**NASA DEVELOP National Program**

**2024 Spring Project Proposal**

**California – JPL**

**Hawai’i Climate**

*Utilizing NASA Earth Observations to Assess Thermal Stress Impacts on Coastal Native Hawaiian Fisheries*

**Project Overview**

***Project Synopsis*:** Water temperature is one of the critical factors affecting fish habitats, making it a crucial issue to monitor. By utilizing NASA Earth observations to monitor thermal changes, project partners can enhance comprehension of aquatic resources within indigenous coastal fisheries, particularly in relation to climate change and local thermal stress events like the 2019 Marine Heat Wave. Historically, Hawaii had over 500 fishponds that supplied vital protein and sustenance to native communities. Now, there are only 20 active fishponds throughout Hawaii. This project's primary objective is to assess thermal effects on the local ecosystems and identify areas most suitable to restore and protect indigenous Hawaiian fishponds. DEVELOP has Partnered with Kua’aina Ulu ‘Auamo (KUA), and they will use our data and methodologies and apply them to their restoration efforts as they begin to locate new sites for fishponds.

***Study Location:*** HI – Oahu, Kauai, & Hawaii

***Study Period:*** January 2013- December 2023

***Advisors:*** Dr. Christine Lee (NASA Jet Propulsion Laboratory, California Institute of Technology) christine.m.lee@jpl.nasa.gov, Dr. Kelly Luis (NASA Jet Propulsion Laboratory, California Institute of Technology) kelly.m.luis@jpl.nasa.gov

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Sector** |
| **Kua’aina Ulu ‘Aumo** | Kevin K.J. Chang, Executive Director; Brenda Asuncion, Coordinator; | End User | Non-Profit |
| **NOAA Pacific Islands Regional Office** | Charles Littnan, Science and Research Director; Tia Brown, Deputy Director; Ariel Jacobs, Supervisory Program Analysis Officer | Collaborator | Federal Government |
| **University of Hawaii at Manoa** | John Burns, Associate Professor; Haunani Kane, Assistant Professor; Kainalu Steward, Graduate Researcher, Brianna Ninomoto, Graduate Researcher; | Collaborator | Academic |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to Use Earth Observations:***

KUA’s mission is to empower and improve all Hawaiians' quality of life by conserving and protecting their natural and cultural heritage. They believe that abundant and healthy ecosystems can provide community well-being. In 2003, they were first known as the Hawai’i Program of the Community Conservation Network (CCN) and gathered 12 different communities together to share their knowledge about community-based resource management. In 2009, they were reformed into the Hawai’i Community Stewardship Network (HCSN) and later gained nonprofit status in 2013 as Kua’aina Ulu ‘Auamo. Over ten years they have brought over $1.3 million in direct investment to community projects. Though they have limited GIS and remote sensing knowledge, they are interested in utilizing our spaceborne Earth Observations in their restoration needs.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **ISS ECOSTRESS** | Evaporative Stress Index, Evapotranspiration, Surface Temperature (ST) | ECOSTRESS will be used to monitor thermal changes on the ocean surface from 2018 – 2023. |
| **Sentinel-2 MSI** | Turbidity, Surface Reflectance (SR), Chlorophyll-a (CH-a) | Sentinel-2 at a 10 m resolution will examine water quality and Chlorophyll-a production. |
| **Sentinel-3 OLCI** | CH-a | Sentinel-3 will be used in conjunction with Sentinel-2 to retrieve Chlorophyll-a. |
| **Sentinel-3 SLSTR** | ST | With a more frequent revisit time of about 1.5 days and a coarser resolution of 500km, Sentinel-3 SLSTR will be compared against Landsat 8 and ECOSTRESS surface temperatures. |
| **Landsat 8 OLI** | Chlorophyll-a, Turbidity, SR, Normalized Difference Aquatic Vegetation Index (NDAVI) | Landsat 8 OLI reflectance bands will derive turbidity and chlorophyll-a concentration in GEE. It will be used to visualize environmental conditions at a 30 m resolution from 2013 to 2019. |
| **Landsat 8 TIRS** | ST | Landsat 8 TIRS will monitor temperature changes with ECOSTRESS and fill in the gaps before 2019 when ECOSTRESS was unavailable. |

***Ancillary Datasets:***

* Hawaiian Fishpond locations – map of known historical and active fishponds provided by KUA.
* NOAA Catch Data – list of primary fish species caught in indigenous sustenance fishing.
* NCEI Bathymetric Attributed Grid (BAG) Mosaic – will give context to the ever-changing coastlines and the different environments in which various fish species thrive.

**Decision Support Tool & End Product Overview**

***End Products:***

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| --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** |
| **Sea Surface Temperature Change Time Series** | Monitoring sea surface temperature changes over time can give our partners an idea of where fishponds can thrive. | Landsat 8 TIRS will be used with ECOSTRESS to derive seasonal surface temperatures from 2013-2023 to assess the temperature changes, especially during the 2019 Marine Heatwave. Sentinel-3 SLSTR, with a coarser spatial resolution will be used in conjunction to create an overview of changing temperatures in the area. |
| **Thermal Habitat Suitability Map** | Partners will be able to use this suitability map to understand where there are areas around the Hawaiian Islands chain that will have suitable thermal habitats for certain fish species. | Sentinel-2 MSI, Sentinel-3 OLCI, Sentinel-3 SLSTR, Landsat 8 OLI, Landsat 8 TIRS, and ECOSTRESS will identify thermally suitable habitats by analyzing Ch-A, turbidity, ST, and NDAVI. |
| **Habitat Suitability vs. Abundance Map** | This will inform partners of the relationship between habitats identified as suitable for fish versus areas with high catch amounts. | Sentinel-2 MSI, ECOSTRESS, Landsat 8 OLI, and Landsat 8 TIRS will be used with NOAA catch data and NCEI BAG Mosaic to identify suitable habitat areas versus the catch abundance. |

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2024

***Similar Past DEVELOP Projects***:

* 2022 Summer Lower Illinois River Valley Ecological Forecasting – <https://appliedsciences.nasa.gov/what-we-do/projects/inundation-mapping-lower-illinois-river-valley-using-synthetic-aperture-radar>
* 2022 Summer New York Ecological Forecasting

<https://appliedsciences.nasa.gov/what-we-do/projects/assessing-coastal-resiliency-across-floridas-aquatic-preserves-response>

* 2021 Summer Coastal California Water Resources II – <https://develop.larc.nasa.gov/2021/summer/CoastalCaliforniaWaterII.html>
* 2021 Spring Coastal California Water Resources – <https://develop.larc.nasa.gov/2021/spring/CoastalCaliforniaWater.html>
* 2020 Spring Great Lakes Water Resources II – <https://develop.larc.nasa.gov/2020/spring/GreatLakesWaterII.html>
* 2019 Spring Great Lakes Water Resources – <https://develop.larc.nasa.gov/2019/spring/GreatLakesWater.html>
* 2018 Osa Peninsula Water Resources II

<https://develop.larc.nasa.gov/2018/summer/OsaPeninsulaWaterII.html>

***References:***

Villa, P., Mousivand, A., & Bresciani, M. (2014). Aquatic vegetation indices assessment through radiative transfer modeling and linear mixture simulation. *International Journal of Applied Earth Observation and Geoinformation, 30*, 113-127. ISSN 1569-8432. <https://doi.org/10.1016/j.jag.2014.01.017>.

Pahlevan, N., Smith, B., Schalles, J., Binding, C., Cao, Z., Ma, R., et al. (2020). Seamless retrievals of chlorophyll-a from Sentinel-2 (MSI) and Sentinel-3 (OLCI) in inland and coastal waters: A machine-learning approach. *Remote Sensing of Environment*, 240, 111604. ISSN 0034-4257. <https://doi.org/10.1016/j.rse.2019.111604>.