RECLAMATION *Managing Water in the West*

Spring 2014
Research and
Development Office
Newsletter 2014-03

The Knowledge Stream

Call for Proposals, Post-JAM, and Technology Challenges Issue

This issue kicks off our annual Call for Proposals season. Each spring we invite any Reclamation employee to submit research proposals to our Science and Technology Program. This program funds research and development addressing any technical problem or challenge that we face in managing water and hydropower in the West. Annually, the Science and Technology Program, managed by Miguel Rocha, receives more than 150 proposals. This year, we highlight our interest in proposals that address worker health and safety issues, and extending the life of aging infrastructure.

A second method we use to identify research targets is our annual Research Jam online crowd-sourcing event, which concluded recently. Inside, we summarize the ideas submitted and acknowledge the issue that received the most votes—the need to find a replacement for the toxic coal tar coating used to prevent corrosion of our metal infrastructure. One option is to conduct a technology challenge, with the prize going to the individual or company that provides the most suitable replacement coating system.

Speaking of prizes, Reclamation is partnering with the United States Agency for International Development (USAID) to conduct an international prize challenge to advance technology for desalination of brackish groundwater. USAID is administering the challenge and providing the prize money. Reclamation is contributing our expertise in advanced water treatment, and will test the competing technologies at Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo, New Mexico (see Governor's visit photograph below).

Curt Brown, Chief of Research

New Mexico Governor Susana Martinez during her recent visit to Reclamation's Brackish Groundwater National Desalination Research Facility (BGNDRF).

Left to right: Cornell "Slim" Baxter, Senior Volunteer; Roberto Granados, Engineering Technician; Randy Shaw, Facility Manager; Governor Susana Martinez; Daniel Lucero, Facility Operations Assistant; and Steven Holland, Electronic Technician.

Reclamation and U.S. Army Corps of Engineers hold Research Collaboration Workshop

March 4 - 6, 2014
Vicksburg, Mississippi

The Research and Development Office (Research Office) and the U.S. Army Corps of Engineers-Engineer Research and Development Center (USACE-ERDC) have a long history of collaboration on many technical topics. In 2013, the Research Office hosted USACE-ERDC for an initial discussion on infrastructure research roadmapping. As a followup to that discussion, staff from the Research Office and Reclamation's Technical Service Center visited USACE-ERDC in March 2014 to identify potential areas of research collaboration.

The focus of these discussions was infrastructure, invasive species, ecohydraulics, technology competitions, and technology transfer, addressing each organization's priority issues, researcher capabilities, facilities and equipment, and programmatic investments.

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Print Options and Instructions

This document is designed to be read either electronically via PDF or printed in color or black-and-white. Please forward it to your colleagues and friends.

You have three options for printing parts or all of this document:

1. Print individual Research Updates on one sheet of paper, double-sided.

2. Print the whole document double-sided, corner stapled on 8.5 x 11-inch paper.

3. For magazine-style, instruct your print professional to print the document double-sided, head-to-head, saddle-stitched on 11 x 17-inch paper.

Your suggestions for improvements are always welcome. Please email them to jakervik@usbr.gov.

Thanks,

Jake Akervik
Communication and Information Systems Coordinator
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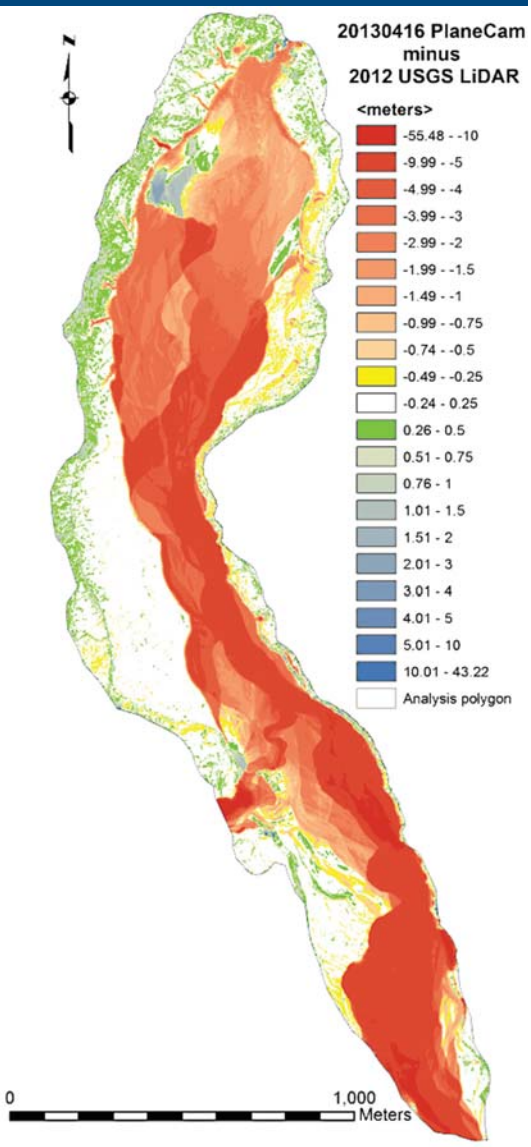
Innovation Around Reclamation



Comparison of a recent Elwha PlaneCam flight with October 2012 U.S. Geological Survey LiDAR data.

The primary unchanged surfaces on the eroding reservoir surface are the white areas below the valley wall. The green areas are mostly different where vegetation has colonized and grown over the valley walls during the (mild) winter.

Comparison from flight-to-flight with the Elwha PlaneCam is generally better since the same method generates a more similar surface.

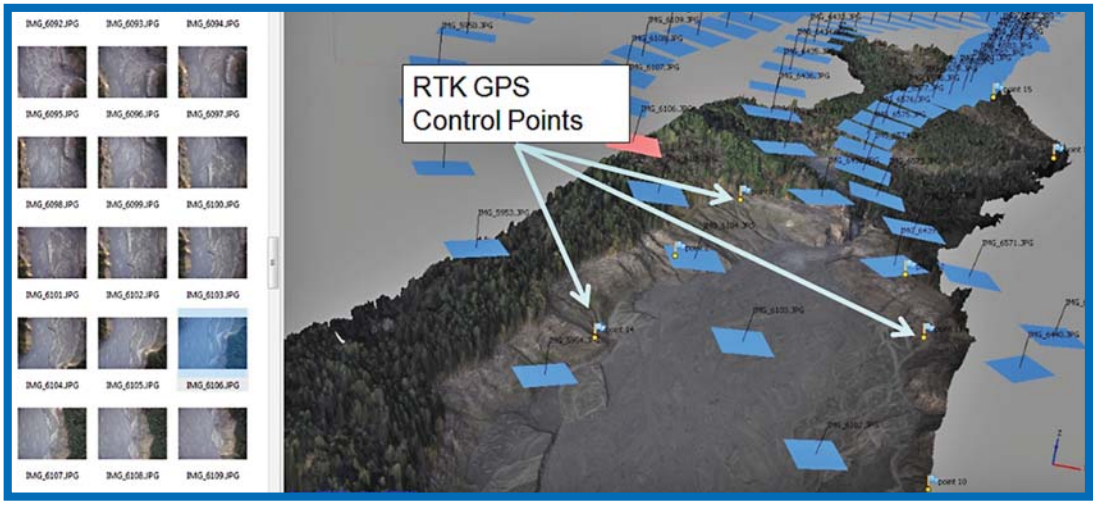
Elwha PlaneCam

The Elwha PlaneCam is a new instrument used for quantitative analysis of sediment erosion and deposition on the Elwha River Restoration Project.

Andy Ritchie, Elwha Restoration Project Hydrologist, with the National Park Service has developed an innovative camera system (the Elwha PlaneCam) using a point and shoot Canon PowerShot D10 digital camera with some modified firmware mounted in a customized wing inspection plate on a Cessna 172 airplane. Flight lines are developed and the pilot just follows those using a Global Positioning System (GPS). The camera takes pictures at a set interval and will work off of internal batteries for a little over 2 hours.

Up close of Elwha PlaneCam—the whole camera system is very compact. The pilot just turns it on before installing it, then turns it off again after landing and removing it.

The raw images from the camera system are used to generate point clouds, three-dimensional (3-D) surface models, pixel-averaged orthoimagery, and orthomosaics. Ground sample resolution (pixel size) is 10 to 15 centimeters (cm) and can generate surface models with 0.5 meter grid size. Vertical accuracy is a function of flight elevation and is dependent on density of ground control, but 20+/- cm relative and comparable to Light Detection and Ranging (LiDAR) surfaces in unvegetated areas can be achieved fairly easily. Raw images can be viewed at: www.flickr.com/photos/usgs_elwhacams/collections/72157629774092791/.



Post-processed imagery using ground control points to tie it to a global coordinate system.

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Maximum resolution from a 1,500- to 2,000-foot Elwha PlaneCam flight (part of an entire image).

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The imagery is then post-processed using ground control points to tie it to a global coordinate system, and generates both Digital Surface Models (DSMs) (used to calculate surface change) and orthoimagery (either pixel-averaged or mosaics).

Formal publication of the methods are in process.

Contact: Andy Ritchie, 360-565-1322, aritchie@usgs.gov.

Analyzing arc flashes. Photograph from: www.usbr.gov/pmts/hydroelectric/teams/psspt.htm.

Arc-Flash Protection Studies

For the last 10 years, the Power System Analysis and Control Group in Reclamation's Technical Service Center has been building capacity (staff) and capability to support mandated Occupational Safety and Health Administration Arc-Flash Protection Studies. In addition, the group has been adding staff for required North American Electric Reliability Corporation (NERC) and Western Electricity Coordinating Council (WECC) Reliability Requirements. The group is now staffed to perform arc-flash studies, protective relay and power equipment reviews, and excitation testing on all Reclamation powerplants (58+ powerplants) on a 5-year rotating schedule.

Contact: Jim Zeiger, 303-445-2850, jzeiger@usbr.gov or Shawn Patterson, 303-445-2311, spatterson@usbr.gov.

Geonet Composite

A geonet composite is a combination of two different geosynthetics. Typically, the geotextiles serve as filters and the geonet serves as a drain. At Reclamation's Red Willow Dam in Nebraska, a geonet was sandwiched between two geotextiles. The geonet composite spans any existing or new cracks in the embankment.

Contact: Peter Irey, 303-445-3033, pirey@usbr.gov.

Geonet being installed at Red Willow Dam, Nebraska.

Recent Events

The list of events below is intended for informational purposes only and does not necessarily constitute an endorsement by Reclamation. These events may be of interest to the science, research, and related communities and are not necessarily hosted by Reclamation.

Find our most recent list of events at: www.usbr.gov/research/events.

Testing Cathodic Protection Systems Training—Webinar

February 27, 2014, Denver, Colorado.

This Reclamation-hosted webinar training consisted of a 40-minute presentation followed by 20 minutes of questions, answers, and comments. Jessica Torrey in Reclamation's Technical Service Center presented a tutorial on testing these systems, including identifying structure versus anode cables, potential and current measurements, basic repair at test stations, and ideal testing schedule and reporting practices. This webinar also introduced a research project to design a tablet app for cathodic protection testing, funded by the Research and Development Office for Fiscal Year 2014 (www.usbr.gov/research/projects/detail.cfm?id=6816).

Contact and additional webinar training information:
Jessica Torrey, 303-445-2376, jtorrey@usbr.gov or
Daryl Little, 303-445-2384, dlittle@usbr.gov;
www4.gotomeeting.com/register/508872367.

Test station for a galvanic anode cathodic protection system.

Unmanned Aerial Systems - Past, Present, and Future—Annual Workshop

April 22, 2014, Denver, Colorado.

Reclamation hosted representatives from the U.S. Geological Survey's National Unmanned Aerial Systems Project Office and the Bureau of Land Management to discuss past accomplishments, present plans, and future prospects for the use of unmanned aerial systems within the U.S. Department of the Interior. Douglas Clark in Reclamation's Technical Service Center presented, and participation via webinar was also available.

Contact and additional workshop information:
Douglas R. Clark, 303-445-2271, drclark@usbr.gov;
www4.gotomeeting.com/register/336875879.

Sharing Water, Building Relations: Transforming Water Conflict in the United States West—Water Conflict Management Training

May 12, 2014, Washington, D.C.

In conjunction with Reclamation's Upper Colorado Region, Technical Service Center, and Research and Development Office, Professor Aaron Wolf from Oregon State University developed a training course on managing water conflict. Professor Wolf discussed the salient elements of this training course in his presentation. Participation via webinar was also available.

See www.doi.gov/ppa/seminar_series/video/sharing-water-building-relations-transforming-water-conflict-in-the-us-west.cfm.

Upcoming Events

Data Stewardship - Best Practices—Information Technology Workshop

June 10, 2014, Denver, Colorado.

Reclamation will host a U.S. Geological Survey representative who will describe the need for data stewardship and illustrate best practices. Douglas Clark in Reclamation's Technical Service Center will present, and participation via webinar is also available.

Contact and additional workshop information:
Douglas R. Clark, 303-445-2271, drclark@usbr.gov;
www4.gotomeeting.com/register/540119503.

Safety Evaluation of Existing Dams International Technical Seminar and Study Tour

June 10 - 19, 2014, Denver, Colorado.

Reclamation officials will provide the training for this seminar. The first portion of this seminar will take place in Denver, Colorado, and will consist primarily of classroom presentations and discussions. A tour of the Reclamation Research Laboratories will also be featured. Lectures, case histories, and structured discussions covering all aspects of a dam safety examination program will be led by Reclamation engineers and geologists with extensive experience and knowledge in the areas of design, construction, operation, maintenance, and dam safety. The training outlines the hydrologic, seismic, geotechnical, electrical, mechanical, and structural considerations of dam safety as well as operation, maintenance, surveillance, and emergency preparedness. Presentations, case histories, and a walk-through abbreviated examination will be used to present the multidiscipline approach to an effective dam safety program. The second portion of this seminar will consist of site visits and will take participants to the States of Nevada and Oregon. Participants will also enjoy a "free" day in Las Vegas, Nevada.

Contact and additional seminar and study tour information:
Leanna Principe, 303-445-2127, lprincipe@usbr.gov or
Angela Medina, 303-445-2139, amedina@usbr.gov;
www.usbr.gov/international/seed_2014seminar.html.

Ochoco Dam in Oregon.

Scoggins Dam in Oregon.

Hoover Dam in Arizona/Nevada.

Arthur R. Bowman Dam in Oregon.

Featured Faces

Subhrendu Gangopadhyay

Subhrendu Gangopadhyay and his family with Reclamation Commissioner, Michael L. Conner, at the Reclamation Engineer of the Year for 2014 award ceremony in Washington, D.C.

More Information

For more information regarding Reclamation's Engineer of the Year for 2014, see Reclamation's press release at:

www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=46046.

Subhrendu Gangopadhyay, Hydrologic Engineer, B.S., M.S., Ph.D.

Reclamation's Engineer of the Year for 2014

Subhrendu Gangopadhyay is a Hydrologic Engineer in the Water Resources Planning and Operations Support Group in Reclamation's Technical Service Center (TSC) in Denver, Colorado. He has nearly 20 years of experience in the field of water resources development, including areas of applied statistics and scientific computing in surface and groundwater hydrology. Subhrendu holds a Bachelors of Engineering in Civil Engineering from the University of Calcutta, India, and a Masters and Doctor of Engineering in Civil Engineering from the Asian Institute of Technology (AIT) in Thailand. In addition, Subhrendu was a post-doctoral researcher in civil engineering (water resources) at the University of Colorado in Boulder. As a civil engineering undergraduate, fluid mechanics, hydraulics, and environmental engineering were Subhrendu's favorite subjects. As a young man growing up in Calcutta, he also felt a personal commitment to finding a solution for the increasing challenge of obtaining suitable water.

Subhrendu started his civil engineering career as a structural design engineer working on nuclear powerplant projects in India. Before joining Reclamation in 2010, Subhrendu spent almost 10 years working internationally on water resources development projects and nearly 7 years in Thailand working as a graduate student at AIT. While at AIT, he worked on a variety of water-related projects. Subhrendu then joined the International Hydrology Program (IHP) at the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in Paris, France, where he participated in the World Water Vision for Life and Environment for the 21st Century Project (Vision Project). Subhrendu also played a significant role in initiating the IHP World Water Assessment Program and the United Nations World Water Development Report. He has performed private water resources consulting and worked for Hydrosphere Resource Consultants in Boulder, Colorado, where he participated in various projects in the Western United States related to water resources planning and management.

Since he started working for Reclamation, Subhrendu has spent significant time and effort implementing the Science and Engineering to Comprehensively Understand and Responsibly Enhance (SECURE) Water Act through the Reclamation Program Management Office Basin Studies Program. He has developed methodologies and datasets to support assessments of climate impacts on Western United States' water resources and has presented findings from basin studies at several public meetings. In addition, Subhrendu worked closely with study partners to develop decision support tools to facilitate adaptation and mitigation options. In 2012, he represented Reclamation at the Sixth World Water Forum in Marseille, France, where he presented Reclamation's work on incorporating climate change into water management activities and operations, and implementing the SECURE Water Act. He was also recently selected as Reclamation's Engineer of the Year for 2014.

Another important feature of Subhrendu's work is his support of the Research and Development Office (Research Office), where he coordinates climate studies within activities with the TSC, as well as funded research projects, in an effort to align research needs with Reclamation's mission. He is a subject matter expert in Research Office collaborations with the University Corporation for Atmospheric Research, where he develops and conducts training on modules to incorporate hydro-climate inputs for climate change in water resource planning. Subhrendu also works on his

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own research projects funded through the Research Office's Science and Technology Program, including collaborating with the U.S. Geological Survey to develop methods to meet Reclamation mission goals; in particular, research to support the SECURE Water Act assessment needs.

Subhrendu and his wife have two boys and a faithful golden retriever child. His family enjoys the great Colorado outdoors, as well as photography. Subhrendu and his family also spend time volunteering in the community.

Mitch Haws, Water Resource Planner, B.A.

Water From the Sun

Mitch Haws is a Water Resource Planner in Reclamation's Program Development Office, located in the Phoenix Area Office, Lower Colorado Region. He has worked for Reclamation for 31 years in materials engineering, grants and contracting, and water resources planning, development, and management.

Mitch Haws

Mitch grew up in the Provo, Utah, area and attended Utah Valley University and Grand Canyon University, where he obtained his Associates and Bachelors in Business Management and Administration. Prior to joining Reclamation, Mitch performed a variety of jobs running the gamut from jockey to iron worker to owner of a stained glass business. In 1983, he began working for Reclamation as a Materials Engineering Technician in the Upper Colorado Region's Cortez Field Office.

Mitch is currently working with watershed management coalitions, which include all of the Phoenix metropolitan area's major cities, to develop strategies for using the region's scarce water resources in the most efficient manner. In addition, he is researching water and energy issues under various Reclamation programs, including the Moisture Balance Drought Index—a drought prediction model, the energy and water nexus issue in Arizona, and the use of renewable energy for transmission of water throughout Arizona.

Additionally, Mitch is working on several projects for Reclamation's Science and Technology Program, which he hopes will result in substantial benefits—1) the Solar Desalination Using Distillation Program, which could greatly assist the Navajo Tribe with its persistent drought problem; 2) the Solar Energy for Water Transmission Program, which could provide a solution for the Navajo Generation Station; and 3) the Solar Covering the CAP Canal Program, which could help determine whether canal covering is a cost-effective method.

Mitch and his wife, Lindy, have been married for 28 years, and they have three adult sons. In his spare time, he enjoys biking, tennis, golf, boating, and most outdoor sports. Mitch also leads the priesthood organization in the local ward for the Church of Jesus Christ of Latter Day Saints.

Mitch Haws standing in front of the Solar Desalination Pilot Plant, a solar photovoltaic thermo hybrid system that generates energy and heat for the desalination of brackish groundwater (Reclamation Science and Technology Program research project ID number 4850).

Reclamation Research Jam

Our third annual research and science idea gathering event saw even more ideas with discussion and comments

The Research and Development Office hosted the Third Annual Reclamation Research Jam internal online crowdsourcing event from February 3 through February 28, 2014. The 2014 Reclamation Research Jam spanned 4 business weeks, 1 week longer than the 2013 Reclamation Research Jam.

The ideas gathered will be shared with Reclamation researchers for possible submission as research project proposals during the upcoming Fiscal Year 2015 funding cycle (see "Science and Technology Program Call for Proposals" on page 12).

Top 10 Reclamation Research Jam 2014 Ideas

Net Votes	Idea Title
30	Life After Coal Tar Enamel – New Long-Term Protective Coatings
28	Less Cracks, Bigger Placement – New Concrete Rules of Thumb
28	Petrographic Standard for Evaluating Filter Material for Potential of Promoting Bacterial Growth Resulting in Clogged Drains
27	Solar Desalination
26	Passivated Coatings and Linings
23	Composite Materials
23	Develop GPS/GIS-Enabled Tablet Applications to Modernize Resources and Facility Condition Monitoring
23	Fiberglass Pipe
21	Nano Spider - Goat Concrete
21	Safety Accident Lessons Learned Database

Reclamation Research Jam 2014 by the Numbers

	2013	2014
Total Votes	925: 847 Up Votes and 78 Down Votes	864: 803 Up Votes and 61 Down Votes
Comments	181	128
Ideas	57	68

Research Office Contact

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Bobbi Jo Merten, Chemist, B.S., Ph.D.

Bobbi Jo Merten Spreads Sweet Idea for Research

Reclamation's Third Annual Research Jam, the online research and science idea gathering event, ran from February 3 to 28, 2014. Sixty-eight ideas were submitted as possible research project proposals, which were also discussed and voted on by Research Jam participants. Dr. Bobbi Jo Merten, a Coatings Specialist working in the Materials Engineering and Research Laboratory (MERL) in Reclamation's Technical Service Center and NACE Coatings Inspector Level 2—Certified, submitted the People's Choice winning idea: Life After Coal Tar Enamel – New Long-Term Protective Coatings.

Bobbi Jo Merten

Bobbi's winning research idea originated from the coatings maintenance and inspection experiences of MERL's coatings team members: Bobbi Jo Merten, Allen Skaja, David Tordonato, and Rick Pepin. It brought to light the disparity between the service life provided by the original coal tar enamel paint used on Reclamation structures and their currently available replacements. Coal tar enamel frequently surpasses 50 to 80 years of service within underground penstocks that are rarely taken out of service, but its toxicity prevents modern usage.

Bobbi states, "Two approaches have been identified to provide cost-savings for Reclamation: maximize service for existing coal tar enamel on penstocks through 100-percent solids epoxy spot repairs and assist the coatings industry in developing a coating or paint that achieves a 50-year service life in below-ground penstocks."

Bobbi would like to apply this idea to laboratory coal tar enamel studies, which have not yet been performed using modern coatings research equipment. She is also hoping to develop a field manual that will assist facility owners in maximizing the life of their existing coal tar enamel systems through successful and efficient spot repairs.

Bobbi is currently working toward her SSPC Protective Coatings Specialist certification. She enjoys the unique perspective that field inspections provide and works to solve Reclamation's ongoing and emerging needs through these insights.

Curt Brown, Chief of Research, presenting Bobbie Jo Merten with the People's Choice Award for her winning idea, "Life After Coal Tar Enamel – New Long-Term Protective Coatings."

Science and Technology Program Call for Proposals

More Information

For information regarding the Desalination and Water Purification Research Program Call for Proposals Funding Opportunity Announcement, see Reclamation's press release at:

www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=46484

During the spring to early summer, the Research and Development Office accepts proposals from Reclamation employees to research solutions to the many challenges associated with managing water and generating power in the West. While proposals are only accepted from Reclamation employees, external groups and individuals can team up with a Reclamation employee to submit a joint proposal. These proposals are being solicited for funding in the Federal Fiscal Year 2015, starting October 1, 2014.

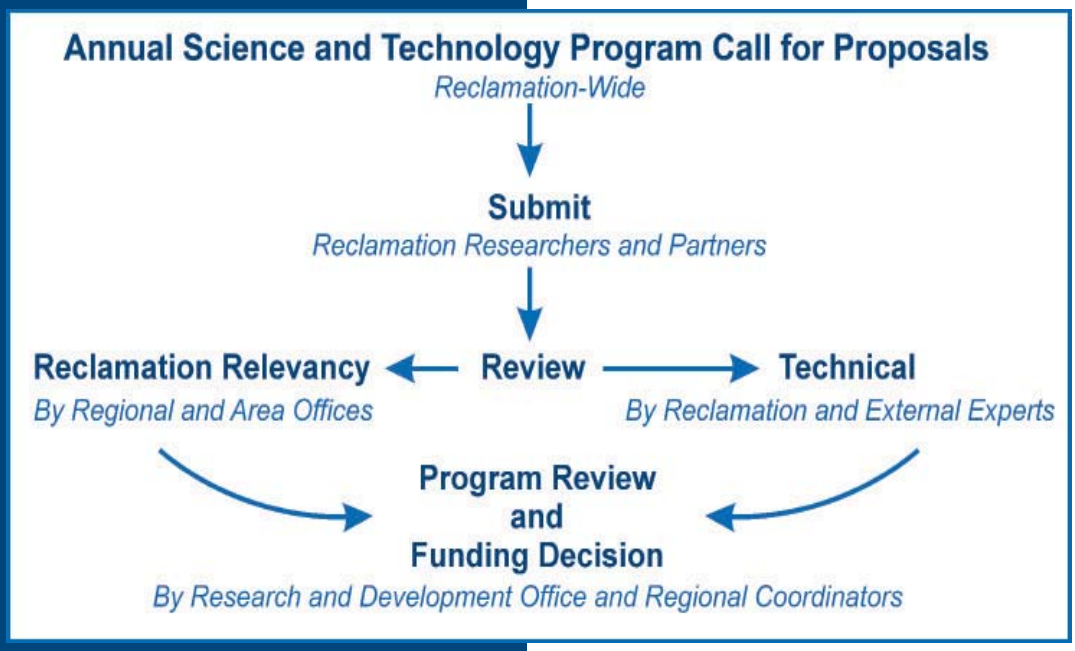
What Is the Science and Technology Program?

The Science and Technology Program is the primary research and development arm of Reclamation. The Science and Technology Program is a Reclamation-wide competitive, merit-based applied research and development program. The focus is on innovative solutions for water and power facility managers and the stakeholders they serve. The program has contributed many of the tools and capabilities Reclamation and western water managers use today. The program aims to:

- Advance the most relevant research and demonstration projects for Reclamation
- Build and strengthen scientific and engineering capacity for Reclamation
- Build partnerships with other water and power management agencies and stakeholders

How Are Science and Technology Program Proposals Reviewed?

Proposals are reviewed for technical merit by a team of outside experts to determine the technical soundness, contribution to the field of investigation, and the reasonableness of the budget. Reclamation offices review the proposals for their relevance to our overall mission and current priorities.



Submission and Review Schedule

April to June: Proposal preparation; full proposals are due in late June.

July to August: Relevance and technical reviews.

September: Multidiscipline Reclamation-wide team reviews and recommends projects for funding.

October: Awards are announced.

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The Science and Technology Program covers the following areas:

- Invasive Zebra and Quagga Mussels
- Climate Change and Variability
- Advanced Water Treatment
- Renewable Energy and Energy Conservation
- Environmental Stewardship
- Water Operations and Decision Support
- Water Infrastructure Reliability
- Expanding Water Supplies

Are You Requesting Research on Specific Topics?

In Fiscal Year 2015, we are placing a special emphasis on research and development relating to safety and occupational health, and aging infrastructure. Although funding will not be set aside for these activities, these activities will be prioritized during the funding selection. In the past, the Science and Technology Program has funded several studies over the years in the field of worker safety and occupational health. Safety and occupational health is a Reclamation core value, and Reclamation employees are its number one resource. We support the development and testing of new technologies or practices that improve safety on the job. Below are a few examples of recently funded safety-related research:

- Development of noise reduction engineering controls at Reclamation powerplants
  www.usbr.gov/research/projects/detail.cfm?id=6433

- Development of test methods for rope safety anchors
  www.usbr.gov/research/projects/detail.cfm?id=6390

- Development of DC Arc-Flash Interrupter
  www.usbr.gov/research/projects/detail.cfm?id=9629

In Fiscal Year 2015, we are also placing an emphasis on research and development that directly addresses maintenance issues resulting from aging infrastructure. Ideally, this research and development will include work at a Reclamation facility and will result in lower maintenance costs or better repairs. A list of previously funded infrastructure research is available at: www.usbr.gov/research/projects.

Where Can a List of Previously Successful Proposals Be Found?

A list of successful proposals for Fiscal Year 2014 is available at: www.usbr.gov/research/projects/years.cfm.

"Ideas won't keep. Something must be done about them."

—Alfred North Whitehead

Research Office Contact

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Technology Challenges

More Information

***Implementation of Federal Prize Authority: Fiscal Year 2012 Progress Report*, A Report from the Office of Science and Technology Policy, In Response to the Requirements of the America COMPETES Reauthorization Act of 2010, December 2013.**

For more information regarding Reclamation partnering with USAID to highlight innovation in desalination science, see Reclamation's press release at:

www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=46428.

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Technology Challenges and Prizes

Starting with the 1714 Longitude Prize that stimulated development of the world's first practical method to determine a ship's longitude, prizes have a long record of spurring innovation. The Orteig Prize inspired Charles Lindbergh to fly nonstop from New York to Paris, France, and launched the international air travel industry. More recently, the Ansari X-Prize spurred development of private industry spacecraft.[1] A 2009 McKinsey report found that philanthropic and private-sector investment in technology prizes increased significantly in recent years, including $250 million in new prize money between 2000 and 2007.[2]

Inspired by the success of private-sector prizes, the Congress passed the America Competes Act of 2011 and the General Services Administration launched "Challenge.gov," a one-stop shop where entrepreneurs and citizen-solvers can find and engage with public-sector prizes. By September 2012, the site had hosted over 200 challenges posted by more than 45 government departments and agencies with more than 16,000 citizen-solvers participating.[3]

The Research and Development Office (Research Office) is gearing up our own technology prize program, the Water and Power Solutions Technology Challenges Program. Reclamation was provided $2 million to use this innovative research methodology to find solutions to difficult problems.

Challenges are beneficial because, through them, Reclamation can:

- Pay only for successful solutions.
- Establish an ambitious goal without having to predict which team or approach is most likely to succeed.
- Reach beyond the "usual suspects" to increase the number of solvers tackling a problem and to identify novel approaches, without incurring great financial risk.
- Bring out-of-the-box perspectives to bear on a problem.
- Maximize the return on taxpayer dollars.

The Research Office has kicked off this effort with our "Desal Prize" partnership with the United States Agency for International Development, detailed on the next page in the article, "Reclamation Partners With the United States Agency for International Development in Latest Technology Challenge."

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1 http://space.xprize.org/ansari-x-prize.
2 McKinsey & Company, "And the Winner Is…";
Capturing the Promise of Philanthropic Prizes, 2009,
www.mckinseyonsociety.com/downloads/reports/Social-Innovation/And_the_winner_is.pdf.
3 www.whitehouse.gov/blog/2012/09/05/challengegov-two-years-and-200-prizes-later.

Reclamation Partners With the United States Agency for International Development in Latest Technology Challenge

Reclamation is partnering with the United States Agency for International Development (USAID) to launch the "Desal Prize"—a worldwide effort to identify and promote innovation in brackish groundwater desalination.

Reclamation—a leader in advancing desalination technology in the Western United States—is providing technical guidance to the project and will host the Desal Prize semi-finalists at its Brackish Groundwater National Desalination Research Facility (BGNDRF) in Alamogordo, New Mexico, in the spring of 2015, where entrants will compete in the first demonstration competitions for the prize. Finalists from this stage will go on to compete in a rigorous field demonstration at one of the USAID mission locations.

The Desal Prize is part of the $32 million *Securing Water for Food: Grand Challenge for Development*, launched at the 2013 World Water Week in Stockholm, Sweden. The initiative is a partnership between USAID, the Swedish International Development Agency, and the Ministry of Foreign Affairs of the Kingdom of the Netherlands, and aims to source, incubate, and accelerate innovative solutions to reduce water scarcity around the world. Projections are that by 2025, two-thirds of the world's population could be living in severe water stress conditions.

By partnering with USAID in the Desal Prize, Reclamation has the opportunity to aid advancement of innovation in small-scale and cost-effective brackish water treatment systems for rural and underdeveloped areas in connection with its mission. Small-scale brackish water treatment systems are currently too complex, expensive, or unreliable. Advancing technology in this area will help Reclamation provide well-head treatment that can use local brackish groundwater as an alternative to long-distance freshwater pipe and treatment systems for rural and tribal communities. Reclamation also will demonstrate its technical expertise in advanced water treatment and further showcase BGNDRF capabilities.

Reclamation's technical assistance up to now includes providing input in performance criteria development and helping select judges for the competition. Reclamation's Saied Delagah and Kevin Price, both chemical engineers and desalination experts, helped in performance and criteria development. Kevin will be a judge for the Desal Prize, and Saied will be an alternate judge. Saied traveled to Jordan with a colleague from USAID to learn about end-user needs of farmers. Input from the farmers and end-users has been incorporated into the development of the prize criteria. Reclamation will also aid in development of a USAID ideation challenge on concentrate management.

The Desal Prize was announced on March 22, 2014, on World Water Day, and proposal submissions will begin in spring 2014. USAID's Desal Prize will be awarded to cost effective, energy efficient, and environmentally sustainable working prototypes. Ten to 12 semifinalists will receive seed money to test or further develop their device. From this group, select finalists will receive additional funds to continue their project in the field before a judging panel selects the awardee(s) for the grand prize. The Desal Prize details regarding prize amounts and proposal submission are subject to change, based on the availability of funds and changes to the prize timeline.

Saied Delagah (right) visiting with Jordan Valley Water Authority's Nabeel Bani Hani and farmers in Jordan Valley using reverse osmosis treated water for irrigation.

More Information

More information on the Desal Prize can be found at:

www.thedesalprize.net
and
www.thedesalprize.org.

Technology Challenges

Saied Delegah

Saied Delegah, Chemical Engineer, B.S., M.S., P.E.

Potential Water Technology Solutions for Rural and Underdeveloped Areas

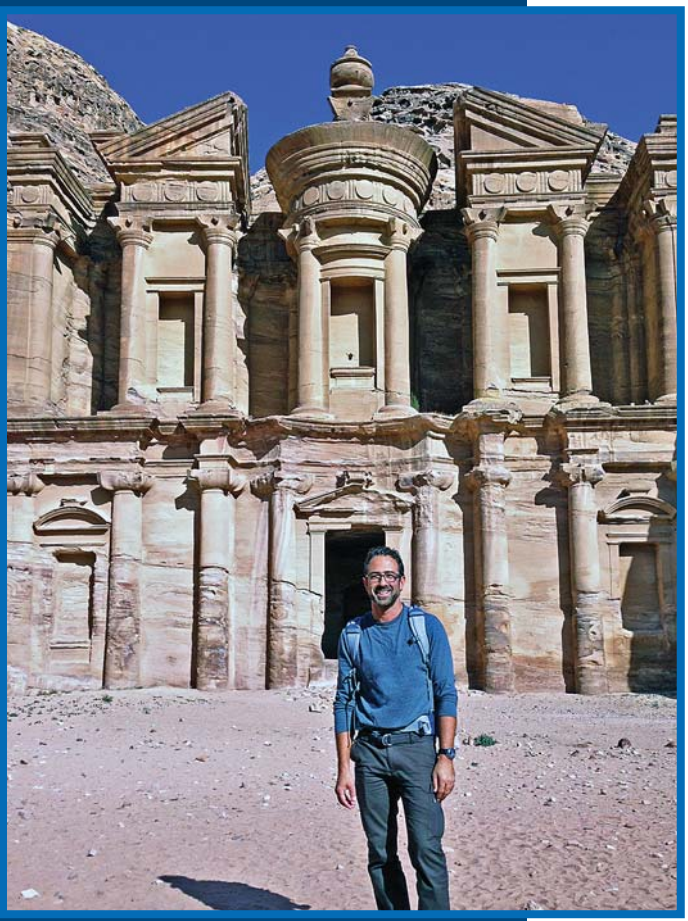
Saied Delagah is a chemical engineer in the Water Treatment Group in Reclamation's Technical Service Center. He has been with Reclamation for 12 years and has worked on a number of advanced water treatment projects ranging from laboratory scale to piloting in the field, as well as demonstration-sized projects.

Saied was born in Boulder, Colorado, and lived in Iran for 10 years. In 1996, he received a Bachelors of Science in Biological Sciences from Colorado State University. He received his Bachelors of Science in Chemical Engineering from the University of Colorado-Boulder in 1999. In addition, Saied earned a Masters of Science in Civil, Environmental, and Architectural Engineering from the University of Colorado–Boulder in 2008 and a Masters of Science in Technology Commercialization from the University of Texas–Austin in 2013. Prior to joining Reclamation, Saied worked as a consultant in desalination membranes and software consulting.

Currently, Saied is managing for the Technical Service Center the Desalination and Water Purification Research external research program, is involved in technology transfer activities, works on advanced water treatment research studies with internal and external clients, manages Reclamation's United States Agency for International Development prize activities, and is involved in various other Reclamation activities. He has worked on water treatment design projects and has been part of a team that received a patent on cellulose acetate membranes development at Reclamation.

Saied was also involved in Reclamation's Hurricane Katrina relief efforts. As part of the relief efforts following Hurricane Katrina, Saied and other Reclamation colleagues camped out on the Hard Rock Hotel's devastated grounds, where they provided treated water to the local hospital.

In his spare time, Saied enjoys traveling (especially internationally), learning, and participating in various forms of water recreation (solid and liquid).



Saied Delagah in the historical and archaeological city of Petra in Jordan.

Research Updates

RECLAMATION Managing Water in the West

Spring 2014
Research and
Development Office
Bulletin 2014-01

The Knowledge Stream
Research Update

Developing Automated Methods to Improve Modeling for River Channels and Features

Getting a more accurate picture of our underwater surfaces

Bottom Line

This study helps build automated methods for a custom Geographic Information System (GIS) interpolation tool that can be used by non-GIS professional engineers and scientists to support hydraulic modeling efforts.

Better, Faster, Cheaper

More accurate underwater mapping can help provide more accurate channel hydraulic data and modeling, for example, determining channel velocities and the flows when discharges may overtop channel banks and flood adjacent lands.

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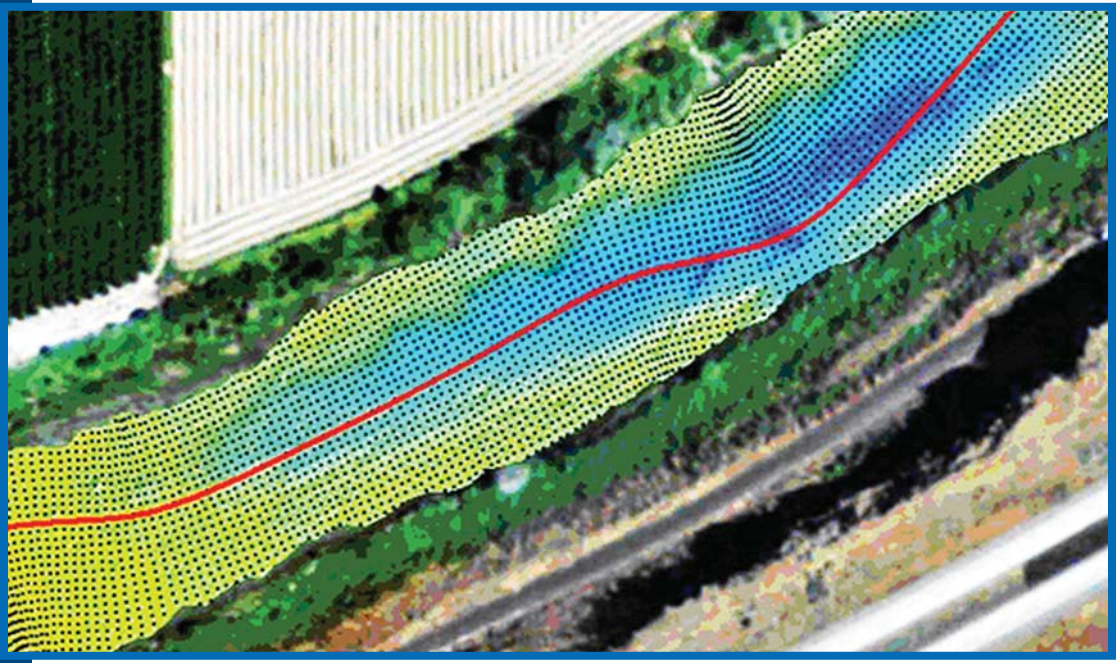
Problem

Mapping the underwater depths of rivers or lakes (bathymetry) is vital to Reclamation's modeling efforts to support detailed hydraulic studies of river systems, flow, and ecosystems. The most critical input to any hydraulic model is the geometric representation of the channel and floodplain surface.

Reclamation engineers and scientists routinely perform numerical modeling to support hydrodynamic, sediment transport, vegetation, riparian habitat, and geomorphic analyses. These modeling efforts typically require a continuous bathymetric surface representation that is spatially interpolated from a collection of surveyed points acquired with sonar and Global Positioning System (GPS) equipment mounted to a boat or raft. Bathymetric representations of a river are usually produced by collecting a set of channel bottom elevation points and then interpolating the elevation values into a continuous bathymetric surface.

More accurate interpolation of river channel bathymetry will result if the interpolation relies on data points that are aware of their location in reference to riverflow direction. However, there is no existing method to transform these separate data points into a coordinate system that is aware of riverflow direction before interpolation, and then return interpolated results to a Cartesian coordinate system.



Mapping the riverbed: a continuous bathymetric surface model constructed from interpolated data points oriented in the direction of riverflow.

Solution

This study provides an automated technique that:

- Transforms surveyed bathymetric point data from a surveyed coordinate system to a system that references each point to its position on the riverbed (longitudinal distance along, and lateral distance from, a linear river thalweg—the lowest depth of the river).
- Performs an appropriate interpolation on the transformed data.
- Transfers the results of the interpolation back to the coordinate system of the input data.

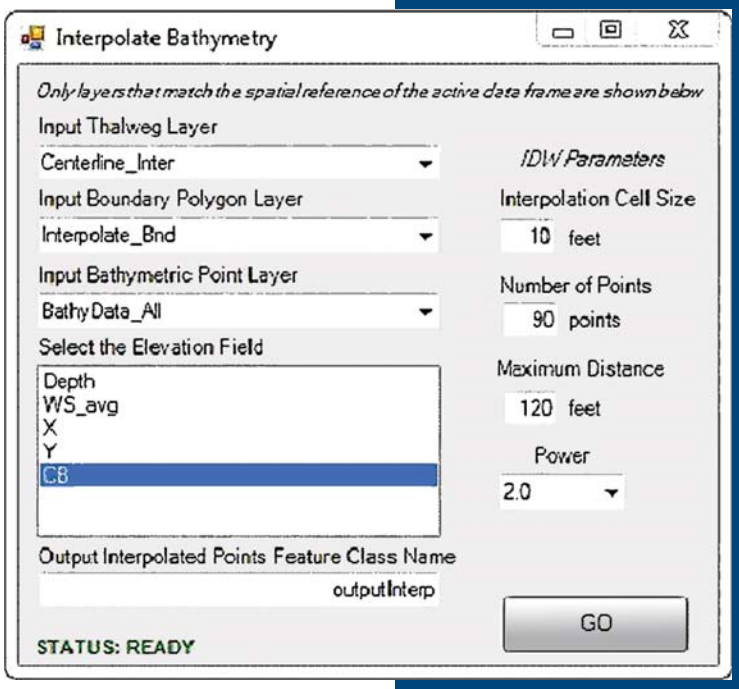
Results and Application

This effort produced a custom tool that functions inside the ESRI ArcGIS ArcMap 10.x software and is designed for use by non-GIS professional engineers and scientists. The tool uses an interpolation method that produces predictive bathymetric surface measurements in the form of interpolated points that show the spatial relationship of input survey points to riverflow direction.

The interpolated bathymetric points can be integrated with breakline features and terrestrial elevation data to create a surface model that contains both wetted and non-wetted features. These surface models can be used to support two-dimensional (2-D) hydrodynamic modeling efforts that require continuous elevations, which encompass floodplains and other areas outside the wetted river channel.

The tool uses standardized interpolation techniques that include identifying and reducing global lateral and longitudinal elevation trends. As such, the tool is designed to be used for river reaches that are morphologically similar and areas where the pattern and density of bathymetric survey are consistent. The tool is useful only in single-channel environments. It is not designed to work in braided channels or in areas of stream confluence.

The accuracy of the interpolated bathymetric point features depends on the quality, density, and collection pattern of the bathymetric survey. The accuracy and usefulness of the interpolated elevation values output from this tool will be related to how well the spatial arrangement of bathymetric survey points is able to capture the entire longitudinal and lateral definitions of the channel.



User interface for the GIS interpolation tool.

Future Plans

This GIS interpolation tool will be used in future modeling and planning analyses as part of the suite of sediment and river hydraulics modeling tools used in the Sedimentation and River Hydraulics Group in Reclamation's Technical Service Center.

"The new GIS bathymetric tool is being used by the Sedimentation and River Hydraulics Group within Reclamation's Technical Service Center to make better surface models for 2-D hydraulic modeling efforts. It gives us more accurate representations of the channel and provides a new window onto riverbeds."

Jennifer Bountry
Hydraulic Engineer,
Reclamation's Technical Service Center

More Information

www.usbr.gov/research/projects/detail.cfm?id=2834

RECLAMATION Managing Water in the West

Spring 2014
Research and
Development Office
Bulletin 2014-02

The Knowledge Stream
Research Update

Adaption Rates of Bed Load Gravel With Riverflows

Determining how the rate of gravel movement along the riverbeds adapts to changing flow conditions

Bottom Line

This research examines how gravel transport rates adjust to different local streamflow conditions in a spatially variable flow. Better estimations of this adaptation parameter will help develop more accurate models of the bed load transport.

Better, Faster, Cheaper

Realistic estimates of bed load adaptation can lead to more accurate models, thus providing better information about habitat, infrastructure, and other factors for more effective actions, such as river restoration or river hazard modeling.

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Collaborators

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- **University of California, Berkeley**
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Problem

Predicting river hazards, determining habitat requirements and functions, and stabilizing rivers all require understanding river dynamics. In gravel bed rivers, the gravel and other coarse sediments move along the bottom of the river, in "bed load." In the Trinity River, California, the Trinity Dam prevents this bed load from traveling downstream. Without managing this coarse sediment below the dam, the river would eventually transport all of the available bed load downstream, leaving nothing for habitat (e.g., gravel for spawning beds).

Modeling how a river transports this bed load is critical to understanding gravel bed rivers. However, quantifying this transportation is complex. Bed load transport rates change with the strength of the riverflows, which is usually quantified within terms of shear stress. For a given shear stress, bed load transport equations are available for predicting the corresponding transport rate. But shear stress in a river varies with the shape and slope of the river channel. Consequently, the concentration of bed load moving down the channel is constantly adjusting to match the changes in shear stress.

For example, the shear stress could be near zero in a pool where the water is slow and placid, then suddenly increase in a steep rapid just downstream. The bed load transport rate would be near zero in the pool, whereas the shear stress in the rapid may be enough to drive a high transport rate. Yet it is unrealistic to expect the transport rate at the beginning of the rapid to instantly jump from zero to a large rate. Instead, the transition from a zero transport rate to a large transport rate would take place over some distance along the riverbed. That distance is the bed load adaptation length. Current numerical models used to predict river channel changes incorporate the effects of bed load adaptation with an adjustable model parameter. However, there is no consensus on how to estimate the adaptation distance. Improved methods for quantifying bed load adaption lengths have the potential to improve the accuracy and reliability of model predictions.

The camera videos the grain transport through the plexiglass sidewall.

Solution

There is very little information on bed load adaptation in literature. One hypothesis is that the adaptation distance increases as the intensity of the flow increases. In other words, the greater the final transport rate, the longer the distance would be to reach it. But the opposite has also been proposed—that a greater distance is required to reach the smaller equilibrium rates associated with weaker riverflows, as the lower shear stresses pick up additional gravel at a lower rate.

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Experiments were conducted to measure the bed load adaptation length, a parameter that quantifies the distance required for gravel transport rates to reach equilibrium after encountering a change in the local flow velocities and shear stresses. To determine how riverflows affect the adaptation distance, bed load transport was measured in a laboratory flume. The flume, at the University of California at Berkeley's Richmond Field Station, was operated at three bed slopes to assess bed load transport over a range of hydraulic conditions. Increasing the slope of the bed allowed the bed load transport rates to be measured at three different shear strengths. Instantaneous bed load transport rates were determined by counting passing sediment particles on digital imagery collected at variable distances downstream from a zero-transport boundary in a small flume.

Results and Application

The bed load adaptation length appears to increase with increasing shear stress. Previously proposed equations were reviewed to determine what might be consistent with these results. Thus, equations that more accurately reflect bed load adaptation lengths were suggested. Bounds were also put on how large the adaptation length is, and the research suggested that it is relatively small—that is, a short distance is required to pick up gravel and reach an equilibrium transport rate.

Thus, adaptation rates may not be that vital for certain model applications (e.g., large-scale 2-dimensional mesh). However, proper scaling of the adaptation distance may be critical for modeling small-scale processes, such as scour around large woody debris or other local habitat features.

The results of this research are being used in a gravel augmentation and river rehabilitation project on the gravel-bedded Trinity River in California. They are also being incorporated in SRH-2D, a 2-dimensional hydraulic and morphodynamic model developed at Reclamation's Technical Service Center that is being used in the design of gravel augmentation and channel rehabilitation projects on the Trinity River and elsewhere.

The flume is running and the computer station is logging data.

"Understanding how gravel moves along a riverbed and how riverflows influence that movement is critical to managing a gravel river such as the Trinity River."

Robin Schrock
Trinity River Restoration Division Program Manager, Reclamation's Mid-Pacific Region

Left to right: David Gaueman, graduate student Omid Arabnia, and San Francisco State University Professor Leonard Sklar.

Future Plans

This information will inform future modeling development for the sediment models such as the SRH-2D. Future research is recommended to further refine the understanding of the relationship of bed load transport within a dynamic gravel river.

More Information

www.usbr.gov/research/projects/detail.cfm?id=3054

RECLAMATION Managing Water in the West

Spring 2014
Research and
Development Office
Bulletin 2014-03

The Knowledge Stream
Research Update

Determining How Runoff and Temperature Changes Are Linked to Fish Habitat

Evaluating climate-induced runoff and temperature change on stream habitat metrics for endangered or threatened fish

Bottom Line

This research helps provide the tools needed to inform planners and designers how climate change can alter the hydrologic runoff and water temperature inputs to stream and floodplain reaches used by endangered or threatened fish species.

Better, Faster, Cheaper

This type of model framework is useful for planning and evaluating habitat improvement projects for ESA-listed salmonids in the context of anticipated global climate change. Water temperature information at a finer scale will help better analyze and design rehabilitation projects for endangered or threatened fish species. This two-dimensional (2-D) model capability is particularly useful in unconfined channel areas that provide important habitat for juvenile salmonids and other fish.

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Problem

Stream rehabilitation projects have been ongoing under numerous programs for many years. Rehabilitation actions are often based on altering channel hydraulics and form to provide appropriate velocities, depths, and sediment sizes preferred by the fish species of interest. These actions are engineering solutions designed to increase the quantity of available habitat from a physical perspective. However, it is generally not clear if actions improve the quality of the habitat, if the habitat generated is sustainable over the long term, and whether fish will ultimately use it.

Salmonids, in particular, require adequate availability of food, but linkages between altered hydraulics and the food web are almost never evaluated, even though these connections could cause a failure to meet the basic rehabilitation objectives. Critical links between fish growth and survival and watershed and river-scale processes (hydraulic residence time, fluctuation in flood plain and side channel inundation, and water temperature) need to be understood.

Stream temperatures are an important component of aquatic habitat throughout the year. To further complicate matters, climate change has become an increasing concern in salmon programs under the Endangered Species Act (ESA), because many streams are already believed to be at an upper threshold of tolerable water temperatures during low-flow, later summer, and fall periods. These linkages are directly related to the flow runoff and water temperature which, in turn, are impacted by climate change.

Solution

This research provides a water temperature model that can be integrated into a set of linked models to help predict the short- and long-term effects of climate change and resource management actions on river processes. The model framework will add the capability of linking watershed and reach-scale hydraulic and water temperature models (and reach-scale numerical models) with biological models that will predict age-specific and life stage-specific fish production based on habitat and food availability.

Collecting stream on the Methow River, Washington.

Application

This model can be applied in several analyses, including evaluating temperatures in complex river systems with many flow paths and floodplain interaction. The model will be useful in evaluating the impact of restoration strategies on stream temperature. For example, if restoration strategies include construction of side channel habitat or levee setbacks, the model can be used to evaluate the impact to stream temperature due to these actions.

The current specific applications of the model include the Methow River, in eastern Washington, which is a well-mixed river with steep slopes and fairly shallow depths. A reach with a warmer tributary and cold water springs was selected for a variety of temperature conditions. This means that the water temperatures are similar from the top to the bottom of the river in a given spot. The 2-D model captures the lateral variations, particularly where there are many channel paths.

The model is also being tested on the San Joaquin River, California, which is a regulated system with gravel pits. The San Joaquin River Restoration Program is interested in evaluating the effect of gravel pits on stream temperature and how potential channel reconfiguration can improve stream temperatures for salmon.

Future Plans

Reclamation is working with the U.S. Geological Survey to use this model framework as a basis to develop the biological modeling tools and assist with temperature data collection protocols. Future research applications might link this model with groundwater inputs to identify important habitat areas (temperature refuges) for fish on a given stretch of river.

Now that the water temperature module is up and running, future research steps include water temperature sensitivity analysis to weather parameters. These factors are represented in the model, but how important factors such as solar radiation, atmospheric radiation, and heat losses are influencing water temperature predictions also need to be understood.

Analyzing more diverse test cases, including regulated rivers with more geographical, biological, and operational diversity, will make the model more robust and applicable to a wider variety of situations. This will also improve the model's reliability and credibility.

"The models will help Reclamation and its partners analyze how future climate may affect river rehabilitation projects to improve conditions for listed salmonids with consideration for habitat response to climate change."

Jennifer Bountry
Hydraulic Engineer,
Reclamation's Technical Service Center

Collaborators

- **Reclamation's Methow Field Office**
- **USGS**
- **University of Washington**

More Information

www.usbr.gov/research/projects/detail.cfm?id=6507

Field data that shows surface and groundwater temperatures.

Model for surface water temperatures, with major groundwater inputs represented in the model.

RECLAMATION Managing Water in the West

Spring 2014
Research and
Development Office
Bulletin 2014-04

The Knowledge Stream
Research Update

Understanding How Mussels Attach to Surfaces

Molecular-level insight to develop durable coatings that prevent mussel attachment

Bottom Line

This research project highlighted advances in the mussel adhesion literature.

Better, Faster, Cheaper

Many costs are associated with mussel attachment to Reclamation structures. Preventing this attachment is one means to reduce impacts to flows, water delivery, and hydropower production. This foundational knowledge will be used to develop durable coatings that prevent mussel attachment.

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Problem

Invasive mussel species, notably quagga mussels, are spreading into Reclamation's reservoirs and rivers in the Western United States. Their rapid and extensive colonization impacts operation and maintenance (O&M) of water storage, water delivery, and hydropower structures and systems. Furthermore, their presence also affects recreational usage and aquatic ecosystems. Once adult mussels settle and attach to a surface, they are very difficult to remove. Reclamation has evaluated commercial coatings that can prevent mussel attachment, such as anti-fouling and foul-release systems. Foul-release coatings were developed for marine applications and have proven to prevent mussel attachment. These coatings are typically soft silicone materials and can be easily damaged. Reclamation's structures require tough coatings that can withstand impacts from woody debris, scour, and other hazards lurking in reservoirs and rivers.

Silicone product that prevents mussel attachment. Photograph taken at Parker Dam field test site in Arizona/ California. During the semi-annual evaluation.

Solution

Understanding mussels' unique underwater attachment mechanism can provide a treasure trove of research breakthroughs in medicine and other scientific fields. National Institute of Health research grants have led to the characterization of the mussel's adhesive and cohesive proteins—a naturally occurring glue that cures underwater. The goal is to reproduce these materials or processes for biomedical applications. These research efforts have created a wealth of information and advanced theories in the mussel attachment mechanism.

This Reclamation Science and Technology Program research project reviewed advancements in understanding how mussels adhere to almost any underwater surface.

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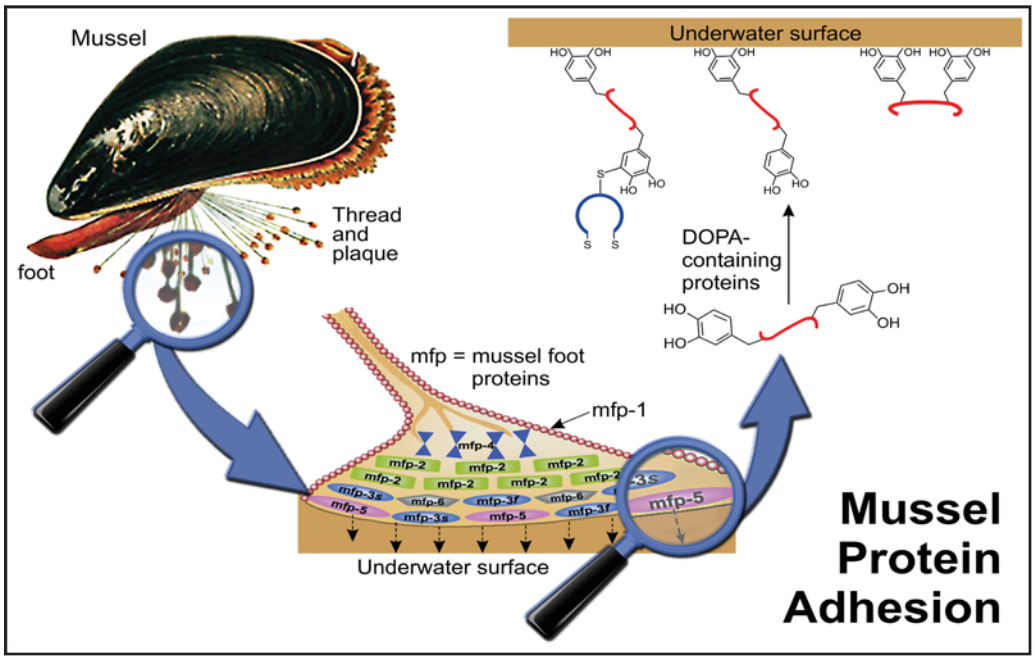
Materials engineers and coatings researchers reviewed the protein chemistry and adhesion mechanism of mussel species. This knowledge has been applied to the evaluation of methods or materials, which may effectively discourage mussel attachment. Summarizing these insights is the cornerstone to the successful development of new materials.

Conclusions and Applications

While each invasive mussel species has slightly different amino acid sequences and molecular weights, the attachment chemistry and process is similar across all mussel species. Research has revealed that the mussel's attachment process, which takes about 5 minutes, combines chemical adhesion and mechanical interlocking to form these characteristically strong bonds. The technical aspects of this process, with a view to preventing mussel attachment on Reclamation's infrastructure, will be summarized and published in the forthcoming book, Biology and Management of Invasive Quagga/Zebra Mussels in the Western United States as chapter, "Mussel Byssus and Adhesion Mechanism, Exploring Methods for Preventing Attachment."

To attach to a surface, the floating mussel extends its foot from within the shell and places it onto the surface. A protein solution is secreted through the foot to form all the necessary anchoring components: the thread (thin filament) and the plaque (disc-shaped pad). Here, the thread is analogous to a boat anchor rope, while the plaque is firmly attached to a surface as the anchor itself. The other end of the thread is secured to the mussel body—the boat in this analogy. Following this 5-minute cure, the mussel lifts its foot to reveal the new anchorage point. The process is repeated to form additional attachments.



The adhesive proteins (mussel glue) used at the plaque/surface interface are of most interest to Reclamation coating researchers. This mussel glue layer is formed from low molecular weight proteins. These proteins contain high concentrations of the amino acid protein 3,4-dihydroxyphenylalanine (Dopa), which is key to the animal's wet adhesion mechanism. Dopa forms strong, bidentate hydrogen bonds as well as covalent bonds with metals. These low molecular weight proteins easily penetrate into the surface microcracks and topography to provide mechanical interlocking where additional chemical bonding sites also become available.

"Revealing the mystery of their underwater adhesion can be the key to new coatings, materials, or technologies that may significantly reduce or prevent the rate of attachment, which is needed to sustain the reliability of Reclamation operations."

Bobbi Jo Merten
Chemist, Reclamation's Technical Service Center

Future Plans

Advances in polymer synthesis, coatings chemistry, and formulation are gearing up to provide a durable foul-release coating that prevents mussel attachment. This is a much-needed tool for Reclamation O&M in order to combat growing mussel infestations and related challenges. Reclamation is partnering with other research organizations and private companies to use insights gained in this research project to develop durable foul-release coatings or materials.

More Information

www.usbr.gov/research/projects/detail.cfm?id=7419

RECLAMATION Managing Water in the West

Spring 2014
Research and
Development Office
Bulletin 2014-05

The Knowledge Stream
Research Update

Affordable Self-Cleaning Trashrack

Irrigation districts can now build their own self-cleaning, solar-powered trashrack

Bottom Line

This research project developed a self-cleaning, low-head, low-energy trashrack system that effectively removes debris from irrigation canal systems.

Better, Faster, Cheaper

This system can reduce time, labor, and money invested in canal maintenance. Head loss across the self-cleaning trashrack is reduced from the head loss associated with self-cleaning screen mechanisms. As this system is solar-powered, it can be installed in remote locations.

Principal Investigator

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Problem

Removing debris from water flowing in canals is an operational issue for virtually any open-channel conveyance system. Materials such as tree leaves and branches, tumbleweeds, aquatic plant matter, dead fish and animals, along with human-created trash are typically carried along with water flowing in a canal. Stationary trashracks are commonly installed to serve as a debris collection point, but these must be cleaned to prevent excessive head loss and/or overtopping of the upstream canal banks as the debris mat accumulates on the rack.

The accumulated debris must be removed manually or mechanically, manually at most trashrack sites. Under adverse conditions (i.e., windy weather or rapid growth of aquatic plants) a trashrack may require cleaning every few hours—or in extreme situations—multiple times per hour. Keeping a trashrack cleaned can tie up an irrigation district's staff time resources as they travel to, and spend time on, a site. Existing automated trashrack cleaning systems typically have significant power requirements and represent a level of investment that has only been feasible for high volume sites on large water delivery systems. Automated cleaning systems have not been an economically viable alternative for most irrigation water delivery systems.

Solution

Reclamation researchers have developed a trashrack system in which the rack bars themselves function as the cleaning mechanism. A self-cleaning prototype was constructed and tested in a laboratory flume. The prototype rack bars were constructed of ½-inch-wide by 3-inch-deep steel bars spaced 3 inches apart on center. The bars are oriented at a 3:1 (horizontal:vertical) slope with the canal invert sloping upward in the direction of flow. The upper edges of the bars were cut in a saw-toothed shape. Each bar is able to travel back and forth in the direction of the rack slope at a distance of approximately 1 foot.

The bars are mechanically linked to synchronize the motion of every third bar. Three 12-volt DC gear motors power the motion of the bars. Each motor is linked to a shaft that passes under the upper end of the rack perpendicular to the bars. Sprockets mounted on the respective shafts are in line with every third bar and engage in sections of roller chain welded to the underside of the bars.

As a cleaning cycle is initiated, all bars are moved in unison toward the upper end of the rack. After this advance travel stroke, two thirds of the bars remain stationary while one third of the bars retract to the original position. Once the first group of bars has been retracted, a second group of bars retracts, and then the third group retracts. During each phase of the retraction, two of every three bars remain stationary. The saw-toothed shape of the bars tends to grip against the debris mat as it is being advanced, and the debris mat is held in place by stationary bars during the retraction. The saw-toothed shape also allows the retracting bars to slip back

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under the debris mat with minimal grip. Photograph 1 shows the prototype rack in the laboratory flume. Photograph 2 shows the shaft/sprocket drive mechanisms.

Automation components include a programmable logic controller along with a water level sensing system capable of monitoring water levels upstream of, and downstream from, the trashrack. The system is programmed to perform a cleaning cycle once the level differential across the trashrack exceeds a target value.

Application

During 2012, the self-cleaning trashrack was tested in the laboratory. The first test used synthetic aquatic plants, followed by tests with sago pondweed, and then filamentous algae materials collected from field sites. Following laboratory testing, the prototype unit was installed at a site on the Tetsel Ditch delivery system in northeastern Colorado. Photograph 3 shows a mat of debris that has been transported off the upper end of the rack and deposited onto a holding deck at the Tetsel Ditch site.

The prototype unit was operated continuously in automated mode beginning in mid-June and continuing through the end of the 2013 irrigation season. For this small-scale site, accumulated debris is deposited on a holding deck. The ditch rider manually clears the deck on his daily rounds. The unit operates entirely on solar-charged 12-volt DC power.

Future Plans

The Reclamation research project team are in discussions with the Angostura Irrigation District (Angostura) in southwestern South Dakota, along with the Dakota Area Office Water Conservation Field Services Program, to explore the possibility of installing a similar unit at Angostura's Cheyenne River inverted siphon entrance. Historical debris accumulation problems at this site are a key issue that led to development of the self-cleaning trashrack concept. With the solar-charged power configuration, this system can be suitable for sites where debris accumulation is a problem at almost any open channel location. The team estimates that total costs (including concrete placement) for a structure similar to the prototype unit (~3-foot-wide channel) will range from $20,000 to $30,000.

Photograph 3.—Prototype trashrack installation and operation at the Tetsel Ditch site in northeastern Colorado.

"After seeing this device installed, I wondered how it worked. Now that I have seen it operate during a cleaning cycle, it is really a simple system that works well."

Herman Neiman
Ditchrider for the
Tetsel Ditch Company

More Information

www.usbr.gov/research/projects/detail.cfm?id=3107

Photograph 1.—Saw-toothed edge rack bars.

Photograph 2.—Shaft/sprocket drive system.

RECLAMATION Managing Water in the West

Spring 2014
Research and
Development Office
Bulletin 2014-06

The Knowledge Stream

Research Update

Using Intelligent Compaction for Better Earthwork Construction Control

Real-time analysis of compactor drum vibrations and roller position to document compaction

Bottom Line

This research investigates an innovative earthwork construction control technology, intelligent compaction, to determine its benefits for Reclamation over traditional compaction control.

Better, Faster, Cheaper

Intelligent compaction can result in higher quality and more efficient and uniform soil compaction. However, its real benefit lies in documenting 100 percent of the compacted area, which could help avoid costly field investigations if later dam safety issues develop.

Principal Investigator

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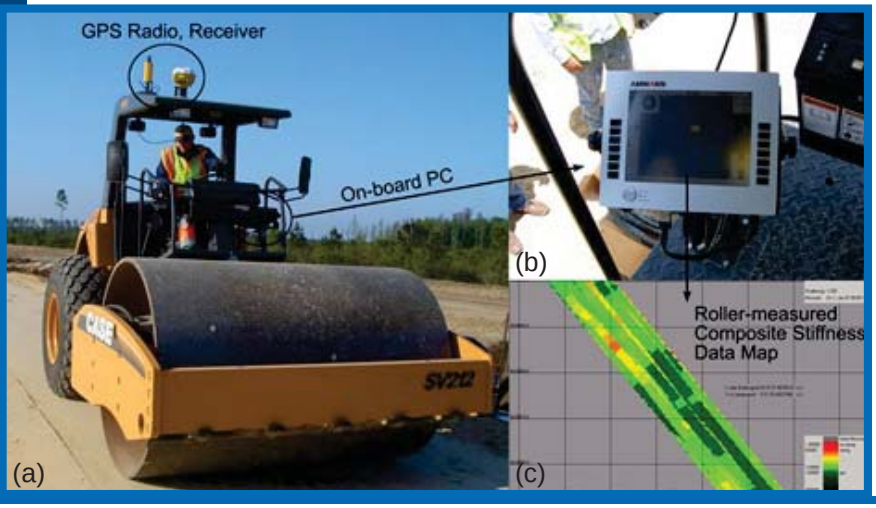
Problem

Soil compaction is the practice of mechanically increasing soil density and is used in numerous applications, including: pipeline embedment, stability berms, canal linings, and embankment fills. Current earthwork tests measure the density in a single location (spot test) and are carried out per a certain volume of fill placed—typically, testing about a half a cubic foot for an area that can contain hundreds or thousands of cubic yards of soil, depending on the nature of material and the placement. This single spot test in a small area is akin to judging the condition of a football field after examining a few blades of grass. The test cannot provide information about the density of the entire area. Thus, if a dam safety issue arises a decade or two later, there are no initial construction data that can illuminate potential problem areas. Instead, to analyze the site, field investigations would need to be conducted, which commonly cost hundreds of thousands of dollars, and could reach millions of dollars on large dams.

Thanks to onboard instrumentation, computing, and the Global Positioning System (GPS), it is now possible to document information about the soil density over the entire site, rather than a single small test spot. With Intelligent Compaction, the state of compaction of soil can be determined in real time and compaction data for quality assurance/quality control (QA/QC) can be documented—for little to no additional cost. By using Intelligent Compaction during construction, these data can be used years later to analyze any future issues without further expensive field investigations.

Intelligent Compaction was primarily developed in the transportation industry, and Reclamation is leading the way in importing this technology into dam safety. In its current form, Intelligent Compaction is available on heavy compaction equipment, but it is anticipated that the technology will become commercially available in smaller equipment (e.g., plate vibrators). This can be implemented in a variety of approaches, including using the Intelligent Compaction roller to:

- Verify adherence to specifications (i.e., track number of passes)
- Determine the over or undercompacted zones for spot testing purposes
- Monitor the compaction curve to establish when a material is fully compacted
- Correlate the roller measured values to traditional spot test values, such as density



Typical Intelligent Compaction equipment, highlighting (a) instrumented roller with vibration sensors and GPS, (b) onboard personal computer, and (c) roller-measured data map.

Solution and Results

This Reclamation Science and Technology Program research project analyzed the practical aspects of using Intelligent Compaction in the Echo Dam Seismic Modification Project. Earthwork specifications mandated that the contractor employ Intelligent Compaction equipped rollers to collect and store these data during compaction operations. Including Intelligent Compaction in the specifications did not increase the construction cost and resulted in documentation of compaction operations throughout the site.

Benefits for Intelligent Compaction include:

- Provides QA/QC data for construction with 100 percent coverage. This is a tremendous improvement over the less than 1 percent coverage for traditional methods and allows inspectors to hone in on problem areas quickly and effectively.
- Decreases dependence on density testing (e.g., using sand cone or nuclear density gage) as the roller becomes the primary QA tool. This eliminates the need for extra personnel and costs associated with density testing. Further, this can be used for materials that are difficult and expensive to test for density, such as pea gravel and rockfill.
- Provides GPS position-indexed and time-stamped QA data for the entire constructed area. These comprehensive electronic data can be stored long-term and referenced if issues arise requiring investigation into the as-built facility.
- Avoids over and undercompaction, which can lead to undesired performance. Real-time data provide immediate feedback for operators to determine where more compaction is needed, for more efficient and uniform compaction operations.
- Allows for the assessment of uniformity of compaction. Uniformity is currently not specified or controlled by Reclamation mainly due to the limited number of spot test data points available. Intelligent Compaction would enable the direct assessment of uniformity.

Intelligent Compaction roller compacting filter sand at Echo Dam. Photograph courtesy of Michael Talbot, Reclamation's Upper Colorado Region.

"Reclamation is posed to greatly benefit from Intelligent Compaction as it provides better coverage, better results, and better documentation than traditional spot-check methods."

Todd Hill
Safety of Dams Project Manager, Reclamation's Mid-Pacific Region

Future Plans

Intelligent Compaction technology should be implemented on a proof-of-concept basis on upcoming Reclamation projects. While Intelligent Compaction could be used in many ways, it is recommended that Reclamation start with the simple approaches to more strictly and easily enforce method specifications and focus spot testing on roller-identified over or undercompacted zones, rather than choosing locations at random. This will provide a higher quality product.

As a next step, it is recommended that Intelligent Compaction be implemented alongside traditional QA/QC for upcoming projects. This work should include the construction of representative test fills. This approach will give Reclamation personnel and contractors experience with the technology, while ensuring that a consistent level of quality is achieved via the traditional QA/QC methods and help develop best practices.

Reclamation should also evaluate the use of Intelligent Compaction for compacting select embedment materials for pipelines, and to document roller compacted concrete placements.

More Information

www.usbr.gov/research/projects/detail.cfm?id=406

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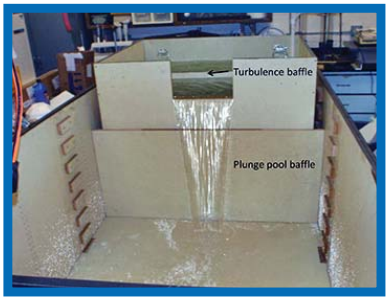

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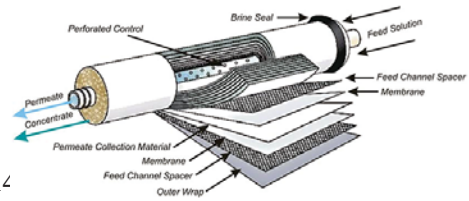

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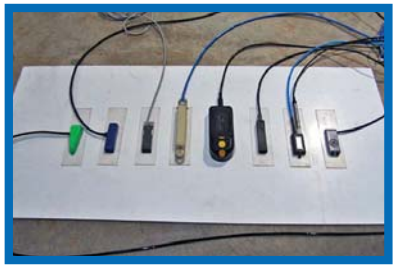

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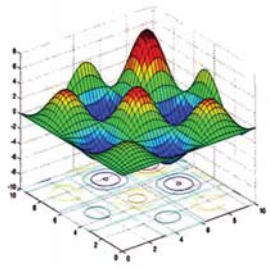

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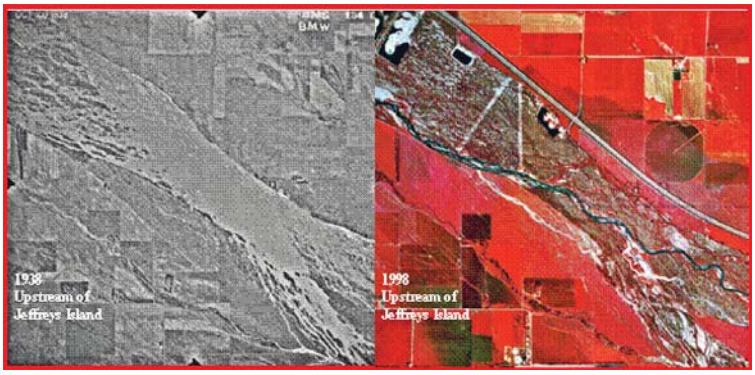

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— continued (from front cover)

"Reclamation and U.S. Army Corps of Engineers hold Research Collaboration Workshop"

The meeting organizers included Curt Brown, Chuck Hennig, Erin Foraker, Bobbi Jo Merten, Denise Hosler, and Rod Wittler from Reclamation; and Beth Fleming, Jeff Lillycrop, and Jack Davis from USACE-ERDC. Parallel sessions on infrastructure, invasive species, and ecohydraulics were held, plus plenary discussions on technology transfer and technology challenges. The workshop also included tours of several test laboratories, simulators, flumes, and other research centers across the ERDC-Vicksburg station to highlight unique ERDC facilities. There was much discussion between the participants of the common mission needs and the different, yet complementary, strengths of each agency. Active information sharing and joint project planning has already started in several areas. The participants identified 65 areas for collaboration on research, testing, and technology transfer, as listed:

- Infrastructure - 22
- Invasive Species -18
- Ecohydraulics - 18
- Technology Transfer - 4
- Technology Challenges - 3

Staffs from both agencies are now working to develop detailed descriptions of opportunities and paths forward, which will lead to identification of highest priorities and near-term objectives.

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Research Collaboration Workshop at the U.S. Army Corps of Engineers-Engineer Research and Development Center (USACE-ERDC) in Vicksburg, Mississippi.