

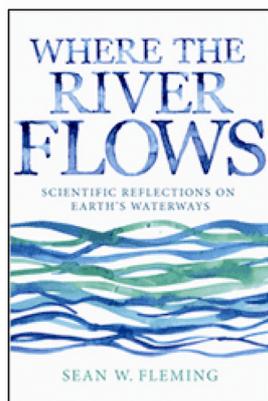
BOOK REVIEWS

for a better understanding of not only a static picture but possibly also of dynamics. The review will be useful for researchers working on method development for visualization in cell biology.

The reviews provide a wealth of information and problems that remain to be addressed in the coming years. Since several diseases are linked to the cellular malfunctioning, many reviews comment on translational aspects, that is increasingly stressed upon by various funding agencies world over.

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Where the River Flows: Scientific Reflections on Earth's Waterways. Sean W. Fleming. Princeton University Press, Oxford. 2017. 216 pp. Price: US\$ 26.95.

Its global prevalence notwithstanding, the state of water in nature reflects our inadequate understanding of its intricate flow dynamics. Despite abundance, its access eludes millions of living beings and the consequent stress on the ecosystem of which it is an integral part is only growing. That currently more than one billion people lack access to clean water and in near future the global demand for water will be twice as much are numerical manifestations of a deep crisis. With nothing that can substitute this life nurturing fluid, the soul-stirring lyrics 'i'll give you answers to the questions you have yet to ask.' from the album 'Where the river flows' offer sound advice to ask right questions for getting past the prevailing hydrological muddle.

Sean Fleming may have listened to this album or the lyrics may have intuitively echoed to him in his quest for seeking interconnectedness between disparate disciplines to get answers to some unusual questions about and on rivers. Intriguing and exciting as these may sound, questions like 'why rivers are where they are' and 'how do rivers remember' propose exciting new ways of understanding varying levels of causality and complexity of the system and how these interact with one another. Plate tectonics may have carved a river's course, but its meandering flow is an aggregate of multiple factors, from the changing climate overhead to the dynamic geomorphology underneath. The sum total is that rivers have manifest identity in sky, land and us.

All rivers are alike in a broader sense, but have varied meandering curves, diverse aquatic fauna, and distinct morphological features. Unravelling this distinctiveness and the (unknown) variables that contribute to it are the challenges that confront hydrologists. Existing watershed models do not provide all the answers and the modelers themselves do not rate the results too high in getting a sophisticated description of river hydrology. Part of the problem, in the words of Belgian Nobel Laureate Ilya Prigogine, rests on our innate desire to reduce systems into sub-systems which only helps in learning more about less. Such an approach does not do much good to our understanding of river hydrology; as the challenge rests on addressing uncertainty in an array of environmental factors that contribute to stream flow and the aquifer beneath it. Rivers are at the centre of human civilization, and warrant compassionate understanding of their existence in time and space.

Where the River Flows offers a paradigm shift in understanding the rivers. It calls for a radical shift outside of the disciplinary box, as rivers are but a reflection of profound interrelationships between landscapes, ecosystems and societies. Fractal mathematics alongside chaos and information theory can be applied to generate a new set of data on the overall pattern created by the river system and the resultant decision-support system. As anthropogenic impacts like climate change accelerate democratically across the world, there is a need for as much finer details (will my farm get rain next week) as about big picture (will river topple its banks this coming season) of how the system works as a whole.

This would be critical in understanding the common but differentiated pattern rivers generate under varying geomorphological settings.

But a counter narrative has kept pace as science struggles to get a better sense of river hydrology. Sustained tempering of rivers on account of damming, diversion and contamination continues to throw formidable challenges in sustaining healthy stream flows for human welfare and the environment. Be it the Mississippi, Ganges or Yangtze, the story of river degradation threatens to off balance the dynamic equilibrium between ever-increasing human populations and their relentless aspiration to stay adequately watered. The United States may have leveled off its water use to 1970 rates in spite of both population and economic growth, the health of its rivers continues to remain alarming. While every drop of water pumped out from the Colorado river is used at least 17 times, which may sound like a good news, its net impact on the Gulf of California has grossly disrupted the hydrological cycle as river water has not reached the delta since 1960.

Fleming's scientific reflections on rivers emerge in the backdrop of such contrasting realities. Calling for an entirely new way of viewing the natural environment, he suggests processing of vast and complex information to reconceptualize the natural environment for recognizing problems differently, and in many cases identify altogether new problems. But can reams of hard data, quantitative modelling techniques, and classical statistical approaches get a better sense of a system that is not only dynamic but a living entity too? Not without reason had Heraclitus said that 'you can't step twice into the same river', highlighting that river is in a continuous flux. As the need for more accurate, precise and consistent forecast move center stage in our dealings with the rivers, the need for factoring the cultural perspectives of riverine societies must get the desired emphasis. All it needs is sharpening scientific skills to convert human observations into quantifiable information. After all, there is a reason for humans to have evolved along the rivers!

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