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Editorial – Towards FAIR and SQUARE hydrological data

C. Cudennec^{a,b}, H. Lins^{c,d}, S. Uhlenbrook^{e,f} and B. Arheimer^{b,g}

^aAGROCAMPUS OUEST, INRAE, UMR SAS, Rennes, France; ^bInternational Association of Hydrological Sciences, Wallingford, UK; ^cUS Geological Survey, Reston, VA, USA; ^dWorld Meteorological Organization, Commission for Hydrology, Geneva, Switzerland; ^eInternational Water Management Institute (IWMI), Colombo, Sri Lanka; ^fPreviously: World Water Assessment Programme (WWAP), UNESCO, Perugia, Italy; ^gHydrology Research, Swedish Meteorological and Hydrological Institute (SMHI), Norrköping, Sweden

EDITOR A. Castellarin

GUEST EDITOR not assigned

Data issues were, are, and will remain a core component of the hydrological sciences. Their character and influence on the way the discipline is practiced may vary through time, but their intrinsic role in understanding and managing water resources and hazards, as well as in developing sound water policies dictates their continuing importance. Whereas the primary data issues during much of the twentieth century focused on establishing and maintaining *in situ* observation networks to provide a sound basis for understanding and predicting the quantity and quality of the resource, both on the surface and in the ground, today's concern encompasses a much broader suite of problems related to water, society and the environment.

To elevate and expand the discussion of the critical role of data in all aspects of the hydrological sciences, including of the still open and emerging Unsolved Problems in Hydrology (UPH) (Blöschl *et al.* 2019), a Special Issue of the *Hydrological Sciences Journal (HSJ)* entitled “*Hydrological Data: Opportunities and Barriers*” has been shaped – with proactive calls to the community of the International Association of Hydrological Sciences (IAHS) and related spheres, especially of the World Meteorological Organization (WMO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). Articles have been sought on all aspects of data in hydrology: from traditional concerns related to networks to more contemporary thinking about low-cost innovations in instrumentation, data management and exchange protocols; big data, as in large-scale multi-model ensembles spanning long time periods; and support to improve understanding and conceptualization of water-related processes. Numerous emerging activities and topics have provided a substantial source of contributions from across diverse hydrological landscapes of the world, hydrological components and perspectives, data stakeholders, and local to intergovernmental mechanisms. Thus, this special issue of *HSJ* provides a snapshot of the 2020 state of the art and challenges of the hydrological sciences, contemporaneous with the emergence of the digital revolution with big data as its heart.

For example, the assimilation of data from new observation technologies is an expanding issue, which has given rise to initiatives within the scientific community, the operational services and facilitating mechanisms of the United Nations

(UN) towards innovative water monitoring capabilities and data exchange: virtual labs to facilitate observation-modelling progress; comparative assessments and scaling-up of knowledge from a limited number of well-known catchments (e.g. PUB – Prediction in Ungauged Basins – and its ongoing follow-up activities); as well as an array of gap-filling efforts involving citizen science, robust and low-cost instrumentation, remote sensing innovations (Hrachowitz *et al.* 2013, Ceola *et al.* 2015, Blume *et al.* 2017, McCabe *et al.* 2017, Tauro *et al.* 2018, WMO 2018, Njue *et al.* 2019).

Similarly, data assimilation among various system components in the modeling of hydroclimatology and hydrometeorology, and their interfaces with the land surface, ecological and social systems, and others is moving forward – including within the framework of the IAHS Panta Rhei initiative (Montanari *et al.* 2013, Cudennec *et al.* 2016, McMillan *et al.* 2016, Di Baldassarre *et al.* 2019). Moreover, the emerging nexus approaches, especially on the water–energy–food nexus, reflect the increasing demand not only for data within each sector, but for viable approaches to their integration that ensure water and food security, sustainable agriculture, and energy production worldwide (Young *et al.* 2015, Ceola *et al.* 2016, Liu *et al.* 2017).

The recent discussions of big data and emerging efforts associated with the shaping of “data science” are crucial concerns for the future of hydrology and should be explored. Also, a number of concerns dealing with retrospective investigations are data-dependent, with particular worries related to data archiving and data rescue.

Moreover, hydrological data are typically obtained through a combination of observations and computational algorithms. For example, river discharge is most often estimated from water level via a rating curve; multi-spectrum analysis of satellite data is frequently combined with multiple information sources to produce a variety of Earth observation products; and observed time-series are used to estimate parameters in complex dynamic hydrological models (Hrachowitz *et al.* 2013, Ceola *et al.* 2016, Blume *et al.* 2017). As a result, the boundary between observed and computed data is often vague and, considering the degree to which such data are shared, re-used and cited, it can be difficult to trace their provenance.

Notably, a strong and vigorous debate on data is critical to the development of new policy messages regarding observation networks, i.e. their density, quality, sustainability, investment, modernization, etc. Such a debate also serves as an important contribution to the development of inputs from hydrological sciences to achieving the UN Sustainable Development Goals, a process that, at its core, is data-dependent, especially along the observation–knowledge–indicator–target chain, in the now strongly intertwining Anthropocene (UN 2015, Brondizio *et al.* 2016, UN Water 2018, Di Baldassarre *et al.* 2019, WWAP 2019). The old basic rule for progress management applies: you cannot manage what you do not measure.

Finally, it is critical that corresponding competencies in hydrology are identified, developed and disseminated via education, training and capacity building (WWAP 2016, WMO 2018).

Contributions to the special issue will appear in two installments, the first of which is published in this volume with 13 articles touching several of the aspects identified above; the second, currently in preparation for publication later in 2020, will complement this issue along similar lines.

The contributions in this special issue of *HSJ* confirm that the overall trend in hydrology is a progression towards FAIR – Findable Accessible Interoperable Reusable data (Wilkinson *et al.* 2016) – noting that specificities of the discipline provide both particular opportunities and barriers. They also confirm that, beyond the generic FAIR movement, the data challenges span the full value chain of hydrological observations, products and services; they rely on quality-demanding data collection and handling protocols and practices to support actions in terms of operational water resources and hazard management, as well as the overall and complementary progress in research.

The latter shows that hydrological sciences and practices not only require and progress towards FAIR data, but also SQUARE data, i.e. those which Support QUality Action and REsearch. In other words, increasing hydrological information, knowledge and intelligence requires progress towards FAIR and SQUARE hydrological data.

Disclosure Statement

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References

- Blöschl, G., *et al.*, 2019. Twenty-three Unsolved Problems in Hydrology (UPH) – a community perspective. *Hydrological Sciences Journal*, 64 (10), 1141–1158. doi:10.1080/02626667.2019.1620507.
- Blume, T., van Meerveld, I., and Weiler, M., 2017. The role of experimental work in hydrological sciences – insights from a community survey. *Hydrological Sciences Journal*, 62 (3), 334–337. doi:10.1080/02626667.2016.1230675.
- Brondizio, E.S., *et al.*, 2016. Re-conceptualizing the Anthropocene: A call for collaboration. *Global Environmental Change*, 39, 318–327. doi:10.1016/j.gloenvcha.2016.02.006.
- Ceola, S., *et al.*, 2015. Virtual laboratories: new opportunities for collaborative water science. *Hydrology and Earth System Sciences*, 19 (4), 2101–2117. doi:10.5194/hess-19-2101-2015.
- Ceola, S., *et al.*, 2016. Adaptation of water resources systems to changing society and environment – a statement by the International Association of Hydrological Sciences. *Hydrological Sciences Journal*, 61 (16), 2803–2817. doi:10.1080/02626667.2016.1230674.
- Cudennec, C., *et al.*, 2016. Hydrometeorology and hydroclimate. *Advances in Meteorology*, 1487890, 4. doi:10.1155/2016/1487890.
- Di Baldassarre, G., *et al.*, 2019. Socio-hydrology: scientific challenges in addressing the sustainable development goals. *Water Resources Research*, 55 (8), 6327–6355. doi:10.1029/2018WR023901.
- Hrachowitz, M., *et al.*, 2013. A decade of Predictions in Ungauged Basins (PUB) – a review. *Hydrological Sciences Journal*, 58 (6), 1198–1255. doi:10.1080/02626667.2013.803183.
- Liu, J., *et al.*, 2017. Challenges in operationalizing the water-energy-food nexus. *Hydrological Sciences Journal*, 62 (11), 1714–1720. doi:10.1080/02626667.2017.1353695.
- McCabe, M.F., *et al.*, 2017. The future of earth observation in hydrology. *Hydrology and Earth System Sciences*, 21 (7), 3879–3914. doi:10.5194/hess-21-3879-2017.
- McMillan, H., *et al.*, 2016. Panta Rhei 2013–2015: global perspectives on hydrology, society and change. *Hydrological Sciences Journal*, 61 (7), 1174–1191. doi:10.1080/02626667.2016.1159308.
- Montanari, A., *et al.*, 2013. “Panta Rhei – everything flows”: change in hydrology and society – the IAHS scientific decade 2013–2022. *Hydrological Sciences Journal*, 58 (6), 1256–1275. doi:10.1080/02626667.2013.809088.
- Njue, N., *et al.*, 2019. Citizen science in hydrological monitoring and ecosystem services management: state of the art and future prospects. *Science of the Total Environment*, 693, 133531. doi:10.1016/j.scitotenv.2019.07.337.
- Tauro, F., *et al.*, 2018. Measurements and observations in the XXI century (MOXXI): innovation and multi-disciplinarity to sense the hydrological cycle. *Hydrological Sciences Journal*, 63 (2), 169–196. doi:10.1080/02626667.2017.1420191.
- UN (United Nations), 2015. *Transforming our world: the 2030 agenda for sustainable development*. Resolution adopted by the General Assembly.
- UN Water, 2018. *Sustainable development goal 6, synthesis report 2018 on water and sanitation*. Available from: https://www.unwater.org/publication_categories/sdg-6-synthesis-report-2018-on-water-and-sanitation/ [Accessed 12 March 2020].
- Wilkinson, M., *et al.*, 2016. The FAIR guiding principles for scientific data management and stewardship. *Scientific Data*, 3, 160018. doi:10.1038/sdata.2016.18.
- WMO (World Meteorological Organization), 2018. *Global hydrometry support facility - innovation strategy 2018–2020*. Geneva, Switzerland: World Meteorological Organization.
- WWAP (World Water Assessment Programme of UNESCO)/UN Water, 2016. *The United Nations World Water Development Report 2016: Water and Jobs*. Paris, France: UNESCO.
- WWAP (World Water Assessment Programme of UNESCO)/UN Water, 2019. *The United Nations World Water Development Report 2019: Leaving No One Behind*. Paris, France: UNESCO.
- Young, G., *et al.*, 2015. Hydrological sciences and water security: an overview. *PIAHS*, 366, 1–9. doi:10.5194/piahs-366-1-2015.