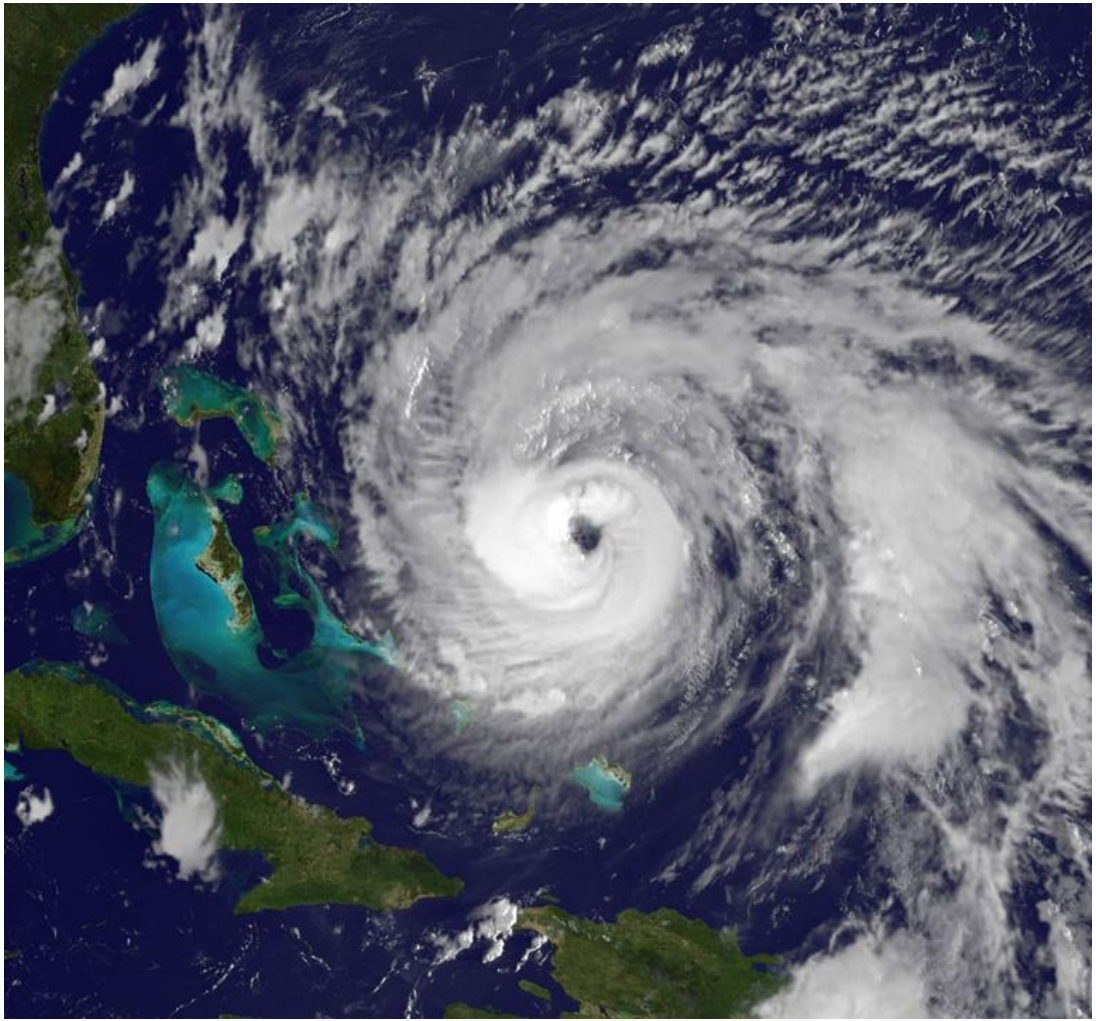


HydroShare – a tool to build resilience

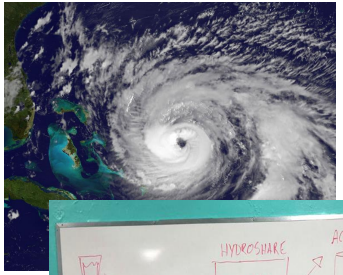
13th CECIA-IAUPR Biennial Symposium on Potable Water Issues in Puerto Rico: Science, Technology and Regulation

Dr. Christina Bandaragoda, University of Washington

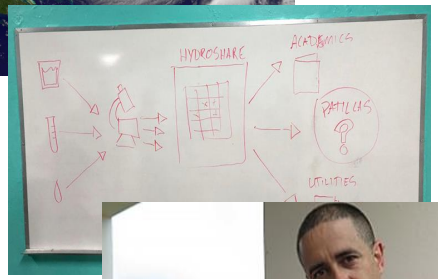
February 14, 2019 Bayamón IAUPR Campus

Proposed testable hypothesis

Communities are more resilient when hurricane-impacted individuals and communities ‘own’ their drinking water data.



Increasing the value
and
usability of water data



Case study: rural decentralized water quality data

When the power goes out –

Is this water safe to drink?

Leptospirosis and Superfund site water quality questions after Hurricane Maria in Puerto Rico (2017) highlighted the difficulties communication, availability of trusted data sources.

When the power goes out –

Is this water safe to drink?

Do people have and use data from the ***decentralized*** community water systems?

Leptospirosis is expected to increase due to human encroachment into wildlife habitat, climate change and environmental shifts. Surveillance for leptospirosis is important for early detection of cases because early treatment is crucial to decrease morbidity and mortality (Guerra, 2013).

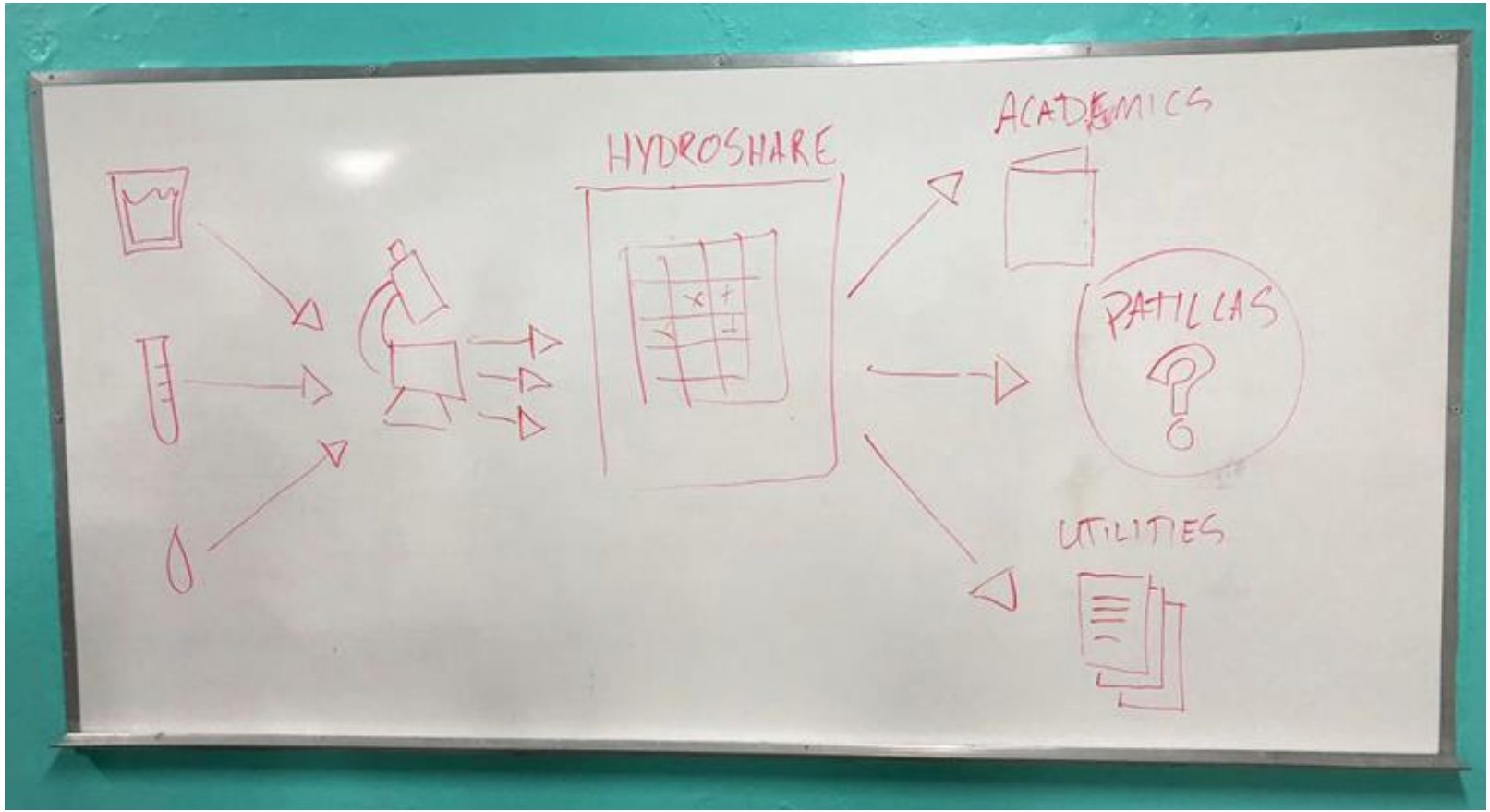
When the power goes out –

Is this water safe to drink?

Do people have and use data from the ***centralized*** government ?

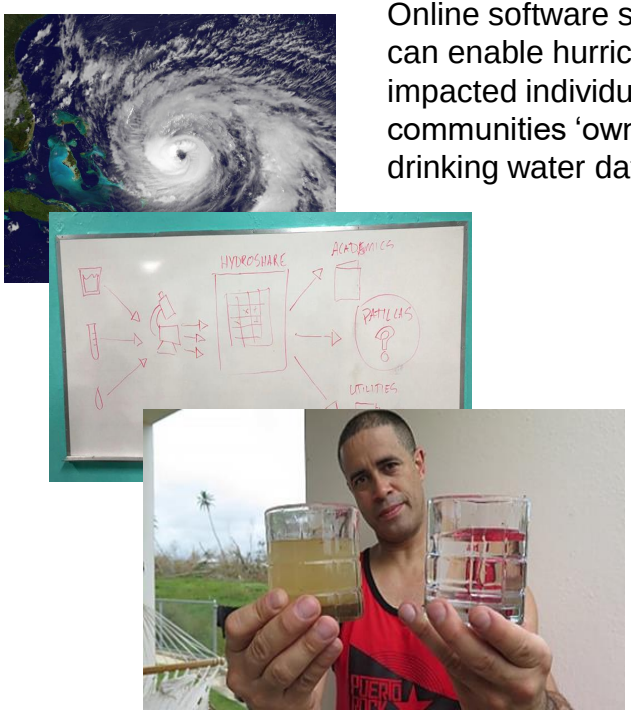
Well water from a federally designated Superfund site meets federal drinking water standards and is fit for consumption [U.S. EPA & Virginia Tech; Sutter, 2017; Sutter and Lavandera, 2017].

Cyberinfrastructure to the Rescue?



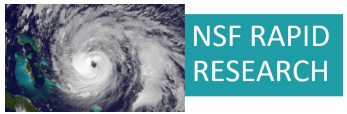
Data Provenance

Documents the inputs, entities, systems, and processes that influence the data – the historical record of the data and the origins.



Online software systems can enable hurricane-impacted individuals and communities ‘own’ their drinking water data.

Presentation Overview



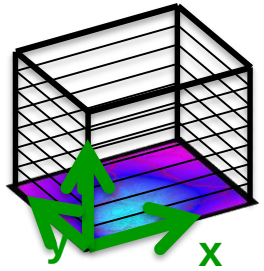
1. HydroShare: Online library for water data
2. Case study demonstrations: **RAPID Almost like Maria**
3. Awareness campaign: **Nuestra Agua & Waterhackweek**

HYDROSHARE

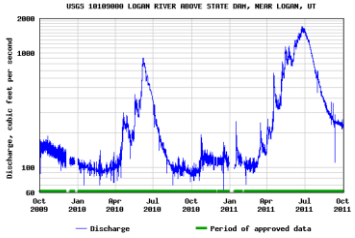
Teamwork for Advancing Hydrologic Understanding

- integration of information from multiple sources and using diverse types
- data and computationally intensive
- collaboration

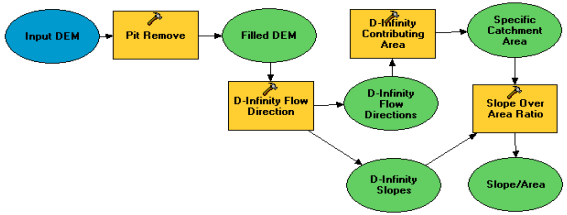
Data = Hydroshare Resources = Social Objects



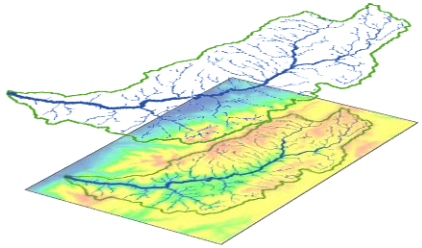
Models



Time series

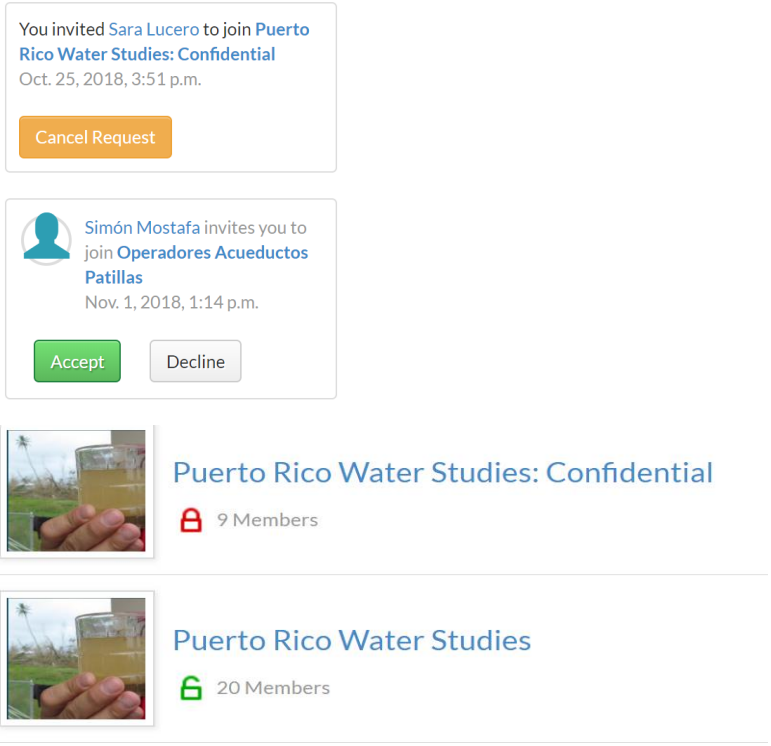


Code Workflows



Maps

Vision



- Access through web browser or phone
- No software installation
- Big Data access, faster computation
- Re-use
- Reproducibility
- Transparency
- Trust
- Collaboration

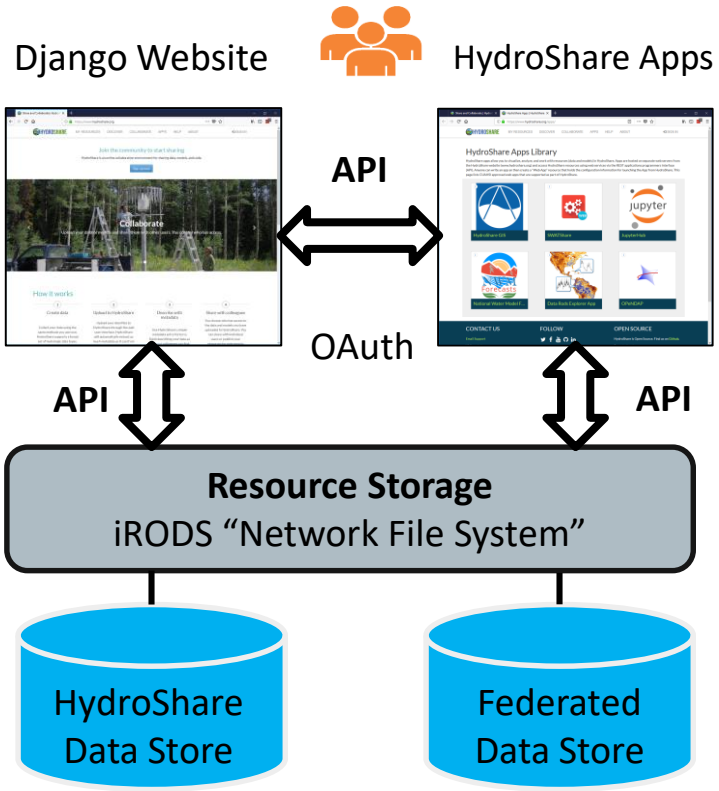
Conceptual Architecture

Resource exploration

- Organize your data
- Add 'metadata' to help people find your data
- Manage access to protect you data

Distributed file storage

- Federal repositories
- State and local government servers
- Academic libraries
- Community repositories

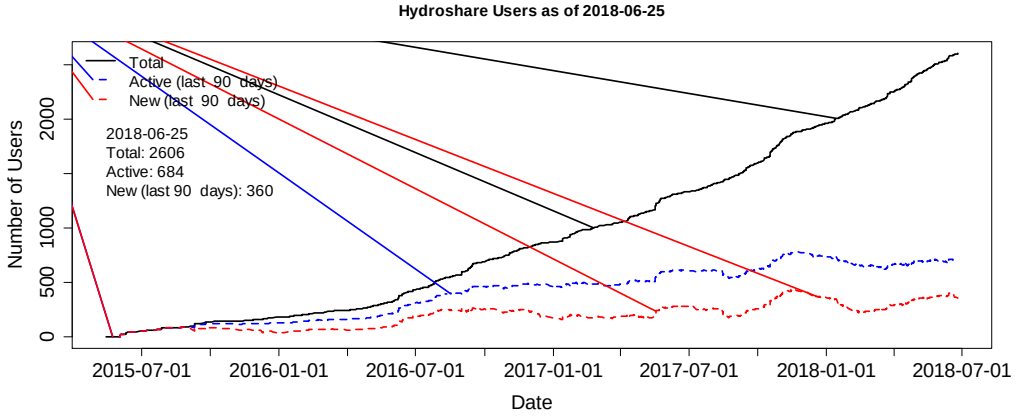


Actions on Resources

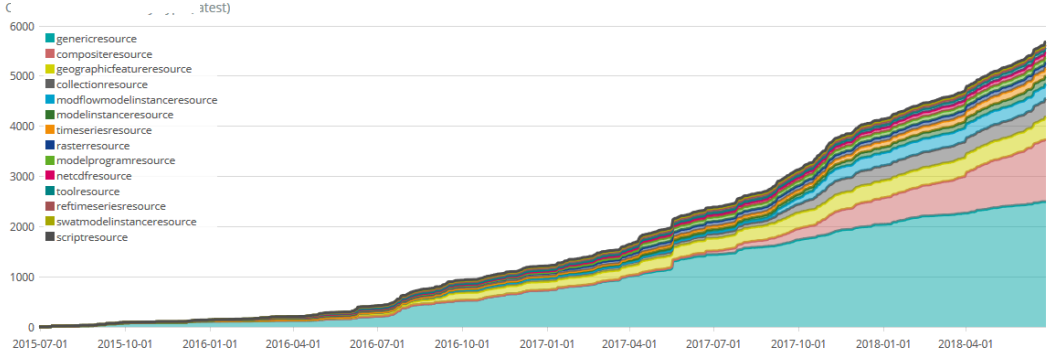
- Use Apps with public and private data (if you have permissions).
- Build Apps
- View data, Build and Run Models-- Examples: SWATShare (Hubzero), JupyterHub, Unidata – THREDDS, National Water Model Viewer

Moving towards fully web based hydrologic innovation environment

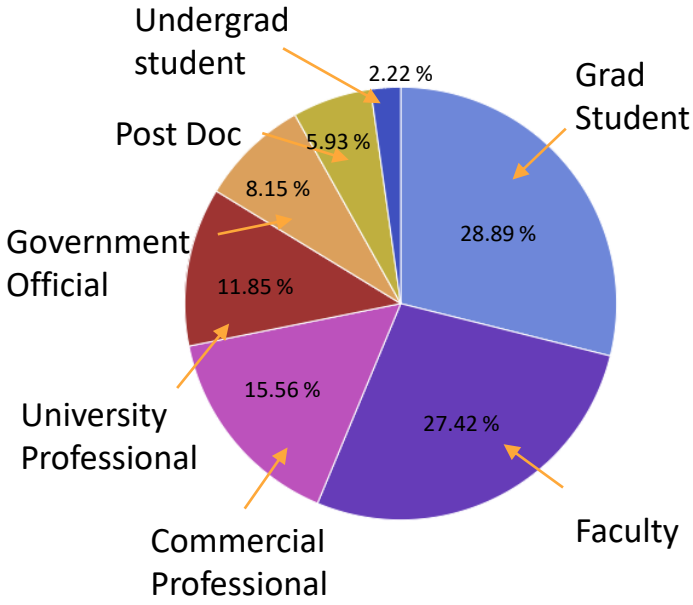
Current Audience and User base



Resources



Primary audience is US Hydrologic Research community (NSF funding) but open to international use and use by water resource professionals, educators and citizen scientists



Statistics as of 6/25/18 , see https://help.hydroshare.org/about-hydroshare/usage-metrics/

For users who have indicated type in their profile

Ideal Data Workflow

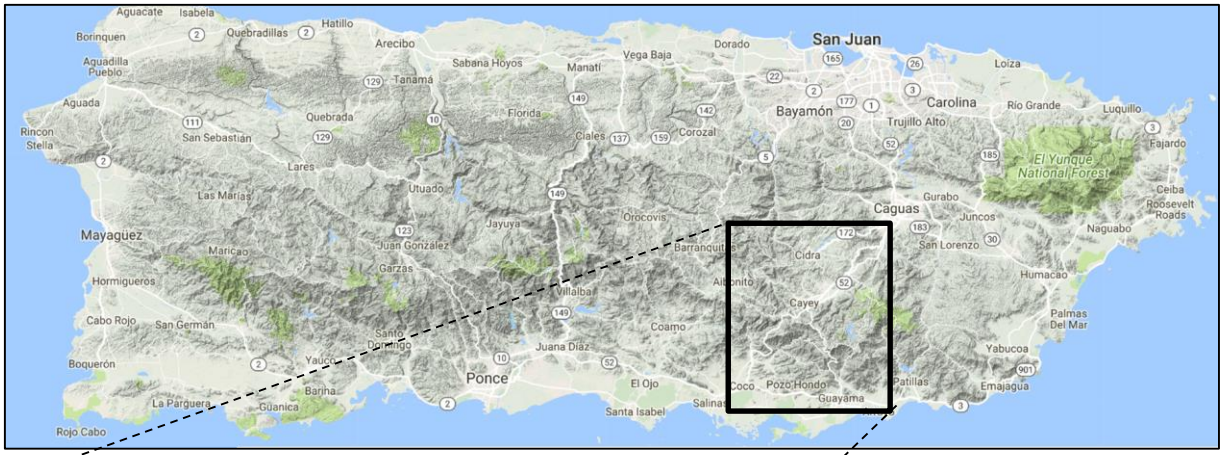
- Easily create a digital instance of a dataset or model
- Quickly share it with colleagues (perhaps privately at first)
- Add value through collaboration, annotation, and iteration
- Describe with metadata
- Efficiently…share publicly or formally Publish

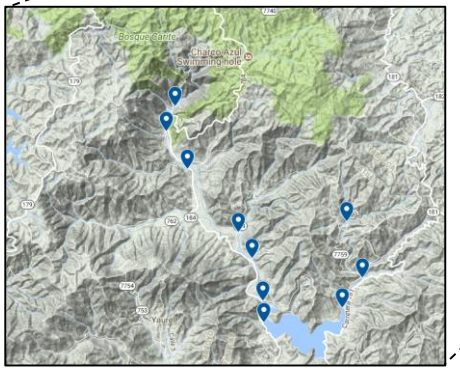
This is still not as easy as it should be!

From Jeff Horsburgh

NSF RAPID RESEARCH

Case Study: Maria Archive





NSF RAPID RESEARCH

Case Study: Maria Archive

Collaborative RAPID

BUILDING INFRASTRUCTURE TO PREVENT DISASTERS LIKE HURRICANE MARIA

	OBJECTIVE 01 Water Quality Sampling Campaign	OBJECTIVE 02 Data Archive	OBJECTIVE 03 Cyberinfrastructure Advances	Expected Science Outcomes
PUBLIC ACCESS INFORMATION	Drinking water samples from public streams Spatially aggregated anonymized information of the impact zone	Baseline assessment: Population Health Data, Healthcare Providers and supporting organizations, natural system environmental variables, Public Water System location and infrastructure status. Hurricane Maria health and environmental data from public data repositories and Luquillo CZO instruments in El Yunque National Park	LANDLAB raster model grid and diverse data formats → Observation Data Model (ODM2) →	**DISASTER:** Contamination, drought, landslides, bio-diversity **DRINKING WATER:** Geographic location and use data

NSF RAPID RESEARCH

Case Study: Maria Archive

Collaborative RAPID

BUILDING INFRASTRUCTURE TO PREVENT DISASTERS LIKE HURRICANE MARIA

PRIVACY PROTECTED INFORMATION

OBJECTIVE 01 Water Quality Sampling Campaign	OBJECTIVE 02 Data Archive	OBJECTIVE 03 Cyberinfrastructure Advances	Expected Science Outcomes
PRASA Utility, community operated tank system, household data Teacher collection of student health data (IRB)	Water samples with personal information De-identified water samples that can be geo-located	Population health researcher user-testing Water quality professionals and researchers user testing Individual data owners user testing	**HUMAN IMPACT:** Spatial distribution of contamination or drought

NSF RAPID RESEARCH

Case Study: Maria Archive

Collaborative RAPID

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Research Goals

1. Archive Hurricane Maria data
2. Extend hydro-data model (ODM2) for genomic data
3. Design system to quantify disaster impacts to health with a spatial distribution of contamination

NSF RAPID RESEARCH

RAPID Drinking Water Campaign

Virginia Tech & InterAmerican University of Puerto Rico

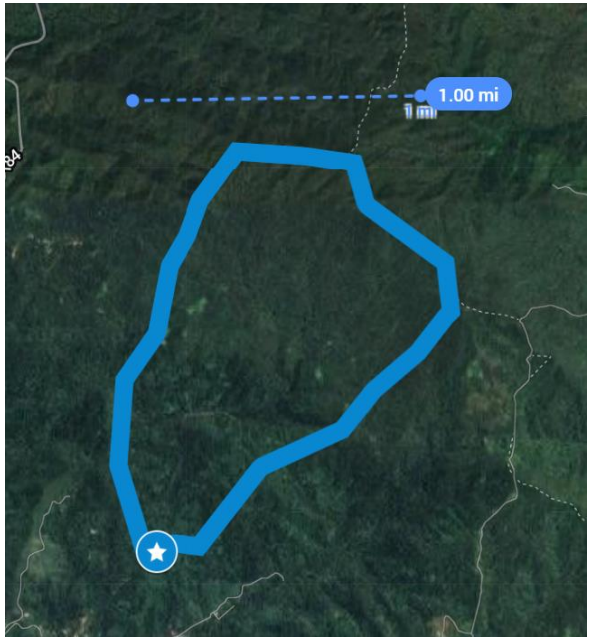
Water Quality Sampling in Southeast Region of Puerto Rico

6 Community Drinking Water Systems
1 Drinking Water Treatment Plan
3 Surface Water Branches
1 Wastewater Treatment Plan

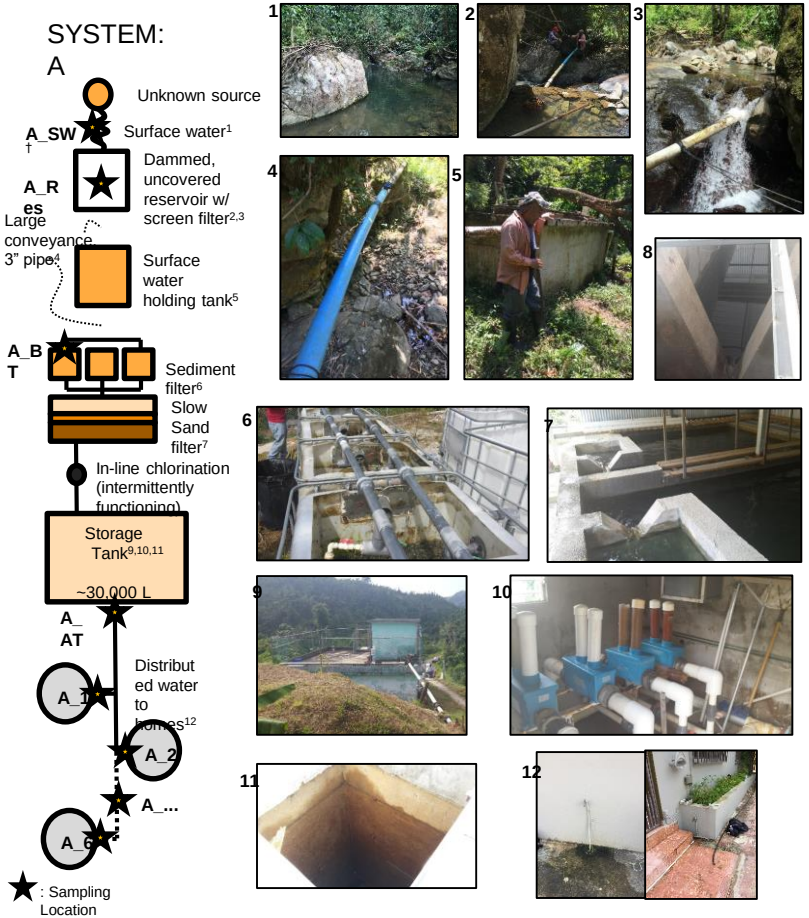
Sample data and map labels replace by Jurutungo (slang for ‘a far away place’) to protect privacy.

Results will be presented by Dr. Amy Pruden, Virginia Tech

Jurutungo



Surface water source area (2 sq.mi.) draining to the reservoir.



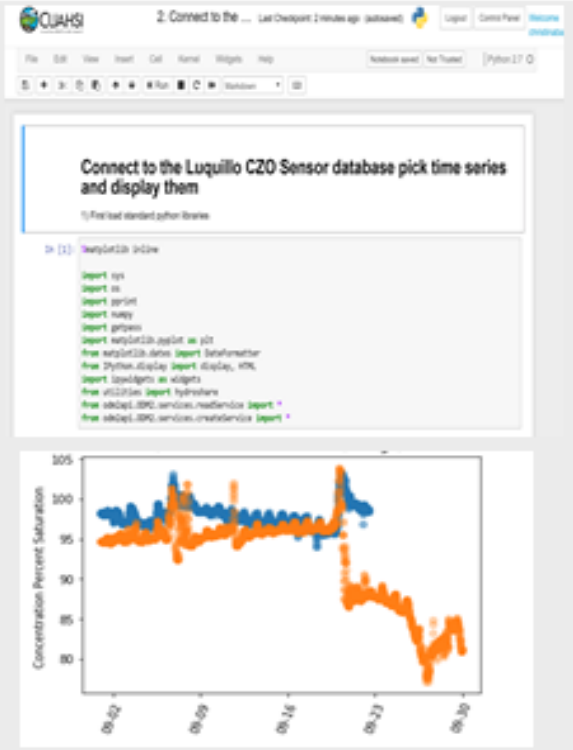
Sample names are in bold. **SGW**: surface impacted ground water; **URes**: upper-most reservoir; **LRes**: lower-most reservoir; **HT**: holding tank; **ST**: settling tank; **BT**: before treatment; **AT**: after treatment; **n** (**1-6**): house number sampled. GPS Mapping by Ben Davis. System Map by Ishi Keenum, Virgina Tech.

NSF RAPID RESEARCH

Luquillo Critical Zone Observatory Data Archive & Visualization

Luquillo Critical Zone Observatory

- Download data
- Run Python code
- Use Jupyter Notebooks
- To analyze data –
- e.g. dissolved oxygen drop in Luquillo CZO stream after Hurricane Maria



From Miguel Leon

NSF RAPID RESEARCH

Stakeholder Meetings

What are the information needs of population health researchers? Local governments? Responders? Citizens?

Participatory Design Workshops

[**Activity** *User Groups*]

Card sorting data priorities

Utility (PRASA)

Government

Academic – health researchers

Working/ Not working

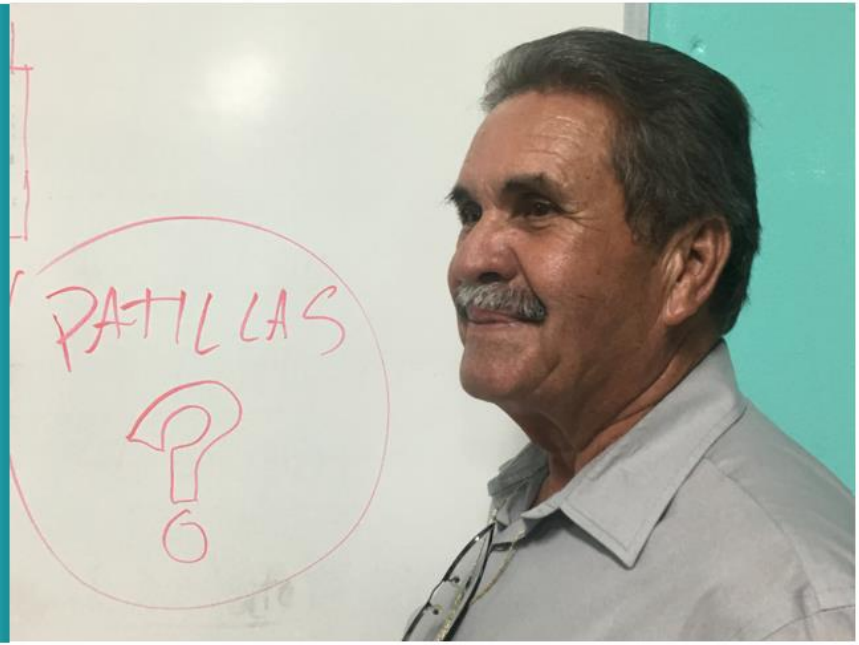
Community (non-PRASA water system)

NSF RAPID RESEARCH

"What works after a hurricane? ? ?

Our community. Teach us how to use our data. "

– Porfirio Fraticelli. Patillas Community Water System Operator. NEW HYDROSHARE USER



NSF RAPID RESEARCH

How can everyone “own” the data?

Four (unexpected) Requirements:

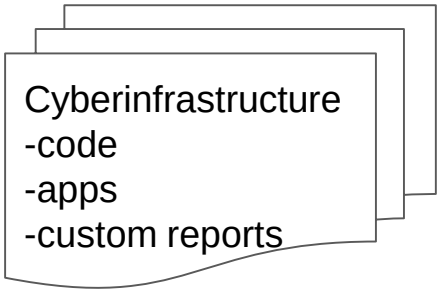
1. Private risk reduction products for individuals
2. Anonoymous public decision-making products
3. Trusted data quality control process and communication
4. Trusted organizational management

water mesh

online infrastructure for real-world health impacts

Data

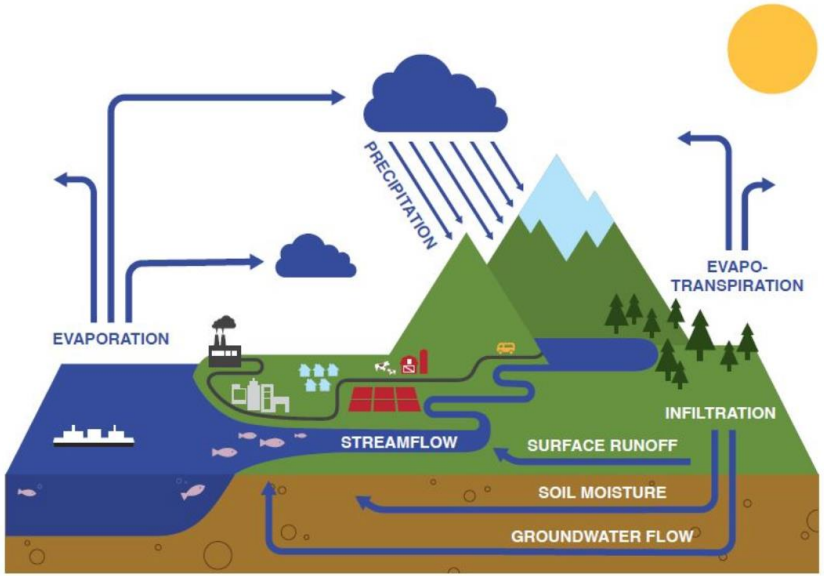
- chemistry
- sediment
- microbe contamination
- upstream areas
- climate data
- terrain
- households



Current State and Risk scenarios to Safe Drinking Water

water mesh

online infrastructure model



1. private data asset
2. community repository
3. software tools
4. compute resources
5. risk management product
6. public benefit

water mesh

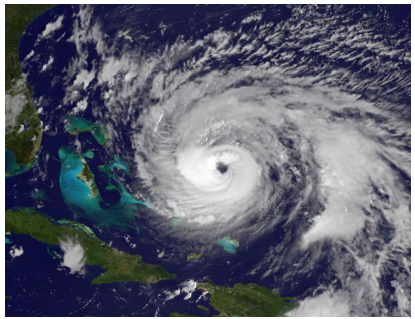
Case Study 1
vulnerable drinking water

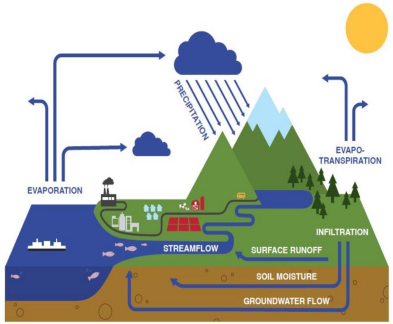
1. Drinking water samples ‘owned’ by stakeholders & shared with advocates (QC, legal, health).
2. HydroShare Groups
3. Landlab Toolkit
4. CUAHSI JupyterHub
5. Drinking water report with source area geo-risk and hurricane risk synthesis.
6. Rural water systems and public utilities enabled to anticipate hurricane risk and comply with Safe Drinking Water Act.

ESIP Lab Project

NUESTRA AGUA

Steps for operationalizing data provenance from the household to public scales





Four (unexpected) Requirements:

1. **Private risk reduction products for individuals**
2. **Anonoymous public decision-making products**
3. Trusted data quality control process and communication
4. Trusted organizational management

NUESTRA AGUA

SIP Lab Project

Lessons learned from Cybertraining

Training the trainers works – first Hydroshare user instruction in Spanish was generated by users after receiving two one-hour demo sessions.

NUESTRA AGUA

SIP Lab Project

Lessons learned from Cybertraining

Needs:
Customizable reporting

From: Commanding Officer, Joint Base Anacostia-Bolling
To: Commanders/Directors of Tenant Organizations

Subj: 2017 ANNUAL DRINKING WATER QUALITY REPORT

Encl: (1) 2017 Annual Drinking Water Quality Report for Joint Base Anacostia-Bolling (JBAB)

1. In accordance with federal drinking water regulations, JBAB is providing you with the 2017 Annual Drinking Water Quality Report for Public Water System ID DC0000004, enclosure (1).

2. This routine report is required by law, and is being provided to ensure that you have all of the information regarding the quality of your drinking water. This is not being sent in response to a health threat.

3. The 2017 Annual Drinking Water Quality Report for JBAB, enclosure (1), provides information regarding drinking water monitoring conducted throughout calendar year (CY) 2017.

4. If you have any questions regarding the quality of your drinking water, contact the JBAB Drinking Water Program Manager at 202-404-1273.

NUESTRA AGUA

SIP Lab Project

Water quality vulnerabilities after hurricane & flooding natural disasters

Microbial Indicators							
	Units	EPA Limits		JBAB-Anacostia Drinking Water		Violations	Description/Typical Sources of Contaminants
		MCLG	MCL or TT	Highest	Range		
Total Coliform Bacteria	# of positive samples	0	1 positive sample/month	2*	0-2	No	Naturally present in the environment
E. coli Bacteria	Number Positive	0	0	0	0-0	No	Human and animal fecal waste

*The positive hit was resampled at the original location, upstream, and downstream. Some resample results came back positive for TC.
For a system that collects fewer than 40 samples/month, if two or more samples during the month are positive, the system has a MCL violation for total coliform.

NUESTRA AGUA

SIP Lab Project

Water quality vulnerabilities after ‘cumulative economic disaster’

Lead and Copper							
	Units	EPA Limits		JBAB-Anacostia Drinking Water		Violations	Description/Typical Sources of Contaminants
		MCLG	Action Level (AL)	Samples Above AL	Range and 90th Percentile		
Lead- Monitoring Period June to Sept 2015	ppb	0	15	0	ND to 6.6 90th percentile is 1.4	No	Corrosion of household plumbing systems; erosion of natural deposits
Copper- Monitoring period June to Sept 2015	ppm	1.3	1.3	0	0.0088 to 0.46 90th percentile is 0.34	No	Corrosion of household plumbing systems; erosion of natural deposits
Lead and Copper results are from June to September 2015 monitoring period, which is the most recent sampling completed in accordance with Federal regulations. The next required sampling will occur in 2018.							

Four (unexpected) Requirements:

1. Private risk reduction products for individuals
2. Anonoymous public decision-making products
3. **Trusted data quality control process and communication**
4. **Trusted organizational management**

ESIP Lab Project

Cyberinfrastructure is hard to visualize – unless you paint a mural!

From Tim Sauder

NUESTRA AGUA

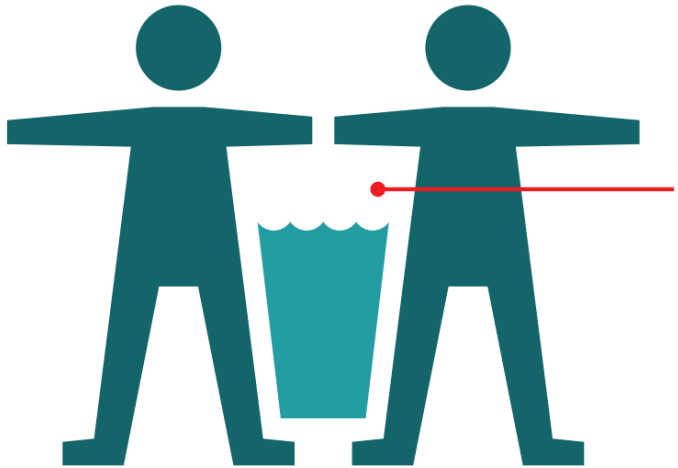
SIP Lab Project

Lessons learned and outcomes from initial Awareness Campaign

"It's our data."
"I'm the computer expert, and I get my hands dirty."

ESIP Lab Project

THE TWO FIGURES COMBINED TO CREATE LOGO ARE REPRESENTATIVE OF THE NEED FOR COMMUNITY INVOLVEMENT IN THE WATER SYSTEM



ABSTRACT DEPICTION OF PEOPLE ALLOWS FOR BOTH MALE AND FEMALE VIEWERS TO SEE THEMSELVES AS VIABLE VOLUNTEERS

GLASS SHAPE REINFORCES THE WATER SYSTEM'S DELIVERY OF SAFE POTABLE WATER TO THE COMMUNITY

NUESTRA AGUA

"OUR WATER" NAME REITERATES THE COMMUNITIES OWNERSHIP OF THEIR OWN WATER SOURCE

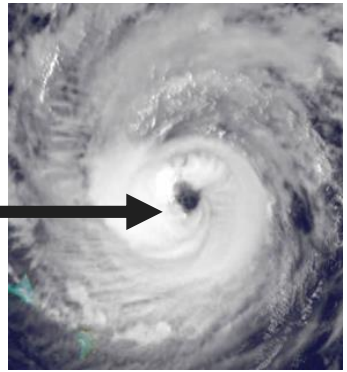
JURUNTUNGO

SUBTITLE ALLOWS FOR SPECIFICATION OF SPECIFIC NEIGHBORHOOD/TOWN

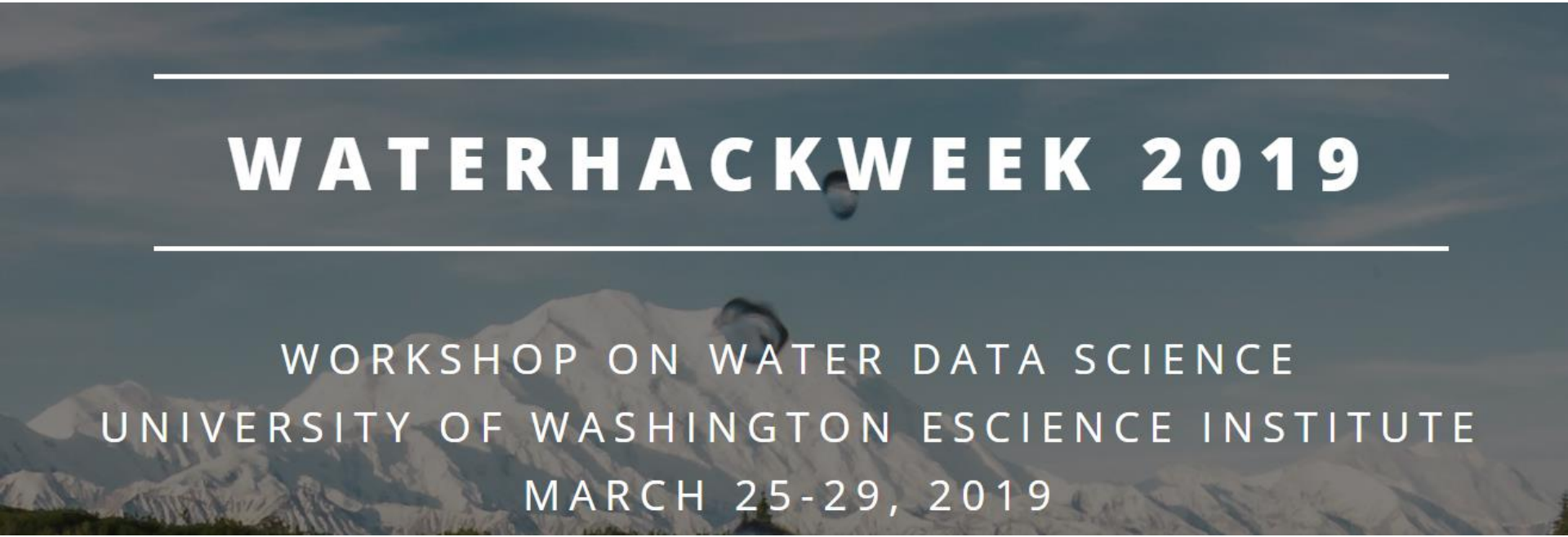
From Tim Sauder

Testing the Hypothesis: Communities are more resilient when hurricane-impacted individuals and communities ‘own’ their drinking water data.

Data provenance is the eye of the storm in a hurricane of data.



Next steps: Visit us at waterhackweek.github.io !!



Collaborators

Christina Bandaragoda, University of Washington
Miguel Leon, University of Pennsylvania
Jim Phuong, University of Washington
Graciela Ramirez-Toro, Inter American University of Puerto Rico
Kelsey Pieper, Virginia Tech
William Rhoads, Virginia Tech
Tim Ferguson-Sauder, Olin College
Jeffery Horsburgh, Utah State University
Jerad Bales, Consortium of Universities for the Advancement of Hydrological Science
Sean Mooney, University of Washington
Martin Seul, Consortium of Universities for the Advancement of Hydrological Science
Kari Stephens, University of Washington
Erkan Istanbulluoglu, University of Washington
Julia Hart, University of Washington
Marc Edwards, Virginia Tech
Amy Pruden, Virginia Tech
Virginia Riquelme, Virginia Tech
Ishi Keenum, Virginia Tech
Ben Davis, Virginia Tech
Emily Garner, Virginia Tech
David Tarboton, Utah State University
Amber Spackman Jones, Utah State University
Eric Hutton, Cooperative Institute for Research in Environmental Sciences
Gregory Tucker, University of Colorado Boulder
Scott Peckham, University of Colorado Boulder
Christopher Lenhardt, Renaissance Computing Institute
William McDowell, University of New Hampshire
David Arctur, University of Texas at Austin

ESIP Lab Project

water mesh

clean water for everyone

Operational data provenance and cybersecurity for anticipatory disaster communication built on mesh networks

Project lead and contact details: Christina Bandaragoda, University of Washington; cband@uw.edu

Project partners and contact details: Graciela Ramirez-Toro, Interamerican University of Puerto Rico; Patricia Ordóñez, University of Puerto Rico Rio Piedras; Tim Sauder, Olin College

Partners on related projects: Fernando Rosario-Ortiz, University of Colorado Boulder; Amy Pruden, Virginia Tech

Student lead: Jimmy Phuong

HYDROSHARE

Team Collaborators

Team: David Tarboton, Ray Idaszak, Jeffery S Horsburgh, Daniel P Ames, Jonathan L Goodall, Alva Couch, Richard Hooper, Shaowen Wang, Martyn Clark, Pabitra Dash, Hong Yi, Christina Bandaragoda, Anthony Castronova, Tian Gan, Zhiyu Li, Mohamed Morsy, Maurier Ramirez, Jeffrey Sadler, Dandong Yin, Yan Liu.

HydroShare is operated by CUAHSI with ongoing development through a collaborative project among Utah State University, Brigham Young University, CyberGIS Center University of Illinois, Tufts, University of Virginia, and RENCI University of North Carolina.

NSF
OAC-1664061
OAC-1664018
OAC-1664119
2017-2021
ACI-1148453
ACI-1148090
2012-2017

http://www.hydroshare.org

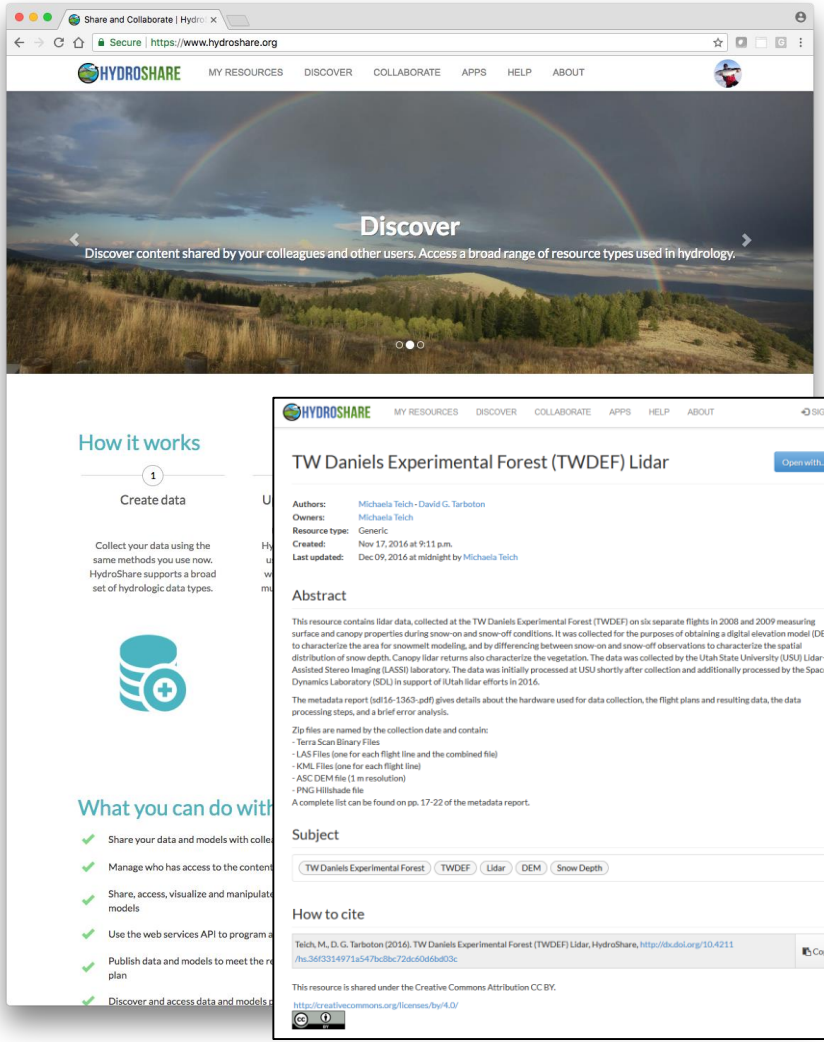
CUAHSI
universities allied for water research

HYDROSHARE

http://www.hydroshare.org

- Web-based Hydrologic Information System operated by the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI)
- Links to computational resources on JupyterHub server.
- Provides permanent publication of data and models with citable digital object identifiers that can link to literature
- Gateway for sharing research and models.

Findable **A**ccessible **I**nteroperable **R**eusable



Converging Projects

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References

Sutter, J.D. EPA: Water at Puerto Rico Superfund site is fit for consumption", CNN, Oct 31 2017, https://www.cnn.com/2017/10/31/health/puerto-rico-water-epa-superfund-test-results/index.html, accessed January 10, 2019.

Sutter, J.D. and E. Lavandera, Expert: Water from a polluted Puerto Rico site 'safe to drink', CNN, October 20, 2017. https://www.cnn.com/2017/10/19/us/puerto-rico-superfund-water-tests-safe-invs/index.html, Accessed Janary 10, 2019.

Guerra, M., 2013, Leptospirosis: Public health perspectives, Published in final edited form as: Biologicals. 2013 Sep; 41(5): 295–297. Published online 2013 Jul 10. doi: 10.1016/j.biologicals.2013.06.010

Shibata, Y.; Sato, Y.; Ogasawara, N.; Chiba, G.; Takahata, K., "A New Ballooned Wireless Mesh Network System for Disaster Use," Advanced Information Networking and Applications, 2009. AINA '09. International Conference on , vol., no., 26-29 May 2009, pp.816,821, doi: 10.1109/AINA.2009.135, http://ieeexplore.ieee.org/document/5076283/

Photo Credits for previous slides: Photo Courtesy of Mandalit Del Barco/NPR. Richard Colón, better known by his stage name Crazy Legs, at his home in Isabela, Puerto Rico, shows the before-and-after of the water filtration system he's helping deliver to people in remote areas. This photo originally appeared in NPR

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