STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

STAFF SUBMITTAL

for the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

May 18, 2021
Honolulu, Hawai‘i

Request to Enter Into a Contract for Professional Services for Expanding the Collection of Climate Data by Implementing the Pilot Phase of the Hawai‘i Mesonet Network of Telemetered Climate Stations

SUMMARY OF REQUEST

Staff is requesting that the Commission on Water Resource Management (Commission) authorize to the Chairperson to enter into agreement with the University of Hawai‘i at Mānoa Water Resources Research Center (UH WRRC). The purpose of this agreement is to provide cost-share funding to implement the pilot phase of the Hawai‘i Mesonet network of telemetered climate stations. The pilot phase will help develop and implement standard protocols, installation procedures, quality control/quality assurance, and data availability for real-time climate monitoring. This phase includes the installation of four fully-operational climate monitoring stations as identified in the Statewide Monitoring Needs Assessment published by the U.S. Geological Survey (USGS SIR 2020-5115).

BACKGROUND

A comprehensive climate observing system has been identified by the State of Hawai‘i as a critical need for the state’s researchers, resource managers, and decision makers. Such a network will provide critical information on changing hydrological conditions that can improve our understanding of climate change and help inform decision makers and managers. Unfortunately, the existing climate observing network in Hawai‘i is inadequate to fully meet the needs of researchers and stakeholders dependent on the data and the research the data supports.

The Hawaiian Islands experience extreme spatial diversity of temperature, precipitation (mean annual rainfall range: 200-10,000 mm), cloud cover, solar radiation (mean annual solar radiation range: 130-300 m^2), wind, humidity, and other variables (Giambelluca et al. 2014) driven by complex topography, varied wind patterns, and a persistent mid-tropospheric inversion layer known as the trade wind inversion (TWI) (Giambelluca et al. 2013). Rainfall gradients are

among the steepest found anywhere on Earth; e.g., in West Maui, mean annual rainfall varies by 3600 mm (141 inches) over 1.6 km (1 mile) (Frazier & Giambelluca 2017). With the anticipated regional climate changes due to global warming, a comprehensive climate observing system is a critical need for Hawai'i's researchers, resource managers, and decision makers (Cheng et al. 2021). This pilot phase of the Hawai'i Mesonet network is in alignment with the recent U.S. Geological Survey report on water-resource management monitoring needs for the State of Hawai'i, prepared in cooperation with the Commission and in collaboration with UH WRRC.

Inadequacy of the Current Network

Until recent decades, the mainstay of the climate observing network consisted of stations operated by the sugarcane and pineapple industries. With the contraction and eventual cessation of large-scale agriculture in the islands, many stations were discontinued. The current climate observing network in Hawai'i is fragmented, unmanaged, declining in spatial coverage, and inadequate to meet stakeholder needs. The fact that data are difficult to access and incomplete imposes a high transaction cost on environmental research in Hawai'i, a barrier to research, and a disincentive for the necessary convergence of weather/climate studies and society.

Vision for A Statewide Hawai'i Mesonet.

The goal of UH WRRC is to build a statewide network of fully-equipped state-of-the-art climate monitoring stations to provide critically needed basic climate information that supports science, education, and resource management for Hawai'i. Statewide surface weather networks ("mesonets") operating in 30 U.S. states (National Research Council 2009) provide information used for weather prediction and warnings, support agricultural, hydrological, and ecosystem management, and facilitate a wide range of research activities. Arguably the most climatically diverse state in the U.S., Hawai'i is ironically one of the 20 states without a statewide mesonet. Each station will be configured with sensors for rainfall, air temperature, relative humidity, wind speed, wind direction, solar radiation, net radiation, soil moisture, soil heat flux and soil temperature; data logger, data telecom device, power supply with solar charging, instrument support structure, and data logger enclosure.

Potential sites for new stations have been identified by prioritizing inadequately monitored areas of importance, i.e., zones of high rainfall, steep rainfall gradients, urban and agricultural lands, and areas within the trade wind inversion elevation band (highly sensitive to changes in climate) as well as areas of important management need. From these potential sites statewide, the Commission staff will assist with the prioritization and selection of four monitoring stations for this pilot phase.

The Hawai'i Mesonet will be an integral part of the Hawai'i Climate Data and Monitoring Center, being organized to leverage recent university and National Science Foundation investments in cyberinfrastructure and data science to facilitate cutting edge research in weather and climate-related phenomena. While plans have been developed to purchase equipment, install and maintain new stations, manage data, and make data and data products publicly accessible, there is currently insufficient funding to get started. This proposal seeks support for a small pilot project to deploy, test, and maintain four telemetered stations at high priority sites, and to refine

and test plans for maintenance and data management, coupling a high-quality sensor network with advanced data processing, management, storage, visualization, and dissemination tools.

FUNDING

The funds for the Commission's share of the work ($99,999) are available from the Department's FY 2021 Budget, LNR 404, Water Resources Program. Funding will come from the Commission's general fund, special fund, or a combination of both.

Table 1. Proposed Budget for Hawaii Mesonet Pilot Phase.

Category	Year 1	Year 2	Total
Salary	$9,900	$10,200	$20,100
Fringe benefits	$2,689	$3,790	$6,479
Travel	$4,860	$4,860	$9,720
Supplied	$630	$630	$1260
Data plans	$0	$480	$480
Equipment	$58,156	$0	$58,156
Total Direct Costs	$76,235	$19,960	$96,195
Modified Total Direct Costs	$18,079	$19,960	$38,039
Indirect Costs[1]	$1,808	$1,996	$3,804
Total	**$78,043**	**$21,956**	**$99,999**

[1]UH WRRC indirect costs are based on modified total direct costs (MTDC), in this case equal to total direct costs minus equipment costs. The indirect cost rate for a State of Hawai'i agency is 10%.

ENVIRONMENTAL REVIEW (CHAPTER 343)

Hawai'i Revised Statutes (HRS) Chapter 343 is triggered due to the use of State funds. However, Chapter 343 does not apply because this is a data collection and research study.

Hawaii Administrative Rule §11-200.1-16(a) provides that "*each agency, through time and experience, may develop its own exemption list consistent with both the letter and intent expressed in this subchapter and in chapter 343, HRS, of: (1), Routine activities and ordinary functions within the jurisdiction or expertise of the agency that by their nature do not have the potential to individually or cumulatively adversely affect the environment more than negligibly and that the agency considers to not rise to the level of requiring chapter 343, HRS, environmental review.*"

The Commission's Comprehensive Exemption List, concurred with by the Environmental Council on January 5, 2021, provides for Exemption Type 5, "*Basic data collection, research, experimental management, and resource and infrastructure testing and evaluation activities that do not result in a serious or major disturbance to an environmental resource*;" Part 1, "*Conduct surveys or collect data on existing environmental conditions (e.g., water flow, water quality, hydrologic conditions, geologic conditions, rainfall amounts, etc.).*"

RECOMMENDATION:

Staff recommends that the Commission:

1. Authorize the Chairperson to enter into a Contract for Professional Services between the Commission on Water Resource Management and the University of Hawai‘i at Mānoa, Water Resources Research Center to implement the pilot phase of the Hawai‘i Mesonet network of telemetered climate stations, including the installation of four fully-operational climate monitoring stations as identified in the Statewide Monitoring Needs Assessment published by the U.S. Geological Survey (USGS SIR 2020-5115).

2. Authorize the Chairperson to make such further amendments or modifications of the contract agreement (consistent with the terms set forth above) as may be necessary to accomplish the goals described here, provided that any amendment or modification does not require additional Commission funding.

The terms of this agreement may be subject to the availability of funding and the approval of the Chairperson and the Department's Deputy Attorney General. Contract execution would be done in accordance with Chapter 103D, HRS, and Chapter 3-122, Hawai‘i Administrative Rules.

Ola i ka wai,

M. KALEO MANUEL
Deputy Director

Exhibits
1. Water Resources Research Center, University of Hawai‘i at Mānoa, Hawai‘i Mesonet Proposal, April 26, 2021.

APPROVED FOR SUBMITTAL:

SUZANNE D. CASE
Chairperson

Proposal Submitted to the Commission on Water Resource Management

26 April 2021

Title: Taking the First Steps to Build the Hawai'i Mesonet: A Pilot Project to Deploy and Operate a Network of Telemetered Climate Stations

PI: Thomas Giambelluca, Water Resources Research Center, University of Hawai'i at Mānoa

Proposed Start Date: 15 June 2021

Proposed End Date: 14 June 2023

Funding Request: $99,999

Project Summary

A comprehensive climate observing system has been identified by the State or Hawai'i as a critical need for the state's researchers, resource managers, and decision makers. Unfortunately, the existing climate observing network in Hawai'i is fragmented, unmanaged, declining in spatial coverage, and inadequate to meet the needs of researchers and stakeholders dependent on the data and the research the data support. Statewide mesonets currently operating in 30 US states provide information used for weather prediction and warnings, support agricultural, hydrological, and ecosystem management, and facilitate a wide range of research activities. Arguably the most climatically diverse state in the U.S., Hawai'i is one of the 20 states without a statewide mesonet. Potential sites for new stations have been identified by prioritizing inadequately monitored areas of importance, i.e., zones of high rainfall, steep rainfall gradients, urban and agricultural lands, and areas within the trade wind inversion elevation band (highly sensitive to changes in climate). Accessibility constraints were also considered and sites of discontinued long-term stations. While plans have been developed to purchase equipment, install and maintain new stations, manage data, and make data and data products publically accessible, we currently do not have sufficient funding to get started. This proposal seeks support for a small pilot project to deploy, test, and maintain four telemetered stations at high priority sites, and to refine and test plans for maintence and data management.

Introduction

The Hawaiian Islands experience extreme spatial diversity of temperature, precipitation (mean annual rainfall range: 200-10,000 mm; Figure 1 [Giambelluca et al. 2013]), cloud cover, solar radiation (mean annual solar radiation range: 130-300 m2; Figure 2), wind, humidity, and other variables [Giambelluca et al. 2014] driven by complex topography, varied wind patterns, and a persistent mid-tropospheric inversion layer known as the trade wind inversion (TWI) [Giambelluca et al. 2013].

Rainfall gradients are among the steepest found anywhere on Earth; e.g., in West Maui, mean annual rainfall varies by 3600 mm (141 inches) over 1.6 km (1 mile) [Frazier & Giambelluca 2017]. With the anticipated regional climate changes due to global warming, a comprehensive climate observing system is a critical need for Hawai'i's researchers, resource managers, and decision makers [Cheng et al. 2021].

Inadequacy of the Current Network. Until recent decades, the mainstay of the climate observing network consisted of stations operated by the sugarcane and pineapple industries. With the contraction and eventual cessation of large-scale agriculture in the islands, many stations were discontinued. The current climate observing network in Hawai'i is fragmented, unmanaged, declining in spatial coverage, and inadequate to meet the needs of the many stakeholders dependent on the data and the research the data support. The fact that data are difficult to access and incomplete imposes a high transaction cost on environmental research in Hawai'i, a barrier to research, and a disincentive for the necessary convergence of weather/climate studies and society.

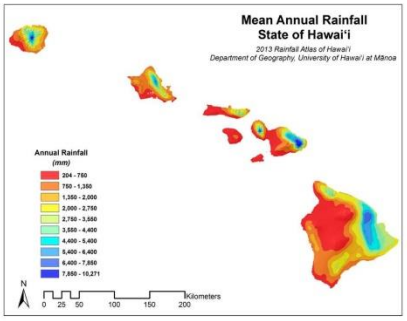

Figure 1. Hawai'i mean annual rainfall [Giambelluca *et al.* 2013].

Vision for A Statewide Hawai'i Mesonet. Our goal is to build a statewide network of fully-equipped state-of-the-art climate monitoring stations to provide critically needed basic climate information to support science, education, and resource management for Hawai'i. Statewide surface weather networks ("mesonets") operating in 30 U.S. states [National Research Council 2009] provide information used for weather prediction and warnings, support agricultural, hydrological, and ecosystem management, and facilitate a wide range of research activities. Arguably the most climatically diverse state in the U.S., Hawai'i is ironically one of the 20 states without a statewide mesonet. Each station will be configured with sensors for rainfall, air temperature, relative humidity, wind speed, wind direction, solar radiation, net radiation, soil moisture, soil heat flux and soil temperature; data logger, data telecom device, power supply with solar charging, instrument support structure, and data logger enclosure.The Hawai'i Mesonet will be an integral part of the Hawai'i Climate Data and Monitoring Center, being organized to leverage recent university and NSF investments in cyberinfrastructure and data science to facilitate cutting edge research in weather- and climate-related phenomena. We will couple a high-quality sensor network with advanced data processing, management, storage, visualization, and dissemination tools.

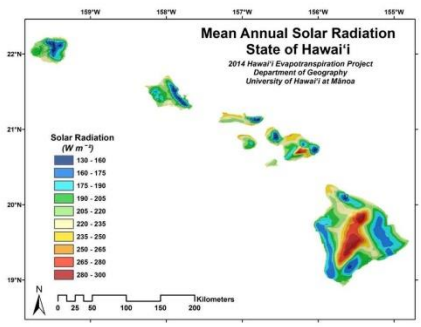

Figure 2. Hawai'i mean annual solar radiation [Giambelluca *et al.* 2014].

Objectives

As we ramp up plans and seek sustainable funding to establish and maintain the Hawai'i Mesonet, it is time to begin deployment of stations, testing a station design and data connectivity system, and gaining experience with community partnerships necessary to provide cost-effective station maintenance. The objective of this project is to conduct a small pilot project to take the first steps in building the Hawai'i Mesonet by establishing, testing, and maintaining four new state-of-the-art climate stations.

Tasks

In this project we propose to get started on the future Hawai'i Mesonet by:

1. Reviewing station and telemetry design criteria.
2. Purchasing equipment for four pilot stations.
3. Selecting four high priority station sites for this pilot project
4. Obtaining permits and installing support structures for each station.
5. Installing and testing sensors, data loggers, telemetry, and power supply systems.
6. Establishing automated data retrieval, data quality screening procedures, and data archival.
7. Integrating data streams from the four new stations into the Hawai'i Climate Data Portal.
8. Refining plans for building out and maintaining the statewide Hawai'i Mesonet.

References Cited

Cheng, C.L., Izuka, S.K., Kennedy, J.J., Frazier, A.G., and Giambelluca, T.W. 2021. Water-resource management monitoring needs, State of Hawai'i: U.S. Geological Survey Scientific Investigations Report 2020-5115, p. 114., https://doi.org/10.3133/sir20205115.

Frazier, A.G., and Giambelluca, T.W. 2017. Spatial trend analysis of Hawaiian rainfall from 1920 to 2012. *International Journal of Climatology* 37: 2522-2531, doi: 10.1002/joc.4862.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte, 2013. Online rainfall atlas of Hawai'i. *Bulletin of American Meteorological Society* 94: 313-316, doi: 10.1175/BAMS-D-11-00228.1.

Giambelluca, T.W., Shuai, X., Barnes, M.L., Alliss, R.J., Longman, R.J., Miura, T., Chen, Q., Frazier, A.G., Mudd, R.G., Cuo, L., and Businger. A.D. 2014. Evapotranspiration of Hawai'i. Final report submitted to the U.S. Army Corps of Engineers—Honolulu District and the State of Hawai'i Commission on Water Resource Management. Honolulu, Hawai'i, USA. http://evapotranspiration.geography.hawaii.edu.

National Research Council. 2009. Observing Weather and Climate from the Ground Up: A Nationwide Network of Networks. National Academies Press, 234 pp.

Budget Request

Category	Year 1	Year 2	Total
Salary	$9,900	$10,200	$20,100
Fringe benefits	$2,689	$3,790	$6,479
Travel	$4,860	$4,860	$9,720
Supplies	$630	$630	$1,260
Data plans	$0	$480	$480
Equipment	$58,156	$0	$58,156
Total Direct Costs	$76,235	$19,960	$96,195
MTDC	$18,079	$19,960	$38,039
Indirect Costs	$1,808	$1,996	$3,804
Total	**$78,043**	**$21,956**	**$99,999**

Budget Justification

Salary. Support is requested for a part-time (15% FTE) researcher/technician, hired as an RCUH employee, to lead the installation, testing, and maintenance of the four-station network. The estimated annual salary base for this position is $66,000 in Yr 1 and $68,000 in Yr 2.

Fringe Benefits. Anticipating that the researcher/technicial will also be supported on other projects to total FTE between 75 and 100%, the RCUH estimated fringe benefits rate is 27.16% in Year 1 and 37.16% in Year 2 (https://www.rcuh.com/wp-content/uploads/2020/07/3.510-Fringe-Benefits_2020.07.01.pdf).

Travel. All four stations will be installed on neighbor islands, requiring interisland travel for installation and maintence. Travel support is requested for four trips (two in each project year), each for two persons and five days. For each trip, airfare is estimated at $225 for two persons ($550 total); accommodations are estimated at $125 per night for four nights, or $500 per person ($1,000 total); perdiem is estimated at $45 per day per person for five days ($450 total); vehicle rental is estimated at $80 per day for 5 days ($400 total); fuel is estimated at $40, and airport parking in Honolulu is estimated at $90. Total per trip is estimated at $2,430.

Supplies. Stations will required construction of a mast. Materials for masts include tools, wire, electrical tape, pipe, fittings, concrete, and wood and fasteners for construction of the concrete form for the footing. Cost of materials is estimated at $315 per station.

Equipment. Four state-of-the-art telemetered climate stations will be purchased. Estimated cost including shipping is derived from a quotation provided by Campbell Scientific, Inc., the primary US vendor for equipment of this type. See the quotation attached.

Indirect Costs. UH indirect costs are based on modified total direct costs (MTDC), in this case equal to total direct costs minus equipment costs. The indirect cost rate for a State of Hawai‘i agency is 10%.

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

Domestic Quote

Quote #: 191175 • Quoted by: Isaac Fjeldsted
Quote Date: 11 Nov 2020 • Valid Through: 26 Feb 2021

To
Thomas Giambelluca
University Of Hawaii Manoa
Geography Dept
2424 Maile Way Rm 445
Honolulu, Hawaii 96822-2232
United States

Ship To
Attn: Thomas Giambelluca
University Of Hawaii
2424 Maile Way
Saunders Hall Rm 445
Geography Dept
Honolulu, Hawaii 96822-2232
United States

Details
Credit Terms: Apply
Freight Terms: PP&A
Incoterms: FOB Logan, UT

Measurements

#		Model / Part	Description	Qty	Unit Price	Ext. Price
1		05108-L15-PW	Wind Monitor-HD 15ft cable per sensor -PW w/Pre-Wire Connector	1	$1,382.73	$1,382.73
2		17953	1 x 1 inch Nurail Crossover Fitting	1	$31.68	$31.68
3		TE525-L15-PW	Texas Electronics Rain Gage 0.01 inch (0.254mm) Tip w/6 inch Orifice 15ft cable per sensor -PW w/Pre-Wire Connector	1	$415.80	$415.80
4		CM270	TE525, TE525MM, or TE525WS Rain Gage Mounting Kit	1	$110.40	$110.40
5		CS650-10-PW-DS	30cm Water Content Reflectometer Plus -10 w/10ft per probe -PW w/Pre-Wire Connector -DS SDI-12 Address = 0	2	$266.88	$533.76
6		SN500SS-17-PW	Apogee Net Radiometer -17 w/17ft per sensor -PW w/Pre-Wire Connector	1	$2,851.38	$2,851.38
7		32295	SN500SS Sensor Mounting Kit	1	$89.28	$89.28
8		EE181-L15-PW	E+E Temperature/RH Probe 15ft cable per sensor -PW w/Pre-Wire Connector	2	$509.13	$1,018.26

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9		RAD10E	METSPEC 10-Plate Solar Radiation Shield for Larger Sensors	2	$172.80	$345.60
10		HFP01-L20-PW	Hukseflux Soil Heat Flux Plate 20ft cable per sensor -PW w/Pre-Wire Connector	1	$704.48	$704.48
11		TCAV-L20	Averaging Soil TC Probe 20ft cable per sensor	1	$342.60	$342.60

Data Logging & Control

#		Model / Part	Description	Qty	Unit Price	Ext. Price
12		CR1000X-NA-ST-SW-CC	Measurement & Control Datalogger -NA No Additional Coms -ST -40 to +70C -SW Standard 3yr Warranty -CC Campbell Calibration	1	$1,680.00	$1,680.00
13		27158	2GB microSD Flash SLC Memory Card	1	$34.56	$34.56

Communications

#		Model / Part	Description	Qty	Unit Price	Ext. Price
14		CELL210-V-25-Y1	4G LTE Cat1 Cellular Module for Verizon (-40 to +80C) -V Verizon US -25 25MB/Mon Data Plan For 1 Year(s)	1	$625.60	$625.60
15		32262	4G/3G Omni 2dBd Antenna w/Type N Female & CSI Mounting Hardware	1	$94.08	$94.08

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WHEN MEASUREMENTS MATTER

Domestic Quote

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16	↳	31315	Bulkhead Surge Protection Installed in Enclosure, Type N to SMA, 700-2700MHz, 18 inches	1	$240.00	$240.00
17	↳	COAXNTN-L10	Antenna Cable RG8 w/2 Type N Male Connectors 10ft per antenna cable	1	$96.24	$96.24

Power

#	Model / Part	Description	Qty	Unit Price	Ext. Price
18	BP24	12V Sealed Rechargeable Battery w/Mounts, 24Ah	1	$196.80	$196.80
19	SP20-PW-SM	20W Solar Panel, 15ft Cable -PW w/Pre-Wire Connector -SM Std Mounting Kit	1	$344.64	$344.64
20	CH201-SW	12V Charging Regulator (-40 to +60C) -SW Standard 1yr Warranty	1	$354.24	$354.24
21 ↳	CABLE2CBL-L2-PT	2-Conductor 22AWG Cable w/Drain 2ft per cable -PT w/Tinned Wires	1	$43.28	$43.28
22 ↳	34031	BP12 & BP24 10A Battery Cable, 24 inches	1	$14.38	$14.38

Enclosures & Mounting

#	Model / Part	Description	Qty	Unit Price	Ext. Price

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WHEN MEASUREMENTS MATTER

Domestic Quote

Quote #: 191175 • Quoted by: Isaac Fjeldsted
Quote Date: 11 Nov 2020 • Valid Through: 26 Feb 2021

23		PWENC14/16-C9-NP-SC-NE-MM	Prewired Enclosure, 14 x 16 inches 9 Connectors per ENC -NP No 9-Pin Ports -SC 1 Conduit -NE No Cable Entry Seal -MM Tripod Mast Mounting NOT CANCELABLE OR RETURNABLE PRODUCT	1	$1,586.88	$1,586.88
24		CM204	Sensor Crossarm w/one CM210 Mounting Kit, 4ft	1	$91.20	$91.20
25		17953	1 x 1 inch Nurail Crossover Fitting	1	$31.68	$31.68
26		3659	1 IPS Unthreaded Aluminum Pipe, 12 inches long	1	$22.08	$22.08
27		CMB200-NF	Crossarm Brace Kit -NF No Special Finish	1	$122.88	$122.88

Services

#		Model / Part	Description	Qty	Unit Price	Ext. Price
28		SYSTEMENG	System Engineering (1 hr) Load datalogger program, test system, configure Pakbus router prior to shipment. Test Communications NOT CANCELABLE OR RETURNABLE PRODUCT	3	$185.00	$555.00

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WHEN MEASUREMENTS MATTER

Domestic Quote

Quote #: 191175 • Quoted by: Isaac Fjeldsted
Quote Date: 11 Nov 2020 • Valid Through: 26 Feb 2021

Must have est on RMA's

Sub Total:	$13,959.51
Tax:	$0.00
Freight:	$579.47
Grand Total:	**$14,538.98**

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