Afterword

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In today's contemporary world, a walk through the epistemology of the hydrological cycle can help us frame many current problems within a broader framework, reminding us to remain humble. Among all the scientific concepts taught in schools of all types and levels across the globe, the water cycle is one of the concepts that stays in our minds long after the end of compulsory education. The ease of remembering this theory can be attributed to its relative simplicity: water evaporates from lakes, seas, and oceans; the vapour forms clouds; from the clouds come rain and snow that feed glaciers and surface and underground waterways, which in turn return to the oceans, and so on.

However, the mechanism is only seemingly simple. In my training as a hydrologist and hydraulic scientist, I learned the hard way how much studying and communicating the complexity hidden behind hydrological science requires patience and dedication. Modern hydrology, in the western world, can be considered to have emerged at the end of the seventeenth century, thanks to two members of the Académie Royale des Sciences: Pierre Perrault (1611-80) and Edme Mariotte (1620-84).

The treatises of these two authors, *De l'origine des fontaines* (Perrault 1674) and *Traite du mouvement des eaux et des autres corps fluides* (Mariotte 1686), can be considered the first attempts to verify, through quantitative analyses, the actual ability of precipitation to supply rivers and sources. Before Mariotte's work, it was difficult to recognise the Sun as the exclusive engine of the hydrological cycle; before making accurate measurements on the amount of precipitation and the drained areas, the belief was that simple precipitation could not fully feed the flow of rivers. Thus, it was considered necessary to 'integrate' the water flows derived from precipitation with complementary theories borrowed from Aristotle's Metaphysics or subsequent theories such as those of Pliny.

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Aristotle's complementary theory to the hydrological cycle generated by the Sun is based on the theory of humours, and he believes that water is generated in underground cavities by condensation. Pliny's theory alludes to a correspondence between the microcosm (man) and macrocosm (planet), where water plays an analogous role to blood by vivifying the earthly body. These latter theories were particularly successful during the Renaissance period and were also adopted by Leonardo da Vinci.

In the meantime, however, if we analyse Islamic and pre-Islamic sources in parallel, we note that, despite having a good knowledge of European and Greco-Roman hydrological notions, they espouse a decidedly more modern conception of the hydrological cycle. The Avestan tradition that sees the sea as a purifying filter and the water cycle triggered by the Sun represents an absolutely contemporary conception of the hydrological cycle, albeit framed within an idea of cosmic order.

A few years ago, together with Massimiliano, I had the opportunity to work on the technical translation of a passage from Āthār al-Bāqiya by al-Bīrūnī. In it, I observed an absolutely contemporary conception of the water cycle, complete with an explanation of the different flow regimes of rivers. I had already read *L'estrazione delle acque nascoste. Trattato tecnico-scientifico di Karaji* by Giuseppina Ferriello, a critical translation of *Inbāṭ al-miyāh al-ḫāfiya* enriched by epistemological and historical analyses, as well as extensive notes and references. I was fascinated by the modernity of scientific ideas and the reasonableness and intelligence of some technical devices in the management of water resources. Speaking with several fellow hydrologists, I began to question why a modern vision of hydrology had developed significantly earlier in the Islamic world than in the Greco-Roman European world. The simple answer is that there is, on average, less water in those regions. However, this is clearly a hasty answer from a technician and does not truly address the question, as the two worlds communicated strongly with each other. Considerations on the aridity of the climates might be true, but they are only marginally relevant if not supported by some evidence. Even Ancient Greece faced serious challenges regarding aridity and water scarcity.

Today, when it comes to the hydrology of arid areas, the term 'wadi hydrology' is often used, as if to emphasise hydrological studies in arid areas as secondary to a hydrological science that was born in the heart of Europe at the dawn of the Age of Enlightenment. Hydrology, born and developed as an applied science in France, the United Kingdom, and the rest of Europe in particularly water-rich areas, introduces a series of interpretative and operational tools that, when applied in different contexts (e.g. those specific to wadi hydrology), may lead to incorrect conclusions.

Just to name a few interesting authors, I suggest looking for Nick Cullather, who has collected excellent work on the modernisation of the Helmand basin, demonstrating the results of an epistemological and techno-positivist bias in the hydrological field. Sara B. Pritchard has carried out similar work on the interventions of French hydrologists in the arid colonies of France in North Africa, which were unsuccessful from the perspective of water resource management.

It is therefore clear how a deep study of the epistemological development of a discipline, especially when it is an applied discipline, is particularly interesting for understanding a series of errors and bad habits that can easily manifest themselves in present times through the discipline itself. The

challenges posed by the future are related to the management of ecosystems and natural resources. Since most observers agree that future wars will be waged over water, it becomes interesting to dissect hydrology and natural sciences dealing with water at both historical and cultural levels.

When I came across the treaty of Ibn Qurra on seawater salinity quoted by al-Bīrūnī, with Massimiliano, I realised how much the relationship between sea salinity and the water cycle is a particularly current topic. Especially in the Middle East and North Africa, desalination is considered a solution to water scarcity; however, for every litre of fresh water, at least one litre of brine is obtained – a highly corrosive and sterilising waste that must be disposed of in some way. When disposing of the brine waste on land, one must ensure that it does not percolate and salinate the aquifer; discharging it into the sea risks sterilising entire stretches of sea due to excess salinity. Many countries, especially those in the Gulf region, currently face these technical problems.

The relationship between humans and sea salinity resurfaces strongly here, making the translation of an unpublished treatise like the one studied here particularly interesting, even for those with a more technoscientific background like myself.