	0
2/19/2023	5902.7	18.8	36	23.68	100.6	99.7	-36.5	0

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2/20/2023	8629.5	0.8	12	24.99	97.6	99.7	-29.4	0
2/21/2023	7314.2	43	48	23.88	99.9	100.1	-38.5	0
2/22/2023	9094.1	2.4	24	24.05	95.8	100.1	-34.7	0
2/23/2023	17086.2	0	0	24.78	88.8	99.9	-41.8	0
2/24/2023	16946.8	0.2	12	25.37	93	99.9	-40.6	0
2/25/2023	6099	42.2	72	24.64	99.2	100.3	-37.2	0
2/26/2023	4619.6	105	60	24.32	100.1	100.5	-27.6	0
2/27/2023	2488.3	69.4	60	23.45	99.6	100.6	-18.7	0
2/28/2023	2025.2	10	12	22.07	100.5	100.6	-2.6	0
3/1/2023	11450.7	2.2	12	24.86	96.8	100.4	2.2	0
3/2/2023	4683.9	19	36	23.1	99.7	100.5	2.9	0
3/3/2023	6939.7	5	24	22.16	98	100.6	-26.6	0
3/4/2023	14951.3	6.4	72	24.19	90.3	100.6	-40.3	0
3/5/2023	6962.8	10.8	24	22.54	98	100.5	-39.1	0
3/6/2023	5491.8	1	12	22.12	98.5	100.5	-41.7	0
3/7/2023	7820.8	1.8	24	23.22	97.4	100.5	-9.2	0
3/8/2023	13129.4	6.6	60	24.46	95.3	100.4	-43.1	0
3/9/2023	16206.5	0	0	24.79	90.4	100.2	0	0
3/10/2023	21219.2	0.2	12	24.92	84.4	100.2	-43.1	0
3/11/2023	18504	0.6	12	24.02	87.5	100.3	0	0
3/12/2023	17850.7	0	0	24.15	86.2	100.2	0	0
3/13/2023	10997.7	0.6	12	23.82	92.1	100.1	0	0
3/14/2023	22829.4	2.2	12	24.93	83.4	100.1	0	0
3/15/2023	9563.8	4.6	36	24.59	92.1	100.2	0	0
3/16/2023	8209.4	15.8	36	24.8	96.6	100.3	0	0
3/17/2023	8547.2	8.2	24	24.26	97.6	100.3	0	0
3/18/2023	7481.6	1.4	12	24.65	96.1	100.2	0	0
3/19/2023	6810.4	6.6	36	24.58	96.5	100.1	-42.8	0
3/20/2023	22108.7	0.2	12	24.86	84.2	100	0	0
3/21/2023	20766.6	0	0	24.51	80.6	100	0	0

B. Macatoc-AWS daily averaged data								
Date	Total Solar Radiation (W/m ²)	Rainfall height (mm)	Rainfall intensity max (mm/hr)	Air Temp (°C)	Relative Humidity (%)	Atmospheric Pressure (kPa)	%MC 10 cm	%MC 30cm
1/1/2023	11389.3	3.4	12	26.9	102.1	101.1	0	8.6
1/2/2023	5754.2	20.6	96	26.2	104.9	101.07	0	7.6
1/3/2023	4300	30.8	96	25.7	105.7	100.99	0	3.3
1/4/2023	2103	42.8	120	24.9	105.6	100.99	0	0.4
1/5/2023	7263.9	78.8	144	26	104.5	101.01	0	3.7
1/6/2023	7102.1	15.8	60	25.4	105.2	101.12	0	5
1/7/2023	7782.6	0.8	12	26.2	99	101.15	0	7.9
1/8/2023	8987	4.6	24	25	98.8	101.31	0	9.2
1/9/2023	4773	3.8	24	24.1	101.8	101.27	0	9.9
1/10/2023	6915.4	6.2	24	24.7	103.2	101.1	0	11.3
1/11/2023	6350.6	3.2	24	24.8	101.2	101.05	0	11.5
1/12/2023	8305.8	0.6	12	25.3	100.7	101.04	0	12.7
1/13/2023	3024.4	41.6	120	24	106.2	100.93	0	9.7
1/14/2023	6832.5	15.4	24	24.3	105.6	100.66	0	7.4
1/15/2023	6709.2	20	60	25.1	104.5	100.58	0	9
1/16/2023	4136.8	24.4	60	25.3	105.3	100.8	0	5.7
1/17/2023	2956.3	14.4	48	24.7	105.9	101.04	0	9.8
1/18/2023	6144.1	7	24	25.5	104.6	101.15	0	13.1
1/19/2023	3455.5	27.8	48	24.5	105.1	101.18	0	12.1
1/20/2023	3138.7	41	48	24.2	106.6	101.09	0	7.4
1/21/2023	3806.7	47.6	84	24.3	106.2	101.04	0	8.1
1/22/2023	8916.7	11	84	25.6	103.8	100.96	0	10.3
1/23/2023	9500.9	2	12	26.1	102.2	100.86	0	15.1
1/24/2023	10774.8	4.6	12	25.6	100.1	100.96	0	16.3
1/25/2023	6983.1	11.2	36	24	101.1	101.06	0	14.8
1/26/2023	3840.5	17	24	22.9	106.5	101.04	0	14.4
1/27/2023	2210.8	61.4	36	23.3	107.5	100.89	0	9.2
1/28/2023	2597	82	48	22.3	107.4	101	0	5.6
1/29/2023	3740.3	34.6	24	22	107.2	101.14	0	5.4
1/30/2023	3511.9	19.2	24	22.7	107.2	101.17	0	10.8
1/31/2023	2207.2	17.4	12	23.6	105	101.13	0	10.6
2/1/2023	8931.1	7.2	12	24.8	105	101.07	0	15
2/2/2023	10047.1	8.8	24	26.5	102.4	101.06	0	14
2/3/2023	14300.9	0.4	12	26.7	98.8	101.04	0	16.6
2/4/2023	6770.1	3	24	24.9	100.9	101.02	0	15.9
2/5/2023	10233.2	4.6	12	25	102	100.99	0	17.1
2/6/2023	17864	0.8	12	26.6	99.9	100.91	0	19
2/7/2023	17718.4	3.8	36	26.8	99.9	100.96	0	19.5
2/8/2023	17029.6	9.6	36	26.2	96.4	101.03	0	19.8
2/9/2023	15151.5	3.6	24	25.2	99.7	101.09	0	19.2
2/10/2023	11823.7	10.8	36	25.7	101.9	101.09	0	16.8
2/11/2023	18349.7	0	0	26.6	99.1	101.08	0	19.1
2/12/2023	17707	0.2	12	27	97.6	101.07	0	21.4
2/13/2023	18993.1	0.6	12	26.4	95.8	100.96	0	22.2
2/14/2023	9904.3	0.2	12	25.6	94.4	100.92	0	22.1
2/15/2023	12832.6	2.2	12	25	95	101.1	0	22.7
2/16/2023	5976.1	8.4	60	24.2	97.4	101.28	0	22
2/17/2023	7897.6	0.2	12	24.8	89.8	101.23	0	23.2
2/18/2023	7232	7	12	24.6	97.8	101.01	0	23.9
2/19/2023	5741.4	15.6	12	23.9	105.9	100.62	0	22.2
2/20/2023	9672.8	8.8	24	25.9	99.8	100.61	0	23.8
2/21/2023	6499.6	29.2	48	24.6	104.1	100.96	0	19.7
2/22/2023	9806.9	0.2	12	25.2	98	101	0	24.2
2/23/2023	18616	0.2	12	26.2	87	100.82	0	35.5
2/24/2023	21323.2	1.6	24	26.9	84.1	100.84	0	49.5

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2/25/2023	10165.3	10	24	25.7	98.4	101.17	0	46.7
2/26/2023	6412.5	33	48	25.2	101.4	101.38	0	36.7
2/27/2023	3111.1	5	24	24.7	95.3	101.5	0	27.2
2/28/2023	2323.5	2.2	12	23.2	96.8	101.49	0	31.9
3/1/2023	13102.6	1.4	12	25.8	96.4	101.27	0	45
3/2/2023	5460.7	4	12	24.7	95.4	101.46	0	46
3/3/2023	6945.2	2	24	23.8	92.7	101.51	0	46.5
3/4/2023	17088.2	0.4	12	25.4	84.5	101.54	0	53.4
3/5/2023	10495	0.8	12	24.8	80.7	101.45	0	49.2
3/6/2023	7280	0.2	12	24.1	82.8	101.44	0	49.4
3/7/2023	11572.4	6	12	24.6	87.6	101.39	0	52.8
3/8/2023	16813.4	0.2	12	25.7	86.6	101.32	0	57.6
3/9/2023	19031.9	0.2	12	26	83.2	101.15	0	53.8
3/10/2023	21512.3	0.8	12	26.1	78.7	101.12	0	56.7
3/11/2023	21181.7	0.6	12	25.5	78.1	101.21	0	55.3
3/12/2023	20135.4	1.4	12	25.5	80.4	101.11	0	56.8
3/13/2023	13608	4	36	25.2	82.3	101.02	0	55.3
3/14/2023	23379.1	6.2	24	25.5	82.8	100.99	0	56.4
3/15/2023	15196.1	3.8	24	26.3	85.1	101.11	0	57.1
3/16/2023	11118.7	1.8	24	26.5	86.2	101.21	0	56.9
3/17/2023	9625.7	2.2	12	25.9	88.9	101.16	0	55.1
3/18/2023	11038	0.2	12	26.3	84.3	101.08	0	59.2
3/19/2023	8534.9	0.4	12	26.4	83.8	101.03	0	60.3
3/20/2023	24629.8	0	0	26.3	77.3	100.93	0	53.6
3/21/2023	21828.2	0	0	26.1	76.4	100.9	0	53.7

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C. MinSU-CTD daily averaged data							
Date	Water level (mm)	Water temp (°C)	Electrical conductivity (µS/cm)	Date	Water level (mm)	Water temp (°C)	Electrical conductivity (µS/cm)
1/1/2023	8650	26.9	0.27	2/10/2023	8339	26.5	0.24
1/2/2023	8613	26.9	0.27	2/11/2023	8239	26.5	0.23
1/3/2023	8620	26.9	0.27	2/12/2023	8222	26.5	0.23
1/4/2023	8855	26.9	0.27	2/13/2023	8188	26.5	0.23
1/5/2023	9042	26.9	0.26	2/14/2023	8170	26.5	0.23
1/6/2023	9046	26.9	0.26	2/15/2023	8108	26.5	0.23
1/7/2023	8975	26.9	0.26	2/16/2023	8108	26.5	0.23
1/8/2023	8833	26.9	0.26	2/17/2023	8066	26.5	0.23
1/9/2023	8696	26.9	0.26	2/18/2023	8057	26.5	0.23
1/10/2023	8546	26.8	0.26	2/19/2023	8121	26.4	0.22
1/11/2023	8468	26.8	0.26	2/20/2023	8175	26.4	0.22
1/12/2023	8391	26.8	0.26	2/21/2023	8473	26.4	0.22
1/13/2023	8418	26.8	0.25	2/22/2023	8358	26.4	0.22
1/14/2023	8413	26.8	0.25	2/23/2023	8278	26.4	0.22
1/15/2023	8394	26.8	0.25	2/24/2023	8238	26.4	0.22
1/16/2023	8584	26.8	0.25	2/25/2023	8263	26.4	0.22
1/17/2023	8710	26.8	0.25	2/26/2023	8331	26.4	0.21
1/18/2023	8751	26.8	0.25	2/27/2023	8736	26.4	0.21
1/19/2023	8909	26.8	0.25	2/28/2023	8805	26.4	0.21
1/20/2023	8985	26.7	0.25	3/1/2023	8620	26.4	0.21
1/21/2023	9109	26.7	0.25	3/2/2023	8674	26.4	0.21
1/22/2023	9019	26.7	0.25	3/3/2023	8583	26.4	0.21
1/23/2023	8854	26.7	0.25	3/4/2023	8475	26.3	0.21
1/24/2023	8747	26.7	0.25	3/5/2023	8559	26.3	0.21
1/25/2023	8743	26.7	0.25	3/6/2023	8440	26.3	0.21
1/26/2023	8783	26.7	0.24	3/7/2023	8326	26.3	0.21
1/27/2023	8900	26.7	0.24	3/8/2023	8289	26.3	0.21
1/28/2023	9251	26.6	0.24	3/9/2023	8326	26.3	0.21
1/29/2023	9183	26.6	0.24	3/10/2023	8303	26.3	0.21
1/30/2023	8983	26.6	0.24	3/11/2023	8296	26.3	0.21
1/31/2023	9132	26.6	0.24	3/12/2023	8235	26.3	0.21
2/1/2023	8977	26.6	0.24	3/13/2023	8189	26.3	0.21
2/2/2023	8806	26.6	0.24	3/14/2023	8132	26.3	0.21
2/3/2023	8672	26.6	0.24	3/15/2023	8153	26.3	0.21
2/4/2023	8645	26.5	0.24	3/16/2023	8069	26.3	0.21
2/5/2023	8516	26.5	0.24	3/17/2023	8053	26.2	0.21
2/6/2023	8434	26.5	0.24	3/18/2023	8042	26.2	0.21
2/7/2023	8458	26.5	0.24	3/19/2023	7994	26.2	0.21
2/8/2023	8437	26.5	0.24	3/20/2023	7925	26.2	0.21
2/9/2023	8424	26.5	0.24	3/21/2023	7929	26.2	0.2

D. Bongabong-AWS daily averaged data								
Date	Total Solar Radiation (W/m ²)	Rainfall height (mm)	Rainfall intensity max (mm/hr)	Air Temp (°C)	Relative Humidity (%)	Atmospheric Pressure (kPa)	%MC 10 cm	%MC 30cm
1/1/2023	17177.1	3.4	48	27.1	82.4	98.32	-33.5	5.0
1/2/2023	10236.7	2.2	24	25.9	87.0	98.30	-37.1	3.0
1/3/2023	6358.5	21.6	84	24.9	88.4	98.23	-38.1	3.6
1/4/2023	4328.3	56.4	108	23.9	90.2	98.33	-28.7	5.2
1/5/2023	9385.9	27.8	60	25.0	88.6	98.46	-26.3	1.4
1/6/2023	8888	52	60	24.7	90.2	98.61	-28.1	-2.5
1/7/2023	14172.6	23	48	25.0	84.4	98.49	-30.0	-2.4
1/8/2023	8982.8	1.4	12	24.0	83.3	98.58	-29.8	-4.8
1/9/2023	10663.5	0.2	12	24.6	79.8	98.51	-33.2	-5.6
1/10/2023	10136.7	0.8	12	24.5	84.3	98.39	-37.4	-6.7
1/11/2023	8371.3	0.2	12	24.6	79.8	98.29	-38.7	1.7
1/12/2023	11368.1	0.2	12	25.2	79.6	98.29	-36.4	4.3
1/13/2023	5838.2	11.6	48	23.8	87.8	98.31	-40.1	4.9
1/14/2023	10666.8	8.8	24	25.2	84.9	97.99	-31.3	5.9
1/15/2023	12248.5	0	0	25.6	85.6	97.99	-28.5	4.6
1/16/2023	9895.2	6.6	24	25.0	88.5	98.24	-31.1	2.8
1/17/2023	10015	1	12	25.0	88.0	98.47	-30.0	2.8
1/18/2023	13404.3	19.8	48	25.4	87.4	98.56	-29.6	2.7
1/19/2023	10581.3	2.6	12	24.2	87.7	98.55	-28.0	2.7
1/20/2023	8898	23.4	24	24.0	90.1	98.49	-28.6	1.4
1/21/2023	6695.8	44.2	36	23.9	89.8	98.49	-25.8	2.4
1/22/2023	12392.8	8.4	36	25.1	86.8	98.35	-27.5	0.9
1/23/2023	17321.7	0.2	12	26.3	81.6	98.12	-31.3	-1.6
1/24/2023	12680.1	1.8	12	25.2	82.7	98.24	-36.2	-5.1
1/25/2023	12257.1	2.6	12	23.3	86.7	98.38	-38.0	-2.5
1/26/2023	10336.3	1.4	12	23.6	85.7	98.36	-37.7	0.8
1/27/2023	6376.5	18.4	24	23.1	90.8	98.32	-40.6	1.1
1/28/2023	9159.8	17.6	12	22.0	90.8	98.40	-37.7	3.2
1/29/2023	16297.5	0.2	12	23.2	85.5	98.43	-35.1	2.8
1/30/2023	9325.4	2.4	12	23.1	88.3	98.56	-38.4	2.5
1/31/2023	8530.8	10.4	12	23.3	89.5	98.53	-38.4	2.5
2/1/2023	16554.5	2.8	12	25.3	85.7	98.38	-32.5	4.5
2/2/2023	17521.9	1	36	26.8	82.6	98.31	-32.4	3.5
2/3/2023	17318.7	0	0	26.6	79.7	98.24	-36.2	1.7
2/4/2023	14767	0	0	25.5	77.6	98.19	-34.0	2.7
2/5/2023	12280.4	2.8	24	25.6	82.3	98.22	-35.7	4.1
2/6/2023	18979	0.4	12	26.6	81.6	98.16	-31.6	5.2
2/7/2023	19190.9	2.6	12	26.3	82.8	98.25	-28.1	5.5
2/8/2023	19816.7	0.8	24	26.3	78.9	98.29	-24.8	7.3
2/9/2023	17662.9	0.4	12	25.9	77.3	98.29	-24.9	7.3
2/10/2023	13427.8	0	0	26.1	81.1	98.30	-23.7	7.0
2/11/2023	21103.4	0	0	27.2	77.2	98.31	-21.5	7.9
2/12/2023	21420.6	0	0	27.3	77.6	98.29	-24.4	6.8
2/13/2023	22109	0.2	12	27.0	75.8	98.18	-29.2	5.4
2/14/2023	13176.9	0	0	25.4	78.9	98.12	-30.8	5.6
2/15/2023	15218.3	1.2	12	25.1	76.7	98.26	-31.6	5.5
2/16/2023	11804.4	12.8	36	23.7	84.6	98.46	-29.2	6.0
2/17/2023	16619.5	1.4	24	24.1	80.4	98.40	-23.1	7.3
2/18/2023	12780.3	0.4	12	24.6	80.5	98.17	-24.6	6.8
2/19/2023	10068.5	3.2	12	25.2	86.9	97.89	-26.1	6.7
2/20/2023	9724	1.8	12	24.6	88.5	97.99	-25.5	6.8
2/21/2023	16146.6	0.2	12	25.1	81.8	98.24	-28.7	6.0
2/22/2023	15788.4	0	0	25.3	79.1	98.22	-32.6	5.9
2/23/2023	20546	0	0	25.8	79.6	98.11	-31.7	5.5
2/24/2023	24076.5	0.6	12	27.3	77.7	98.09	-28.1	4.6

*First Quarter Report of CY 2023 on Data Visualization and Analysis Generated by the Science-Based
Real-Time Watershed Monitoring Instruments in Mag-Asawang Tubig Watershed
and Bongabong River Watershed*

2/25/2023	13382.5	0.6	12	26.6	83.2	98.39	-33.6	4.0
2/26/2023	12429.2	22.4	36	24.4	89.9	98.60	-37.5	4.3
2/27/2023	10956.4	5.6	12	23.8	87.7	98.66	-20.7	7.4
2/28/2023	11237.2	0.2	12	24.1	82.4	98.60	-23.6	6.1
3/1/2023	20029.9	0.4	12	27.2	79.5	98.41	-22.4	7.2
3/2/2023	11365.3	7.8	24	23.8	85.1	98.63	-24.5	6.0
3/3/2023	17277.6	0.2	12	24.1	77.0	98.60	-30.0	5.8
3/4/2023	24232	0	0	25.7	72.5	98.59	-34.9	6.0
3/5/2023	18639.4	0.2	12	24.4	78.8	98.55	-35.8	3.2
3/6/2023	25096.4	0.4	24	25.0	75.7	98.53	-34.0	0.8
3/7/2023	16794.5	0.2	12	25.2	80.2	98.54	-38.8	1.3
3/8/2023	18880.4	0	0	25.6	80.9	98.46	-32.3	3.7
3/9/2023	19167.9	0	0	25.3	79.9	98.30	-32.0	3.4
3/10/2023	23627.9	0.2	12	25.7	76.2	98.22	-33.0	3.1
3/11/2023	24958.6	0.2	12	25.7	72.6	98.25	-34.0	2.6
3/12/2023	22805.5	1.2	12	25.4	71.4	98.18	-32.8	3.5
3/13/2023	22483.2	0	0	25.7	73.3	98.10	-32.8	4.2
3/14/2023	23519.5	0.4	12	26.1	70.9	98.07	-32.9	3.5
3/15/2023	20839.8	0.6	12	27.0	76.6	98.24	-33.3	5.0
3/16/2023	19381.3	3.2	24	26.5	79.4	98.32	-35.7	4.5
3/17/2023	21559.2	0.8	12	26.3	78.6	98.24	-38.7	4.7
3/18/2023	17393.8	0	0	26.6	78.8	98.21	-35.4	5.3
3/19/2023	19007.5	0.2	12	26.6	77.2	98.13	-35.1	5.4
3/20/2023	26492.8	0	0	25.7	74.1	98.01	-34.9	4.3
3/21/2023	19856.2	0	0	25.3	68.0	97.97	-32.7	4.0