In Pursuit of Integrated Water Data:

A Strategy for Building Trust and Capacity to Integrate Community Science and Governmental Data

August 2020

"Take no individual's word for it, but if the masses agree, take their cumulative word."

-Adapted from the Royal Society by Caren Cooper

I. INTRODUCTION

The Internet of Water (IoW) is a bold vision for how to improve water data infrastructure to fundamentally transform water management and enable a sustainable future. The IoW has partnered with non-governmental organizations (NGOs) engaged in community science water data collection through the Water Data Collaborative (WDC) to 1) facilitate seamless integration of NGO data into the IoW technical framework and 2) maximize the potential for community science data to be included in public policy and community decision-making. As part of this grant, the IoW is working with the WDC to develop a long-term strategy to jointly educate the public, decision makers, and the scientific community on the value of community-science data and facilitate better data integration between governments and community groups. Specifically, in 2019-2020, the IoW team worked with two consultants, Jeremy Diner and Barbara Horn of Colorado River Watch to develop the following trust-building strategy outline to support the integration of community science data into the public data sphere. [1]

II. BACKGROUND AND CURRENT CONTEXT

Community science has long been a major component of the scientific landscape. Just a few examples from the world of water include developing tide charts, uncovering lead poisoning in Flint, Michigan,[2] and providing essential data about the Animas River after the Gold King Mine disaster.[3] With these examples and more, community science has demonstrated its ability to create reliable scientific

[1] Barbara Horn is a Water Resource Specialist at the State of Colorado and a decades-long advocate for community science, and an active member of the Water Data Collaborative Steering Committee. Jeremy Diner is a water and community science expert formerly with American Rivers, who served as the IoW community science liaison for this effort. IoW team members Peter Colohan, Ashley Ward, and Wendy Graber made substantial contributions to this outline.

[2] Cooper, Caren, 2016. *Citizen Science: How Ordinary People Are Changing the Face of Discovery*. The Overlook Press. New York, NY.

[3] https://www.postindependent.com/news/local/citizen-scientists-connect-with-local-rivers/

knowledge and build social capital. Community science (formerly citizen science)[4] is the collective scientific contribution of questions, observations, data production, and interpretation by people outside of the traditional scientific realm. Community science democratizes science, and provides new answers to questions like: what data are collected, who generates the data, who interprets the data, who gets to use the data, and how are the data shared?

Using today's technology, individuals and community groups are able to measure a wide range of water quality parameters such as pH, temperature, dissolved salts,[5] turbidity,[6] harmful algal blooms,[7] and more. In 2016, the National Advisory Council for Environmental Policy and Technology (NACEPT) released a report recommending the U.S. Environmental Protection Agency (EPA) proactively and fully integrate community science into the agency's work.[8] Two years later, NACEPT released a follow-up report recommending EPA move from collecting to acting on community science data, with a focus on effective communication and authentic collaboration.[9] States, tribes, and local governments across the country are now building resources to support community scientists, serving as living laboratories for designing effective community science programs. However, building trust between government agencies and community science groups, and building capacity for collaboration within both government agencies and community science organizations, remains a critical challenge

Perspectives from Community Science and Government Agencies

In general, within community science organizations three common perspectives emerge about how these groups relate to government:

1. Disengaged/Uninterested - Those that think the government will not use community science data in a meaningful way, are primarily interested in collecting data for non-governmental audiences, and do not wish to engage with governments.
2. Limited Engagement - Those that have limited, primarily cursory experiences (either positive or negative) with government that inform their perspectives.
3. Engaged - Those that have a good working relationship with government.

Within public agencies, three common perspectives emerge that parallel those of community scientists:

1. Disengaged/Uninformed - Those in state or local government that have no idea community science exists, and have no experience of the type or quality of data available from community science.
2. Limited Engagement - Those in state or local government that have had limited, primarily cursory engagement with community science (either positive or negative).
3. Engaged - Those in state and local government that have a good working relationship with community science.

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[4] As part of the Water Data Collaborative's commitment to justice, equity, diversity, and inclusiveness, we are replacing the use of the terms 'citizen science' and 'volunteer monitoring' with 'community science.'

[5] https://link.springer.com/article/10.1007/s13201-018-0780-0

[6] https://www.nature.com/articles/s41598-019-56474-z

[7] https://cyanos.org/cyanoscope/

[8] https://www.epa.gov/sites/production/files/2016-12/documents/nacept_cs_report_final_508_0.pdf

[9] https://www.epa.gov/sites/production/files/2018-04/documents/nacept_2018_citizen_science_publication_eng_final_v2_508_0.pdf

Engaged government agencies that partner with community science groups struggle with a number of issues including: a lack of funding or staff capacity to engage community science organizations, an inability to consume and digest large quantities of data from community science groups, a lack of knowledge about the legalities (or liability) associated with using community science data, and an inability to weigh competing claims between industry and environmental groups when data is in dispute.

Constraining Factors

For community science data sets to improve our understanding of the physical world and inform decision-making, both trust and capacity between governments and community science organizations must be improved. For example, in a survey of four U.S. federal agencies, data quality and privacy were mentioned as the leading perceived risks to greater inclusion of community science.[10] Another study found that data quality and governments' ability to keep up with the pace of growth of community science were the main barriers to adoption of community science data.[11]

Trust

All good relationships start with trust. Engendering trust between governments and community science organizations depends on three key factors:

1. *Privacy and data security* - Both governmental and non-governmental data producers want to ensure that their data will be safe before they are willing to share and exchange data.
2. *Metadata and data quality* - Governments need to be able to filter data of varying quality to know what data are suited to a particular purpose.
3. *Communication and relationship building* - Communication needs to be greatly increased between community groups and governments in order to build the human relationships that break down barriers and lead to trust.

The third factor, relationship building, is particularly important when there are adversarial groups that are advocating for opposing positions before the government. For example, if a business is discharging a small amount of pollution into a river, the local environmental group might have incentive to over-emphasize the risk of that pollution when reporting data to the government, or even falsely report a number that is higher than reality. At the same time, the business would have a similar incentive to under-emphasize the risk. With integrated water data, conversations can be elevated from "What is the concentration of a pollutant?" to more productive questions, such as "Does the pollutant concentration pose a risk?" or even further, "What should we do about the release?"

Capacity

Another primary concern is governments' capacity to integrate and process large amounts of heterogeneous data from state-to-state and watershed-to-watershed to address different challenges. These data can range from numeric fecal bacteria or harmful algal bloom monitoring data to non-numeric macro-invertebrate health data, just to name a few. Governments need to develop capacity to

[10] https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.293/
[11] https://theoryandpractice.citizenscienceassociation.org/articles/10.5334/cstp.231/

ingest and process this wide range of information, perform quality assurance and quality control (QA/QC), and convert that data into actionable information and tools for the public. Such information and tools can include health warnings, decision-support for pollution management tools, and tools designed for transparency and public reassurance. With the exponential growth of community science and technology generating ever-more data—government agencies with limited budgets struggle to make use of these valuable new sources of information.

Toward Integrated Water Data

The following graphic demonstrates the types of engagement scenarios that are likely to develop based on the relationship that exists between the community's monitoring effort and the government's data integration effort.

Figure 1: Integrated Water Data Framework
This figure describes the range of possible relationships between community science groups and government agencies. The upper right, Integrated Impact, designates the ideal relationship.

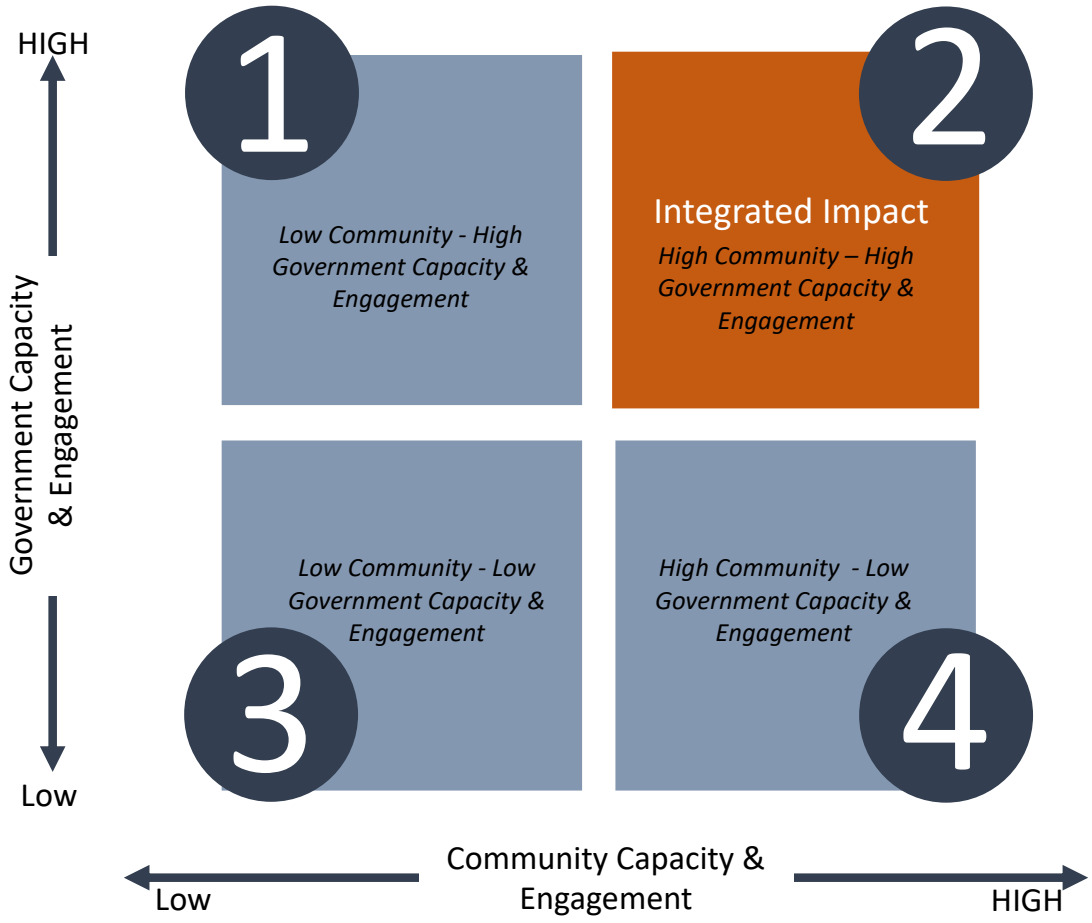

Figure 1 Description

1: ***Disengaged Community:*** *Governments are prepared to coordinate, assimilate and share data; community doesn't know, isn't ready, or isn't collecting data. This can lead to internal bias against working with community science organizations and disappointment within governments.*
2: ***Integrated Impact:*** *Both groups invest in coordination, leverage each other's capacities, and maximize impact through joint efforts.*
3: ***Non-engagement****: Neither group attempts to leverage the other's data, limiting their impact.*
4: ***Disengaged Government****: Community groups collect data, try to share, but governments aren't prepared to assimilate or broadcast. This can lead to internal bias against working with governments and disappointment among community organizations.*

III. TRUST AND CAPACITY-BUILDING ACTION PLAN OUTLINE

The action plan outline below is designed to support integrated water data by building trust between community science and governmental organizations. The goal of this action plan is to build examples where both government agencies and community science organizations are highly engaged with one another to create coordinated impact, leveraging their unique capacities. **The IoW and WDC will develop the action plan,** pending additional grant funding**.**

A. Assess Current Conditions, Barriers, and Solutions

As a first step toward building the action plan, the IoW and WDC will scan the landscape and survey key stakeholders on current conditions, barriers, and potential solutions for data integration. The results will be described in a short report. Tasks will include:

1. **Survey attitudes of key stakeholders** including community science and government agency staff on the barriers and solutions to integrating data.
2. **Analyze case studies** that exemplify the progress (or regression) that can occur in the presence or absence of trust (e.g. Iowa created a framework for integrated state and community science data, then a new governor eliminated it).
3. **Prepare a best practice map** of which states have built trusted relationships that includes replicable best practices and builds on the WDC's State of Citizen Science research and the IoW's growing inventory of state agency water data platforms.
4. **Research best trust-building practices** and capture 10-15 new support services that states could deliver to community data producers.
5. **Develop visualization tools** to represent the breath and scope of possible interventions from stakeholders that would improve trust and capacity between groups.

B. Develop Guidance on Trust- and Capacity-Building Best Practices

The IoW and WDC will develop guidance promoting best practices for government agencies and community science organizations that advance the goal of integrated community and government water data. Best practices will be complied in a guidebook and will cover the follow topics:

1. **Community Science Activities that Build Trust**
   1.1. Create project design, data validity, Quality Assurance Project Plans (QAPP), etc.
   1.2. Develop and conduct trainings on study design, EPA methods, etc..
   1.3. Develop inter-organizational knowledge sharing networks.
   1.4. Build relationships with local water utilities and state government.
      1.4.1. Avoid shaming, anger, and "inadvertent advocacy"—the act of unintentionally expressing personal policy preferences or ethical judgments while presenting scientific or technical findings.
2. **Community Science Activities that Build Capacity**
   2.1. Design projects to be at the forefront of science as the first priority, and for the desires of the volunteer second;
   2.2. Improve how data is communicated by standardizing data and metadata formats, standardizing tiers for data quality, and uploading all data to EPA's Water Quality Exchange;
   2.3. Support and engage with national water data and community science organizations (e.g. IoW, WDC, EPA, River Network, Waterkeeper Alliance, etc.);
   2.4. Bring resources to bear on the problem of concern, whether financial or human capital.
3. **Government Activities that Build Trust**
   3.1. Improve communication about data and metadata requirements;
   3.2. Define and adopt open standards, with input from community science groups, to improve transparency;
   3.3. Improve data security and privacy features;
   3.4. Invest in independent verification of community science data;
   3.5. Treat equal data equally. If the data collection process, QA/QC, and metadata meets the government agency's data collection standard, then the data should be flagged as such in public databases.
   3.6. Ensure that data can be de-selected based on quality but not based on prejudiced notions of the value of community science data.
4. **Government Activities that Build Capacity**
   4.1. Pursue change to institutional policies, laws or incentives at state and federal levels.
   4.2. Build on the Crowdsourcing and Citizen Science Act of 2016 to create a top-down organizational structure within the EPA and states to manage community science data.
   4.3. Leverage the forthcoming "Using Citizen Science at EPA: Vision and Principles" document to implement outlined principles at EPA. Evolve the vision of community science within the EPA by educating EPA personnel who wish to be engaged with community science.
   4.4. Improve technical infrastructure:
      - Invest in the data infrastructure that would allow more community science data sets to be absorbed and integrated with public data sources (e.g. via IoW, WDC activities).
      - Define and adopt standards that would improve interoperability (e.g. methods of data collection and management).
      - Clearly and consistently communicate what data is needed, from where, and of what quality.
   4.5. Strengthen financial and technical support for community science:
      - Increase investment in agencies' capacity to support and integrate community science and pursue federal resources to support community science.
      - Provide more state or local resources to support community science groups. For example, in many Northeast states, EPA provides kits and staff to support community science, and in

Maryland, the Department of Natural Resources hosts an annual volunteer monitoring conference.[12]

C. Conduct Outreach and Education with Stakeholders

The IoW and WDC will design and conduct a nationwide outreach and education campaign for all community science stakeholders including the following tasks:

1. **Secure Public Agency Champions** - Strengthen partnerships with EPA and state governments willing to provide coordinated outreach and support in developing robust top-down community science data management systems. Building on WDC's State of Citizen Science research, provide targeted outreach to priority states.
2. **Secure NGO Champions** - Build on WDC's effort to strengthen partnerships with NGOs willing to provide coordinated outreach and support in developing a robust bottom-up approach to producing tools and trainings that can be applied universally.
3. **Develop Boilerplate Communication Language for Public Agencies** - Develop boilerplate language that can be used by states or municipalities that want to improve their ability to use community science data. Example from New South Wales, Australia: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Research/Citizen-science/oeh-citizen-science-strategy-2016-2018-150859.pdf
4. **Develop "Fit for Purpose" Data Framework** - Develop a framework for government agencies and NGOs to mutually understand what level of data quality is "fit for purpose" for addressing key questions (e.g. monitoring a leaking oil pipe requires a study design, but does not require a QAPP to demonstrate oil is leaking.)
5. **Identify Emerging Partners** - Identify governments and groups that are at the initial phases of participating in community science to help bring them along into this emerging field.
6. **Engage in Effective Advocacy** - Advocate for a Clean Water Act amendment to require more robust monitoring and use of community science data, and encourage local, state, federal legislatures to better fund agencies that support community science.

Next Steps

The IoW and the WDC have identified key NGO and governmental stakeholders (listed below) to participate in the initial scan of the landscape, provide feedback on the action plan, and assist with the prioritization of activities.

1. Community Science Experts:
   - Danielle Donkersloot, Natural Resources Specialist at the Bureau of Land Management in Wisconsin, formerly of the Izaac Walton League of America.
   - Julie Vastine, Executive Director of the Alliance for Aquatic Resource Monitoring at Dickinson College in Carlisle, Pennsylvania.
   - Kris Stepenuck, Extension Leader for Lake Champlain Sea Grant Program and Extension Assistant Professor of Watershed Science Policy and Education. Formerly from the Wisconsin Department of Natural Resources.

[12] https://dnr.maryland.gov/streams/Pages/MWMC/conference.aspx

- Erick Burres, statewide Citizen Monitoring Coordinator at the State Water Resource Control Board of California.
- Members of the Water Data Collaborative

2. Government Data Experts:
   - Aaron Borisenko, Water Quality Monitoring Manager at Oregon Department of Environmental Quality
   - Tim Asplund, Natural Resource Program Manager, Wisconsin Department of Natural Resources
   - David Chestnut Senior Scientist at South Carolina Department of Health and Environmental Control
   - Mary Skopec, Executive Director of Iowa Lakeside Laboratory and former Water Coordinator at Iowa Department of Natural Resources
   - Michael Eberle, National Surface Water Program Leader, United States Forest Service
   - Dwane Young, Chief, Water Data Integration Branch, Office of Water, United States Environmental Protection Agency

Conclusion

Community science is emerging as a critical partner to governments in collecting and managing data on the state of the nation's water resources. This is possible thanks to a long history of successful projects, combined with the rapid rise of distributed and cost-effective water quality monitoring technology. Community science groups have been working to build this capacity for decades, and more governments are taking notice. National and state governments have an opportunity to develop an integrated strategy to leverage this capacity to increase society's knowledge of the water resources on which we depend, but they cannot do it alone. It will be essential for community groups, and coordinating organizations such as the IoW and WDC to serve as close partners and confidants, working to build trust and capacity in each other. If we achieve this, government agencies will seamlessly integrate and instantly share community-derived data, and a new age of collaboration around integrated water data and improved water outcomes will be born.