Hydrology and Change

Since “panta rhei” was pronounced by Heraclitus, hydrology and its objects, such as rivers and lakes, offer grounds to observe and understand change and flux. Change occurs at all time scales, from minute to geological, but our limited senses and life span, along with the short time frame of instrumental observations, restrict our perception to the most apparent daily to yearly variations. As a result, our typical modelling practices assume that natural changes are a short-term “noise” superimposed to the daily and annual cycles in a scene that, in the long run, is static and invariant. Hydrologist H. E. Hurst, studying the long flow records of the Nile and other geophysical time series, was the first to observe a natural behaviour related to multi-scale change and to study its implications in engineering designs. This behaviour, in which long-term changes are much more frequent and intense than commonly perceived, makes prediction of future states much more difficult and uncertain, particularly for long time horizons, than commonly thought. Surprisingly, however, the implications of multi-scale change have not been assimilated in geophysical sciences, as reflected by a vocabulary in which change is identified with “noise”, and a perception that only an exceptional and extraordinary forcing can produce a long-term change. A change of perspective is thus needed, which should depart from the 19th-century myths of static systems, deterministic predictability and elimination of uncertainty, and should move toward a new understanding and modelling of natural processes, in which change and uncertainty are essential parts.