Developing Collaborative Solutions for Continental-Scale Integrated Water Prediction

COASTAL COUPLING COMMUNITY OF PRACTICE

Third Annual Coastal Coupling Community of Practice Meeting
May 10 - May 13, 2021

On May 10 - 13, 2021 nearly 100 participants gathered virtually for the third annual gathering of the Coastal Coupling Community of Practice (CC CoP). A full summary of the meeting is below.

Meeting Goal

The goal of the meeting is to maintain engagement between Federal agencies and model developers that supports collaborative solutions for continental-scale integrated water prediction. Day 1 will consist of a welcome, an opportunity to re-engage with your fellow. Community of Practice members, and presentations from keynote speakers. To maintain engagement and a tacit learning environment, participants will discuss technical model developments (Day 2) and data needs (Day 3). To continue the engagement efforts,participants will discuss how stakeholder requirements can drive model requirements (Day4).

Objectives

1. Review the community progress to date.
2. Review technical model progress.
3. Discuss the need for shared consistent data sets and efforts that are ongoing.
4. Discuss gathering stakeholder requirements and how to translate this into model requirements.
5. Discuss future opportunities for sustained engagement.

DAY 1: MONDAY, MAY 10TH

Tom Graziano, Welcome

- The Delivery of National Water Model (NWM) v3.0 in FY23 will be the 5th upgrade of the NWM and the first operational capability that is coupled with the ESTOFS and SLOSH models.
- OWP is working with their partners to re-architect the NWM to be modular, open source, flexible, model agnostic, interoperable, and use more current computational language.
- The NOAA Water Team (Tom Graziano, lead), NOAA Climate Team (Wayne Higgins, lead,) and the NOAA Weather Team (John Murphy, lead,) are working to draft the Weather, Water, Climate Integrated Five-Year Strategy, which will focus on six societal challenges: 1) Water availability and quality; 2) Extreme events and cascading hazards; 3) Coastal inundation; 4) Blue economy; 5) Space weather; 6) Greenhouse gas mitigation. This will be finalized in 2021.

Cayla Dean, Setting the Stage

- The goal of the Coastal Coupling Community of Practice (CC CoP) meeting is to maintain engagement between Federal agencies and model developers that supports collaborative solutions for continental-scale integrated water prediction.
- CC CoP Challenge**:** Coastal coupling of models through collaborative community engagement for integrated coastal solutions employing research, model development and application, data provision, observations, analysis, and service delivery
- CC CoP Near-term goal: Create a sustainable framework for engagement between scientists and modelers from the federal government and academia that supports collaborative solutions for continental-scale integrated water prediction
- CC CoP Long-term goal: Develop products and services that meet the needs of water resources managers, water suppliers, planners, and decision-makers that help to protect the lives and property of the 100 million people living in the coastal zone**.**

CC CoP Steering Committee

- **Trey Flowers, NOAA.** The challenge of coastal coupling of models is immense which is why it is yet to be accomplished at an operational level at NOAA. To achieve the goals, we truly need to to work together; this effort must span agencies and research-to-operations (R2O) pathways.
- **John Warner, USGS.** USGS continues to look at scientific capabilities and provide understanding of methods as modeling systems are developed. It is time to use methods that are consistent with the Unified Forecast System (UFS) as this will help with R2O challenges.
- **Chris Massey, USACE.** USACE focused on navigation and flood risk mitigation, storm surge, and wave modeling. USACE works with partner agencies to fill in gaps. Green engineering is becoming more important to provide flood protection (with dunes, estuaries, etc). Moving towards a community based approach will provide a comprehensive solution.

- **Rick Luettich, UNC.** Academic community has intellectual resources that can be helpful. And workforce at a key point in their career that can help connect to real-world issues. The summer institute is a wonderful opportunity for students and postdocs to build bridges.

Ed Clark, Coastal Coupling Community of Practice

- Congressional support for coastal coupling comes from the 2020 Coordinated Ocean Observations and Research Act which specifies that the NOAA shall: 1) initiate and lead research and development activities to develop operational water resource prediction and related decision support products; 2) collaborate with, and provide decision support regarding total water prediction; and, 3) collaboratively develop capabilities necessary for total water predictive capacity, including observations, modeling, data management, supercomputing, social science, and communications.
- The entities that will support coastal coupling include: the National Water Center; NOAA's National Hurricane Center; NOAA's Office of Coast Survey; the National Weather Service (NWS) Hydrology Program; the CC CoP; NOAA's Weather, Water, and Climate teams; and NOAA's Great Lakes Environmental Research Laboratory.
- The CC CoP is at the beginning of developing a new suite of services that are routinely delivered to communities along the coast and also provide impact based decision support during generational-defining events.

Mark Osler, Future of Water Prediction at Climate Timescales

- Our Nation's coasts are facing growing challenges that include economic impacts from sea ports; severe weather events; public health threats from harmful algal blooms; risks to real estate and infrastructure costs due to sea level rise and high tide flooding.
- Responding to these challenges will require accurate and authoritative data, modeling, mapping, and service delivery that aids to quantify and communicate both the drivers of coastal change and improve our understanding of present day and future risk at the coast.
- Within the next three years, NOAA will provide a one-way coupled national water model with ocean boundaries from 2D hydrodynamic ocean modeling; this will provide total water forecasts along the coasts and within rivers and streams out to 10 days.
- Demand for predictions beyond 10 days continues to grow. As the climate continues to change, a whole of government approach is needed to improve the science, integrate observations, produce coupled Earth models approaches to understand the variability and averages of extremes that drive coastal inundation, and produce actionable information across timescales at spatial scales that are useful to users.

DAY 2: TUESDAY, MAY 11TH

Aijun Zhang, NOS OFS Linking to NWM Products

- To support the NOS mandate to provide guidance and information to support navigation, NOS developed and operates a national network of 15 Operational Nowcast and Forecast

Hydrodynamic Model Systems (called OFS).

- Currently, all OFS rely on USGS real time observations for river inflow, which presents a challenge due to a lack of river forecast, missing data, or data delays.
- CO-OPS is looking to leverage the NWM products for NOS operational applications and has started to use NWM products for OFS river forcing conditions. Currently, the USGS data performs better than NWM products in NOS operational outputs. Results also show that modeled salinity results improve when more freshwater data from river forecast centers (RFCs) are included.

Camaron George, Total Water Level Prediction for the NWM

- The Hurricane Supplemental Coastal Team wanted to test multiple modeling strategies over multiple domains and multiple events to determine which is the best option for the team's purpose.
- The team identified SCHISM (Virginia Institute of Marine Science) and AdH (USACE) models as the best two options based on requirements for the project. Once that was done, the team set up selected model(s) for required small, mid, and large domains; chose Hurricane Sandy, Hurricane Florence, and Blue Sky Days as the events. Overall, SCHISM performed better compared to AdH.
- Forcing sources (freshwater from NWM; atmospheric from NWM; and oceanic from ESTOFS and P_SURGE) will be incorporated one at a time to determine which source is best for each forcing.

Fred Ogden, Next-Generation Water Resources Modeling System: A Community R2O Software Framework for Water Prediction

- The regional performance of the NWM shows significant variability. The primary literature shows that hydrologic models formulated for specific dominant processes consistently outperform general models, when appropriately applied. Models with fewer parameters that describe dominant processes outperform general models that emphasize process through parameter selection (i.e. parsimony). Advances will come by developing a framework that allows the evaluation of different models.
- NextGen will bring together and leverage advances in computer science, engineering, geoscience data, and hydrologic science. Results from the NWM 2.0 suggest that regional variation in performance suggests that regional formulations are appropriate, and optimizing complexity will speed simulation with increased predictive skill. The WaterML 2.0 Hy_Features data model allows for a model setup workflow unification, as well as providing a consistent method to couple models to a hydrofabric. Computer science advances can leverage open source development to make it easier for community engagement; provide a well-defined method to couple models with an Existing Basic Model Interface (BMI) coupling standard; and machine learning to speed advances.
- A joint meeting between USACE, USGS, BoR, NOAA developed requirements for the Next-Generation Water Resources Modeling Framework as well as interagency requirements, which are listed in the workshop slides.

Chris Massey, Compound Flooding: State of Practice, Current Issues and Advancements within the USACE

- The USACE supports a number of civilian and military applications in forecast and planning capacities. Forecasting is typically for military applications (OCONUS) while CONUS applications are typically for infrastructure operations (flood gates, etc.).
- Design of flood risk reduction measures/ structures in the coastal zone often require compound flood considerations. USACE links/couples models to understand and quantify risk around complex coastal storm hazards.
- There is a need for both loose and fully coupled (two-way dynamical coupling) coastal surge/wave and inland rainfall-induced flow models. Full coupling may only be needed in specific geographic and physical settings and for rapid forecasting needs. Present one-way coupled models may be good enough from an engineering perspective.
- There is a need to extend present compound flooding considerations to antecedent conditions as well as future conditions (e.g., climate change).

Meg Palmsten, Forecasting total water levels and coastal change hazards

- Local NWS Weather Forecasting offices partnered with USGS for guidance on wave-induced coastal erosion and flooding. USGS currently provides real-time, 6-day forecasts, every hour for dune erosion and dune inundation at the 500m resolution along the Atlantic coast and Gulf of Mexico.
- The USGS outputs are communicated to NWS forecasters through the AWIPS dashboard and to the public through the USGS total water and coastal change forecast website.
- USGS is actively working to expand to other areas and other environments besides sandy coastlines, including Alaska, marshes and estuaries in the Great Lakes, and coral-reef lined coasts.

PANEL DISCUSSION // Ehab Meselhe, David Welch, Ruoying He, Amin Kiaghadi

The panel focused on the technical modeling components specifically related to how the community can facilitate the integration of models and tools into an operational context as well as what operational modeling means to different members of the CC CoP.

What does operational modeling mean? Operational modeling is about providing timely information to decision makers to provide guidance to the community for safety, and the protection of life and property. Panelists noted that using multiple models is ideal to provide a consensus forecast, as this has more confidence compared to a single-model forecast. Reducing public confusion and providing a uniform message is key to maintaining confidence with the public around what information is being provided. Users need both synthesized information as well as raw model outputs, however it is a challenge to synthesize the information so it is useful and usable. Decision support is also key to ensure decision makers understand how to use the information.

How can we balance the need for uniform modeling frameworks versus having the simplest set of models for each region? It is important to distinguish between a uniform framework and modules that interface with the framework. A consistent, strong framework will allow modules to be added/removed (e.g. rainfall, storms surge, etc) as needed. There is a lot of regional variability, so making a single, National model is not practical; leveraging modules allows for flexibility, and for the heterogeneous specialization a region or issue requires. A modular approach also allows the external community to contribute by building or improving the code base of modules. Regions will need to do their due diligence by analyzing existing data to what processes are important for their modeling needs.

What would make working to improve the UFS attractive to the academic community? The academic community is excited and actively looking for effective ways to engage with the UFS. Enhancing the UFS community efforts requires improved communications with academics, as UFS is not widely known outside of NOAA. Another challenge is that the UFS is complicated and encompasses a wide range of topics; academics need to understand how to engage with such a large project. Offering graduate student assistantships, workshops, training, internships, summer institutes, and/or coding competitions would generate interest and mechanisms for the external community to engage with the UFS and potentially offer a value to NOAA. An example of this might be an OWP-led grad student competition. This also has the benefit of training the future workforce.

What is the role of Federal agencies vs. regional organizations for providing regional operational model support as well as resolution for which the models are intended to provide guidance? It is unlikely that regional organizations and universities will provide 24/7 operational support, however, they understand local needs and can play an important role building prototypes and regional models that interface with a uniform framework. These may be transitioned to Federal agencies to become operational. Having a uniform framework will provide the flexibility for the external community to develop regionally-specific modules. Improving communication between regional organizations and Federal agencies is also important. Regional organizations need to understand the strengths and weaknesses of Federal agencies and vice versa. It is in the public's best interest to have these tools and services seamlessly integrated.

Is there an opportunity for private industry to interface with the CC CoP and fill in gaps in the national-to-local resolution? Liability is important. It is unclear who is liable if the private sector or local organizations issue forecasts and evacuations. NOAA and NWS is experienced in communicating this information, and local organizations may not have the communication capabilities or decision support networks to be effective during an emergency.

DAY 3: WEDNESDAY, MAY 12TH

Rich Edwing, Integrated Water for Prediction and Information (IWPI) Gap Analysis Overview

- The purpose of the gap analysis is to identify the observations needed to meet the outcomes of the NWI, and it is being conducted in three phases: The first phase assesses gaps needed for NOAA user requirements; the second phase assesses gaps to produce products and services and connects back to observations; and the third phase is to prioritize and identify improvement strategies.

- Phase I found that there are 50 observational requirements fulfilled by observation systems, 5 requirements have their needs partially met, and 5 systems need improvement (60 total requirements). A total of 25 requirements identified as primarily fulfilled by models or databases - not just by observations.
- Preliminary results from Phase II are a ranked list of systems and products. The top ten systems that are found to support and to be most impactful, as well as top ten products that are found to be most impactful were presented. There is also a gap side, where observing capabilities need the most improvements for most impact, and which products as well should have improvements.
- The next steps for the Gaps Analysis is the complete Phase III.

Jeff Danielson, NOPP Task 1

- The National Oceanographic Partnership Program (NOPP) has four tasks: 1) digital elevation models; 2) remote sensing; 3) in situ measurements; and 4) wave/surge/sediment transport to update structure response forecasting.
- The objectives of the first task (digital elevation models) are to develop and maintain updated topobathy metric digital elevation models (TBDEMs), as well as work on coastal sediment and vegetation, as well as structures and infrastructures being characterized.
- A Three-tier approach is being adopted because of the extensive study area (Atlantic and Gulf Coasts). A high level review of the methods being used in Task 1 were presented, focusing on which databases are being used to develop the critical layers.

Dean Gesch, Coastal National Elevation Database (CoNED): Integrated Topobathymetric Models

- The USGS Coastal National Elevation Database (CoNED) Applications Project aims to support coastal and marine spatial planning by constructuring the CoNED at select focus regions and establish a topobathymetric elevation model baseline product for scientific investigation and applications.
- CoNED puts together geospatial data sources at high resolution for scientific modeling, and the modeling community is the major user of this data.
- A few examples where high resolution topobathy models are being used were presented, as were the gaps in data and other challenges. These include a lack of high-resolution bathymetry coverage in rivers and inland waterways, documented source data with reliable metadata, horizontal and vertical reference frame transformations and uncertainties, spatial interpolation and gridding, and migration to updated National Spatial Reference System (NSRS) and gravimetric-based geoid model (Conversion tools will be provided by NOAA NGS, but data volumes to transform existing archives will be extensive). The White Ribbon Zone (0-10m) is the most challenging to get this type of data.

Sadiq Khan, National Water Model Topographic and Bathymetric data needs

- An overview of existing topobathy datasets for a coupled NWM was provided. In addition to coverage gaps, Sadiq is analyzing how current the datasets are.
- Data gaps for the West Coast were highlighted. Data on the Pacific coast are mainly CoNED and NCEI, and the latest NCEI data is not available. The group is coordinating with USGS for more recent high-resolution data to fill these gaps.
- Another gap emphasized was for Maine, New Hampshire, and the upper Hudson river. The data is coarse resolution because the hydrodynamic model is less accurate and is unstable.

DAY 4: TUESDAY, MAY 13TH

Summary from Day 3 Breakout Sessions

- **What partnership(s) can be leveraged to fill data gaps related to integrated water?** State agencies; NSF; FEMA; USACE; regional river basin associations; local citizen scientists and national/big business (AWS, Google, Planet, Maxar); and interagency working groups; universities; and local governments.
- **What other gaps in data or needs exist that haven't been captured in the workshop?** Data that provides context coastal risk, such as infrastructure and reservoir management; data focused on underserved communities and social sciences; language and terminology given regional differences; understanding complexity around infrastructure and man-made impacts (e.g. dam operations and culverts); streamlining and sharing data seamlessly; realtime surface and subsurface ocean profiles; and ocean forcing data older than two years.
- **Of these gaps identified above, where do priorities lie?** Bathymetric data for calibration and validation; topo data; data that provides context for human impacts, infrastructure and socioeconomic vulnerability (stormwater, levees, floodwalls, culverts, etc.); creeks; and smaller rivers; language and communication; streamlining data automation and dissemination.
- **How will data gaps change as we start looking at water prediction on subseasonal-centennial timescales?** Approaches will need to be more interdisciplinary and integrated; more data exist with future timescales; products will need to be more probabilistic; improved decision support will be needed to communicate uncertainty; communication will need to be sensitive to regional and demographic differences; addressing local gaps and local instructure will need to be prioritized; and long-term timecast dataset (10-40 years) from ocean model outputs; information on human behavior and uncertainty; improved communication approaches.
- **What new technologies will help fill gaps?** Remote satellite/sensing technologies; uncrewed systems; artificial intelligence and machine learning; crowdsourcing; citizen science and crowdsourcing (high water marks, etc); drones; new data formats (e.g. Zarr); cloud computing/storage; and ground-penetrating radar.

Ellen Mecray and Miki Schmidt, A Model of Service Delivery for the NOAA Water Initiative

- The Service Delivery Framework was approved by NOAA's cross-Line Office Weather, Water, Climate Board and contains:
  - Vision: U.S. residents understand and use the breadth of NOAA's information for their decisions
  - Mission: NOAA will continuously build a network of trusted experts who engage internally and externally with partners to inform NOAA's product and service development to be useful, usable, and used
- Continuous engagement is the central element for successful service delivery.

- What does the Service Delivery framework mean for NOAA? 1) Coordinating and integrating NOAA contributions to understand needs and communicate with product and service developers; 2) Prioritizing investments in product lines, e.g., science (observations and data), services (technical assistance, engagement, training), and stewardship (resource management, place-based); 3) Developing new, and refining existing, products and services informed by user needs; and 4) Transmitting and translating actionable information for decision-makers across multiple sectors.

Mikaela Heming, From Research To Action: The Cooperative Model

- Co-development is defined here as: Researchers working collaboratively with science beneficiaries and end users from before the project starts and throughout application of the science to best fit the needs of end users
- The Cooperative model is built upon the approach to coastal resilience taken by the Sentinel Site Cooperative program, a NOAA-funded pilot program organized at the national level to interact directly with the science providers at NOAA across multiple offices and synthesize and provide that information in respective local needs. The Cooperative program recently implemented a transition into being hosted by their respective Sea Grants with local adjustments.
- The Cooperative model begins with understanding the science and user needs; the next step is facilitating conversations; the final aspect of the Cooperative model is success through application.

Melanie Lander, Applying Data and Models with the Community in Mind

- Sea Grant programs are based within Universities so that extension agents can literally ‘extend’ research into the hands of end users. Programs are embedded within the local community in order to identify their needs (e.g., long-term community planning, climate and ecological research, social science research to communicate more effectively).
- The project focus is around enhancing coastal hazard risk communication among underserved communities.
- Recommended best practices to communicate risk to underserved communities: Invest time in knowing the community; reach out to the community; be honest and transparent; empower the community; trust is a long-term process; evaluate the process.

Amanda Tritinger, Engineering With Nature

- Engineering with nature (EWN) supports the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaboration. Key elements include: Science and engineering that produces operational efficiencies; Using natural process to maximum benefit; Broaden and extend the benefits provided by projects; Science-based collaborative processes to organize and focus interests, stakeholders, and partners.
- This project works through: policy development; engagement, partnersing and teaming; research; on-the-ground projects and demos; and strategic communications.

- EWN wants to provide tools for success and for more innovative design. Fear of change, lack of trust, and/or policies may hinder new designs. EWN is developing a large-scale network to create a space for partners to better collaborate and discuss how to overcome common/similar challenges. They are also using past case studies to draft international guidelines for the use of natural and nature-based features. Another tool to help facilitate communication are the EWN atlases which include case studies at a distillable level.

Appendix A. Acronyms

Acronym	Term
AWIPS	Advanced Weather Interactive Processing System
BMI	Basic Model Interface
BoR	Bureau of Reclamation
CC CoP	Coastal Coupling Community of Practice
CoNED	Coastal National Elevation Database
CO-OPS	Center for Operational Oceanographic Products and Services
EWN	Engineering with nature
FEMA	Federal Emergency Management Agency
IWPI	Integrated Water for Prediction and Information
NCEI	National Centers for Environmental Information
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NOS	National Ocean Service
NSF	National Science Foundation
NSRS	National Spatial Reference System
NWI	NOAA Water Initiative
NWM	National Water Model
NWS	National Weather Service
OFS	Operational Nowcast and Forecast Hydrodynamic Model Systems
OWP	Office of Water Prediction
R2O	Research-to-operations
RFC	River forecast center
TBDEM	Topobathy metric digital elevation model
UFS	Unified Forecast System
UNC	University of North Carolina
USACE	United States Army Corps of Engineers

USGS	United States Geological Survey

Appendix B: Meeting Actions

Action	Lead	By When
Send publications and other community relevant announcements to the CC CoP Secretariat for addition to the website	CC CoP Members	
Brief the CC CoP leadership on the actions and outcomes from this annual meeting and identify areas where they may be helpful in moving forward with the needs identified	CC CoP Leadership Team	
Distribute the CC CoP Engagements Calendar	CC CoP Leadership Team	
Create webinar schedule for the year	CC CoP Secretariat	

Appendix C: Participants

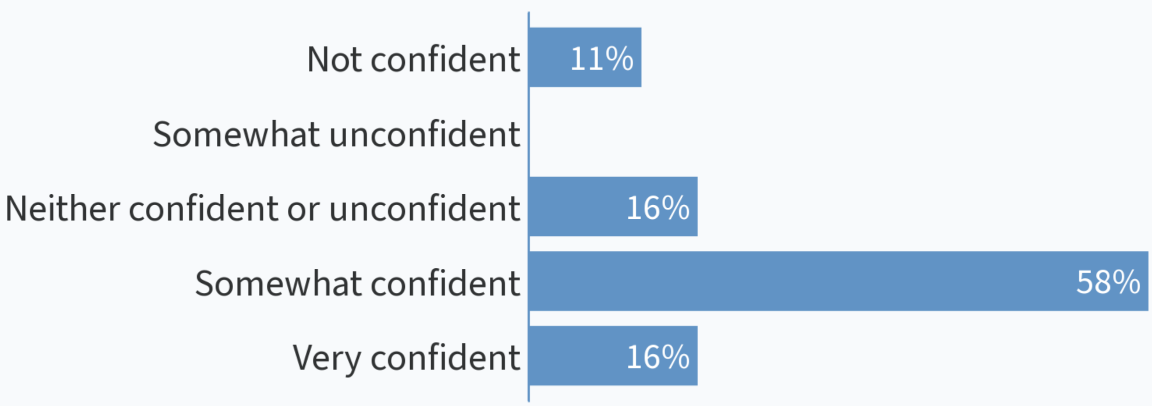
Aijun Zhang - NOAA
John Kelley - NOAA
Alexander Prusevich - UNH
John Ratcliff - UNC
Alfredo Aretxabaleta - USGS
John Warner - USGS
Ali Abdolali – NOAA
JS Allen - NOAA
Alison Macnell- NOAA
Joseph Zhang - VIMS
Amin Kiaghadi- TWDB
Julio Zyserman – NOAA
Andre Van der Westhuysen- NOAA
Jun-Whan Lee - VA Tech
Audra Luscher - NOAA
Juzer Dhondia - NOAA
Babak Tehranirad - USGS
Kai Parker -
Bob Vallario - DOE
Karen Bareford - NOAA
Brenna Sweetman - NOAA
Kendra Dresback - OU
Brant Priest - NOAA
Kristin Raub - NEU
Brian Blanton - UNC/RENCI
Kristine Mosuela - Wood PLC
Brian Cosgrove- NOAA
Kyle Mandli - Columbia
Camaron George - NOAA
Lauren Stewart – NOAA
Carl Gouldman- NOAA
Leah Fisher - California Strategic Growth Council
Carolyn Lindley - NOAA
Lei Shi - NOAA
Cayla Dean - NOAA
Li Erikson - USGS
Changsheng Chen - UMass
Lisa Auermuller – NOAA
Chris Ellis - NOAA
Lisa Lucas - USGS
Chris Massey - USACE
Liv Herdman - USGS
Daniel Sharar-Salgado - UDEL
Machuan Peng - NOAA
Daoyang Bao - LSU
Margaret Owensby - USACE
David Muñoz - NOAA
Mark Merrifield - Scripps
David Vallee - NOAA
Mary Culver - NOAA
David Welch - NOAA
Matt Bilskie - UGA
Dean Gesch - USGS
Meg Palmsten - USS
Debra Hernandez - SECOORA
Melissa Lupher - TWDB
Degui Cao - NOAA
Melissa Moulton – UCAR
Derrick Snowden – NOAA
Micah Wengren – NOAA
Dina Sang - NOAA
Mohammed Islam - USACE
Donald Johnson - NOAA
Mojgan Rostaminia - NOAA
DongHa Kim- NOAA
Murielle Gamache-Morris - Thrivner
Ed Clark- NOAA
Nels Frazier - NOAA
Ed Myers - NOAA
Noah Knowles - USGS
Ehab Meselhe - Tulane University
Pat Burke - NOAA
Ellen Mecray - NOAA
Pete Murdoch - USGS
Emanuele Di Lorenzo – Georgia Tech
Philip Chu - NOAA
Emily Landeen – NOAA
Phillip Orton - Stevens Institute
Eric Anderson – NOAA
Qi Shi - NOAA
Fred Ogden - NOAA
Ram Neupane - TWDB
George Xue - LSU
Richard Gibbs - NOAA
Gary Brown - USACE
Rick Luettich - UNC PAGE
Gregory Steyer - USGS
Ryan Grout - NOAA
Gustavo Coelho - George Mason University

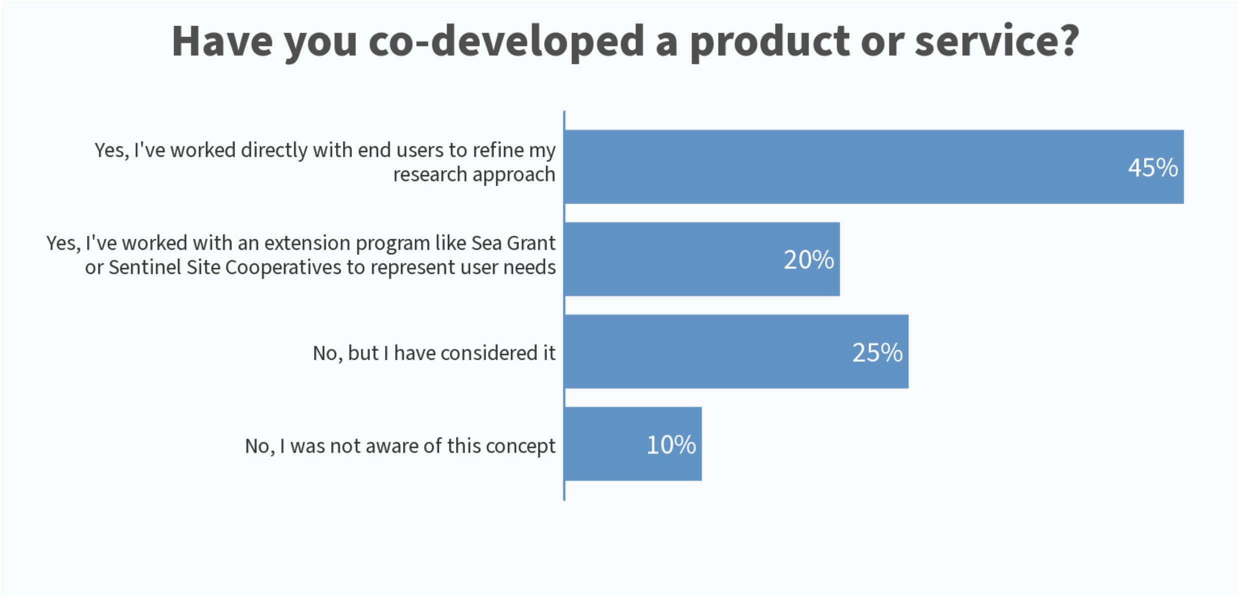
Ruying He - NC State
Hamed Moftakhari - UA
Sadiq Khan - NOAA
Hamid Moradkhani - UA
Saeed Moghimi - NOAA
Hassan Mashriqui - NOAA
Sam Rendon - USGS
Hendrik Tolman - NOAA
Seann Reed- NOAA
Henok Kefelegn – NOAA
Shachak Peeri- NOAA
Himangshu Das - JSUMS
Shintaro B -
Ilya Rivin - NOAA
Steve Dykstra - USC
Isaac Ginis - URI
Thomas Williams - Stevens Institute
James Kessler - NOAA
Tim Osborn - NOAA
Jason Ducker – NOAA
Tom Graziano - NOAA
Jeff Danielson - USGS
Tom Shyka - NERACOOS
Jena Kent - NOAA
Tracy Fanara - NOAA
Jennifer McGee – Wood PLC
Trey Flowers - NOAA
Jesse Feyen - NOAA
William Brooks - NOAA
Jiangtao Xu – NOAA
Yi Hong - NOAA
Jim McManus - UNC
Yongshan Wan - USF
Joe Salisbury - UNH
Yu Zhang - UT Austin

Appendix D: Poll Everywhere Q&A

From your perspective, which of these elements within the framework, are the most applicable to your work?

How confident are you in your understanding of what "co-developed" research looks like?





Who are your typical stakeholders?

- NOAA, communities, and disaster agencies
- NPS, USFWS, NFWF
- Coastal resource managers
- Across NOAA, Guam, to Alaska, to Puerto Rico, all services
- Federal agency and academic consumers, as well developer stakeholders
- State decisionmakers
- Communities, state agency managers, water management districts, local weather forecast offices (NOAA)
- Local, state and regional governmental agencies, other federal agencies, hydro power providers, water supply entities
- Municipalities _ State agencies _Counties
- Communities, other state agencies, USGS
- NOAA NOS and NWS

What are the limitations to innovative design?

- Priority and utility of potential designs
- Funding
- Regulations
- Lacking clear picture of your deliverable
- Fear of change
- Demonstrated lack of trust when others present new or challenging ideas
- Lack of true dev-test-prod environment
- Slow feedback cycle