Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps for the Island of O`ahu

Kick-off Meeting – Dec. 7, 2018

Dr. Ian N. Robertson – Project Manager
Dr. Yong Wei, University of Washington (UW)
Development of Tsunami Source Scenarios
Dr. Kwok Fai Cheung, Applied Research International (ARI)
Tsunami Inundation modeling and mapping
Dr. Patrick Lynett – Independent Technical Review

Project Outline

- Development of Comprehensive High Resolution Probabilistic Design Zone Maps Compatible with ASCE 7-16 for the Island of O`ahu, State of Hawai`i.
- Project managed by Department of Business, Economic Development and Tourism (DBET), Office of Planning, Coastal Zone Management Program, State of Hawai`i
- Funding provided by National Oceanic and Atmospheric Administration (NOAA)
- Project timeline shortened from two years to one year, ending September 30, 2019.

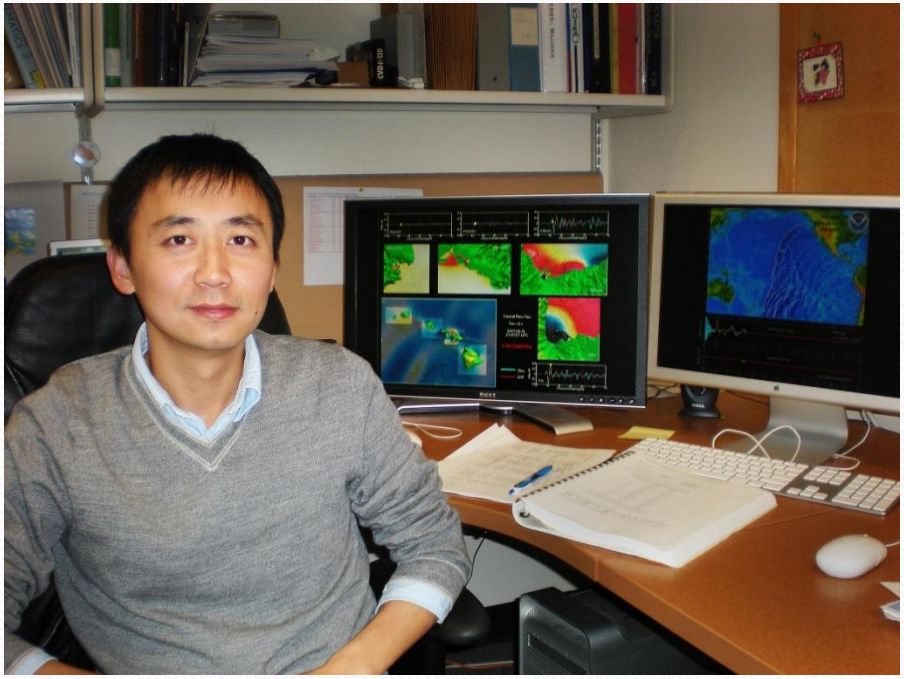
Team Members

- Project Responsibilities
  - Project management
  - Prepare work plan
  - Prepare progress reports
  - Organize and lead technical meetings
  - Organize and lead informational meetings
  - Project administration

Ian N. Robertson, Ph.D., S.E.

- Vice-chair ASCE 7 Tsunami Loads and Effects Subcommittee
- Principal author of FEMA P-646 Third Edition – Vertical Evacuation
- Final edits of “Guide to the Tsunami Design Provisions of ASCE 7-16”.

Team Members



- Project Responsibilities
  - Develop tsunami source scenarios consistent with ASCE 7-16 offshore data
  - Participate remotely in technical and informational meetings
  - Assist with progress reports and final products

Yong Wei, Ph.D., University of Washington

UNIVERSITY of WASHINGTON

- Member of ASCE 7 Tsunami Loads and Effects Subcommittee
- Generated tsunami sources and performed inundation modeling for the ASCE 7-16 Tsunami Design Zone maps.
- Developed the High-Resolution Benchmark TDZ maps for Honolulu and Hale'iwa

Team Members

- Project Responsibilities
  - Verify the bathymetry and topography to be used for the tsunami inundation modeling
  - Perform high-resolution inundation modeling based on the tsunami source scenarios
  - Prepare final map products
  - Participate in technical and informational meetings
  - Assist with progress reports and final products

Kwok Fai Cheung, Ph.D., Applied Research International, LLC

- Has performed all tsunami inundation mapping for generation of State of Hawai`i Tsunami Evacuation Maps.
- Has performed tsunami studies for ports and harbors and coastal areas throughout Hawai`i and around the Pacific Basin

Team Members

- Project Responsibilities
  - Assist Dr. Cheung with DEM verification, tsunami inundation modeling, and generation of mapping products.

Yoshiki Yamazaki, Ph.D., Applied Research International, LLC

- Developed tsunami modeling program NEOWAVE with Kwok Fai Cheung.
- Has performed tsunami studies for numerous areas throughout Hawai`i and around the Pacific Basin

Team Members

- Project Responsibilities
  - Serves and the Independent Technical Reviewer for the project.
  - Will provide technical review of all products produced by the project team.

Patrick Lynett, Ph.D., Patrick Lynett LLC.

- Member of ASCE 7 Tsunami Loads and Effects Subcommittee
- Has performed numerous tsunami modeling studies of coastal regions and ports and harbors, with particular emphasis on flow velocities and eddy development.

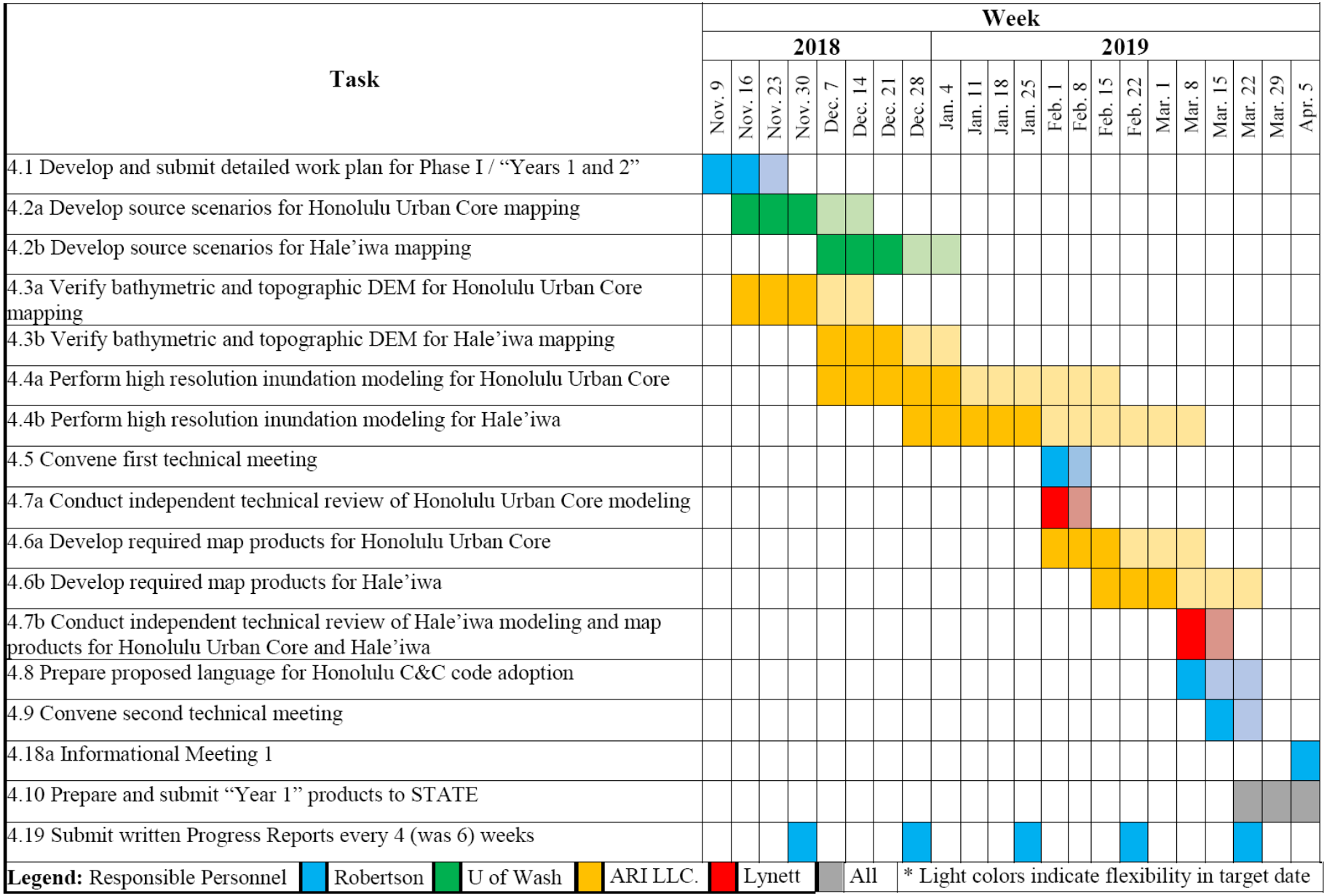
Project Contracts

- Prime contract between Hawai`i State DBET's Office of Planning and Ian N. Robertson, Ph.D. (INR) effective Oct. 3, 2018
- Subcontracts established between INR and:
  - University of Washington (UW) on Nov. 29, 2018
  - Applied Research International, LLC (ARI) on Nov. 16, 2018
  - Patrick Lynett, LLC on Nov. 15, 2018

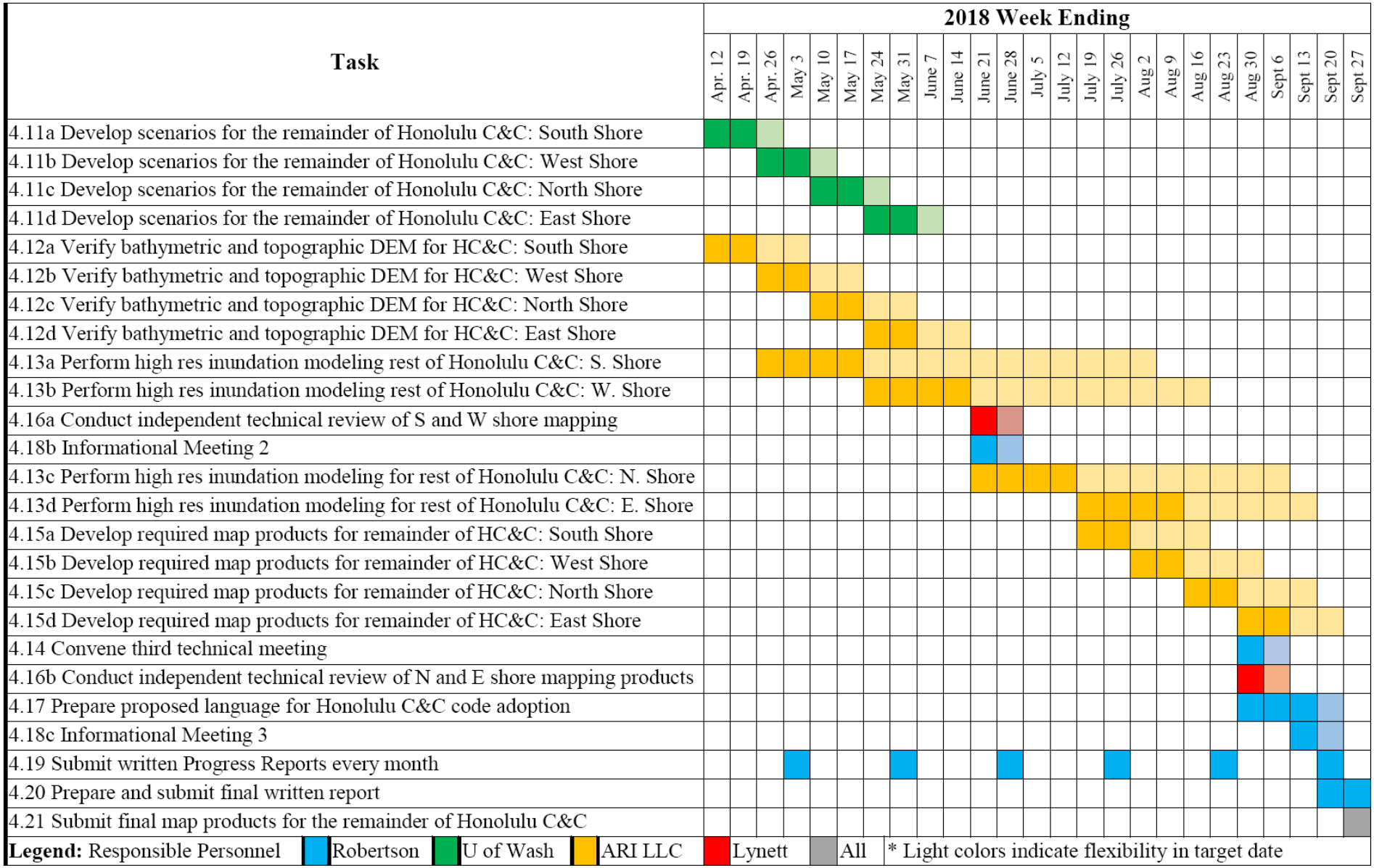
Project Objective

- Phase 1, “Year 1”
  - Develop high-resolution (10m horizontal grid) probabilistic tsunami design zone maps consistent with the requirements of ASCE 7-16 for Honolulu Urban Core and Hale`iwa.
  - Validate these maps relative to benchmark high-resolution maps generated under a prior project.
  - Produce mapping products as specified in the Prime Contract.
- Phase 1, “Year 2”
  - Develop high-resolution (10m) probabilistic tsunami design zone maps consistent with ASCE 7-16 for the rest of O`ahu.
  - Produce mapping products as specified in the Prime Contract.
  - Develop code language for inclusion of these maps in the Honolulu City & County Building Code.

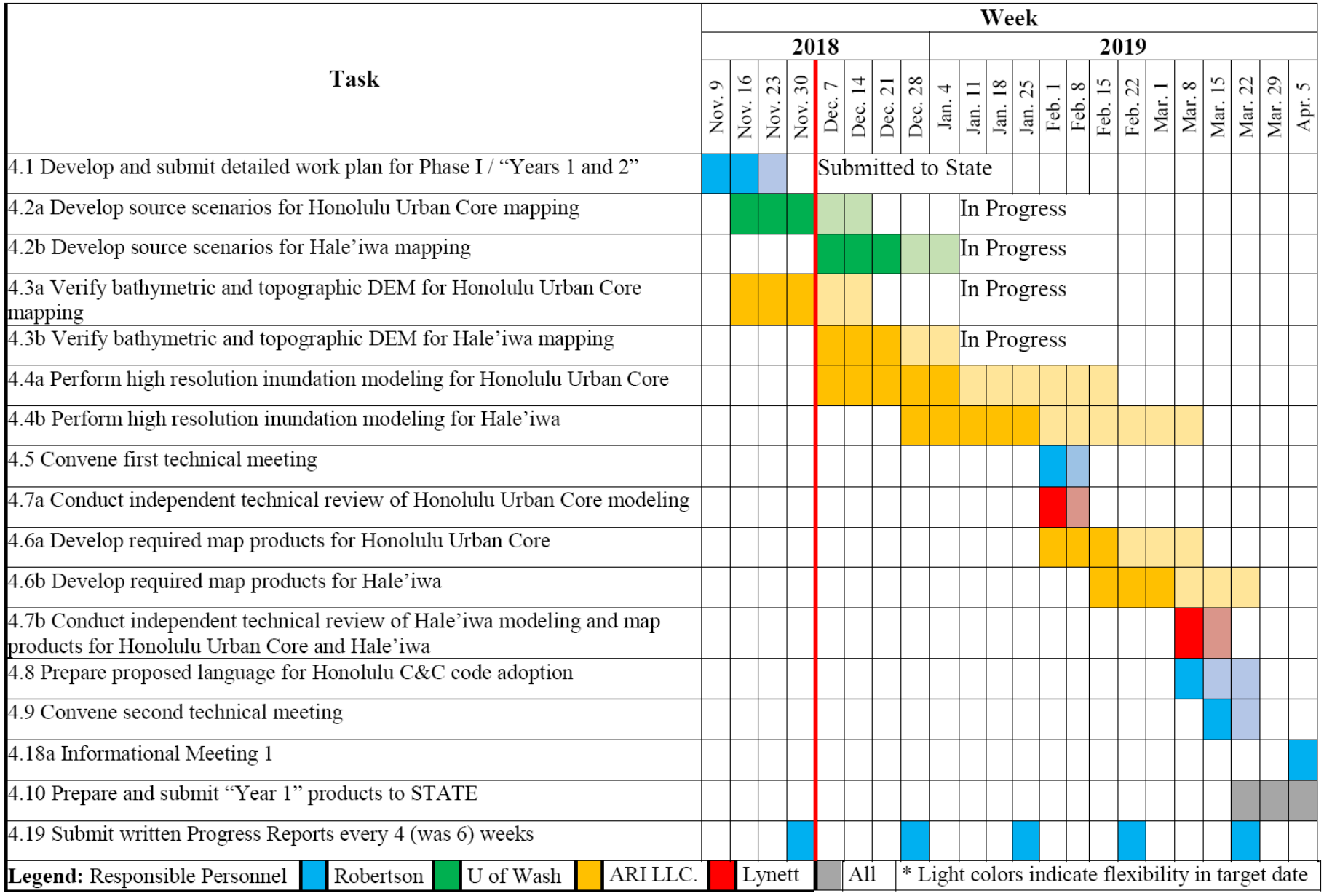
Project Schedule – "Year 1"



Project Schedule – "Year 2"

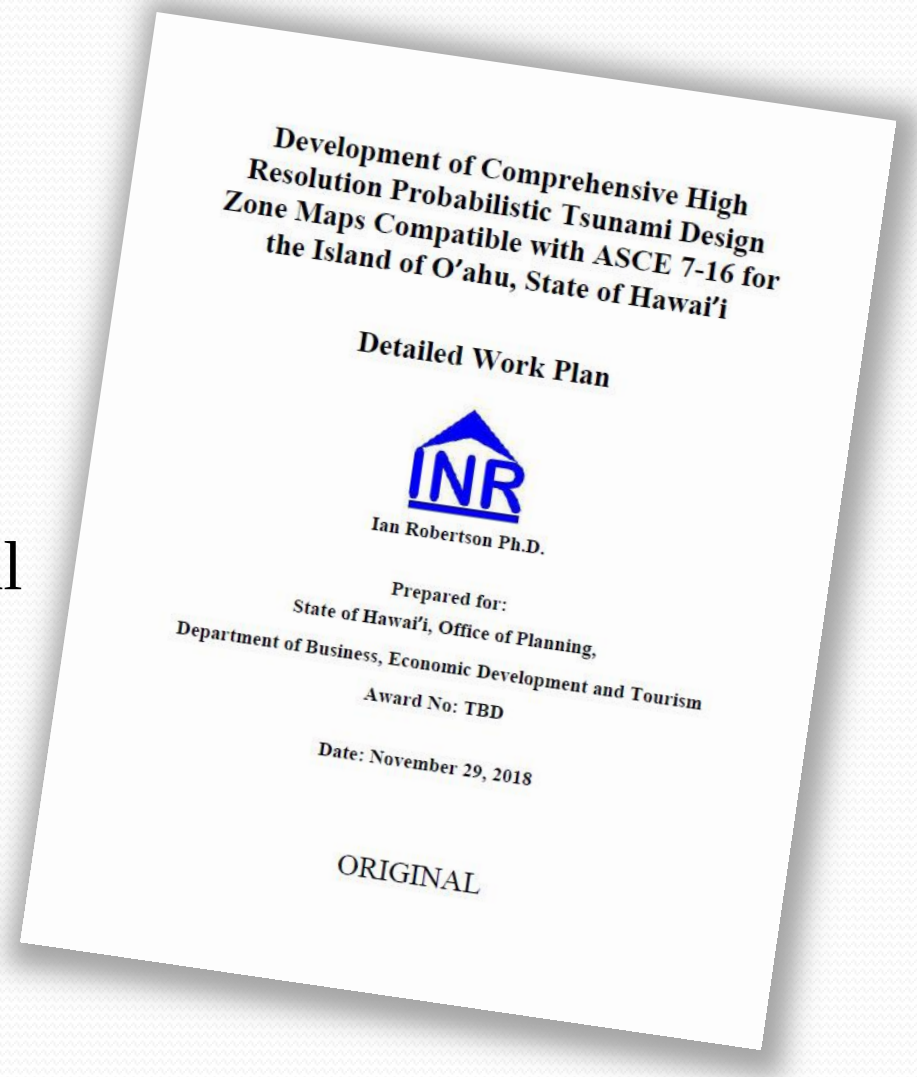


Project Schedule – "Year 1"



Task 4.1 – Detailed Work Plan

- Draft detailed work plan for Phase 1, “Years 1 and 2” was submitted to Office of Planning on Nov. 16, 2018.
- Review comments received Nov. 21, 2018.
- Comments addressed and final detailed work plan submitted on Nov. 29, 2018.



Development of Comprehensive High Resolution Probabilistic Tsunami Design Zone Maps Compatible with ASCE 7-16 for the Island of O'ahu, State of Hawai'i

Detailed Work Plan

INR

Ian Robertson Ph.D.

Prepared for:
State of Hawai'i, Office of Planning,
Department of Business, Economic Development and Tourism
Award No: TBD

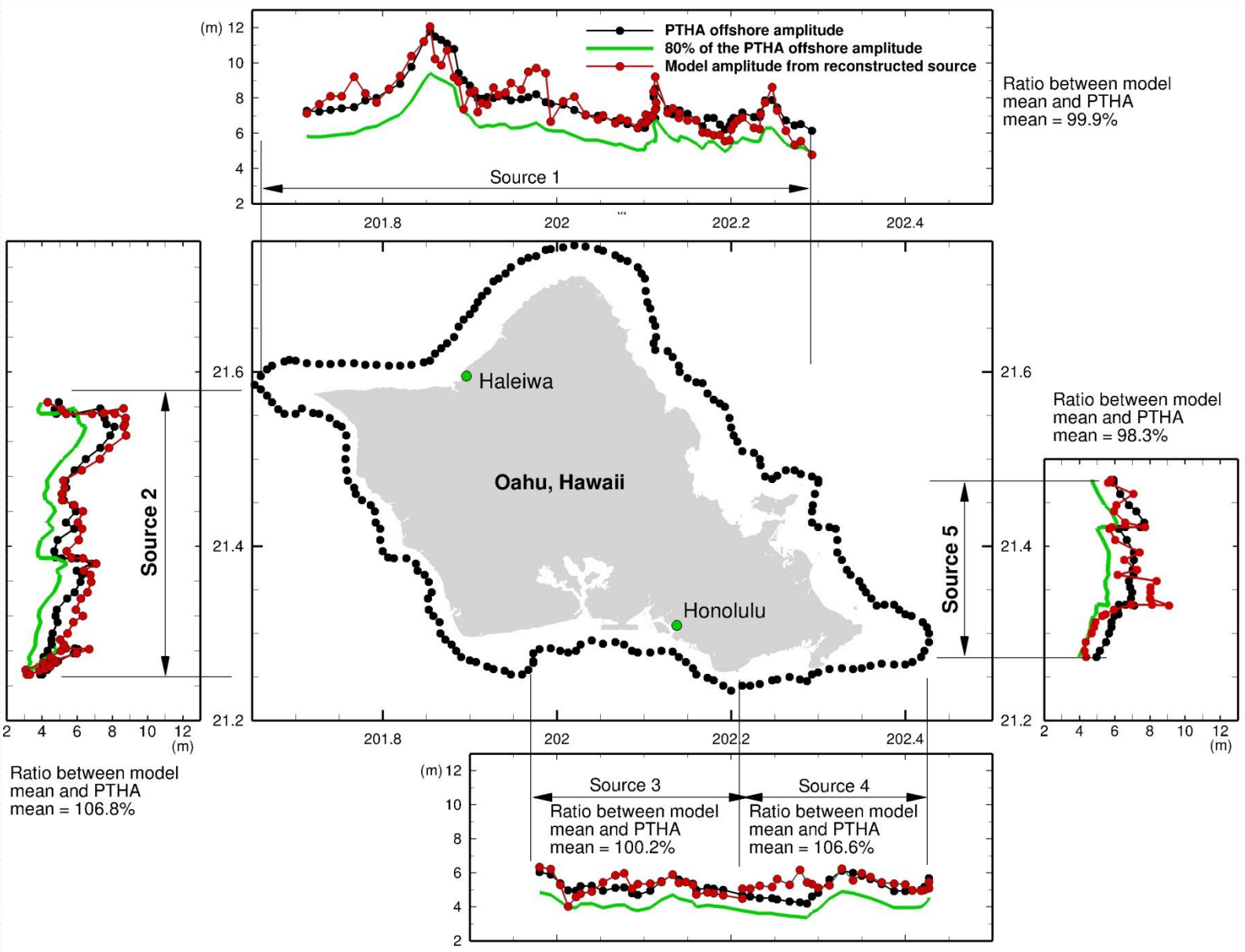
Date: November 29, 2018

ORIGINAL

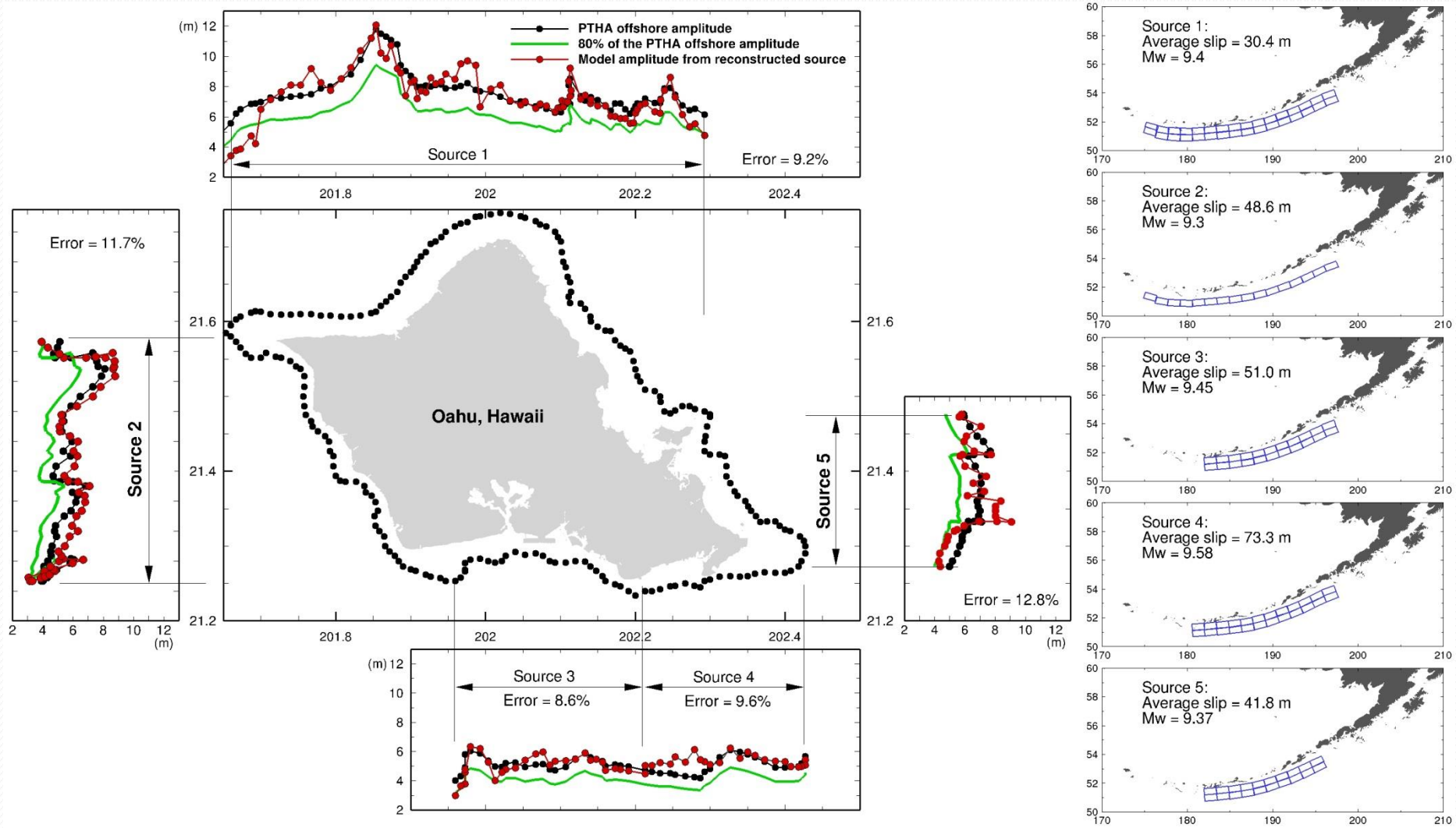
Task 4.2 – Develop Source Scenarios

- Tsunami Source Scenarios must produce offshore wave heights that agree with the ASCE 7-16 Offshore Wave Heights listed in the ASCE Tsunami Geodatabase.
- ASCE 7-16 only requires that for site specific PTHA, no point be less than 80% of the Geodatabase value.

Task 4.2 – Develop Source Scenarios



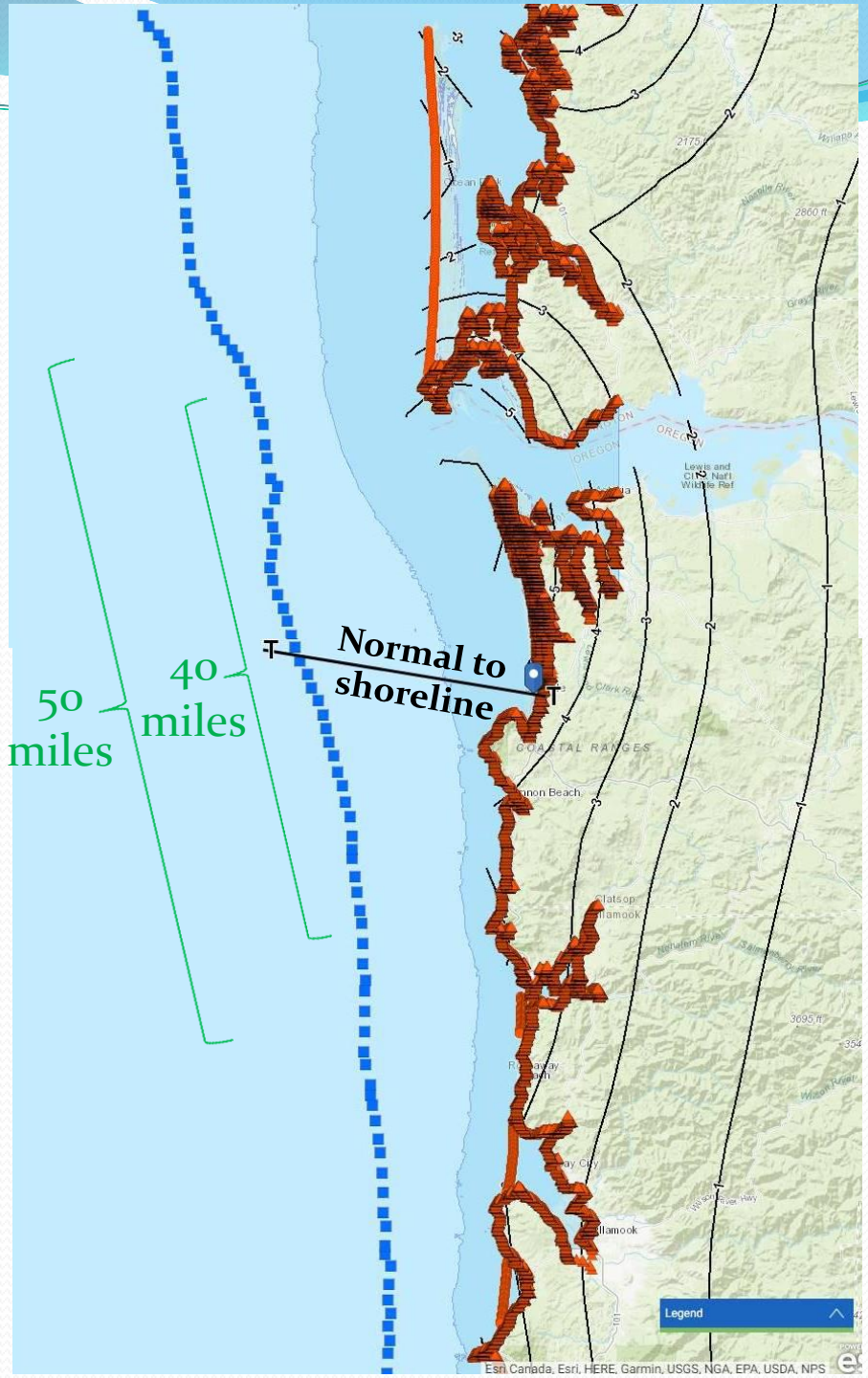
Task 4.2 – Develop Source Scenarios



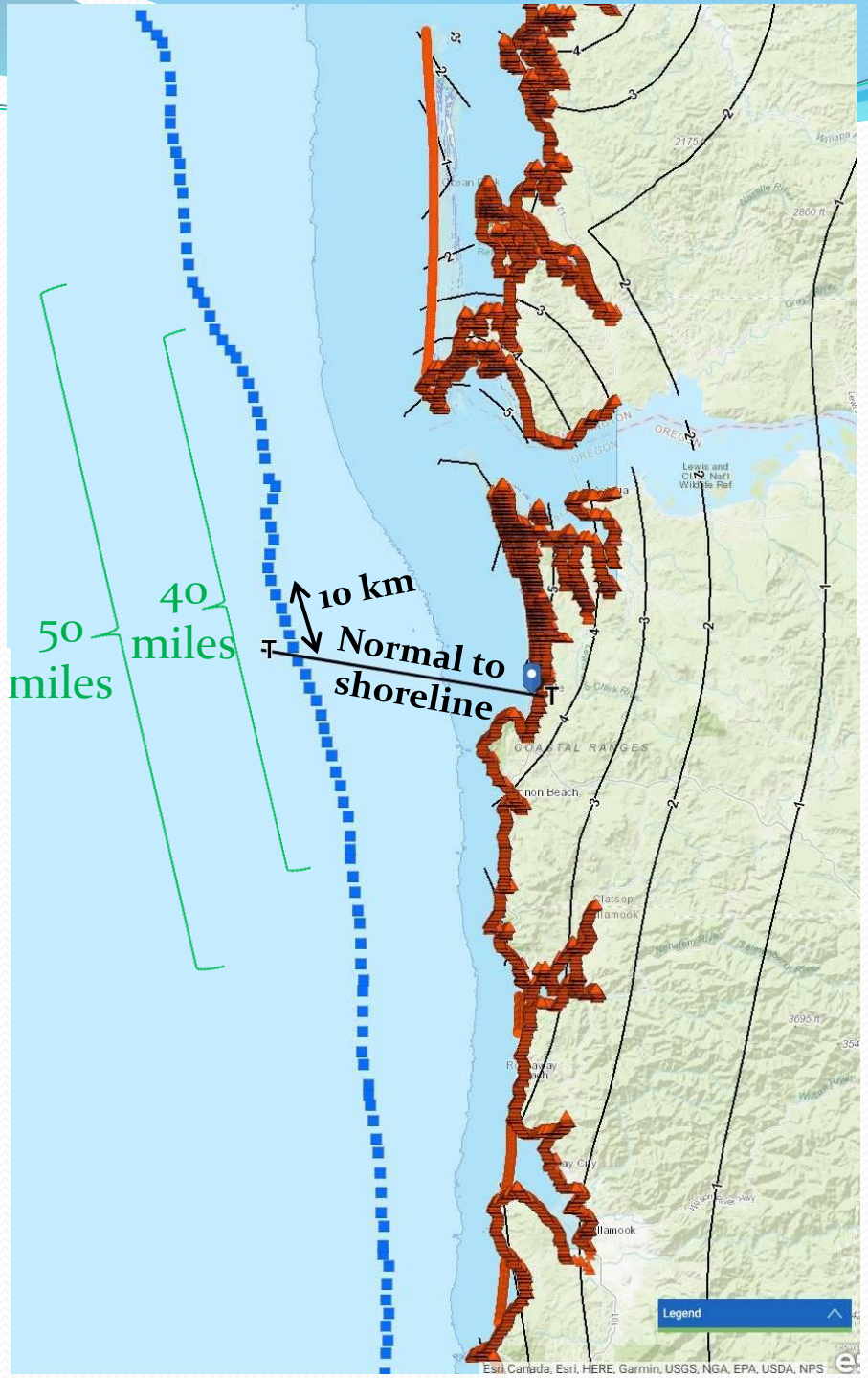
Task 4.2 – Develop Source Scenarios

- Tsunami Source Scenarios must produce offshore wave heights that agree with the ASCE 7-16 Offshore Wave Heights listed in the ASCE Tsunami Geodatabase.
- ASCE 7-16 only requires that for site specific PTHA, no point be less than 80% of the Geodatabase value.
- New requirements have been approved for ASCE 7-22 which require 100% average match over a 40-50 mile length, with no point falling below 80%.

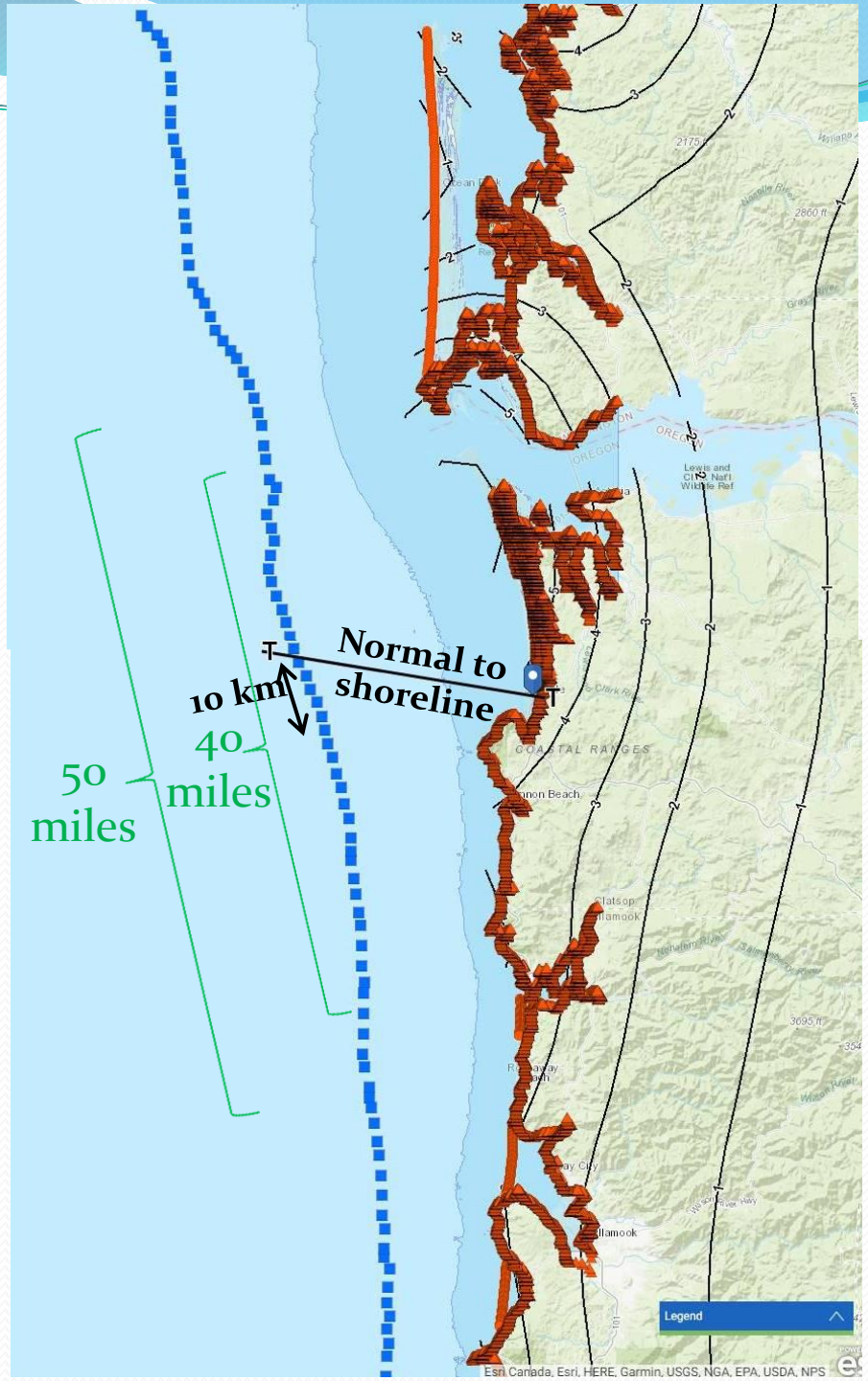
Example: Seaside, OR



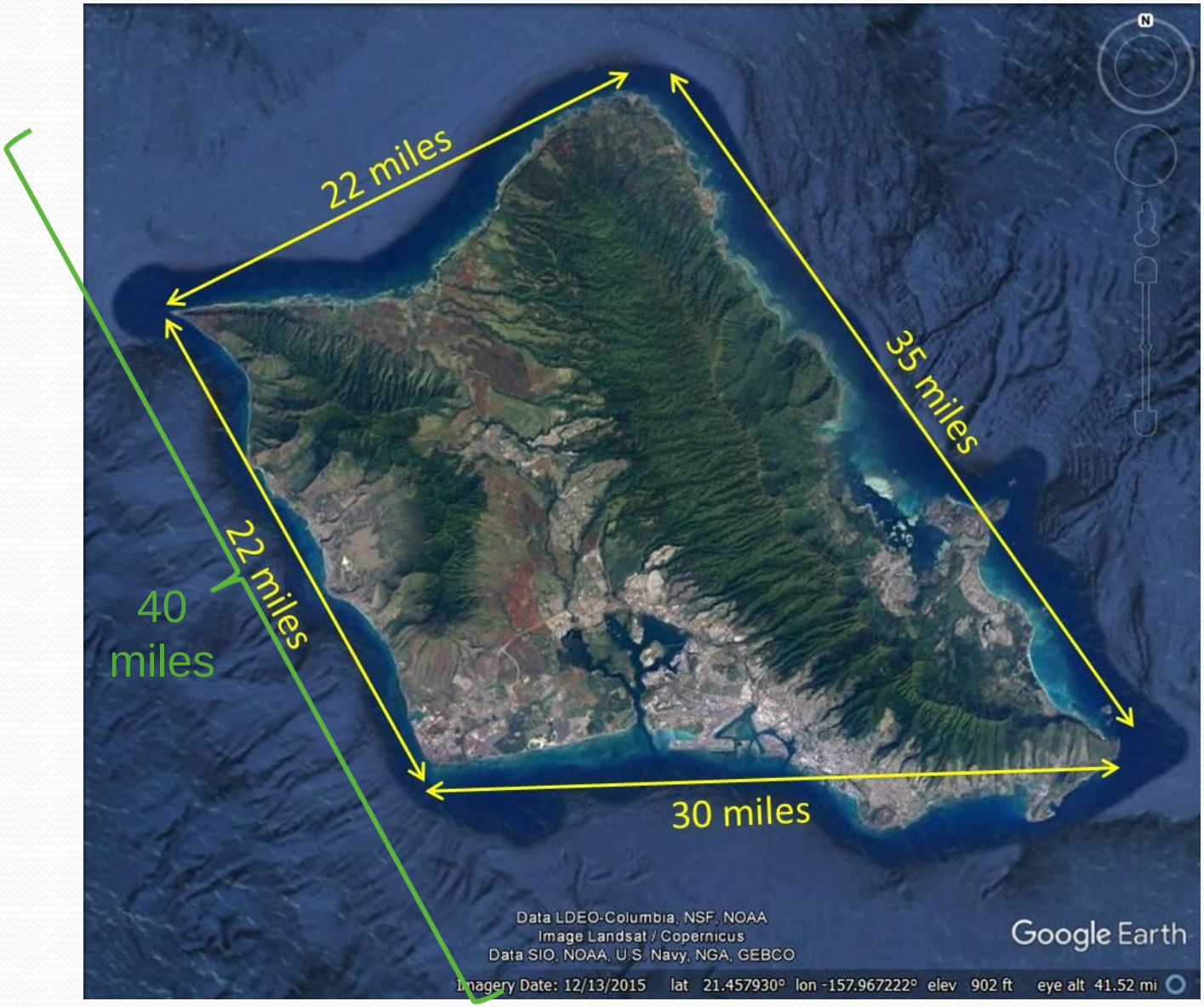
Example: Seaside, OR



Example: Seaside, OR



Application to Island of O'ahu



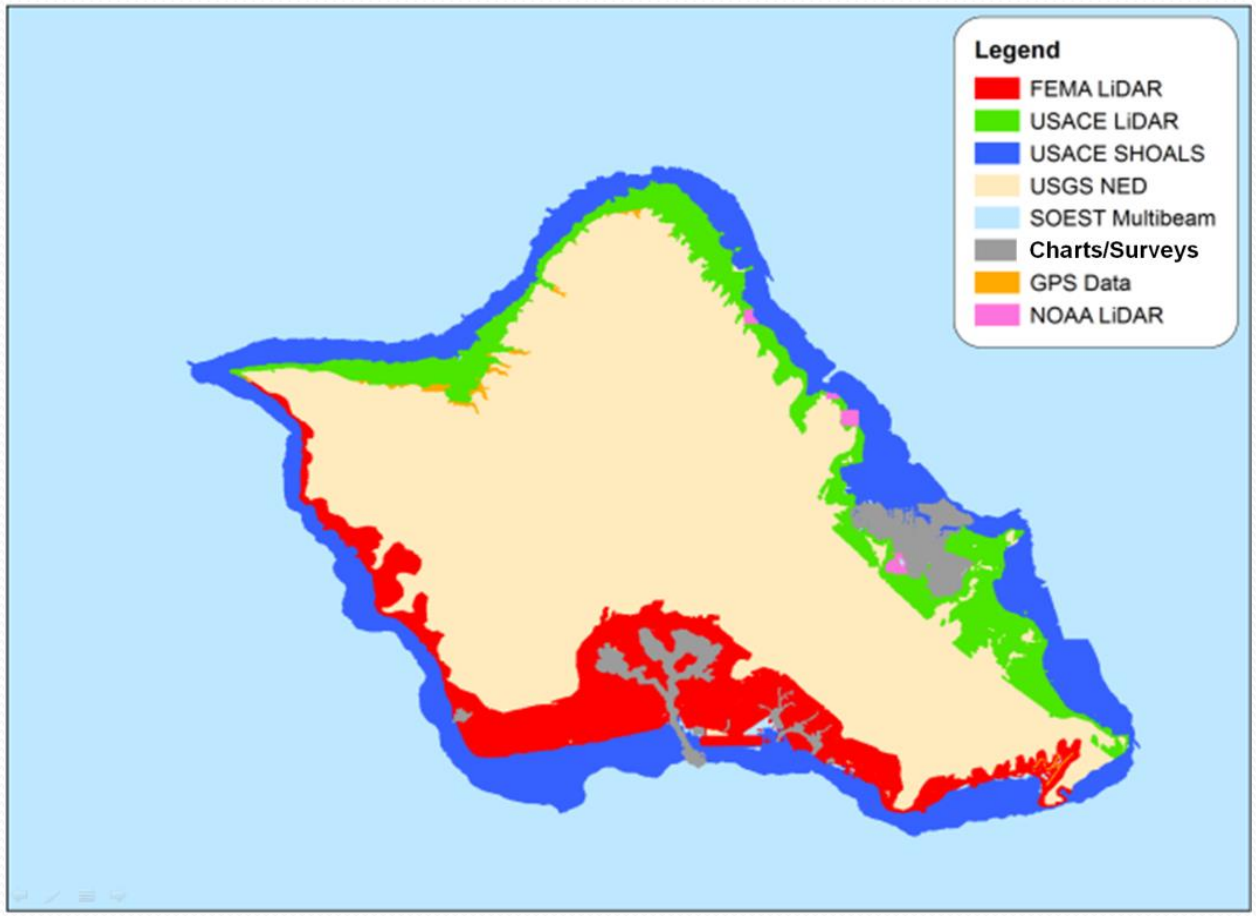
Task 4.2 – Develop Source Scenarios

- Tsunami Source Scenarios must produce offshore wave heights that agree with the ASCE 7-16 Offshore Wave Heights listed in the ASCE Tsunami Geodatabase.
- ASCE 7-16 only requires that for site specific PTHA, no point be less than 80% of the Geodatabase value.
- New requirements have been approved for ASCE 7-22 which require 100% average match over a 40-50 mile length, with no point falling below 80%.
- We plan to comply with the spirit of this new requirement even though it does not apply strictly to TDZ mapping.
- This new requirement may also not apply directly to islands, based on the size of the island.
- We propose to determine source scenarios for each “face” of the island of O`ahu, meeting the 100% and 80% criteria.

Task 4.3 – Verify DEM

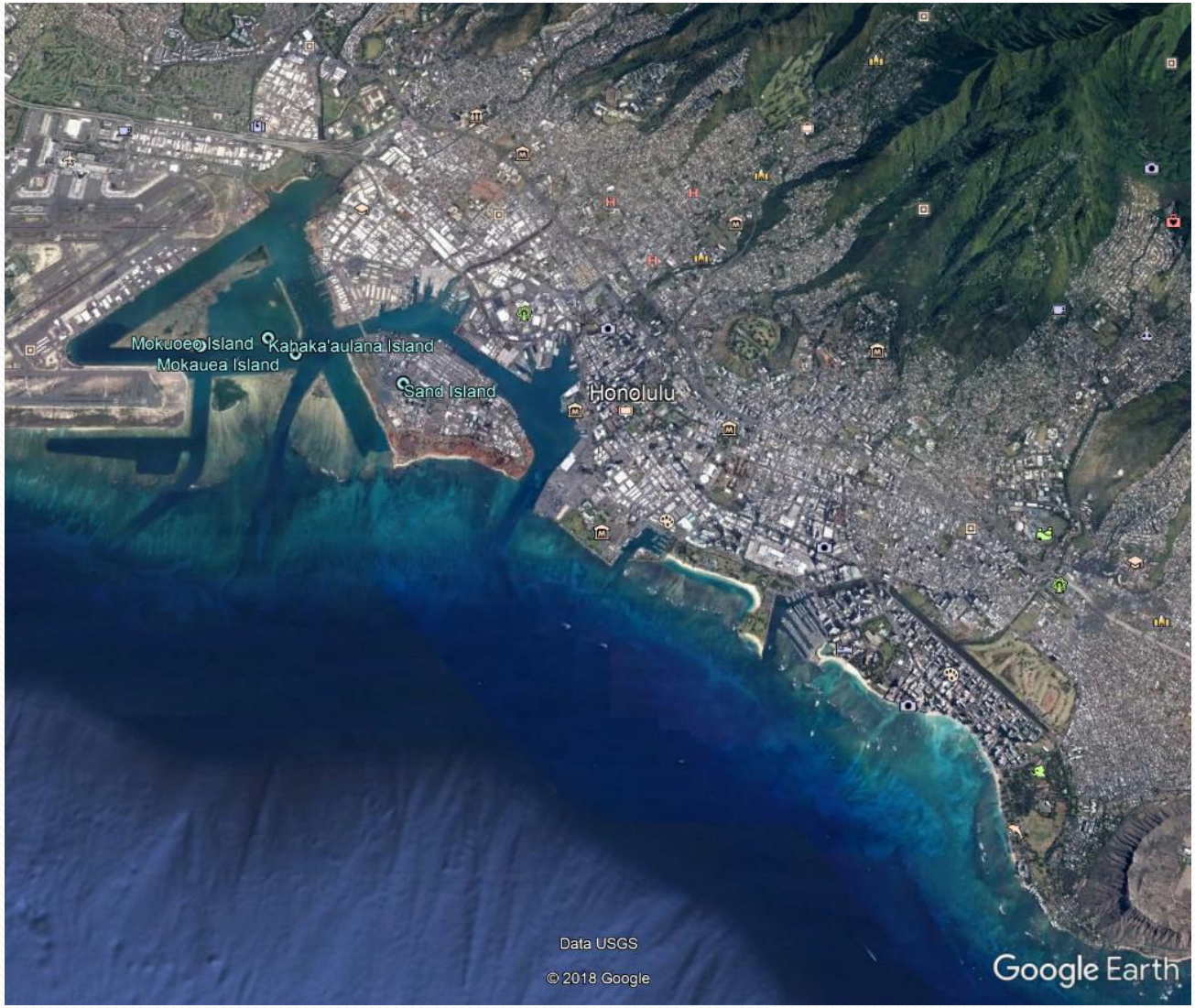
- For more than a decade, ARI has compiled high-resolution bathymetry and topography from a number of sources to generate their Digital Elevation Model (DEM) of O`ahu.
- This DEM has been used for prior tsunami inundation and harbor current studies on O`ahu.
- It is being verified by comparison with the 2013 USACE aerial LiDAR dataset for nearshore and coastal areas.

Task 4.3 – DEM for O`ahu

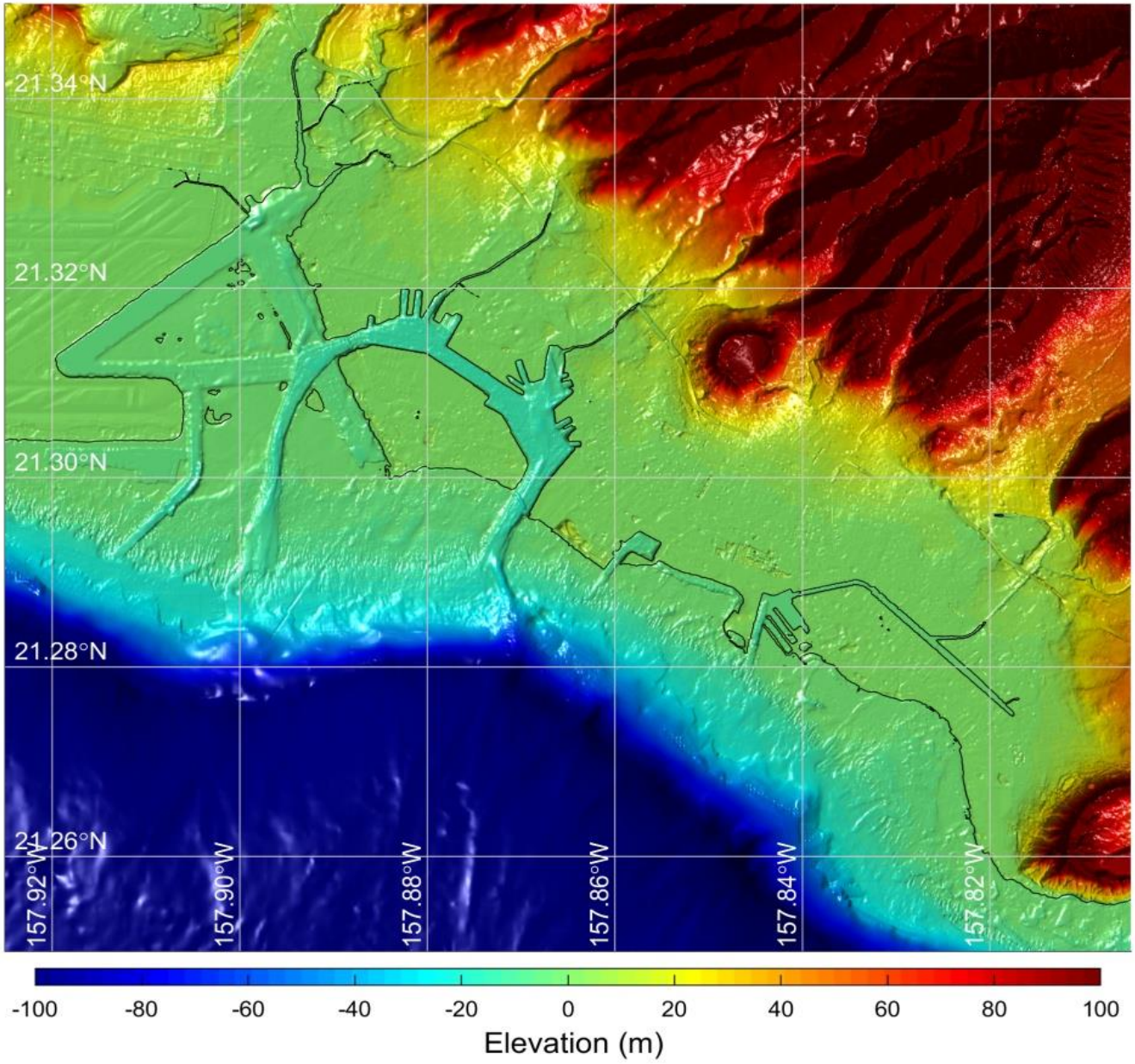


Sources used to compile ARI DEM for the Island of O`ahu (1999 to 2009)

Task 4.3a – Honolulu Urban Core DEM

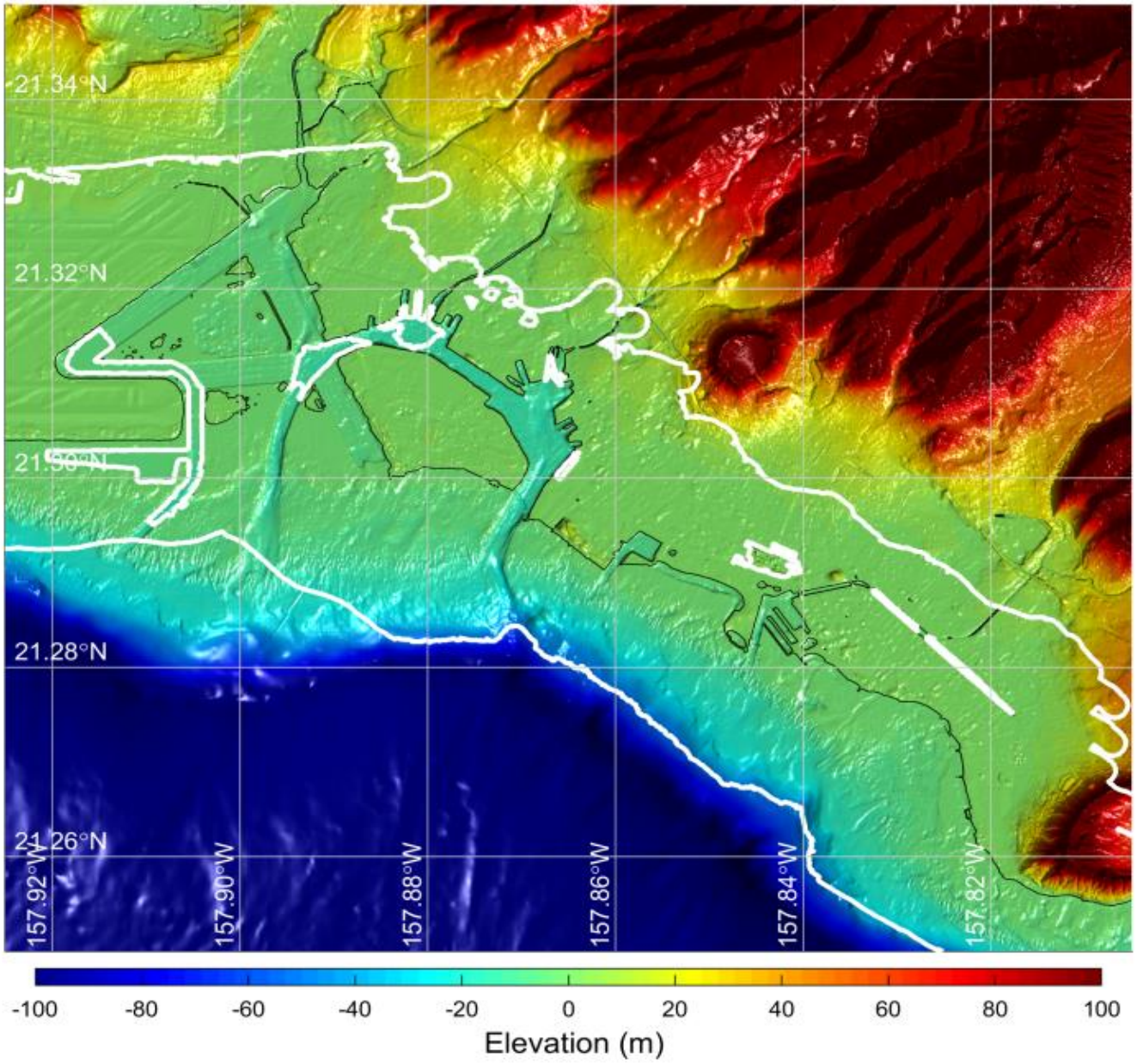


Task 4.3a – Honolulu Urban Core DEM



Task 4.3a – Honolulu Urban Core DEM

2013 USACE LiDAR boundaries

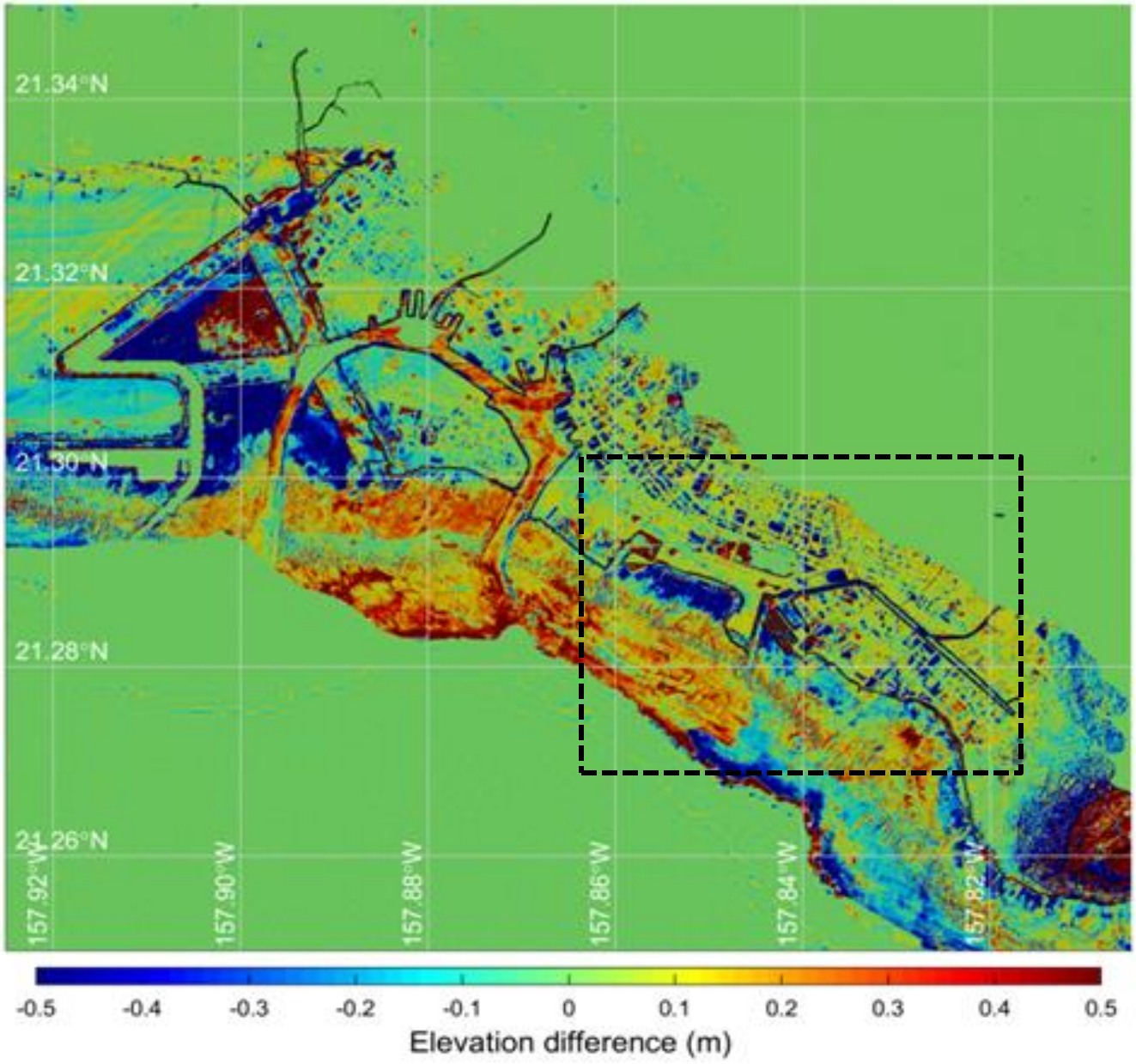


Task 4.3a – Honolulu Urban Core DEM

Difference between ARI DEM

and

2013 USACE LiDAR

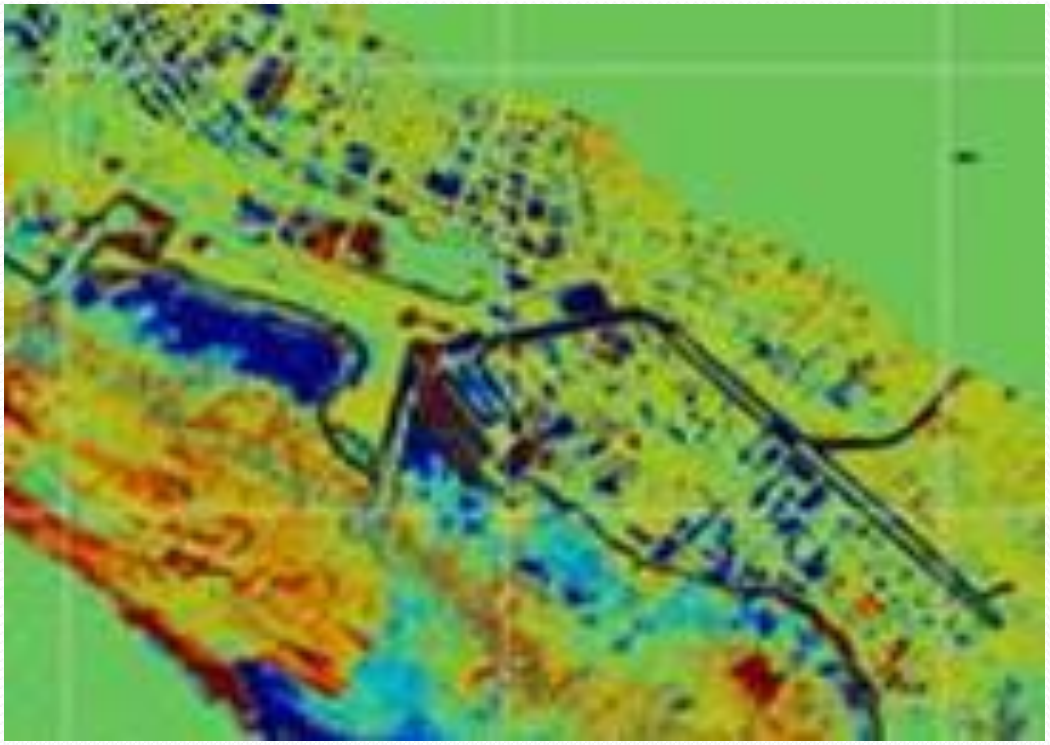


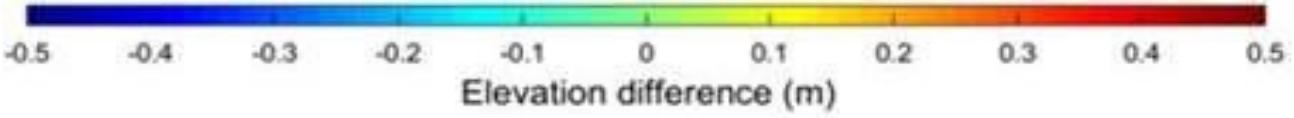
Task 4.3a – Honolulu Urban Core DEM

Difference between ARI DEM

and

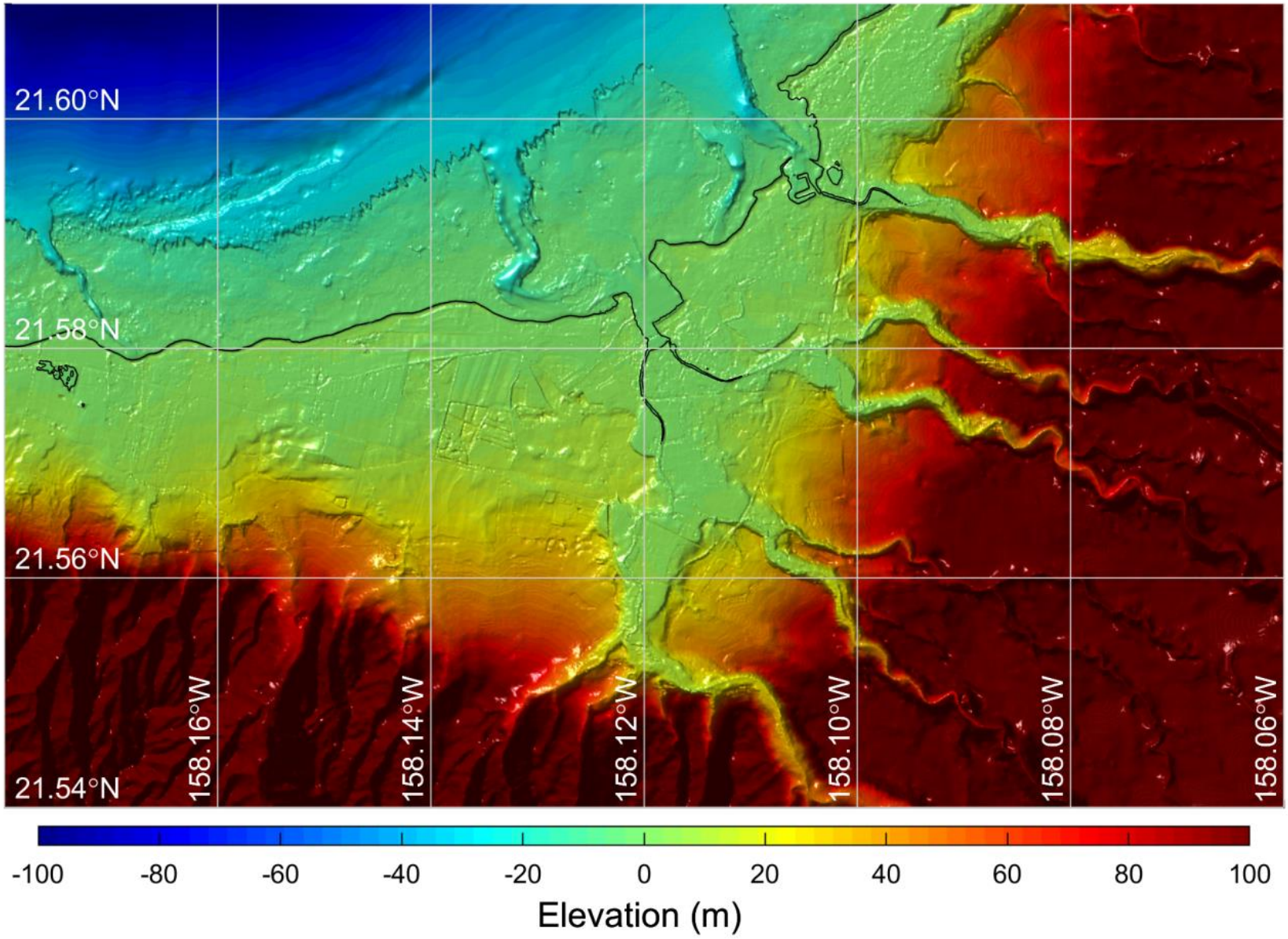
2013 USACE LiDAR





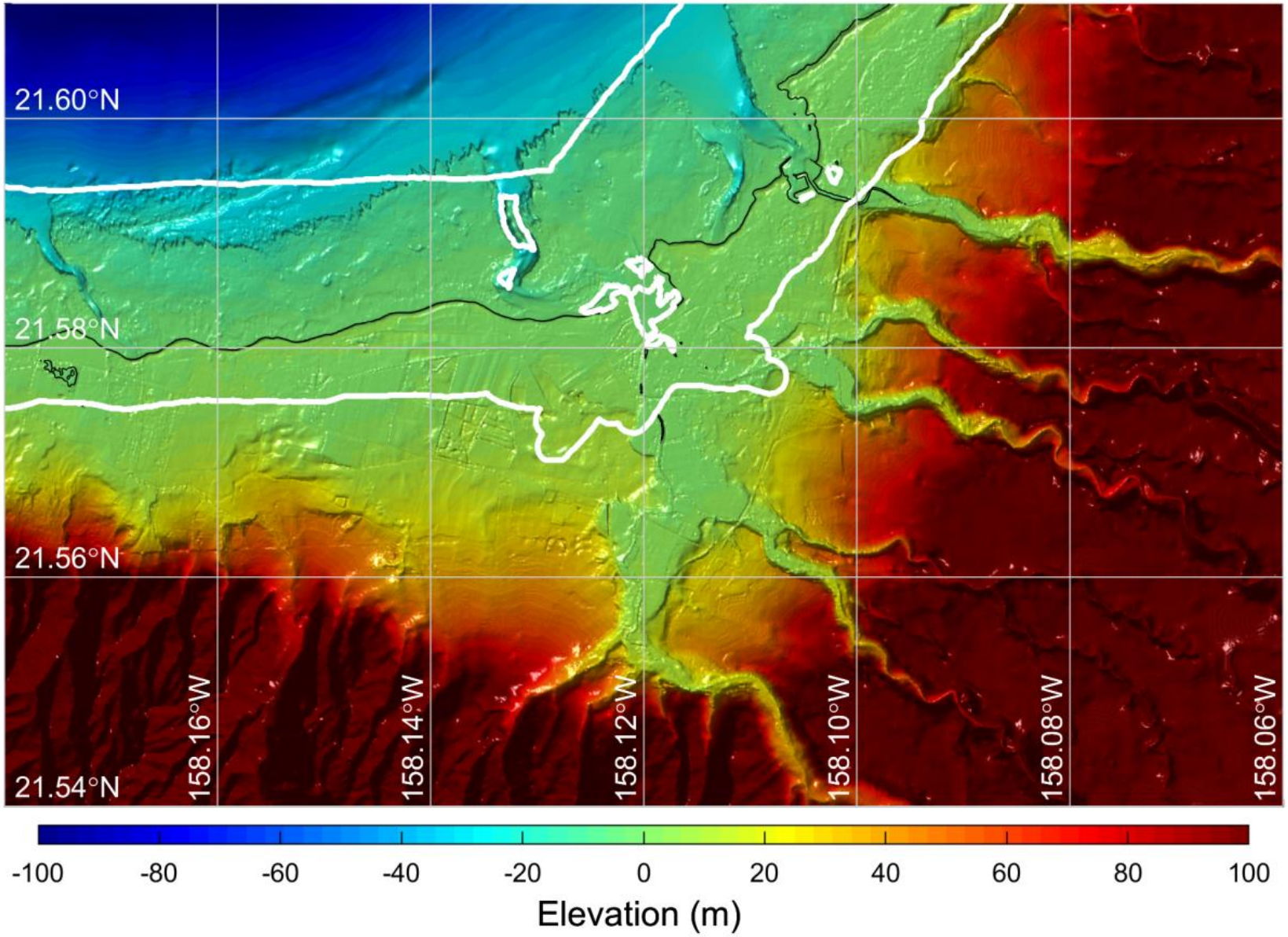
Task 4.3b – Hale`iwa DEM

Task 4.3b – Hale`iwa DEM



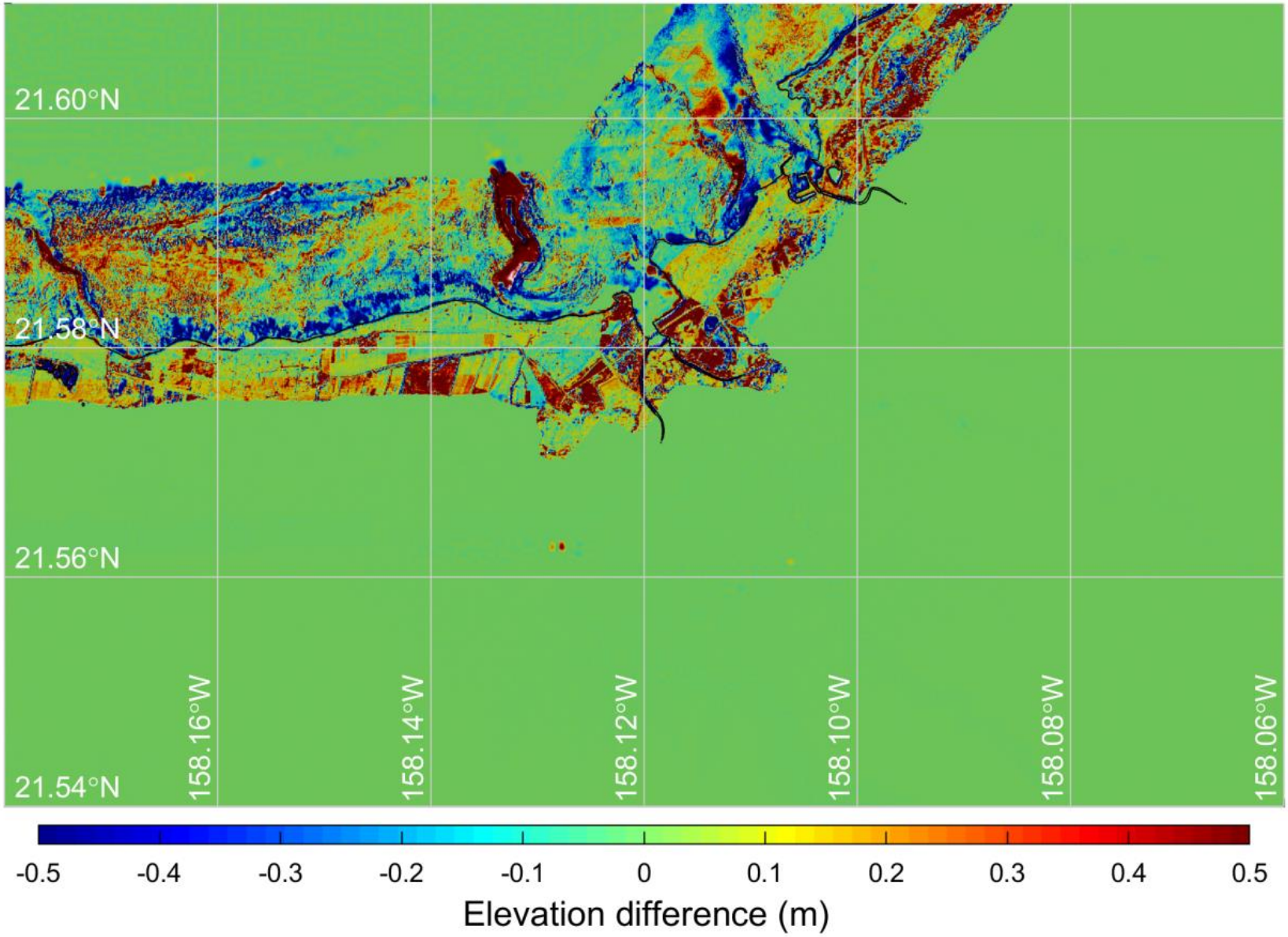
Task 4.3b – Hale`iwa DEM

2013 USACE LiDAR boundaries



Task 4.3b – Hale`iwa DEM

Difference between ARI DEM and 2013 USACE LiDAR



Task 4.3 – DEM Verification

- The ARI DEM has been verified against the 2013 USACE LiDAR data.
- We plan to proceed with inundation modeling using the ARI DEM based on this verification.
- A report documenting this DEM verification process will be submitted by the end of December.

Future Tasks

- Task 4.2 – Tsunami Source Scenarios
  - Will be completed by the end of December for Hale`iwa and Honolulu Urban Core.
  - A report documenting the scenario development will be submitted soon thereafter.
- Task 4.3 – DEM verification for Hale`iwa and Honolulu
  - Report documenting DEM verification will be submitted by the end of December.
- Task 4.4 – Perform high resolution inundation modeling for Hale`iwa and Honolulu Urban Core
  - Will start as soon as source scenarios are ready.

Thank-you

Any Questions?