Consortium of Universities for Advancement of Hydrologic Science, Inc. (CUAHSI)
Statement on Holistic Evaluation of Research in Hydrologic Sciences
(with consideration of COVID-19 pandemic impacts)

CUAHSI Board of Directors and Officers

1. Purpose of this document

This document intends to provide context on norms within the hydrologic science community to provide a framework for understanding what research products and processes are valued by the academic hydrologic sciences community. This will better inform those charged with review and assessment of hydrologic scientists, enabling consideration of traditional as well as new types of contributions to advancing the field of hydrologic sciences. This document does not include other areas of academic contributions including teaching, service, and outreach.

While many groups (e.g., National Academies, 2021; Aubry et al, 2020; Malisch et al, 2020; Shillington et al, 2020; Krukowski et al, 2021; Sotto-Santiago et al, 2021) have recognized the impacts to research, teaching, and career development of the COVID-19 pandemic in academia, there are some effects that are unique to, or particularly acute within, the hydrologic sciences. The information below will enable contextualization of the impacts of COVID-19 on research in hydrologic sciences and will improve understanding of how individuals' career trajectory might have been differentially impacted during the pandemic.

2. What do we, as hydrologists, value as research contributions to the field?

Advancement of the hydrologic sciences requires progress in diverse arenas, and the types of contributions by academicians in the hydrologic sciences vary substantially from individual to individual. We recognize that each individual's portfolio will be unique and will involve different activities. Here we attempt to articulate the categories of research contributions critical for advancing the discipline. We do not assign a weighting to each category, nor is the order below meant to imply such a weighting. Individuals and institutions may apply their own values as appropriate to the individual being evaluated.

Our field values contributions including:

- **Generating new knowledge:** We value improved understanding of hydrologic processes and generation of new theory describing these processes.
- **Interdisciplinary linkages and feedbacks:** We value efforts to merge hydrologic theory with knowledge from allied disciplines (e.g., geology, geophysics, geomorphology, aquatic ecology, biogeochemistry, genomics, atmospheric sciences, meteorology) to understand synergistic and symbiotic processes, including those that may occur at physical and disciplinary boundaries.
- **Data creation**: Data collection in the field and laboratory has been the cornerstone of

development of hydrologic understanding, and we value its open sharing and curation.

- **Synthesis efforts:** The hydrologic sciences have been built on place-based science, and we value efforts to generalize results to determine ways in which they are transferable.
- **Development of new tools, techniques, and approaches:** The hydrologic sciences have benefited from a proliferation of new methodologies and technologies for observing and teaching and our community values the contributions of those who develop these innovative techniques.
- **Model development and use**: The science and practice of hydrology requires the ability to simulate and predict hydrologic processes, which may involve physical, numerical or statistical modeling. Our community values those who improve our modeling capacity and those who use models to evaluate scenarios or develop decision-making frameworks.
- **Applied research, extension, and public engagement:** We acknowledge the efforts of our colleagues working towards successful transfer of hydrologic science to practice through applied research, extension, and public engagement. We value the time, skill, and expertise required to conduct or co-create timely research-based knowledge and share via cooperative extension programs and through policy engagement..
- **Advancing diversity, equity, inclusion, and justice:** We value the research contributions of colleagues that advance justice in hydrologic science in broad ways including for environmental justice and for greater diversity, equity, and inclusion within the hydrologic science community.

3. Specific effects of pandemic disruptions on hydrologic sciences research.

While many of the commonly identified impacts (e.g., loss of lab access, cancellation of conferences) are mirrored in the hydrologic sciences, we believe it important to articulate some specific examples through which these disruptions are manifest in the hydrologic sciences. Below we provide a non-exhaustive list of examples to help readers envision the specific impacts on research within the hydrologic sciences.

A. Hydrologic sciences research is sensitive to temporal disruptions.
    - Hydrologic systems are dynamic and fluctuate at a range of periods. Interruptions of regular observations cannot be replaced, and event-based research can be significantly set back. (e.g., missing a snowmelt season or baseflow recession).
    - Long term (multi-year/decadal) records and experiments have been interrupted.
    - Intensive data collection during synoptic events (e.g., floods, fires, droughts) was missed due to travel restrictions at researchers' institutions or study areas.
    - Cancellation or indefinite postponement of field campaigns and field camps.

B. Hydrologic sciences research is sensitive to disruptions in site access and travel.
    - Many field sites and field-lab facilities were closed or had access heavily limited for users, limiting access to these critical sites and remote locations.
    - Loss of mobility for field technicians to collect data, maintain instrumentation, and conduct other activities on-site.
    - Travel for researchers from home institutions to field sites was restricted, disrupting plans for field-based research. This was particularly challenging for those where summer 2020 was a critical field season (e.g., students whose timelines may not allow this to occur in subsequent years).
    - Researchers conducting interviews or focus groups could not meet with subjects in person and had to reimagine or delay planned research.

- Disruption and deviations in extension and public education services resulting from the ban on public gathering and non-essential travel due to COVID-19.
- Researchers studying at international field sites have had travel severely limited and will be particularly delayed due to the pandemic.

C. Hydrologic sciences research is dependent on large-scale or distributed equipment
   - For equipment deployed in the field, equipment failure and/or lack of access for maintenance led to data loss.
   - In some cases, equipment was permanently lost in the field, due to extreme events, vandalism, or fouling, when lack of access precluded normal measures to maintain equipment and prevent loss.
   - Coordinated deployment of specialized equipment (e.g., aircraft-based sensors) was rescinded or heavily modified as sponsoring agencies implemented COVID restrictions.
   - Travel and access restrictions limited in-person collaboration on software and hardware infrastructure that underlies mathematical modeling in the hydrologic sciences.
   - Access to computing resources were limited as institutions prioritized COVID research at supercomputing facilities.

D. Hydrologic sciences research is dependent on long-term records collected by government agencies.
   - Travel restrictions prevented government employees from having timely access to field sites and maintenance of equipment that contribute to long-term datasets.
   - Field-based QA/QC used to ensure quality of measurements was limited (e.g., ground truthing of remotely sensed data).
   - Long-term datasets are critical for numerical model calibration and validation, so disruptions to these datasets will have continuing impact on model-based research.

E. Hydrologic science is a multi-disciplinary collaborative field, spanning engineering, physical science and biology/ecology. Pandemic conditions reduced opportunities to build collaborations.
   - Cancellation of conferences and workshops for networking, sharing research, and meeting with collaborators.
   - Reduced capacity/density on university campuses reduced internal collaboration as well as mentoring of early career researchers.
   - Limited access to campuses delayed establishment of research groups and infrastructure for early career researchers.
   - Working from home and restricted visitor policies at most universities reduced external collaboration.
   - Emotional exhaustion and burn-out may have been experienced by both researchers and stakeholders, which limited collaboration, consultation, and information gathering.

F. Experimental and lab-based research was disrupted by loss of access to research labs and maker spaces.
   - Access to lab spaces was restricted by many institutions, preventing experiments and sample analyses from being conducted during the pandemic.
   - Capacity for timely analysis at shared and commercial facilities was limited due to access restrictions.

- Community facilities where researchers visit to collaboratively analyze their samples were shut down or restricted visitors.
- Donation of PPE to healthcare workers and subsequent inability to restock thosesupplies delayed some laboratory analyses.
- Many maker spaces were re-tasked with 3D printing of PPE and other supplies needed by local hospitals and healthcare workers.

4. Beyond traditional research products, how do hydrologists demonstrate contributions to their field?

In addition to traditional research products (manuscripts, books and book chapters, competitive funding), other products and services are important to shaping the future of the field. The stressor of the pandemic and resultant prioritization of effort galvanizes the importance of a wide range of contributions to the field of hydrology. Below we list examples of research outputs and activities that are consistent with types of contributions we value as a discipline, but which may not necessarily have been considered in traditional faculty hiring, promotion, and tenure decisions and may not be fully recognized using traditional metrics of publication and citation.

- Generation and curation of Findable, Accessible, Interoperable and Reusable (FAIR) data
- Operation of infrastructure to maintain the integrity of long-term, continuous data sets and experiments
- Contributions to community-developed data sets or experiments (e.g., the 1000 Intermittent Rivers project and inter-model comparisons)
- Design of new instrumentation and modeling tools, with documentation of their performance to facilitate technology transfer
- Openly accessible and well-documented computer code
- Contributions to community-developed model code
- Training materials and events for practitioners and stakeholders
- Development of community-engaged research and participatory science, including co-production activities
- Service learning and community-inspired educational activities
- Contributions to policy-making, public scholarship, and resource management activities
- International collaboration, training, and exchange of ideas, particularly efforts that facilitate adoption and testing of developing practices in new environments

5. How should different parties use this document?

<u>Those applying for positions, promotions, and/or tenure:</u>

- This document outlines the contributions that are valued in our field. Consider providing this document to reviewers or referencing this letter as you prepare your application materials or dossier.
- In application materials for hiring or promotion, articulate your past and potential contributions in the context of the norms of how contributions within the hydrologic sciences are valued
- This document provides examples of the types of impacts COVID-19 has had on academic researchers. When you articulate the impact of the pandemic on your own career, consider impacts across these categories to ensure you completely document impacts and your responses.

External evaluators and reviewers:

- Recognize that the contributions hydrologists value (section 2) and products they generate (section 4) should not be considered a checklist, but instead a demonstration of the diversity of ways that contributions are made and documented in our field.
- Consider it your obligation to discuss the hydrology-specific issues related to the COVID-19 pandemic that were faced by the candidate. External evaluators or reviewers should help contextualize the impacts on the person being evaluated as part of the field. It is particularly important to highlight impacts that may not have been ubiquitous across all disciplines to educate review committees.
- Evaluations should be written in the context of COVID-19 impact, acknowledging the acute and long-lasting impacts on the candidate.
- Acknowledge that COVID impacts were widespread and will persist for several years, and that institutional-level adjustments (e.g., extended tenure clocks), while helpful, are not sufficient to mitigate all impacts on hydrologic scientists.

Review committees and senior faculty:

- Listen to the candidates and external reviewers
- Specifically ask for statements about COVID impacts or consider allowing longer research or teaching statement describing efforts during the pandemic
- Realize that even though we all 'look like hydrologists' from the outside, the specific needs and impacts are highly variable (e.g., lab vs. field vs. modeling)

Academic and professional leaders:

- Support inclusion of diverse products and multiple methods for individuals to demonstrate impact in the field of hydrology
- Include information about unique effects on different fields (including hydrology) in requests to internal and external evaluators and in internal review and promotion materials in order to provide relevant context
- Remind review committees about hydrologic-specific impacts of COVID-19
- Recognize that extended tenure clocks or delays of mandatory merit and promotion review are a component of support but may not adequately or equitably address long-term impacts

Funding agencies

- Program officers should actively reach out to their communities to assess how they were impacted and identify opportunities to mitigate impacts.
- Agencies should consider differential COVID impacts across subdisciplines in allocating recovery funds among disciplines, programs, and projects.
- Future review panels should consider how the products of current research grants may have been delayed or diminished by COVID impacts.
- Recognize that COVID impacts will delay some products or require extended time periods to complete a scope of work, providing flexibility.

Reviewers and leaders will need to remember that the impacts of the pandemic will almost certainly cascade into the foreseeable future. Delayed experiments and fieldwork translate to delayed analyses, which further translate to delayed dissemination and publication of results. Some originally envisioned research outcomes may be realized in different or significantly modified ways. Pandemic-associated restrictions affected outreach and engagement and the support and development of professional collaborations, which may have long-term effects.

BOARD APPROVAL AND SIGNATORIES

This statement was primarily authored by Alejandro Flores, Anne Jefferson, Steve Loheide, Jeanne VanBriesen, and Adam Ward and was approved by a vote of the CUAHSI Board of Directors on April 19, 2021, with all directors, officers, and the executive director concurring.

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