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The Science Needed to Understand and Protect Groundwater and Preserve The Environment

Introduction

Two positions seem to predominate in the debate about water. One is based on what was discussed at the 1992 Dublin Conference, where some movements talked about a supposed water scarcity and proposed solving it through open participation of private enterprise in water management. Other groups considered water a common good and stated that, even though sufficient fresh water exists, socioeconomic and political conditions make access and distribution unequal. However, none of the positions contribute scientific arguments guaranteeing methodologies to allow people to fully realize their potential in all their activities. Both positions seem to sidestep the fact that most of the water in the hemisphere moves slowly and constantly underground in flows of different sizes and that, with the passage of time —sometimes thousands of years—, it can traverse hundreds of kilometers from one surface basin to another.

We know that to manage any natural resource (forests, fishing, minerals, hydrocarbons, etc.), it is fundamental to understand its dynamic and evaluate the reserves and its possible behavior in different scenarios of extraction. It is therefore incomprehensible that in Mexico and throughout the world people say that civil society, the state, and the market should support and guide the government in setting up rules for sustainable water management, when these very actors still do not know what they need to about the main source of water, groundwater, not to mention its links to the dynamics of the environment. This contributes to the lack of sustainability originating in the dearth of environmentally viable, socially accepted, and politically legitimate proposals that could include the participation of an informed, aware citizenry. What is needed is to promote equitable water management through scientifically-based decision-making, in which the economic framework would make it possible to viably execute water infrastructure and services that would protect the relationship between water and the other components of the environment.

Achieving scientifically regulated water management would require a very different education that the one we have now, an education that would not look at the issue in a fragmented way; until now, water continues to be seen as something separate from the environment. It would require an inter-disciplinary perspective with the participation

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of professionals from different fields (geologists, biologists, edaphologists, economists, geographers, civil engineers, and doctors, among others), as well as decision-makers (deputies, senators, plus other public servants). In addition to recognizing the conditions and meaning of the movement of water, particularly that of groundwater, they would have to be informed about the conceptual content of the different terms related to water and use that knowledge in their respective disciplines.

We should mention that looking at the issue in a fragmented, de-contextualized way is the same as remaining immersed in a kind of dis-information that usually ends up by not pointing out how environmental conditions are worsening. This is the result of deficient management, in which unfortunately not everything that happens is due to mere ignorance.

Taking into account that approximately 97 percent of the fresh water in Mexico is groundwater, the terms "scarcity" and "water crisis" are very subjective. However, water insecurity —that is, the lack of the ability to guarantee a reliable provision of quality water in acceptable quantities to sustain the means of subsistence, health, socioeconomic development, and maintenance of ecosystems in a climate of peace and political stability— manifests itself every day nationwide. That is why the aim of this article is to question some of the concepts used in day-to-day parlance, showing how the lack of solid knowledge, despite research having been done on the issue since 1963 by Tóth, for example,[1] has meant that water management has not included how groundwater operates and dovetailing it with other environmental issues.

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It is noteworthy that in a context of water insecurity, the environment is clearly not being preserved; the consolidation of the soil is belittled; the presence of noxious elements in water is implicitly accepted; no controls exist for reducing the impact of groundwater on climate change; no incentives are given to methodologies with a systemic vision; nor is there interdisciplinary scientific participation in decision-making that includes transboundary groundwater in Mexico's North or South.

Society and the Real Situation of Water

In the context of a fragmented vision of the systemic situation of water, society is unaware that approximately 97 percent of the hemisphere's water is found in the subsoil, and that agriculture, industry, and urban activities involving water depend 75 percent on it as a source. That is why people will be surprised that ecosystems and wetlands depend on this kind of water. It is necessary, then, to highlight that the concepts used in discussing water foster an imprecise idea because they are part of a language designed and imposed exactly to misinform. This contributes to the generation of conflicts regarding water.[2]

So, we should ask ourselves, for example, if when talking about "availability," we are referring to the existing water, left-over water, accessible water, or that which can be used directly. We must inquire if the concept "demand" alludes to what is required or if it institutionalizes losses and theft of water; if talking about "scarcity" involves the non-existence of water or covers up inefficient management. When we use the word "resource," are we talking about a commodity for sale or a common good? Is an "aquifer" a reservoir that implies an indivisible "water+rock" or is it just underground water contained in rock? Is "over-exploitation" intensive extraction, its effects, a declaration of incompetence in attempted water management, or does using the term seek to give big users an advantage over small ones? When we defend the "human right to water," is the term being used similarly to their mention in other human rights recognized in international conventions like those of children or women, or are people actually thinking that you should pay to enjoy that right?

As we can see, the use and scope of these concepts are unclear, inexact, and unfair in their application. Just the first five can be defined in several ways, while "over-

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exploitation" continues to be ambiguous because it lacks a technical and legal definition. This makes it possible for it to have legal interpretations counter to human rights that would skip over small consumers' rights to access to groundwater. The seventh term allows unscrupulous people to create false expectations among the populace about "their rights," revealing the actions of different actors who clearly understand the implications of the lack of clear language that would make it possible to pose the question correctly and come up with a correct response.

Science and Groundwater

Groundwater moves in flows between and through basins,[3] with different areas for recharging and discharging, and is of different physicochemical quality and age. This means that their flows' trajectories are linked to specific environmental manifestations, which can be defined on the surface as the geomorphological reference point, and the presence or absence of surface water, soil, original vegetation, and basement rock. As mentioned above, from the middle of the last century, several authors, among them József Tóth, began to systematically define water and its correlation to certain elements. However, in Mexico, we lack government impetus on all levels for achieving the systemic, scientific vision about groundwater that we require.[4] Tóth's flow systems have been proven solid and scientifically coherent, as well as functional, and are a scientific reference point applied in several countries to come up with solutions to environmental issues linked to groundwater and other components of the environment.

In North America, Canada has taken firm steps in instituting flow systems as a methodology for understanding its groundwater, showing that science is taken into account in government decision-making.[5] In Mexico's case, it is incomprehensible that these actions are not recognized when this country, the world's fifteenth largest economy, aims to achieve the status of equals in NAFTA and has made a priority of modernizing conflict resolution mechanisms to make them more agile, transparent, and effective.[6] This becomes fundamental when we recognize that half the controversies presented at the World Bank court involving companies that have invested in Mexico under NAFTA are related to water,[7] and the National Water Commission (Conagua) states that 7 out of 10 of these involve groundwater.

In this context, Mexico faces the challenge of harmonizing its actions with those of other countries in North America, where scientific advisors are chosen based on an open, merit-based selection process. This requires recognizing that groundwater is a fundamental component of national policy. However, we are a long way in our country from having scientists involved in decision-making. Obviously, this would require substantially increasing support for updating hydro-geological scientific knowledge.

Instead of that, up until now, what we hear is, "Here, we solve practical problems." In Mexico, at least with regard to groundwater, the participation of science is avoided and most of the time, politically tainted "solutions" are put forward. With this, the private sector comes out the winner, while the environmental and financial costs are transferred to society, which continues to lack a clear vision about what appropriate water management should be.

In this sense, we can no longer postpone the participation of an informed society, capable of understanding the problems involved, of negotiating, deliberating, and of making decisions and doing follow-up of processes and results. However, regional and national water-policy planning reveal the total absence of consensuses linked to the environmental and social reality.

Thus, it has become imperative that we motivate different visions in which the responsibility for bad water management is attributed to the actions of those who, by law, must manage it. This implies remediating the impacts of ignorance about the dynamics of groundwater and their implications in landslides, soil subsidence, environmental changes due to hydraulic works, the impacts of mining, the effects of water containing agro-chemicals filtering into irrigation, scenarios which have left groundwater out of the equation.

Plans that do not take into consideration how groundwater functions and foster the irresponsible —and even criminal— use of land where aquatic habitats affected

are not even part of the discussion not only dismiss the health of ecosystems, but also affect human health and the possibility of any kind of sustainable development, causing severe conflicts.

Not understanding the origin of groundwater and its functioning in the environment has had a series of impacts on the latter; but, due to the fact that these flows move slowly, it is possible to predict, control, and avoid them, which is not the case with surface water and the conflicts associated with its management and preservation.

Conclusions

The dispute over water seems to be fed by the lack of knowledge about its main source: groundwater. The concepts "water scarcity" and "common good" subtly distract from this debate. That is why it is necessary to know more about the existence and functioning of the object of the discussion. It is clear that systemic knowledge can help avoid its being invisible to the public. It has become invisible because of the lack of an interdisciplinary education that deals with and disseminates the issue, as well as a common language that is precise and corresponds to reality. However, what exists is a clear tendency to keep knowledge about groundwater at the level it was at in the middle of the twentieth century, by not incorporating or applying systemic knowledge. VM

Notes

1 József Tóth, "A theoretical analysis of groundwater in small drainage basins," *Journal of Geophysical Research* vol. 68 (1963), pp. 4791-4812, and *From the artesian Paradigm to basin hydraulics* (Budapest, Hungary: Institute of Geography and Earth Sciences, Eötvös Loránd University, 2008), 106 pp.
2 José J. Carrillo *et al.*, "Conflictos por el agua subterránea en México," in Omar Moncada Maya and Álvaro López López, comps., *Geografía de México. Una reflexión espacial contemporánea. Tomo 1* (Mexico City: Instituto de Geografía, UNAM, 2013), pp. 151-166.
3 József Tóth, op. cit.
4 Liliana Peñuela Arévalo *et al.*, "Importancia del agua subterránea en la conservación de los ecosistemas," in *Biodiversidad en el Distrito Federal: Estudio de Estado* (Mexico City: GDF, Dirección General de Zoológicos y Vida Silvestre and Conabio, 2015).
5 Brian Owens, "Canada names new chief science adviser," *Science*, September 26, 2017, http://www.sciencemag.org/news/2017/09/canada-names-new-chief-science-adviser, accessed December 14, 2017.
6 Uniradio Informa, "Los objetivos de México para la renegociación del TLCAN," August 11, 2017, http://www.uniradioinforma.com/noticias/mexico/489911/los-objetivos-de-mexico-para-la-renegociacion-del-tlcan.html, accessed December 14, 2017.
7 Suits are brought before the World Bank's International Centre for Settlement of Investment Disputes (ICSID), headquartered in Washington, D. C., https://icsid.worldbank.org/sp/Pages/about/default.aspx, accessed December 10, 2017.