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Viewpoint

Impact of Disaster Research on the Development of Early Career Researchers: Lessons Learned from the Wastewater Monitoring Pandemic Response Efforts

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The environmental science and engineering research community has repeatedly demonstrated its ability to rapidly mobilize to protect human health and the environment by performing research critical to disaster response. Recent examples include measuring pathogens exposure after hurricanes,[1−3] evaluating drinking water contamination resulting from wildfires[4] and chemical spills,[5] investigating the cause and effects of lead contamination in Flint, Michigan,[6] and assessing the ramifications of the Fukushima nuclear disaster.[7] An ongoing example is the recent mobilization and rapid advancement of sewage monitoring as a tool for managing the COVID-19 pandemic. Early in the pandemic response, researchers predicted that SARS-CoV-2 genetic signals in wastewater could assist with monitoring the spread of COVID-19. Researchers not only rapidly mobilized to begin sampling, but collaborated with one another, sharing their protocols, results, and methodological pitfalls in real-time. Wastewater monitoring as a tool for managing the COVID-19 pandemic is

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Table 1. Challenges and Opportunities for Early Career Researchers Participating in SARS-CoV-2 Wastewater Monitoring

Challenges	Opportunities
• stopping ongoing projects and/or delaying graduation[a]	• access to new funding opportunities
• learning new experimental methods at an accelerated pace with rapid developments from global collaborators and peers[a]	• job openings across several sectors with skilled lab workers being in high demand[a]
• managing supply chain issues and other resource constraints (funding and personnel)	• opportunities for outreach
• establishing collaborations and buy-in from diverse stakeholders (health departments and utilities)	• collaborations and connections, many through Slack WBE collaborative[a]
• securing funding and university support (e.g., lab space and access)	• contributing to a fast-moving field with a direct impact
• limited availability of long-term funding	• public awareness of the research[a]
• publishing pace and avenues	• new equipment, more space, and/or an expanded group[a]
• fewer opportunities to present work at conferences and limited networking opportunities[a]	• new technical and nontechnical skills[a]
• training new personnel while abiding with social distancing practices	• engagement with entrepreneurship via startup ventures
• developing methods with pressures of trying to generate actionable data	• increased adoption of preprint servers to rapidly disseminate data
• caring for and/or grieving the loss of sick loved ones	
• working in isolation	

[a]Challenges and opportunities that have a disproportionate impact on the development of early career researchers.

now relied upon globally, with the public appreciating and benefiting from open access to data via online dashboards, demonstrating the power of coordinated research in the face of great challenges.

While the ability of researchers to respond to natural- and man-made disasters has been well demonstrated, the impact of these rapid responses on early career researchers has not yet been fully explored. Behind the COVID-19 wastewater monitoring successes are many early career investigators (undergraduate students, technicians, graduate students, postdoctoral scholars, and assistant professors). These developments have happened while early career investigators were learning how to conduct research and/or establishing their careers. Conducting research under these unprecedented circumstances has surely impacted the career trajectories and research training of these individuals. Here we explore some challenges and opportunities summarized in Table 1 from the research community as discussed at a virtual workshop hosted by the Research Coordination Network on Wastewater Surveillance held December 3, 2021.

The broad research community conducting wastewater monitoring during the pandemic has faced significant challenges in their research including changes in research direction, supply chain issues, difficulties publishing their work in a competitive environment, managing large fluxes in funding with unknown sustainability, and rapidly identifying and training personnel. We posit that early career researchers face distinct challenges. Funding for this work has typically been short-term, which may be challenging to manage for early career researchers that are looking to build a significant body of work for degree and career advancement. Across all disciplines, early career researchers may have pivoted their research early in the pandemic, for instance, to a computational project or a literature review while lab access was limited. However, researchers conducting SARS-CoV-2 wastewater monitoring have dedicated more sustained time and effort to this work, pivoting their dissertations and/or existing research programs. Publishing in this space has been challenged by the lack of established journal or conference "homes", as well as the need for rapid results communication to advance pandemic response. Many early career researchers have faced skepticism from colleagues on the value added of this type of research; some may view the contributions we are making as service or as lacking "novelty". However widely held these beliefs, this skepticism looms larger for early career researchers that are establishing their reputation in the field and could lead them to rethink the possible longer-term career impacts of this transition in research.

Participation by early career researchers in this field has also had advantages. For example, researchers in this space have had the benefit of participating in a quickly evolving field that is greater than the sum of its parts and have been afforded vast opportunities for collaboration. Many of the coauthors of this paper have not met outside of social media, virtual workshops, and seminars that have occurred over the past two years but have had the opportunity to learn from one another. Early career scientists have also developed new collaborations with utilities, researchers in other disciplines, and health departments, and have had the opportunity to see the impacts of their work in real time. In addition, researchers trained in this area have gained a range of technical skills that have been uniquely integrated such as understanding molecular biology in complex matrices, analyzing health surveillance data (and recognizing its pitfalls), and applying spatial data science. Additional capabilities developed include understanding sewer system dynamics, logistics, and management as well as translating research outcomes to diverse stakeholders. These experiences and connections will have long-standing impacts on how early career researchers involved in wastewater monitoring efforts will approach research—the opportunity to witness, at an accelerated pace, how collaboration can catalyze the advancement of knowledge will affect our approach for future research projects.

Despite the unique scale of wastewater monitoring during the COVID-19 pandemic, there are several facets of challenges and opportunities that are broadly applicable to early stage investigators conducting science during crises. While the nature of the global supply chain issues that occurred during the pandemic was unprecedented, obtaining and securing lab supplies during any natural or human-made disaster is consistently challenging. Fluctuations of funding are also characteristic, new funding opportunities are typically available in the immediate aftermath of a disaster. Disaster research forces early stage investigators to practice communicating scientific outputs to broad audiences. Most emblematic of disaster research is the immense weight of generating actionable data that could have immediate consequences on human health and the environment. These challenges are

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worthwhile given the opportunity to conduct science with societal impacts, which notably has a disproportionate beneficial effect on retaining women and underrepresented minorities in engineering.[8]

We environmental engineers and scientists pride ourselves in conducting science in service of human health and environmental protection. Early career researchers conducting disaster research experience the satisfaction of performing impactful work that achieves this goal, but given the challenges faced, would benefit from additional support from more senior colleagues such as valuing the technical and nontechnical skills gained, providing opportunities to communicate research findings, and recognizing unique scientific and societal contributions. Moving forward, we encourage the broader environmental science and engineering field to weigh the impacts of disaster research on the career trajectories of early career scientists when making hiring and promotion decisions to encourage a research community that is not afraid to take risks to benefit society.

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Notes

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Biography

Jeseth Delgado Vela is an Assistant Professor in the Civil and Environmental Engineering Department at Howard University. She received her PhD from the University of Michigan. She is a recipient of the Ford Foundation Dissertation Award, was named an Early Career Research Fellow by the Gulf Research Program in 2021, and currently serves on the Inaugural Early Career Advisory Board of *Environmental Science & Technology*

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