Introducing the Tutuila Hydrologic Monitoring Network

A Management Summary to suppliment the 2018 ASPA-UHWRRC Hydrologic Monitoring Network Handbook

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MONITORING ISLAND WIDE CLIMATE PARAMETERS, STREAM DISCHARGE, AND GROUNDWATER LEVELS

This document synthesizes the Hydrologic Monitoring Network Handbook produced as a WRRC special report, April 2018. The full report contains procedures for use and maintenance of instruments and overview information for all deployed equipment in the network.

Information about water availability and movement is fundamental to ensuring economic well-being, protecting lives and property, and promoting sustainable use of water resources. On remote oceanic islands, resource limitations can be a defining factor in an island's habitability. Therefore, it is essential to maintain an up-to-date understanding of rainfall, weather, surface water, and groundwater in these settings, especially in the face of a changing climate and uncertain future. Starting in the 1950's weather monitoring and stream gauging services for the territory of American Samoa were performed by the United States Geological Survey (USGS). However, in 2008 this program was discontinued. Because of the critical nature of these datasets, the University of Hawaii (UH) Water Resources Research Center (WRRC) and the territory's sole water utility, American Samoa Power Authority (ASPA), have entered into a cooperative agreement for the purpose of developing a new weather station, stream gauging, and aquifer monitoring network. The instruments used in this network are intended to be simple, robust, and easily maintained to ensure longevity and continuity of data. Weather stations have been placed at pre-existing ASPA leased locations, and stream gauges are sited near roads, bridges, or previously used USGS sites for ease of access and maintenance. Aquifer data is monitored at available locations within the existing ASPA well network.

Table 1: List of field equipment deployed on Tutuila Island as part of the ASPA-UHWRRC hydrologic monitroing network. Current as of January 2020.

Instrument	Qty.
Spectrum WatchDog 2900ET Weather Station	4
Campbell Scientific custom Wi-Fi Weather Stations, mounted on custom welded 3 m towers	6
Onset HOBO Water Level and Temperature Data Loggers for stream gauges and monitoring wells	14
Onset HOBO Fresh Water Conductivity Data Logger	3
WatchDog 1200 Micro Station with LightScout Silicon Pyranometer	1
Wireless Vantage Pro2 Plus weather station with UV and solar light sensors with radiation shield	1
RAINEW RAINLOG 2.0 - Rain gauge with data logger	11
FlowTracker Handheld ADV	2
Teledyne StreamPro ADCP	1
ENO Scientific 2010 Wellsounder PRO	1
Geokon Model 4500 Piezometer	3
AquaMetrix ES toroidal conductivity sensor	1
Aquametrix AS Conductivity Sensor	1

NUMBER OF WEATHER STATIONS

7 4 stations installed in 2015, 3 new ones in 2016, and all but one upgraded in 2017

NUMBER OF STREAM GAUGES

8 6 stream gauges installed in 2016 and 2 additional gauges installed in 2017

AQUIFER MONITORING SITES

5 Instrumented 3 monitoring wells and 2 production wells, in 2017 with pressure and salinity sensors

MILLIONS OF DATA POINTS RECORDED

1.9 + A total of 21 instruments recording at 15 minute intervals starting in 2015, 2016, or 2017

NETWORK MAP

There are twenty-one instruments in the ASPA-WRRC monitoring network as of August 2017

Technicians at ASPA download data from instruments and uploaded the raw data to a publicly available online repository on a quarterly basis

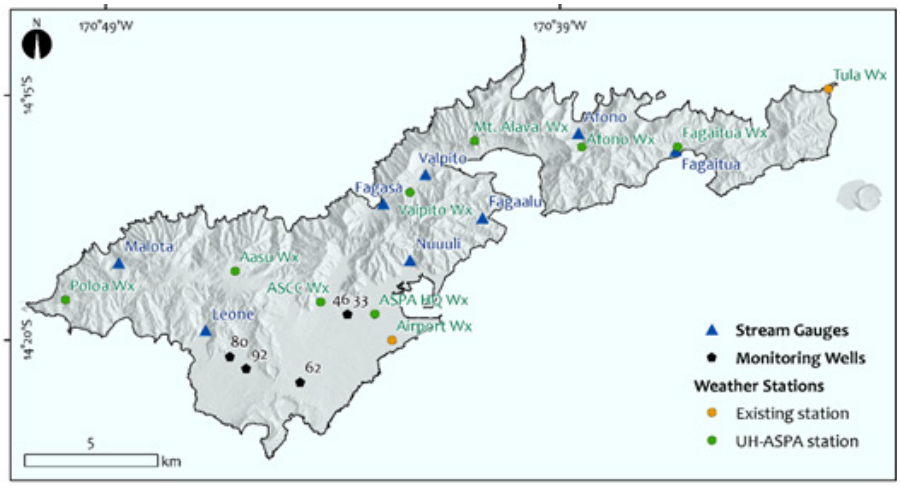


Figure 1: Locations of monitoring instruments in the ASPA-UH-WRRC monitoring network. Weather stations maintained by other agencies and with significant periods of record, which essentially represents the extent of the island's weather station network for the period of 2008 to 2015, are shown as orange dots.

Weather Stations

The ASPA-WRRC weather station (Wx) network consists of seven solar powered Spectrum Watchdog or Campbell Scientific stations which record data on 15 minute intervals and transmit data via WiFi. The weather stations are sited in the best available locations given the limeted amount of open space on the island and stations cover an elevation range from near sea level to 475 m at the peak of Mt. Alava.

Stream Gauges

The ASPA-WRRC stream gauge network currently consists of eight gauges located on different streams throughout Tutuila. Stream gauges are instrumented with stainless steel HOBO brand water-level logging pressure transducers installed in durable steel housings, which are permanently mounted to stream-side bridges or bedrock outcroppings.

Aquifer Monitoring Intruments

Five dedicated aquifer monitoring locations have been established on Tutuila, and more are currently being installed. Two of these are active ASPA telemetered production wells, and three are ASPA monitoring wells with installed data loggers. Monitoring well sites generally consist of an open borehole with an instrument deployed below the water table.

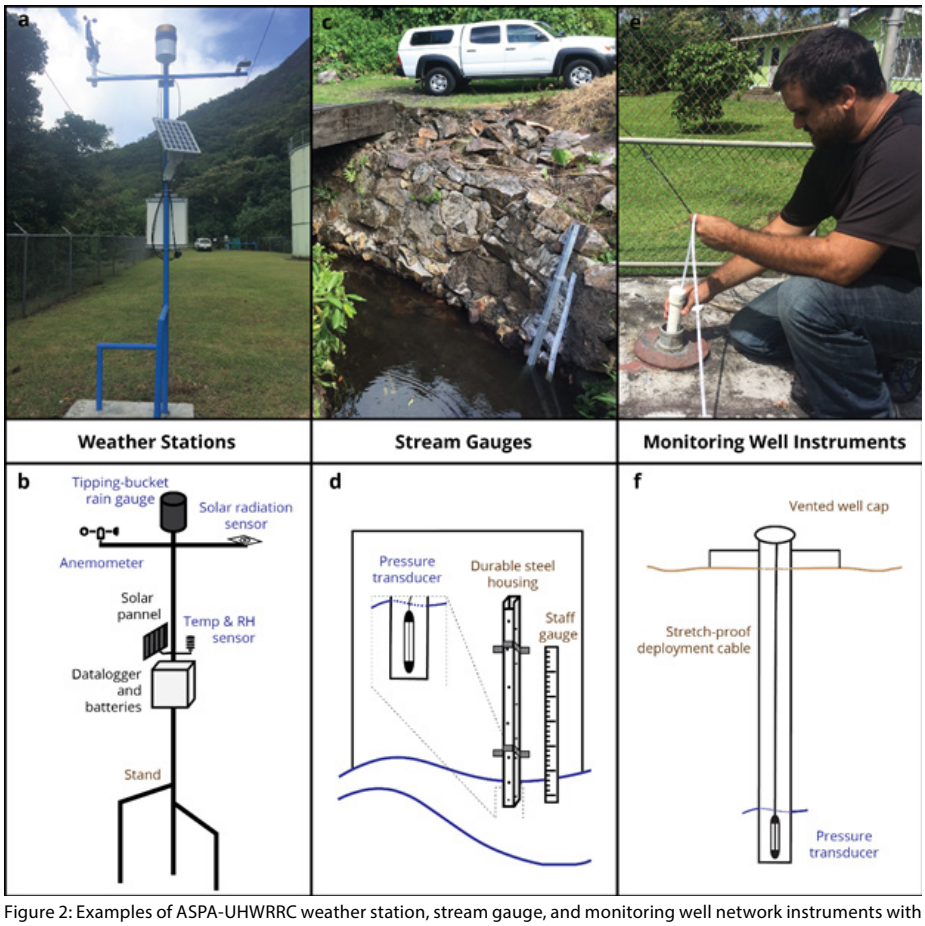


Figure 2: Examples of ASPA-UHWRRC weather station, stream gauge, and monitoring well network instruments with schematics. Blue text on schematics indicates sensors and brown text indicates hardware and infrastructure.

DATA ANALYSIS AND DISTRIBUTION

All data and code from this project is open-source, and is made publically available for download from either the project's user-friendly website, or directly from the GitHub repository.

Once raw data is downloaded from the instruments, ASPA technicians then upload files to a publically accessible GitHub repository. The repository not only hosts raw data files, but also contains all of the Python code used to process and QA/QC raw data into consolidated data products. All data processing code is written in Python using Jupyter Notebooks, which provide support for inline plots, hyperlinks, and explanations, thereby facilitating the user experience and enhancing interpretability even for non-data scientists. The repository can also be downloaded, and any aspect of the code can be modified to adjust output resolution of datasets, change QA/QC, parameters, or make other changes if the user desires.

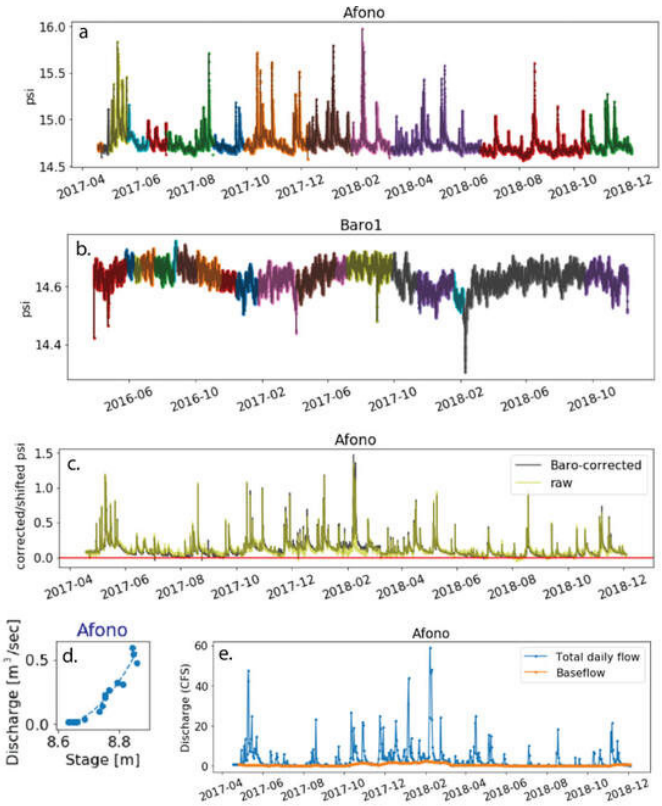
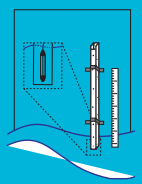


Figure 3: Example visualizations for a selection of the procedures implemented in streamflow processing for the Afono Stream Gauge. Steps include but are not limited to, a) consolidation of individual downloaded files (each color represents an individual data file) b) consolidation and incorporation of barometer data, c) barometric correction of stream stage, d) rating curve calculation, and e) baseflow separation.

WEATHER STATION DATA

Click on these links to download:

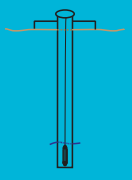
- Code for processing data[1]
- Raw weather data files[2]
- Processed data files[3]



STREAM GAUGE DATA

Click on these links to download:

- Code for processing data[4]
- Raw streamwflow data files[5]
- Processed data files[6]



AQUIFER MONITORING DATA

Click on these links to download:

- Code for processing data[7]
- Raw streamwflow data files[8]
- Processed data files[9]

Full links to data and code: [1] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/blob/master/ASPA-UH_Wx_REPO/ASPA-UH_Wx_Data_processing2.ipynb, [2] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/tree/master/ASPA-UH_Wx_REPO/Raw_data, [3] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/tree/master/ASPA-UH_Wx_REPO/workspace, [4] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/blob/master/ASPA-UH_Stream_REPO/Run/UH_ASPA_Streamflow_process_w_USGS.ipynb, [5] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/tree/master/ASPA-UH_Stream_REPO/Raw_streamflow_csv/StreamGage_data, [6] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/tree/master/ASPA-UH_Stream_REPO/workspace, [7] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/blob/master/ASPA-UH_MonWells/Scripts/UH-ASPA_Monitoring_Well_Data_Processing.ipynb, [8] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/tree/master/ASPA-UH_MonWells/Raw_Data, [9] https://github.com/cshuler/ASPA-UH_Integrated_Modeling_Framework/tree/master/ASPA-UH_MonWells/workspace

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