Cooperative Institute for Research to Operations in Hydrology

FY26 Research Priorities and Project Request Questionnaires

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Introduction

CIROH's mission is to boost the delivery of actionable water intelligence. CIROH's research aims to contribute to the operational hydrology needs of users in NOAA, other federal agencies, local and regional governmental organizations, non-profit organizations, and commercial enterprises. CIROH's research accomplishments have been translated into operational benefits for those monitoring and predicting streamflow and other hydrologic variables, forecasting floods, monitoring drought and low flow conditions, operating reservoirs and other water infrastructure systems, planning and designing engineered systems, assessing water quality, and supporting water resources management decision making and risk communication.

Annually, CIROH develops new projects that complement its existing research portfolio and align with its four research themes:

1. Expansion and improvement of water resources prediction capabilities
2. Advancement and acceleration of community water resources modeling
3. Innovative hydroinformatics applications
4. Applying social science, economics, and impact modeling to strengthen decision support and build community resilience

The four research themes set the domain for CIROH's research priorities, partnerships, and collaborations. This document contains CIROH's FY26 research priorities and project questionnaires from NOAA Office of Water Prediction (OWP), National Ocean Service (NOS), and the USGS.

White papers are invited from researchers that are eligible to be principal instigators at a CIROH member or partner institution. White papers must respond to one or more research priorities or questionnaires. White papers must also complement CIROH's ongoing 150+ research projects and contribute to advancing CIROH's impact across its four research themes.

Details of completed and ongoing CIROH projects are available on the CIROH website. Description of CIROH's FY26 project development process, templates for white papers, submission instructions, and guidance for asking questions about the priorities and white paper process are available in accompanying documentation.

NOAA Office of Water Prediction Research Priorities

The NOAA OWP research priorities were developed with input from OWP staff, RFC DOHs, and NIDIS. The priorities also were informed by the consideration of research accomplishments reported in the 2025 CIROH Science Meeting abstracts. The OWP priorities are presented in the form of science questions organized into focal areas (FA). The FA ordering is based on alignment with research theme ordering. The FA and science question ordering does NOT reflect priority.

OWP-FA1. Forcings Selection/Evaluation/Preprocessing

- What are feasible approaches to improve probabilistic downscaling of CMIP6 and other similar gridded meteorological outputs?
- What are the impacts associated with Quantitative Precipitation Forecast (QPF) accuracy relative to the uncertainties in hydrologic modeling in the context of streamflow forecasting accuracy?
- What are the tradeoffs in forecast skill between adding meteorological models vs. adding hydrologic model complexity?
- How do different methods of precipitation frequency estimation impact flood risk assessments?
- Rather than relying solely on meteorological forecasting, can radar-informed nowcast forcing of parsimonious hydrologic models running in the NextGen Framework increase flash flood forecast skill for catchments smaller than 1,000 km^2?

OWP-FA2. Observations and Remote Sensing

- To what extent can emerging sensing technology and machine learning improve and expand hydrological forecasting to hyper-local scales?
- How accurately does satellite remote sensing of snow water resources contribute to hydrologic prediction?
- Which method is optimal for downscaling of remotely sensed soil moisture for validation of model/module performance?
- Can key reservoir variables be monitored in near-real-time by integrating wide-swath SWOT altimetry and deep learning techniques?
- Does a "Water Node" effectively utilize satellite products, applications, and services to inform decision-making in water prediction?
- Can the collection and application of hydrologic data be enhanced to improve operationalized weather and flood prediction in American Samoa?
- Can post-event flood inundation extent data collected via small Unmanned Aircraft Systems (sUAS) be used for forecast evaluation services?

- What observable features in LiDAR point clouds improve our ability to model the impact of hydraulic structures or other hydraulic features on channel routing and flood inundation?

OWP-FA3. Multi-model Mosaic/NextGen Framework

- What are the needed properties of a multi-model mosaic to provide the range of NWM outputs?
- What optimality criteria exist to aid in selection of multi-model mosaics?
- How can hydrologic process synthesis across diverse landscapes inform future National Water Model formulations using the NextGen Framework?
- How can the hydrologic forecasting capabilities of the NWM in the NextGen Framework be improved through integration with the UFS?
- What is the relationship between model complexity, structure, and land surface/forcing heterogeneities in Next Generation Water Resources Modeling?
- What are the primary factors limiting the forecast skill of modeling the hydrologic response to extreme precipitation events?
- What are the dominant observables for setting up models in the National Water Model in the NextGen Framework?
- What are the properties of a complete model definition for the NextGen Framework that maximizes modeler interpretation and formulation completeness while allowing verification against a perceptual model?

OWP-FA4. Cold Regions Hydrologic Processes

- What are the fundamental controls on the space/time distribution of snow water equivalent?
- How do cold region hydrologic processes influence ice-induced flood inundation patterns?
- How accurately do different NextGen snow process modules for possible use in the National Water Model represent snow accumulation, redistribution, and ablation processes for seasonal water supply forecasts?
- What are the key differences in process representations and predictive performance of water resources modeling frameworks in cold regions?

OWP-FA5. Hydrologic Drought/Low Flows

- What is the role of subsurface conceptualization in improving low-flow estimates in the NextGen Framework?
- How do precipitation, soil moisture, evapotranspiration, groundwater, or other relevant indicators influence hydrologic drought and/or low-flow events at different times of the year in different regions, to inform and improve hydrologic drought early warning and decision making?
- What are the most effective indicators for hydrologic drought early warning and decision making, and how do these indicators differ for a variety of sectoral impacts

(including, but not limited to: energy, navigation, manufacturing, hybrid entities (such as data centers))?

- How accurately do NOAA and USGS national-scale models characterize drought and groundwater-driven low-flow conditions, and how does accuracy vary with geographic extent, geology, watershed characteristics?
- Develop a U.S. Water Monitor product to complement the U.S. Drought Monitor to accurately monitor and display the hydrologic conditions across the United States.
- What is the relationship between floods and droughts, specifically how much rain does it take (including amount and duration) to ameliorate and terminate drought conditions and how does this differ spatially in the United States?
- What ecological low flow thresholds exist and how do they relate to hydrologic low flow indicators to strengthen monitoring efforts for hydrologic drought early warning and decision making?

OWP-FA6. Total Water Level Predictions

- What are the key drivers of forecast uncertainty in riverine-coastal systems?
- Is there an optimal method for operational compound flood forecasting?

OWP-FA7. Flash Flooding

- What methods increase the reliability of flash flood forecasts in small (<1,000 km^2) watersheds?
- How can a National Water Model configuration be defined that operates on a sub-hourly time step with sub-hourly latency in order to provide real-time rapid onset flood predictions?

OWP-FA8. Flood Inundation Mapping/Hydraulics

- How does the skill and efficiency of low-complexity Flood Inundation Mapping (FIM) models compare to more complex models? Under what conditions is more complexity warranted?
- What are the fundamental limits on the accuracy of dam and levee breach modeling?
- Does improved representation of floodplains and natural features enhance channel routing in the National Water Model?

OWP-FA9. Calibration/Evaluation

- Is the CIROH-funded Tools for Exploratory Evaluation in Hydrologic Research (TEEHR) effectively accelerating research to operations?
- What are the features/capabilities of a general NextGen Evaluation Manager that aid the research community?
- Which NextGen framework modules improve performance for the cases of fluvial and pluvial flooding?
- To what degree does locally-biased forcing data affect national-scale model calibrations and the corresponding regionalizations, retrospective simulations, and forecast accuracy?

- Can a multi-step/multi-objective calibration process improve NWM calibration outcomes? (e.g. (1) first calibrate parameters to create a good seasonal water balance, (2) followed by parameters to partition baseflow and surface runoff, (3) followed by parameters that influence fast response runoff)

OWP-FA10. Ensemble Forecasting

- Does gridded precipitation post-processing improve the prediction of extreme precipitation events in Ensemble Streamflow Forecasts?
- Does multi-source hydrologic ensemble augmentation improve forecast accuracy in CHPS-HEFS systems?
- What factors contribute to the accuracy and reliability of ensemble streamflow forecasts in both NextGen and the Hydrologic Ensemble Forecast Service?

OWP-FA11. Data Assimilation

- What is the impact of different data assimilation techniques on streamflow prediction accuracy?
- Do statistical and AI methods provide a significant advantage in generating meteorological forecasts that increase the probability of detection and reduce the false alarm ratio for streamflow prediction?
- How can operational assimilation of observations address the inherent limitations of forecast models running in the NextGen Framework?
- Does enhanced data assimilation and fusion significantly improve operational hydrologic forecasting capabilities in the NextGen Framework?
- Which probabilistic post-processing and data-assimilation techniques increase the reliability and overall skill of streamflow ensemble forecasts generated by the NOAA NextGen Water Resources Modeling Framework across the range of U.S. hydrologic regimes?
- How can DA be used to increase the efficiency and accuracy of CHPS-based RFC forecast workflows?

OWP-FA12. AI/ML

- To what extent can machine learning improve the representation of physical processes within hydrologic models?
- Can ML-based tools aid in evaluation of flood inundation extents?
- Can physics-informed machine learning accurately map compound floods?
- Can a machine learning model accurately predict river temperature and other water quality parameters across different scales?
- Do super-resolution precipitation and data fusion using deep learning techniques offer opportunities to improve operational flash flood forecasting involving pluvial events?

OWP-FA13. Data and HydroInformatics

- Does intelligent data analytics and communication cyberinfrastructure effectively support research to operations in hydrology?

- To what extent do modernized standards and tools facilitate the sharing and integration of real-time hydrologic observation data?
- What are the features of a hydrofabric for continental scale hydrologic, hydraulic, and FIM predictions and what are its optimality constraints?
- Does a general hydrofabric exist, or do its properties differ based on the intended use/purpose of the hydrofabric?
- What novel geospatial architectures can be developed within the OWP Hydrofabrics?
- Do data methods support high-bandwidth data queries for evaluation?
- Does a national cyberinfrastructure framework effectively engage the hydrologic community?
- Do big data approaches enhance NWM streamflow access?
- Can a unified Alabama Mesonet effectively support climate-, fire-, and weather-related decision-support?
- Do AI-augmented immersive digital twins and visual analytics frameworks provide valuable insights for hydrology?
- Does collaboration through data and model sharing with CUAHSI HydroShare effectively advance hydrologic research?
- Can CUAHSI HydroShare be modernized to meet the evolving needs of the hydrologic community?
- What infrastructure is necessary to support the NextGen National Water Model and the commercialization of derived products?

OWP-FA14. Decision Support and Engagement

- Can modeling and forecast product delivery be improved for agricultural lands?
- Does audience segmentation improve flood inundation mapping engagement and testing?
- Does science communication research optimize flood warning information sharing for local stakeholders?
- To what extent do coastal nature-based solutions mitigate flood impacts and enhance resilience?
- Does the use of unit discharge (discharge per unit area) promote the ability of forecasters to more rapidly detect events that aid in understanding of flood risk?
- What are the risks associated with the use of NWM retrospective flow exceedance statistics in terms of flood warning production?
- Do suitable techniques exist to estimate flow exceedance statistics at ungauged locations?
- What NWM model output features enhance situational awareness and promote effective warnings?
- How can forecasting effectively inform reservoir operations to balance flood risk reduction and water conservation?
- Can a framework effectively connect forecast system investments to the economic and societal value of forecast improvements?
- Can nationally consistent coastal flood severity thresholds be defined?

- Are there effective methods to identify and reach at risk communities in experimental FIM areas?
- What factors influence decision-makers' and public risk perception and information-seeking behaviors related to water quantity in the Southeastern U.S.?
- To what extent can models formulated using the NextGen Framework support community resilience planning?

OWP-FA15. Community and Education

- Do Community NextGen and NextGen In A Box (NGIAB) effectively pave the pathway to operations?
- Does community accessible development of the Nextgen Water Resources Modeling Framework promote advances within the CIROH Research to Operations Hybrid Cloud?
- What is the role of the National Water Center Innovators Program CUAHSI Summer Institute in education and outreach and future workforce development? How might it be improved?

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NOAA National Ocean Service Research Priorities

Point of Contact: Dr. Rebecca Atkins, rebecca.atkins@noaa.gov. Questions about the NOS research priorities may be sent directly to Dr. Atkins.

The NOAA NOS research priorities were developed with input from NOS staff and OWP. The NOS priorities consider ongoing NOS-funded projects (funded through CIROH and in other ways) and ongoing CIROH projects. The NOS priorities are presented in the form of FA descriptions. The FA ordering does NOT reflect priority.

NOS-FA1. Assess Effectiveness of Total Water Level Visualizations & Conduct User Testing of Compound Flood Products

Collaboration across NOS offices on stakeholders and products would be beneficial for improved flood risk communication to coastal communities. This research would leverage the needs and resources across multiple NOAA programs and offices to improve coastal inundation service delivery to ensure clear messaging and maximize impact for coastal resilience.

NOS-FA2. Assessing the National Water Model Coastal Total Water Level Forecast Skill with a Focus on Waves

The United States Geological Survey includes waves in total water level calculations to address setup and overtopping. As work on the National Water Model continues, it becomes more important to understand the wave impacts on water levels in the transition zone. The aim of this project is to compare the NWM output to waves and storm surge observations such as the data available on the Flood Event Viewer to assess the NWM forecast skill. An ideal period of evaluation would include 2024, with a specific emphasis on hurricanes Helene and Milton. The first priorities in the NOAA Coastal Coupling Community of Practice Roadmap for the Total Water Level Working Group are looking at the role of waves on total water levels at the shoreline and comparing with observational data.

NOS-FA3. Assessing and Optimizing Dynamical Downscaling for Sub-seasonal to Annual Coastal Inundation Forecasting

This project aims to improve coastal flood forecasts by dynamically downscaling a numerical model. It will use NOS's Operational Coastal Ocean Models (e.g. STOFS-3D-Atlantic) and long-range atmospheric forecast models to create a high-resolution ensemble of forecasts. The team will assess the accuracy of these predictions and compare them to simpler statistical methods to determine the benefits of this complex downscaling approach. To create a more efficient two- and three-dimensional ensemble model, the project will also evaluate optimizing GPUready code, automating mesh refinement, and improving connections to inland hydrology. The ultimate goal is to enhance long-range predictions of coastal sea level height and high tide flooding.

NOS-FA4. High-Resolution On-Demand 3D Modeling for Coastal Emergency Response
Our current basin-scale, unstructured Ocean basin-scale 3D coastal ocean forecasting systems (e.g. STOFS-3D-Atlantic), are effective for large areas but often lack the fine-scale, localized data needed for emergency response applications like search and rescue or oil spill tracking. While these models can achieve meter-scale resolution in specific waterways, the rest of the domain remains coarse. To close this critical gap, we require efforts to leverage the successful OCSMesh package to develop a method for the rapid, on-demand generation of high-resolution unstructured 3D models. This will allow us to provide detailed 3D circulation modeling data precisely where it's needed, directly benefiting emergency responders, coastal survey teams, and water quality specialists. By enabling more accurate and timely forecasts, this project will lead to more effective emergency responses and enhanced protection for our coastal communities and ecosystems.

NOS-FA5. Towards a Cook Inlet Ecosystem Forecast Supported by STOFS-3D-Alaska
To support the study of harmful algal blooms (HABs) and other crucial bio-geochemistry applications in Alaska's inland-coastal ecosystems, this project will expand the existing STOFS-3D-Alaska system to Cook Inlet. The system currently being developed to integrate coastal ocean, wave, and sea-ice models in Bering Sea. This project aims to extend the system's circulation capabilities and develop a crucial bio-geochemistry application to address the HABs issue. This effort will also explore new frontiers in NOAA modeling, including the integration of high-resolution sea ice and inland water exchange. The ultimate goal is to accelerate the development of a unified forecasting system for this vital Alaskan ecosystem.

NOS-FA6. Evaluating flood mitigation performance of Natural Infrastructure (NI)
A lack of understanding of the performance of natural infrastructure (NI) prevents its use within flood mitigation schemes. Projects can alleviate this through advancing compound flood models capable of predicting shoreline change and the vulnerability of coastal communities, infrastructure, and ecosystems during a range of storm and sea level scenarios. Modeling should operate compound flood models at a resolution to deliver information that can inform project implementation in partnership with coastal decision-makers. Project outcomes should support long-term resilience by informing land management actions and policy strategies that marry traditional ("grey") and NI designs, ideally incorporating intended users into the project.

NOS-FA7. Improve Temperature and Salinity Performance in Coastal Ocean Models to Advance Guidance and Forecasting at the Coast
Salinity and temperature extremes and variability present critical environmental and socio-economic challenges. These phenomena, driven by sea level rise, reduced freshwater flow, and drought, can severely impact local livelihoods by degrading water quality for agriculture, aquaculture, drinking, and industrial use. Comprehensive research employing three-

dimensional coastal ocean circulation models (e.g., harmful algal blooms in the Great Lakes, salinity forecast guidance in Lake Pontchartrain or Lower Mississippi salt wedge dynamics, etc.) that resolve temperature and salinity, including inland hydrology (e.g., groundwater, river inputs, and precipitation), is crucial for developing adaptive strategies and mitigating the adverse effects of ecosystem change. This project will seek to improve the performance of simulated salinity and temperature at the coast and to provide a technically informed strategic direction for the suite of operational forecast systems that can sufficiently simulate three-dimensional temperature and salinity values in the coastal ocean.

NOS-FA8. Evaluating the Impact of Updating the Hydro Fabric on National Water Model Total Water Level Forecast Skill

Models require accurate digital elevation models (DEMs) to skillfully forecast complex flooding events. Even high quality, integrated DEMs leave out the smaller rivers and streams, which serve major flooding corridors. Often missing data is obscured in DEMs and replaced with bathymetric values resulting from hydroflattening (where water surface elevations appear to represent bathymetric elevations). The focus of this project is to update a portion of the NWM hydro fabric to more accurately reflect river and stream bathymetry and then test the current and updated NWM versus available observational data for several historical flooding events. The state of North Carolina has invested heavily in hydraulic models (HEC-RAS) of its rivers and streams (North Carolina Flood Risk Information System; https://fris.nc.gov/map/). Grimley and Sebastian (2025; https://doi.org/10.17603/ds2-mzc8-s589), and Grimley et al (2025; https://doi.org/10.1029/2023WR036727) have created a DEM of the rivers and streams in North Carolina that can be used to create a revised version of the NWM hydro fabric for this study. This project should evaluate the effects of the revised hydro fabric on NWM results for Hurricane Florence (2018), for which there is a reasonable set of water level gauge and high water mark observations and at least two additional storms.

NOS-FA9. Advance the Coastal Ocean Reanalysis to Version 2.0

To support the study of coastal flooding at subseasonal to decadal time frames and continue improving spatial scale of products and services, this project aims to update the Coastal Ocean Reanalysis (CORA) to version 2.0 for the Gulf and East Coast (GEC) up to 2025. CORA is a high-resolution coastal water level reanalysis that reconstructs historical sea levels and also simulates occasional inundation of normally dry land (i.e., coastal flooding). This project should focus on investigating other physical parameters that would improve the model skill. We seek expertise to investigate improving and updating CORA-GEC through any of the following; improved bathymetric data, integration of vertical land motion, inclusion of tropical/extratropical influences (historic and/or synthetic simulated storms), inclusion of freshwater discharge and high frequency oscillations in addition to wind wave including infragravity waves, and distant swell and harbor seiches. The work should result in improving model output and updating this critical historical coastal modeled data set. The ultimate goal is to maintain and advance the CORA-GEC and support further development of flood risk assessment and planning products and services.

NOS-FA10. Validating coastal flooding characteristics of Coastal Ocean Reanalysis using AI to analyze citizen science and remote sensing data

This project leverages artificial intelligence (AI) to analyze citizen-science photo archives, and satellite imagery or other remote sensing data, particularly for Pacific Islands and Alaska, to validate coastal flooding characteristics simulated by NOAA's Coastal Ocean Reanalysis (CORA). CORA is a high-resolution coastal water level reanalysis that reconstructs historical sea levels and simulates occasional inundation of normally dry land (i.e., coastal flooding). However, large-scale validation of flooding events in CORA remains a challenge. This project will address that gap by using AI-generated descriptions of archived citizen-science photos and remote sensing observations to systematically classify observed flooding events and compare them with CORA-simulated flood occurrences. The ultimate goal is to advance the CORA and support further development of flood risk assessment and planning products and services.

USGS Research Priorities

The USGS research priorities were developed with input from USGS scientists. The USGS priorities consider ongoing USGS-funded CIROH projects. The USGS priorities are presented in the form of FA descriptions. The FA ordering does NOT reflect priority.

Research Theme 1: Expansion and Improvement of Water Prediction Capabilities

The USGS Water Resources Mission Area (WMA) is developing the National Water Census (NWC), which will provide on-line model results for water quantity, quality, and use components of the Nation's surface and ground water, in a supply and demand context. When fully realized, the NWC will provide information on past conditions over multiple decades, updated information on current or near-current conditions, and forecasts of future conditions in the short and long term. While the timeline and components delivered differ from the mission of the NWS, there is potential for overlapping research needs in Research Theme 1.

The Water Observing Systems Portfolio (WOSP) encompasses Programs that aim to carry out the WMA's objectives to collect, manage, and disseminate consistently high-quality and reliable water information in real-time and over the long-term. The primarily overarching priorities of the WOSP are the following:

1. Strategically enhance and expand the spatial and temporal collection of high-quality water observations to address national and local needs; and
2. Sustain and evolve secure enterprise data systems to manage operations and ingest, process, store, and deliver high-quality water observations

The following research focal areas provide an overview (organized by the individual science programs of the WOSP) of the research topics that are of specific interest to advance the objective and overarching priorities for the WMA-WOSP.

USGS-FA1. Next Generation Water Observing System (NGWOS) Program

The NGWOS program designs and implements water observation networks in targeted basins across the Nation by the USGS to provide high-fidelity, real-time data on water quantity, quality, and use necessary to support National modern water resource availability prediction and decision support systems with lower uncertainties, and rapid and informed hazards response. The NGWOS program is also the research arm of the WOSP tasked with developing new and innovative techniques, methods, and instrumentation using Technology Readiness Levels and Product Maturity Levels as frameworks for eventual migration into our National monitoring networks. Research priorities for NGWOS include:

- Establishing Electrical Engineering students at the HIF and develop curriculum around sensor innovation/design, power systems, telemetry /IoT technologies and autonomous vehicles.

- Developing Smart Gaging Network approaches and technologies targeting deployment at the national, regional, or local scales and could include the following:
    - Technologies that support the seamless data collection, integration and delivery of data from mobile assets (drifters, autonomous underwater vehicles, rapid deployment gages) with our fixed site networks;
    - Technologies for increased spatial and temporal coverage through improved integration of IoT sensors at or near USGS fixed sites which may include mesh networks and custom 5G networks;
    - Systems designed using MQTT data, command/control, and integrated edge-computing capabilities;
    - Technologies that increase edge computing capabilities on dataloggers at the gages or within a network of gages that may include artificial intelligence / machine learning (AI/ML);
    - Improved infrastructure for the rapid integration of new sensors and/or platforms.
- Remote sensing research, focusing on the following:
    - Autonomous systems for measuring water properties, including aerial, surface and underwater vehicles
    - Radar analysis (including InSAR) for monitoring hydrologic variables that is broad enough to include crustal motion monitoring for infrastructure resilience and datum integrity
- Specific priority areas of instrumentation R&D:
    - Wireless sensors (specifically rain gages) integration with traditional datalogger technologies

USGS-FA2. National Hydrologic Monitoring (NHM) Program
Through the National Hydrologic Monitoring (NHM) program, the USGS WMA operates, modernizes and strategically expands its streamflow, groundwater and water-quality monitoring enterprise to provide impartial, timely, rigorous, and relevant data for short- and long-term water decisions by stakeholders across the United States. Research priorities for NHM include:

- Advanced computing applications to support data-driven maintenance and guidance on needed measurements at USGS monitoring stations
- Research and testing of various observational data uncertainty analysis approaches
- R&D into display of data uncertainty on USGS monitoring location pages.
- Research associated with automated water data records processing algorithms
    - Automated estimation techniques for filling in gaps in timeseries records for streamflow and water quality parameters
    - Automated anomaly detection for timeseries records for streamflow and water quality parameters
    - Automated shifts (e.g. sensor drift or fouling) for timeseries records for streamflow and water-quality parameters

Research Theme 3: Innovating Hydroinformatics Applications

Research Theme 3 is an area where there is already some collaboration with NWS and USGS and there should be plenty of opportunities to build off or leverage this research theme to advance USGS goals more broadly, especially in terms of advanced tools and technologies, services, and compute resources. The USGS could benefit from the application of data fusion to obtain more accurate or complete water datasets at varying scales. Two data types of interest are bathymetry and river corridor geometry and characteristics, leveraging USGS datasets in addition to other datasets available from governmental or academic institutions. Another beneficial area of hydroinformatics research would involve application of the Internet of Things (IoT) concept of a "digital twin" as related to stream gages and other environmental monitoring locations of interest. This area of research has the potential to make improvements in the operation and systems understanding of such monitoring locations.

USGS-FA3. National Water Information System Modernization Program

The current version of Water Information System (NWIS) is inflexible, suffers from extensive technological debt and is at increased risk of system failure because of aging infrastructure. There is a need for a modernized NWIS to support a robust, authoritative enterprise water information system to advance the Water Mission Area priorities and meet the needs of USGS and WMA stakeholders. The focus of the NWIS Modernization program is to provide the necessary improvements to NWIS. Research priorities associated with NWIS Modernization include:

- Research around automated records processing algorithms
- Advancements in image processing and edge computing for imagery
    - Design and test Internet of Things (IoT) sensors and edge computing resources which collect imagery and/or video
    - Design and test of novel Unoccupied/Uncrewed (UAS) platform, sensor packages, and techniques which utilize remote sensing data in new ways.
    - Design a machine learning "gamification" project to build-well labeled and/or segmented imagery data sets using USGS monitoring station imagery data utilizing public involvement in data production (through playing the game).
    - Test citizen science contributed imagery research to determine if it is feasible to include an publicly supplied "scientific imagery" resource as valid hydrologic data.
- Software development capacity (anything from full-stack development to simple scripting)
- Hydroinformatics
    - Advancing standards for water data models (e.g., WaterML, Hydrologic Features) and the way in which they are applied in modern software (standard exchange methods or service patterns)
    - Research to advance the internet of things for water monitoring

USGS-FA4. LiDAR Processing to assist with determining flood impacts

Currently, flood impacts are surveyed; however, there is growing interest in using Light Detection and Ranging (LiDAR) data to obtain location and elevation of the flood impact locations. Research is needed to compare the accuracy of LiDAR to acquired point location and elevation of the lowest bridge driving surface elevation (bridge deck) and bridge low-steel (low-chord) utilizing two different bridge extraction scripts develop by (1) University of Texas and (2) National Weather Service. The bridge extraction scripts will be compared to actual field survey and the USGS Elevation Point Query Service. Such research will prove/disprove the validity of using LiDAR data in lieu of actual surveyed data to acquire location and elevation of critical infrastructure features such as bridges and roads for the purpose of the USGS Real-time Flood Impact Map. The USGS Real-Time Flood Impact Map displays the locations (called "Flood Impact Location") where the USGS measures the height of critical safety or infrastructure features that may be vulnerable to flood impacts. Some examples of flood impacts include the stream and river embankment; roads and bridges; pedestrian paths; buildings; and more.