

**Title:** Scaling, Similarity, and the Fourth Paradigm for Hydrology

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**Review:**

In hydrologic science, a system is associated to a set of processes by admitting the fact that there exists no universal law that can identify all the processes associated with a system. Keeping this in mind, these processes are translated into governing equations to formulate a model that can help to resolve a problem of interest. Unfortunately, the inputs data to these models do not come at the same resolution (i.e., physical and temporal dimension). Therefore there exists a need to scale the inputs data to a common resolution that is best suited for the model and its discretization. Moreover, some of the inputs data may not be readily available. This leads to derive these inputs data by relating the characteristics of the system of interest to another system.

Though the growth of hydrologic science, from empiricism (1<sup>st</sup> paradigm), to theory (2<sup>nd</sup> paradigm), to computational simulation (3<sup>rd</sup> paradigm) has yielded important advances in understanding and predictive capabilities in hydrologic science, scaling (i.e., transfer of information across scales) and similarity (i.e., relating characteristics of one system to another system) remain one of the most challenging problems in hydrologic sciences. However, as underscored in the literature, there has been a dramatic increase in the type and density of hydrologic information that is becoming available at multiple scales, from point- to meso-scale and regional to global. Therefore, in this paper, the authors assert that it is time for the hydrologic sciences community to embrace the 4th paradigm of data-intensive science for a data-driven hypothesis testing framework for scaling and similarity.

Based on this review, the following comments are made:

- 1) The authors assert that it is time for hydrology to embrace a fourth paradigm of data-intensive science. In this paper, the authors too could have used some data to demonstrate the fourth paradigm of data-intensive science.
- 2) In this paper, the authors should clearly state the difference between “concepts” and “hypotheses”.
- 3) As per the authors, the advances in data-intensive hydrologic science have laid the foundation for a data-driven hypothesis testing framework for scaling and similarity. For hydrologic sciences community, the concept of hypothesis testing is not new. This concept has been floating and researched for many years. Therefore, the authors need to elaborate more on hypothesis testing that are relevant for the purpose that is outlined in this paper. The paper should also mention the criteria used in a data-driven hypothesis testing framework.

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- 4) Though the authors assert that it is time to embrace the 4<sup>th</sup> paradigm of data-intensive science, it is hard to understand the actual reasons that have motivated the authors to call upon the hydrologic sciences community to develop a focused effort towards adopting the fourth paradigm of data-intensive science. The authors' assertion gives an indication that, until now, the hydrologic sciences community is reluctant to use the existing data. If this is the case, instead of asking for a paradigm shift, it would be more appropriate to find out the reasons that harbor the hydrologic sciences community from using the existing data.
- 5) From the reader's point of view, the problem of scaling and similarity is always going to be there in hydrologic science. The problem of scaling and similarity needs to be addressed when the data is acquired. From the reader's point of view, hydrologic science should not be pleased for having dramatic increase in the type and density of hydrologic information, should rather be disappointed for not being able to devise a proper mechanism and methodology to acquire the data that can eliminate the problem of scaling and similarity.
- 6) On page number five, "REH" is undefined.
- 7) On page number two, as per the current version of the paper, heterogeneity or variability in hydrology manifests at multiple spatial scales, from local (O(1 m); e.g., macropores) to hillslope (O(100 m); e.g., preferential flowpaths) to catchment (O(10 km); e.g., soils) and regional (O(1000 km); e.g., geology). Are these numerical values widely accepted by the hydrologic sciences community?

**Signed**

**Editor-in-chief**

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