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The community consultation process leading to the compilation of the 23 Unsolved Problems in Hydrology (UPH)

First launch at IAHS GA in Port Elisabeth, South Africa, 2017

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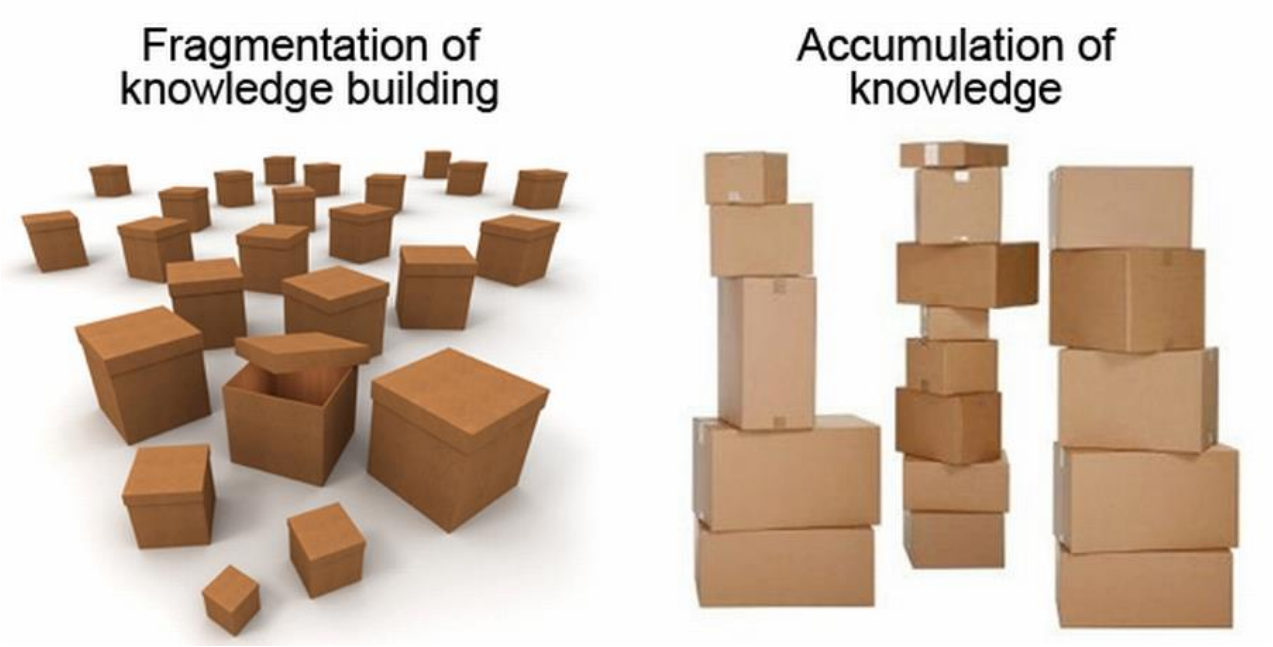
Purpose

- Increasing **coherence** in hydrologic research through providing common research subjects
- **Energising** hydrological community by increasing awareness that we do not fully understand processes
- Speaking with one voice, enhance funding opportunities for **community projects**



Blöschl et al. (2013) Cambridge Univ Press

Consulting the Hydrological Scientific community (IAHS, EGU, AGU, IAH)

What are the unsolved problems in Hydrology that would foster research in the 21st century?

Problems should be

- **universal** (not only apply to one region)
- ideally relate to **phenomena** (Why does this happen?)
- be **specific** (to be suitable for research)

Steps in the consultation process

Nov. 2017

3 500 views

200 posts

April 2018

Splinter-meeting with 60 scientists

VCSS with 110 scientists

July 2019

Community paper with 20 880 views 46 citations

>200 scientists involved

Identifying and selecting UPHs

- Instructions at YouTube
- Suggestions via LinkedIn and at physical meetings
- Open discussions and feedback
- Voting by raising hands in large groups
- Aggregation and tuning by small group
- Paper review by everybody

Voting at Vienna Catchment Science Symposium in April 2018

Community Paper with >200 authors

https://www.tandfonline.com/doi/full/10.1080/02626667.2019.1620507

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Articles

Twenty-three unsolved problems in hydrology (UPH) – a community perspective

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...show all

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ABSTRACT

This paper is the outcome of a community initiative to identify major unsolved scientific

Conclusion and Lesson learned

- The UPH initiative is a **proof-of-concept** that this kind of broad consultation process is actually feasible, and is well received by the hydrological scientific community.
- Community consultations provide:
  - common research subjects,
  - increased coherence of the scientific process,
  - co-building of scientific strategies,
  - accelerated progress in hydrological sciences and applications.
- Thus, we highly recommend community consultations on various topics to advance hydrological sciences.


Thank you!
…some UPH info follow below…

Character of questions

- Questions focused on **process-based understanding** of hydrological variability and causality at all scales
- Increased attention to **environmental change** → Understanding how change propagates across **interfaces** within the hydrological system and across disciplinary boundaries (co-evolution)
- Expansion of human footprint → new set of questions related to human interactions with nature and water cycle **feedbacks**

UPHs on Time variability and change

1. Is the hydrological cycle regionally accelerating/decelerating under climate and environmental **change**, and are there **tipping points** (irreversible changes)?
2. How will **cold region** runoff and groundwater change in a warmer **climate** (e.g. with glacier melt and permafrost thaw)?
3. What are the mechanisms by which **climate change** and water use alter **ephemeral rivers** and groundwater in (semi-) arid regions?
4. What are the impacts of **land cover change** and soil disturbances on water and energy fluxes at the land surface, and on the resulting groundwater recharge?

UPHs on Space variability and scaling

5. What causes **spatial heterogeneity** and homogeneity in runoff, evaporation, subsurface water and material fluxes (carbon and other nutrients, sediments), and in their sensitivity to their **controls** (e.g. snow fall regime, aridity, reaction coefficients)?

6. What are the hydrologic **laws** at the **catchment scale** and how do they change with scale?

7. Why is most **flow preferential** across multiple scales and how does such behaviour co-evolve with the critical zone?

8. Why do **streams** respond so **quickly** to precipitation inputs when storm flow is so **old**, and what is the transit time distribution of water in the terrestrial water cycle?

UPHs on Variability of extremes

9. How do **flood-rich** and drought-rich **periods** arise, are they changing, and if so why?

10. Why are runoff **extremes** in some catchments more **sensitive** to land-use/cover and geomorphic **change** than in others?

11. Why, how and when do **rain-on-snow events** produce exceptional runoff?

UPHs on Interfaces in hydrology

12. What are the processes that control **hillslope–riparian–stream–groundwater** interactions and when do the compartments **connect**?

13. What are the processes controlling the fluxes of **groundwater** across **boundaries** (e.g. groundwater recharge, inter-catchment fluxes and discharge to oceans)?

14. What factors contribute to the long-term **persistence** of sources responsible for the degradation of **water quality**?

15. What are the extent, fate and impact of **contaminants** of emerging concern and how are microbial **pathogens** removed or inactivated in the subsurface?

UPHs on Measurements and data

16. How can we use innovative technologies to **measure** surface and subsurface properties, states and fluxes at a range of spatial and temporal **scales**?

17. What is the relative value of traditional hydrological observations *vs* **soft data** (qualitative observations from lay persons, data mining etc.), and under what conditions can we substitute space for time?

18. How can we extract information from available data on human and water systems in order to inform the building process of **socio-hydrological** models and conceptualisations?

UPHs on Modelling methods

19. How can hydrological **models** be adapted to be able to extrapolate to **changing conditions**, including changing vegetation dynamics?

20. How can we disentangle and reduce **model** structural/parameter/input **uncertainty** in hydrological prediction?

UPHs on Interfaces with society

21. How can the **(un)certainty** in hydrological predictions be **communicated** to decision makers and the general public?

22. What are the synergies and tradeoffs between societal goals related to water management (e.g. **water–environment–energy–food–health**)?

23. What is the role of water in **migration, urbanisation** and the dynamics of human civilisations, and what are the implications for contemporary water management?