Cascadia CoPes Hazards Research Hub
Pilot Research Project Grant Application Template

Cover page

Project Title:	Flood model validation through remote sensing and community engagement
Budget Request	$37,946
Lead investigator name:	Christie Hegermiller
Lead investigator institution:	University of Washington
Lead investigator email:	caheg@uw.edu

Applicant information:
Provide the following information for each member of the project team:

Name:	Christie Hegermiller	Karthik Venkataramani	Ryan Chiu	Sanpisa Sritrairat
Role on project (e.g., PI, Co-PI, Advisor, Postdoctoral Fellow, Graduate/Undergraduate Research Assistant)	PI	Postdoc	Graduate Research Assistant	Community partner
Role in the Hub, if applicable (PI, Co PI, Key Personnel, Postdoctoral Fellow, Graduate/Undergraduate Research Assistant, CHARTER Fellow)	Key Personnel	n/a	Graduate Research Assistant	Community partner
Hub Team/ Theme membership/ leadership, if applicable	Team 2	n/a	Team 2	n/a

Title:	Assistant Professor	Postdoc	PhD Student	Community Engagement Specialist
Organization:	UW	UW	UW	Washington Sea Grant/WA Coastal Hazards Organizational Resilience Team (COHORT)
Email address:	caheg@uw.edu	vkarthik@uw.edu	rchiu18@uw.edu	sanpisa@uw.edu

Abstract

Half a foot of relative sea level rise is projected for parts of coastal Washington within the next 30 years, prompting a need for effective coastal resilience and hazard mitigation strategies. Our high-fidelity, hydrodynamic numerical model (built by Team 2 - Compound Flooding) specifically focuses on understanding past and present flooding events in Grays Harbor and Willapa Bay, which are typically generated by compounding influences, in order to be able to predict flood hazards in the future under sea level rise and changes to climate. Strong morphodynamic changes at the inlet and navigation channel of both estuaries complicate upstream hydrodynamics and therefore require a dependable validation method especially during intense atmospheric river events. We propose to use the Dynamic Surface Water Extent product developed by NASA to infer flood extents from raw optical and radar imagery during storm events and use as validation for our numerical model. Through a series of engagements with communities in Willapa Bay and Grays Harbor, facilitated by our community partner (Sritrairat - Washington Sea Grant and Washington Coastal Hazards Organizational Resilience Team), we will develop an improved flood risk and flood extent visualization tool that will be beneficial for emergency preparedness and hazards mitigation.

Research Plan

Community Needs for Coastal Hazards Information

With the expected sea level rise (Miller et al., 2018) and significant increase in frequency and magnitude of extreme precipitation events due to climate change (Morgan et al., 2021), there is a dire need for Washington's coastal communities to focus on improving and adapting existing coastal resilience plans. The recent "Resilience Action Demonstration Project" (RAD; Blalock et al., 2022) identified 112 potential coastal hazards resilience projects, mostly related to flooding and erosion, in Grays Harbor and Pacific County. In response to communities' request for the state to help address the growing severity of natural hazards, the Coastal Hazards Organizational Resilience Team (COHORT) was created, consisting of staff from Washington Sea Grant (Sritrairat), WA Department of Ecology, WA Emergency Management Division, and Washington State University Extension. The COHORT works closely with coastal communities and Tribes to support the co-creation of community-prioritized coastal resilience strategies by providing technical support, connecting communities experts, convening interagency collaborations, streamlining funding strategies, and providing education and outreach related to coastal hazards. The COHORT have identified local needs to better understand locally-relevant short-term and long-term flood and erosion risks. The majority of risk assessments rely on tools such as numerical models to project hazards under a range of future scenarios. However, the communities' confidence in these tools can be challenging without comprehensive validation measures or alternative methods of communication.

The main objective of Team 2's Compound Flooding project is to understand past and present flooding events in Grays Harbor and Willapa Bay, which are typically generated by compounding influences, in order to be able to predict flood hazards in the future. Nonlinear interactions between ocean-driven processes and river-driven dynamics can complicate coastal flooding predictions, requiring tools such as numerical models to simulate highly temporally and spatially variable conditions. The numerical model that we have developed to study compound flood events in this region has been validated by a sparse dataset of in situ observations (e.g., bay water levels, current velocities) collected 25 years ago. While it is optimal to use hydrologic data (e.g., high water marks, water levels in flooded regions) to validate model predictions, those data are lacking. Both estuaries have shown upstream hydrodynamics influenced by strong morphodynamic responses at the inlet and navigation channel over the course of a decade (Olabarrieta et al., 2011; Stantec Consulting Services & National Fisheries Conservation Center, 2021), highlighting the need for more recent calibration measures. Recently, high-resolution satellite imagery (optical and radar) has been used to calibrate and verify flood models designed to study other regions severely affected by compound flooding (Gagnon & Quirós, 2020; Eilander et al., 2023; Masafu & Williams, 2024). Satellite-derived flood extent maps and flood predictions generated from a hydrodynamic model can be used in conjunction to document flooding in vulnerable communities, communicate hazard information, and monitor conditions in coastal Washington in a cost-effective way.

Innovative Scientific Approach

The objective of the proposed pilot project is to investigate the application of satellite-derived water surface extent products for numerical model validation and flood risk communication. We will address the following questions: 1) Can our model be calibrated and

validated using water/land surface classification derived from satellite images collected during flood events? and 2) How can this tool be of use for emergency management and planning agencies?

We have developed a high-resolution (20-50 m in estuary) hydrodynamic model (Delft3D-FM) to simulate past, present, and future coastal flooding in Grays Harbor and Willapa Bay. The model includes tides, winds and sea level pressure, waves, and river discharge, and produces maps and time series of relevant flooding variables such as water levels, inundation depth, and currents. Using the Dynamic Surface Water Extent product (DSWx) product from NASA's Jet Propulsion Laboratory Observational Products for End-Users from Remote Sensing Analysis (OPERA) project, optical (*released*) and eventually synthetic aperture radar (SAR) data (*late 2024*) from the Landsat and Sentinel satellites can be used to characterize water/land surfaces with 30 meter resolution. Optical imagery obstructed by cloud cover will be supplemented with radar imagery which is capable of penetrating cloud cover and capturing images at night. Recent and archived optical and radar images can be accessed through NASA's Earthdata collection and analyzed through their DSWx product.

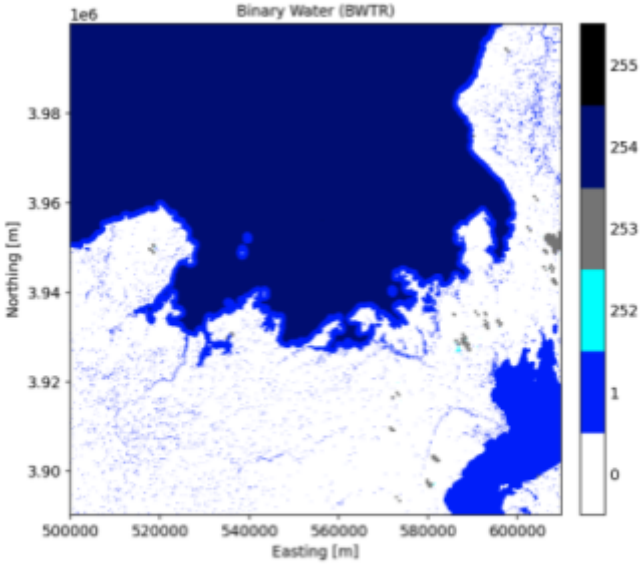


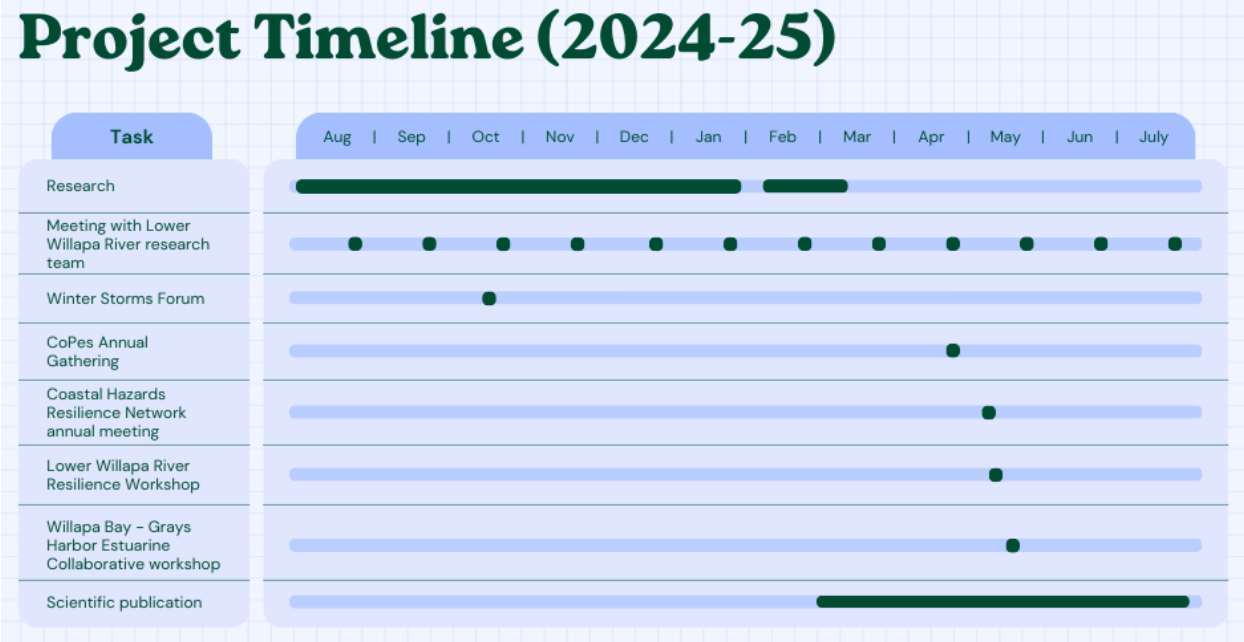
Figure 1: Binary water layer of the DSWx data product. Pixel values of 0, 1, and 254 correspond to not-water, water, and ocean masked classes respectively.

The first question will be addressed by identifying recent flood events (e.g., November 2021, December 2023) where sufficient satellite imagery is available and then simulating flooding conditions for those events using the numerical model. Resulting flood extent maps from the model and satellite product will be converted to binary masks following the method of *Masafu & Williams (2024)* and layered on top of each other to determine their agreement (e.g., Figure 1). Next, we will evaluate model skill with respect to flood extent prediction relative to the satellite-derived mask. This validation framework allows us to combine satellite-derived flood extent maps with modeled inundation depths and flooding currents to deliver more dependable products to communities. The second question will be addressed by leveraging Sritrairat's existing COHORT partnerships and attending multiple planned community engagement events that bring together coastal Washington Tribal and local communities, emergency managers, local governments, and state agencies. Our research team will have ongoing discussions with the NFWF-funded Lower Willapa River Resilience Project team, led by the Pacific Conservation District and Washington Sea Grant, and local COHORT's partners throughout the region to understand the community's priorities, modeling needs, and focus areas of interest. The local satellite-derived flood extent maps will be created and shared at existing community meetings (listed below). Sritrairat, through the COHORT process, will share the results with additional community members and agencies to extend the potential impact of this work.

Expected Outputs and Impacts

- A new framework integrating satellite-derived imagery (optical and radar) for validating flood model simulations.
- Attend the Emergency Management Division/COHORT's organized event, Winter Storms Forum, and engage with local and Tribal emergency managers, public works, planners, and other government agencies to develop partnerships and to understand what type of hydrodynamic forecast parameters might be useful for the community.
- Present results at the 2025 CoPes Annual Gathering.
- Attend the Coastal Hazards Resilience Network annual meeting hosted by the Department of Ecology and Washington Sea Grant and engage with researchers, state and federal agencies, consulting companies, local governments, and emergency managers.
- Develop flood extent maps to share and solicit feedback at existing community events, including:
    - One Lower Willapa River Resilience Workshop
    - One Willapa Bay - Grays Harbor Collaborative Estuarine quarterly meeting. The group consists of local, Tribal, state, federal, industry, and environmental organizations in Grays Harbor and Willapa Bay (Sritrairat co-convenes).
- Document the developed framework for validating a regional hydrodynamic model with the newly released DSWx product in a peer-reviewed paper submitted to an open access, high impact scientific journal.

Project Timeline



IDENTIFYING INFORMATION:

NAME: Hegermiller, Christie

ORCID iD: https://orcid.org/0000-0002-6383-7508

POSITION TITLE: Assistant Professor

PRIMARY ORGANIZATION AND LOCATION: University of Washington, Seattle, Washington, United States

Professional Preparation:

ORGANIZATION AND LOCATION	DEGREE (if applicable)	RECEIPT DATE	FIELD OF STUDY
United States Geological Survey, Woods Hole, Massachusetts, United States	Postdoctoral Fellow	09/2019 - 09/2021	Coastal Oceanography
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, United States	Postdoctoral Fellow	10/2017 - 09/2019	Coastal Oceanography
University of California, Santa Cruz, Santa Cruz, California, United States	PHD	08/2017	Ocean Sciences
Boston College, Chestnut Hill, Massachusetts, United States	BS	05/2011	Environmental Geosciences

Appointments and Positions

2023 - present	Assistant Professor, University of Washington, Seattle, Washington, United States
2021 - 2023	Senior Research Scientist, Sofar Ocean Technologies, San Francisco, California, United States
2012 - 2017	Doctoral Researcher, United States Geological Survey, Santa Cruz, California, United States
2010 - 2011	Research Assistant, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, United States
2008 - 2011	Research Assistant, Boston College, Chestnut Hill, Massachusetts, United States

Products

Products Most Closely Related to the Proposed Project

1. Olabarrieta M, Warner J, Hegermiller C. Development and Application of an Infragravity Wave (InWave) Driver to Simulate Nearshore Processes. Journal of Advances in Modeling Earth Systems. 2023 June 27; 15(6):-. Available from: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022MS003205 DOI: 10.1029/2022MS003205
2. Bao D, Xue Z, Warner J, Moulton M, Yin D, Hegermiller C, Zambon J, He R. A Numerical Investigation of Hurricane Florence-Induced Compound Flooding in the Cape Fear Estuary Using a Dynamically Coupled Hydrological-Ocean Model. Journal of Advances in Modeling Earth Systems. 2022 November 25; 14(11):-. Available from: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022MS003131 DOI: 10.1029/2022MS003131

3. Hegermiller C, Warner J, Olabarrieta M, Sherwood C, Kalra T. Modeling of Barrier Breaching During Hurricanes Sandy and Matthew. Journal of Geophysical Research: Earth Surface. 2022 March 21; 127(3):-. Available from: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021JF006307 DOI: 10.1029/2021JF006307
4. Sherwood C, van Dongeren A, Doyle J, Hegermiller C, Hsu T, Kalra T, Olabarrieta M, Penko A, Rafati Y, Roelvink D, van der Lugt M, Veeramony J, Warner J. Modeling the Morphodynamics of Coastal Responses to Extreme Events: What Shape Are We In?. Annual Review of Marine Science. 2022 January 03; 14(1):457-492. Available from: https://www.annualreviews.org/doi/10.1146/annurev-marine-032221-090215 DOI: 10.1146/annurev-marine-032221-090215
5. Erikson L, Espejo A, Barnard P, Serafin K, Hegermiller C, O'Neill A, Ruggiero P, Limber P, Mendez F. Identification of storm events and contiguous coastal sections for deterministic modeling of extreme coastal flood events in response to climate change. Coastal Engineering. 2018 October; 140:316-330. Available from: https://linkinghub.elsevier.com/retrieve/pii/S037838391730532X DOI: 10.1016/j.coastaleng.2018.08.003

Other Significant Products, Whether or Not Related to the Proposed Project

1. Houghton I, Penny S, Hegermiller C, Cesaretti M, Teicheira C, Smit P. Ensemble-based data assimilation of significant wave height from Sofar Spotters and satellite altimeters with a global operational wave model. Ocean Modelling. 2023 June; 183:102200-. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1463500323000410 DOI: 10.1016/j.ocemod.2023.102200
2. Hsu C, Hegermiller C, Warner J, Olabarrieta M. Ocean Surface Gravity Wave Evolution during Three Along-Shelf Propagating Tropical Cyclones: Model's Performance of Wind-Sea and Swell. Journal of Marine Science and Engineering. 2023 May 31; 11(6):1152-. Available from: https://www.mdpi.com/2077-1312/11/6/1152 DOI: 10.3390/jmse11061152
3. Houghton I, Hegermiller C, Teicheira C, Smit P. Operational Assimilation of Spectral Wave Data From the Sofar Spotter Network. Geophysical Research Letters. 2022 August 04; 49(15):-. Available from: https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022GL098973 DOI: 10.1029/2022GL098973
4. Hegermiller C, Warner J, Olabarrieta M, Sherwood C. Wave–Current Interaction between Hurricane Matthew Wave Fields and the Gulf Stream. Journal of Physical Oceanography. 2019 November; 49(11):2883-2900. Available from: https://journals.ametsoc.org/view/journals/phoc/49/11/jpo-d-19-0124.1.xml DOI: 10.1175/JPO-D-19-0124.1
5. Over J, Brown J, Sherwood C, Hegermiller C, Wernette P, Ritchie A, Warrick J. A survey of storm-induced seaward-transport features observed during the 2019 and 2020 hurricane seasons. [Preprint]. 2022. DOI: 10.31223/X5DP69

Certification:

I certify that the information provided is current, accurate, and complete. This includes but is not

limited to current, pending, and other support (both foreign and domestic) as defined in 42 U.S.C. § 6605.

I also certify that, at the time of submission, I am not a party to a malign foreign talent recruitment program.

Misrepresentations and/or omissions may be subject to prosecution and liability pursuant to, but not limited to, 18 U.S.C. §§ 287, 1001, 1031 and 31 U.S.C. §§ 3729-3733 and 3802.

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Karthik Venkataramani

Dr. Venkataramani is an expert in satellite remote sensing data and programming, with a robust background in applying machine learning and data science to environmental and geophysical challenges. His work spans atmospheric physics and earth observation, utilizing machine learning to enhance the utility of remote sensing data.

As part of the NASA Observational Products for End-users from Remote sensing Analysis (OPERA) project, Dr. Venkataramani has integrated machine learning and data science methodologies for mapping inland water bodies using optical and synthetic aperture radar (SAR) data. The overall goal of the project is to produce near-global analysis-ready data products at 30 m resolution from ongoing satellite missions. At the University of Washington, he applied machine learning techniques to refine digital surface models (DSM) generated from multi-view optical imagery. This involved harmonizing optical and LIDAR ground truth data, along with ancillary data like vegetation indices, to improve canopy height estimates and snow depth analysis. Dr. Venkataramani also contributed to developing teaching materials for the NASA Transform to Open Science (TOPS) program. He created open-source tools and repositories promoting the use of NASA data and cloud-based workflows for reproducible science and understanding climate change risks. Overall, Dr. Venkataramani's proficiency in satellite remote sensing data and programming makes him an asset in environmental monitoring, disaster management, and geophysical research. His contributions continue to advance our ability to monitor and respond to environmental changes effectively.

Ryan Chiu

Ryan is a graduate student in the Civil and Environmental Engineering Department at the University of Washington focusing on hydrodynamics driving flood events in Washington's coastal estuaries. For his Master's degree, he investigated spatiotemporal dynamics in estuaries and served on the Moro Cojo Slough Technical Advisory Committee in Central California.

As a member of the CoPes Hub Team 2, he is working on using a 2D hydrodynamic model to investigate drivers of compound flooding in Grays Harbor and Willapa Bay for previous storm events and future sea level rise scenarios. He plans to continue coastal hazards-related research and intends to use this pilot project to expand his network by engaging with researchers, consultants, and local agencies in the natural hazards community.

IDENTIFYING INFORMATION:

NAME: Sritrairat, Sanpisa

ORCID iD: https://orcid.org/0009-0001-3072-8954

POSITION TITLE: Community Engagement Specialist

PRIMARY ORGANIZATION AND LOCATION: University of Washington, Seattle, Washington, United States

Professional Preparation:

ORGANIZATION AND LOCATION	DEGREE (if applicable)	RECEIPT DATE	FIELD OF STUDY
Columbia University, New York, New York, United States	PHD	02/2013	Earth and Environmental Sciences
Columbia University, New York, New York, United States	MPHIL	05/2008	Earth and Environmental Sciences
Columbia Univeresity, New York, New York, United States	MA	05/2006	Earth and Environmental Sciences
Rensselaer Polytechnic Institute, Troy, New York, United States	BS	05/2004	Hydrogeology
Rensselaer Polytechnic Institute, Troy, New York, United States	BS	05/2004	Biology and Environmental Science

Appointments and Positions

2023 - present Community Engagement Specialist, University of Washington, Seattle, Washington, United States

2013 - 2019 Assistant Professor of Environmental Science, Mahidol University, Bangkok, Not Applicable, N/A, Thailand

2011 - 2013 Andrew W. Mellon Postdoctoral Fellow, Tishman Environment and Design Center, The New School, New York, New York, United States

2008 - 2010 Graduate Fellow, NOAA/National Estuarine Research Reserve, New York, Washington, United States

2005 - 2007 Graduate Fellow, Hudson River National Estuarine Research Reserve/NY Sea Grant, New York, Washington, United States

Products

Products Most Closely Related to the Proposed Project

1. Blalock J, Marcoe K, Countryman C, Sritrairat S, Corbett C, Miller I. Baker Bay and Grays Bay: 2024 Sea Level Rise Resilience Strategy. Washington Coastal Hazards Resilience Network. 2024 July. Available from: https://wacoastalnetwork.com/bay-to-bay-community-

based-coastal-resilience-action/

2. Punwong P, Sritrairat S, Selby K, Marchant R, Pumijumnong N, Traiperm P. An 800 year record of mangrove dynamics and human activities in the upper Gulf of Thailand. Vegetation History and Archaeobotany. 2018 July 01; 27. DOI: 10.1007/s00334-017-0651-x
3. Sritrairat S, Peteet D, Kenna T, Sambrotto R, Kurdyla D, Guilderson T. A history of vegetation, sediment and nutrient dynamics at Tivoli North Bay, Hudson Estuary, New York. Estuarine, Coastal and Shelf Science. 2012 May 01; 102-103:24-35. Available from: https://www.sciencedirect.com/science/article/pii/S0272771412000741 PMID: 0272-7714
4. Peteet D, E M, D PC, Sritrairat S. Environmental History of the Hudson River. Henshaw RE, editor. Albany, NY: SUNY Press; 2011. Linking uplands to the Hudson River. 407p.
5. Sritrairat S, Punwong P, Phusakulkajorn W, Udomchalothorn T, Sripinyowanich S, Palakit K, Suttiwong A, Pulnil P. Interdisciplinary Approach using Climate Model, Crop Models, and Public Outreach to Increase Agricultural Climate Change Resiliency: A Case Study from the Greater Bangkok. Ecological Society of America Annual Meeting; 2023 August; Portland, OR, United States. Available from: https://esa2023.eventscribe.net/fsPopup.asp?PresentationID=1276501&query=sritrairat&Mode=presInfo

Other Significant Products, Whether or Not Related to the Proposed Project

1. Mejía GA, Groffman PM, Downey AE, Cook EM, Sritrairat S, Karty R, Palmer MI, McPhearson T. Nitrogen cycling and urban afforestation success in New York City. Ecol Appl. 2022 Apr;32(3):e2535. PubMed PMID: 35044032.
2. Downey AE, Groffman PM, Mejía A, Cook EM, Sritrairat S, Karty R, Palmer MI, McPhearson T. Soil carbon sequestration in urban afforestation sites in New York City. Urban Forestry and Urban Greening. 2021 November; 65. Available from: https://id.elsevier.com/as/authorization.oauth2?platSite=SD%2Fscience&additionalPlatSites=GH%2Fgeneralhospital%2CSC%2Fscopus&scope v4&state=retryCounter%3D0%26csrfToken%3D390393f6-069a-4218-a91f-ac43ca045732%26idpPolicy%3Durn%253Acom%253Aelsevier%253Aidp%253Apolicy%253A 04139f5c-29b5-4b97-9aef-de6dd9bed76a
3. Han YM, Peteet DM, Arimoto R, Cao JJ, An ZS, Sritrairat S, Yan BZ. Climate and Fuel Controls on North American Paleofires: Smoldering to Flaming in the Late-glacial-Holocene Transition. Sci Rep. 2016 Feb 10;6:20719. PubMed Central PMCID: PMC4748283.
4. Kenna T, Nitsche F, Herron M, Mailloux B, Peteet D, Sritrairat S, Sands E, Baumgarten J. Evaluation and calibration of a Field Portable X-Ray Fluorescence spectrometer for quantitative analysis of siliciclastic soils and sediments. J. Anal. At. Spectrom.. 2011; 26(2):395-405. Available from: http://dx.doi.org/10.1039/C0JA00133C DOI: 10.1039/C0JA00133C
5. Xu CY, Griffin KL, Blazier JC, Craig EC, Gilbert DS, Sritrairat S, Anderson OR, Castaldi MJ, Beaumont L. The growth response of Alternanthera philoxeroides in a simulated post-combustion emission with ultrahigh [CO2] and acidic pollutants. Environ Pollut. 2009 Jul;157(7):2118-25. PubMed PMID: 19269074.

Certification:

I certify that the information provided is current, accurate, and complete. This includes but is not

limited to current, pending, and other support (both foreign and domestic) as defined in 42 U.S.C. § 6605.

I also certify that, at the time of submission, I am not a party to a malign foreign talent recruitment program.

Misrepresentations and/or omissions may be subject to prosecution and liability pursuant to, but not limited to, 18 U.S.C. §§ 287, 1001, 1031 and 31 U.S.C. §§ 3729-3733 and 3802.

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Budget:

	Requested amount
Salaries	
Other Personnel: Postdoc (1 months)	$6,760
Hub Trainee: PhD student (0.5 quarter)	$4,476
Fringe	
Other Personnel: Postdoc (1 months)	$1,528
Hub Trainee: PhD student (0.5 quarter)	$815
Supplies and Materials	$300
Equipment (over $2,000)	
Travel	$5,000
Graduate student tuition	$3,926
Participant Support Costs	
Other	$3,000
Total direct costs	$25,805
Indirect costs	$12,142
Total costs (indirect costs + direct costs)	$37,947

Budget Justification:

The budget will support one postdoc (Karthik Venkataramani; UW Civil and Environmental Engineering (CEE)) to identify satellite imagery aligned with recent and historic flooding events and create surface water extent maps using the DSWx product. It will also support one PhD student for 0.5 quarters to simulate flooding events using Delft3D-FM and conduct comparison analyses on the flood extent results.

Travel funds are requested for three trips to meet with the community in the Grays Harbor and Willapa Bay regions to discuss the product, generate potential community applications, and present our findings. Additional funds will be used to travel to the Winter Storms Forum and the CoPes annual gathering. Our first trip will be attending the Winter Storms Forum organized by the Emergency Management Division/COHORT in October 2024 to learn about community needs from emergency management and government agencies. The second trip will be traveling to Fort Worden, WA in April 2025 to present our findings to the Cascadia CoPes Hub. We will then attend the Coastal Hazards Resilience Network annual meeting in May 2025 and engage with researchers, state and federal agencies, local governments, and emergency managers whose work is focused on Washington-related coastal hazards. Our next trip will be attending the Lower Willapa River resilience workshop in May 2025 to learn about other coastal resilience projects and meet with community officials on how they can utilize our product. The final trip will be to attend the Willapa Bay - Grays Harbor Estuarine Collaborative workshop in May 2025 to share our product and solicit feedback from the community and local stakeholders.

Funds for supplies and materials will be used towards printing posters and communication maps for the workshops listed above. Lastly, funds are requested for publication fees to publish our work in an open access, high impact journal.

References:

Blalock, Jackson et al. (2022). Resilience Action Demonstration Project Final Report. https://doi.org/10.25923/ad7f-2p39

Eilander, D., Couasnon, A., Leijnse, T., Ikeuchi, H., Yamazaki, D., Muis, S., Dullaart, J., Haag, A., Winsemius, H. C., & Ward, P. J. (2023). A globally applicable framework for compound flood hazard modeling. *Natural Hazards and Earth System Sciences*, *23*(2), 823–846. https://doi.org/10.5194/nhess-23-823-2023

Masafu, C., & Williams, R. (2024). Satellite Video Remote Sensing for flood model validation. *Water Resources Research*, *60*(1). https://doi.org/10.1029/2023wr034545

Miller, I.M., Morgan, H., Mauger, G., Newton, T., Weldon, R., Schmidt, D., Welch, M., Grossman, E. (2018). Projected Sea Level Rise for Washington State – A 2018 Assessment. A collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, University of Oregon, University of Washington, and US Geological Survey. Prepared for the Washington Coastal Resilience Project.

Morgan, H., Mauger, G., Won, J., Gould, D. (2021). Projected Changes in Extreme Precipitation Web Tool. https://doi.org/10.6069/79CV-4233

Olabarrieta, M., Warner, J. C., & Kumar, N. (2011). Wave-current interaction in Willapa Bay. *Journal of Geophysical Research*, *116*(C12). https://doi.org/10.1029/2011jc007387

Stantec Consulting Services & National Fisheries Conservation Center. (2021). Twin Harbors Sediment Dynamics - Final Report. Washington Coastal Hazards Resilience Network. https://wacoastalnetwork.com/wp-content/uploads/2021/04/Twin_Harbors_Sediment-Study_Final_Report_20210226.pdf

Quirós, E., & Gagnon, A. S. (2020). Validation of flood risk maps using open source optical and radar satellite imagery. *Transactions in GIS*, *24*(5), 1208–1226. https://doi.org/10.1111/tgis.12637

Washington Sea Grant
University of Washington
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July 17, 2024

Dr. Christie Hegermiller
Department of Civil and Environmental Engineering,
University of Washington
160 Wilcox Hall, Box 352700
Seattle, WA 98195-2700

Dear Dr. Hegermiller,

I am writing on behalf of Washington Sea Grant to express our support for your CoPes Pilot Research Project Application entitled *"*Flood model validation through remote sensing and community engagement". If this proposal is selected for funding, it is Washington Sea Grant's intent to collaborate as outlined in the proposal.

This project will integrate innovative modeling methods with community engagement to allow a co-development of flood model and maps alongside local communities and decision makers. The resulting model and flood extent maps will be beneficial for communities in Grays Harbor and Willapa Bay for emergency preparedness, hazard mitigation, and resilience planning.
Washington Sea Grant has served the Pacific Northwest and the nation for more than 50 years by funding high quality marine research and working with communities, managers, businesses, educators and the public to advance regional understanding and sustainable use of ocean and coastal resources. Housed in the University of Washington's College of the Environment, Washington Sea Grant is deeply engaged in research, technical assistance, and outreach to inform coastal resilience on the Washington coast.

Washington Sea Grant has long-established community relationships and coastal resiliency efforts in the proposed study area in Southwest Washington. The proposed work will leverage an ongoing (2023 - November 2026) effort "Climate resilience along the lower Willapa River: design concepts for habitat restoration, water quality, and flood reduction," which is funded by the National Fish and Wildlife Foundation (NFWF) Coastal Resilience Fund and co-led by the Pacific Conservation District and Washington Sea Grant.

Washington Sea Grant welcomes the opportunity to participate with Dr. Hegermiller's research team in this effort and future projects.

Sincerely,

Kate Litle
Deputy Director