BUREAU OF RECLAMATION

FY 2021 Science and Technology Research Projects

Snow depth estimation using InSAR (Interferometric Synthetic-Aperture Radar) Technique: $29,885

The purpose of this research is to evaluate the feasibility and effectiveness of using the InSAR technique as a tool for measuring seasonal snow depth and inform snow-melt water resources for the Reclamation water information system. Snow depth estimation is a critical component for quantifying seasonal Reclamation water resources at reservoir areas, expanding the use of the hydrologic database across Reclamation regions, assisting other water facility operational decisions for hydrological applications with real-time data, and informing recreational reservoir water users of reservoir water conditions. This research is aimed at evaluating the feasibility and value of using the InSAR technique to increase the detection accuracy of snow depth and density, quantify seasonal snow-melt water resources, and improve accuracy into river and reservoir operations models to better inform water allotments and planning efforts. The proposed research could provide an alternative snow depth estimation approach to the Reclamation water resources area offices and other agencies. Since InSAR data and the time-series analysis results will be periodically collected, this information could provide valuable information to Reclamation in snowmelt water resources evaluation in the future.

Development and Refinement of Rotor Turning Device for Safer and More Efficient Maintenance and Diagnostic Tasks: $77,500

This project will develop a full-scale prototype for electrically turning rotors in the field and further advance the software for autonomous switching of the turning equipment, as well as simplify the connection setup of the equipment. Such advancements toward a final product would allow for ubiquitous adoption of this technology across Reclamation regions and facilities.

A Collaborative Stochastic Weather Generator for Climate Impacts Assessment: $47,080

Stochastic weather generators provide opportunities to simulate weather conditional on a multitude of variables and form a robust complementary approach to climate projections in impacts assessments studies. Though weather generators have been prominent in the literature and have demonstrated varied applications including climate impacts assessments, they don't appear to be a dominant approach that is regularly used in climate impacts assessments. A weather generator was used for a climate impacts assessment study in the Lower Santa Cruz River Basin in Arizona. This research project will help make this weather generator more broadly usable by adding functionality so that users can process climate projection data and define seasons based on their knowledge of

updated understanding of seasonality from a changing climate or defining seasons as a suite of scenarios; documenting the tool and publishing the methodology in a peer-reviewed journal; and developing a package for the widely used statistical computing platform R – suggested package/library name, rwxgen. This peer reviewed methodology and resulting tool (R-library, rwxgen) will support informed use of weather and climate data in water management applications under a changing climate.

Hoover Dam Cylinder Gate: Stoplog Sealant Alternatives: $25,000

The cylinder gate at Hoover Dam is used to control the flow of water into the penstock intake towers. Stoplogs are a hydraulic engineering control elements that are used in floodgates to adjust the flow of water into a dam's intake into the penstock. The cylinder gate and stoplogs are used in conjunction to keep water from entering the intake, with the stoplogs in front of the gate. Despite the gate and stoplogs keeping a majority of the water from rushing in, a sealant must be used to stop water from entering small crevices between the stoplogs. There is a need for a better mechanism for deployment or a different type of sealant to seal the stoplogs. It is in Reclamation's interest to have a better tuned method of sealing the stoplogs at their dams. The research strategy for this proposal is to analyze the methods that federal, state and private industry use to seal stoplogs at dams. Other deployment methods and types of sealants will be discovered by the researcher. After various deployment methods and sealants are discovered, Reclamation will be able to analyze, and if worthwhile, emulate a more successful method of sealing the stoplogs. The expected outcomes of this proposal would be increasing Reclamation's knowledge of delivery methods and mixtures which would increase deployment precision, reduce the swelling inside the mechanism during deployment, and be less time consuming for dam personnel sealing the stoplogs. These outcomes may be due to either a different deploying method, alterations to the container, a different mixture being utilized to seal the stoplogs, or a combination of the three.

Modeling Riverine Pool Temperature Stratification and Reservoir Selective Withdrawal for Fish Spawning and Rearing Habitat: $60,000

This project will create and then demonstrate an advanced 3D temperature model, SRH-TEM, to predict thermal gradients in deep riverine pools and reservoir selective withdrawal for fish survival, spawning and rearing habitat. The research consists of two components: model development and field demonstration. Three Reclamation teams will join the proposed research: The Trinity River Restoration Program (TRRP) team on improving fish habitat and population growth on the Trinity River, CA; The Bird Track Springs team on improving fish habitat through temperature management on the Grande Ronde River, OR, and The TSC Hydraulics Lab team for cold-water selective withdrawal at Shasta Lake, CA or Flaming Gorge Dam, UT.

Implementation of a Laboratory Information Management System for Reclamation Infrastructure: $100,000

This project will help implement a new lab information management software to aid in tracking samples and documenting test results. The software is also used to track machine calibration schedules to keep testing devices up to standard. This robust database will replace several paper-based sample and test tracking methods which will ensure quality and security of all data. The ability to query all data throughout Reclamation could be helpful for answering several geotechnical or concrete related questions.

Evaluation and Validation of Fatigue on Aging Hydro Mechanical Components using Finite Element Analysis: $80,000

This project will evaluate and validate the effect fatigue has on aging mechanical components. This would be done using finite element analysis (FEA). FEA is a method of calculating and predicting how complex systems react to real-world forces with the aid of a computer system. Elements of a system are broken into a mesh (small solvable portions of a larger component) and run through a solver such as ANSYS to gain usable data and information. The results of FEA can be used to analyze and predict characteristics of existing powerplant equipment such as stress concentrations, vibration resonances, or modes of failure like fatigue. The findings and capabilities from this research are expected to have far reaching effects on Reclamation's ability to proactively prevent catastrophic failures, through more effective inspections, and proper analysis of facility equipment to include cranes, gates, bearing brackets, operating rings and more. Gaining this new capability and knowledge will likely save Reclamation significant costs associated with rework, contracting, unit downtime and increased operational safety.

Improving Reclamation's Geologic and Geotechnical Investigations with Drill Parameter Recorder Technology: $59,650

Reclamation has drill crews that support several applications, including: instrumentation installation, subsurface characterization, investigations of structural deterioration, performance monitoring, water wells, etc. Enhancing our drilling investigation techniques is fundamental for improving the reliability of Reclamation's vast and aging infrastructure. This project will install a Drill Parameter Recorder (DPR) to allow for real-time monitoring while drilling (MWD) of important fugitive parameters, such as: penetration rate, hold-back force, torque, thrust, rotational speed, mud or water flow rates and pressures, with depth and time. The parameters can be used to spatially correlate strata between borings, and identify areas of highly fractured rock, voids, clay seams, or weak/thin stratigraphic zones that may be washed-out or lost during drilling. Correlations also exist to specific energy (the energy required to drill a certain volume of rock), rock mass strengths and other components of the Rock Mass Rating (RMR) system. Given the real-time ability to generate detailed subsurface profiles of fracture zones or areas with higher permeability, DPR technology could be extremely valuable in increasing the effectiveness of foundation grouting programs; thereby helping to minimize seepage loss from water storage or conveyance structures.

Resolving Spatiotemporal Distribution of Suspended Sediment Concentration over the Columbia and Snake River Using Remote Sensing: $42,533

The goal of this collaborative project is to provide actionable science and user-friendly tools to natural resource and water managers to evaluate the distribution of Suspended Sediment Concentration (SSC) along the Columbia and Snake River (CS River) in face of a changing climate, increased wildfires and evolving land management strategies. This research effort will leverage advances in the field of remote sensing and cloud computing to: (1) Develop a robust remote sensing-based machine learning model to accurately infer SSC levels using Landsat and Sentinel satellite imagery, (2) Apply this model to derive a comprehensive picture of hotspots of sediment sources and sinks along the CS River between 1984-present, and (3) Provide a user friendly, freely available Google Earth Engine (GEE) APP that can readily estimate SSC levels along the CS River for collaborative land management planning and post disturbance rehabilitation. This project would provide a bridge between management and science as a GEE-based APP is user friendly and allows land managers or non-scientists to not be encumbered by difficultly in navigating complex models.

Physical and Surrogate Data Collection of Sediment Transport in Ephemeral Systems: Funding: $129,000

A method to adequately quantify sediment delivery from ephemeral tributaries in a reliable and cost-effective manner does not exist. River maintenance and other in-channel projects – whether for water delivery, public safety, river stability and habitat restoration, or other – need to be designed and implemented with knowledge of river processes and channel morphology to ensure project success. Process and morphology are a result of the magnitude and timing of water and sediment delivery to the channel. This research will benefit any office charged with rivers that have ephemeral tributaries. The work to be completed under this proposal expands on the knowledge gained so far and aims to continue data collection at the Pinos site; compare the data collected at the Pinos site to established modeling methodologies; including Reclamation's BORAMEP program as well as at least one watershed modeling tool for estimating sediment yield; cooperate with project partners to identify and select a new site for data collection; hypothesize the relationship between surrogate and physical measurements based on basin characteristics such as drainage area, average slope, lithology, bed material size distribution; and design a data collection platform at a new site so the hypothesis can be tested.

Investigating the use of green infrastructure to improve water quality and expand usable water supplies: Funding: $29,656

This scoping proposal addresses the need to expand water availability for multipurpose objectives through conjunctive reuse practices. "Green infrastructure" (GI), such as constructed wetlands and soil/aquifer treatment, is an emerging tool to compliment advanced water treatment technologies. GI involves passive, naturally occurring biogeochemical processes such as biodegradation, plant uptake, photolysis, volatilization, sorption, and precipitation, for water quality improvement and environmental protection. The intent of this scoping study is to compile existing design and performance information on GI projects that have been developed by Reclamation (pilot-, demonstration-, and full-scale), identify areas for potential enhancements based on "lessons learned" from these existing facilities, and identify potential locations where GI can be used to enhance the suitability for use, and thus increase the availability of potential water supplies.

Reservoir Delta Morphology and Effects on Tributary Fish Passage and Habitat – A Scoping Study: Funding: $30,000

Channel morphology frequently changes in tributaries to Reclamation's storage reservoirs in response to hydrology, sediment, and fluctuating pool elevations. This dynamic environment presents challenges to threatened and endangered aquatic species by causing shallow depths, disconnected surface flow, and channel obstructions, thereby blocking upstream fish passage. These changes have occurred in the channels between the minimum and maximum pool elevation and within the reservoir delta, which extends upstream into the contributing tributaries. Reservoir operations and the associated effects on water level and channel morphology are especially difficult during dry years. Spawning grounds are located upstream within contributing tributaries, making fish passage crucial for local salmonid population survival. The purpose of this scoping study is to understand the problem, data, tools, and models currently available for reservoir tributary sediment budgets and delta development. Information will then be used to evaluate restoration and fish passage projects that are successful with existing processes to make future projects more sustainable. The preliminary analysis will encompass all five Yakima basin reservoirs.

Crafting a Modern Systems Approach in Assessing Critical Nodes for Regional Security and Regional Safety of Dams: Evolving Beyond the Legacy Program: $90,780

The purpose of the systems-approach for the critical node study is to rank each facility based on their contribution to Reclamation's mission. The strategy is to identify all of Reclamation's missions and then have Reclamation experts with different backgrounds independently allot a weight, based on mission criticality, to each identified mission. The missions were broken down into five categories: environmental responsibility, flood control, power generation, recreation and water delivery. These weights are to be averaged so outliers do not significantly alter the utilized weights. After the missions of Reclamation are identified and weighted, each facility will then be rated by Reclamation and partner agency experts. This rating will reflect the contribution of each facility toward the mission. A matrix will be used to apply the weights to the rating factors and rank all facilities in order of their contribution to Reclamation's overall mission. For this phase, only the facilities along the Colorado River's main stem will be examined. However, this systems-approach may reveal broader applications to other major water conveyance systems in the Lower Colorado Basin Region.

Furthering Cracked Embankment Erosion Research: $31,106

This research intends to impact the condition assessment of embankment dams and levees, by furthering research of internal erosion, the second most common failure mechanism affecting Reclamation's inventory of embankment dams and canals. About 1 in 4 dams in Reclamation's inventory has experienced an internal erosion incident with one failure. Previous Reclamation research was focused on understanding initiation of erosion and unfiltered exit. This research intends to further our understanding of "No self-healing" and "flows not limited" progression events of the internal erosion event. This proposal seeks to complete a comprehensive literature review and develop a more defined research proposal with direct impact of the risk assessment of internal erosion progression.

Dam Incident Investigations: Determining best practices for investigations that can improve future performance of dams: $31,000

Dam failure investigations, such as occurred after the Teton Dam failure or Oroville Dam incident have led to some of the most important advancements in the industry both in terms of policy and practices. The purpose of this project is to complete a literature review to determine what other industries are doing and how we can learn from them and from recent dam failure and incident investigations such as Oroville Dam and Spencer Dam. This knowledge can be used by Reclamation management to craft policy that more clearly outlines investigation triggers, and how we can better leverage lessons learned from incidents/near misses to improve dam performance in the future.

Evaluating Big Thompson water supply modeling capability improvements from new model forcing and recalibration: $74,132

This project will investigate whether harnessing new meteorological data and analysis paired with recent advances in model calibration tools will improve Easter Colorado Area Office hydrologic model performance for the Colorado Big Thompson system. To address this research question, researchers will incorporate the EWS network into higher resolution gridded model forcing, and by improving and applying the Optimization Software Toolkit for Research Involving Computational Heuristics (OSTRICH, Mattot, 2017) to operational ECAO hydrologic model. In addressing this question, the team will upgrade and make available several valuable tools, including OSTRICH and a

National Weather Service (NWS) river forecast system model emulator that can be used offline from the River Forecast Center (RFC) system for model evaluation and improvement. The project will assess the GMET/HRRR datasets and related ECAO modeling improvement, and the upgraded tools and nationally available datasets can benefit Reclamation offices beyond ECAO. If successful, better model performance could improve both short range and water supply forecast skill.

Underwater Remotely Operated Vehicle (ROV) Data Collection at Reclamation Sites: $108,473

Underwater remotely operated vehicles (ROV's) have been primarily used for many years to inspect underwater features. Recent technological advances allow for better cameras, better lighting, further range, ease-of-operation, and advanced data collection payloads. Reclamation ROV operators and data collection experts seek to upgrade current capabilities to better address Reclamation's mission specifically in water and sediment management and underwater inspections. The project tasks include conducting a survey to determine gaps in ROV technology that could be addressed by currently available solution.

Develop Integrated Tools for Digital Excitation and Speed Governor Control Systems: $120,000

Reclamation operates hydroelectric generators connected to the Western US power system. It must operate its fleet of generators by the North American Electric Reliability Council (NERC) and Western Electricity Coordinating Council (WECC) guidelines to reliably and adequately supply electric power in a manner to support stewardship of BOR facilities for the American public. Operating according to these regulatory guidelines can be extremely labor-intensive and cost-prohibitive. Designing integrated tools into our existing in-house digital controller designs would simplify regulatory compliance while also reducing maintenance costs and revenue losses caused by generator outages. Highly trained control-system engineers must travel on-site with specialized test equipment to perform a large portion of troubleshooting/maintenance tasks for excitation and speed governor control systems. This scenario can be very costly when considering travel expenses, engineering costs, and, most importantly, lost revenue income when forcing generators to shut down while installing and removing specialized test equipment. However, this test equipment integrated into digital controllers would allow maintenance personnel to collect data and troubleshoot these complex control systems by using these built-in tools to diagnose system issues. This type of troubleshooting would not need highly trained engineers on-site if users were provided better tools with control systems. It would also not require taking the generator out of commercial service to install and remove equipment.

Utilizing Hydrophones to Detect Streambed Mobilization in the Wild and Scenic Reach of the Rio Chama: $94,000

The Rio Chama is a tributary of the Rio Grande in northwestern New Mexico. The Chama receives a combination of native water and inter-basin transfer water from the San Juan-Chama Project. Because of climate change, native water flows in the Rio Chama are expected to decrease by one-third and inter-basin transfer flows by one-quarter over the next century. The stretch of the Rio Chama between El Vado Dam and Abiquiu Dam was designated Wild and Scenic in 1988. This stretch of the Rio Chama is a high-sediment system with a significant amount of fine sand, silt and clay (mud) deposited on gravel-cobble (coarse) bed material. This mud restricts oxygen transport in the gravel streambed, reducing food sources and affecting spawning habitat of the brown trout, a

key species in the designation of the Wild and Scenic reach. The area for this research would be a site referred to as "Archuleta" located approximately 7.3 miles downstream of El Vado Dam. Hydrophone systems would be placed in various locations within the Archuleta site. Continuous data collection would occur and sediment samples would be taken at each hydrophone site at the beginning and end of the data collection period to provide another means of evaluating if and what changes occurred in the streambed during higher flows. A turbidity monitor would also be installed at the Archuleta site to give insight into fine sediment transport; this would be compared to the coarse sediment transport information recorded by the hydrophones. Through the collection and analysis of this data, it is the intention of this proposal to better understand the range of flows that will initiate and most effectively mobilize streambed sediments for the benefit of brown trout in the Rio Chama and to advance the research of using hydrophones for this purpose.

Predicting Reservoir Drawdown Flushing to Improve Reservoir Sustainability: $90,000

Reservoir sedimentation is impacting all Reclamation (and other public and private) facilities as water storage and supply become increasingly threatened with the aging infrastructure. Drawdown flushing can be used to remove reservoir sediment in small gorge-shaped reservoirs and to extend the reservoir life span. A 2D sediment transport model will be used to study the effectiveness, timing, and the downstream impact of reservoir flushing. The research will develop and improve guidelines for drawdown flushing for Reclamation reservoirs.

Chemical Fingerprinting of Delta Smelt for Sensitive Detection in the Environment: $84,875

Delta Smelt are a small, ESA-listed fish native to the Sacramento-San Joaquin Delta and upper San Francisco Estuary. Low population density, combined with their preference for turbid, shallow regions of the Delta, make Delta Smelt difficult to find, hindering accurate surveying of the remaining wild population and complicating adaptive management of Central Valley Project pumping operations. It is also common knowledge in the Delta science community that Delta Smelt smell like cucumber. This project will verify the chemical responsible for the distinct olfactory signature of Delta Smelt. Variation in the signature produced by individuals and groups and by distinct Delta Smelt life stages will be investigated. Once a chemical signature for Delta Smelt is characterized, in-field experiments in the Sacramento-San Joaquin Delta in collaboration with California Department of Water Resources staff will test the capabilities of state-of-the-science geochemical techniques to detect Delta Smelt in the wild. Chemical fingerprinting will be compared to environmental DNA (eDNA) detection of Delta Smelt already under study by California Department of Water Resources (DWR) staff and UC Davis researchers. This research aims to produce a method for rapid environmental detection of Delta Smelt that will facilitate survey efforts and adaptive maximization of CVP exports without jeopardizing the remaining wild Delta Smelt population.

Atmospheric Plasma Coating Removal: $85,260

The paints, epoxies, sealants, coal tar, and other coatings have been used for many years to protect Reclamation assets from environmental exposure. However, the process for removing degrading coatings have largely remain unchanged for the past 100 years. Removing and containing hazardous materials in coatings is still complicated, time consuming, costly, and can be dangerous. This project will evaluate a technology called Atmospheric Plasma Coating Removal (APCR), which can successfully remove old or impaired coatings. This process of removing coatings has been

demonstrated to be cleaner, environmentally safe, and cost effective. The proposed research will investigate the applicability of the APCR process to the maintenance of Reclamation aging water delivery infrastructure, its scale up potential, hazardous waste mitigation, and economics of this process versus conventional coating removal processes. The outcome will be improved processes for the removal of existing coatings and surface preparation of steel structures in Reclamation facilities.

Investigating Newly Formulated Polysiloxane Coating Systems with Improved Erosion and Impact Properties: $59,088

Polysiloxane coating systems were originally designed for atmospheric exposure but have proven to provide excellent barrier properties based on EIS and cathodic disbondment test results. A few commercial Polysiloxane products have equivalent performance to vinyl coatings, apart from erosion and impact resistance. Vinyl is known to provide a long service life, but high VOC content has restricted its use in many industrial markets. For example, vinyl is still providing corrosion protection at Shasta Dam unit 5 penstock after 70 years of service. As an alternative, Polysiloxanes would be environmentally friendly and safer to apply. The purpose of this study is to partner with Sherwin Williams and Duromar to evaluate experimental Polysiloxane coating systems formulated to improve erosion and impact properties while retaining all high-performance corrosion resistant characteristics. The result of this study would provide Reclamation with a safe and environmentally friendly coating system that provides equivalent corrosion resistance and toughness as vinyl coatings. This research will require Material Transfer Agreements (MTA) in order to evaluate the experimental products provided by Sherwin Williams and Duromar.