Understanding Mexico's Water Crisis

Gabriela Angeles Serrano*

Iván Stephens/Cuartoscuro

Water management and use are facing many daily challenges and are the subject of heated debate throughout the world. However, very little is understood about the negative implications of environmental decision makers' holding on to misconceptions and outdated paradigms about the behavior of the hydrological system. The dearth of mechanisms for translating existing technical and scientific knowledge into public policies is very grave, particularly since these public policies should not only protect the environment, but also be consistent with the social, economic and cultural dynamics that are driving environmental transformation.

This essay aims to explore how these generalized schema and misconceptions are used to indicate the state of the water crisis in Mexico and emphasize how the lack of articulation between the technical or scientific conception of the problem and its implementation could be, like in other regions, a great limitation for managing water resources in a more fair, balanced way. This is because there are cases in which an environmental problem, like the decline and dete-

* Researcher at CISAN. ganserr@servidor.unam.mx

rioration of aquifers, grows after applying a specific public policy or regulatory norm, although it appears to be scientifically or technically correct.[1]

Decision makers say there is a water crisis in Mexico because water sources are over-exploited, because most of the country's terrain is arid or semi-arid and because of growing demand on the part of an expanding population. They also say that these three elements put the brakes on achieving sustainable development. But this analysis does not take into account the problem's complexity, from the physical conditions to social and economic aspects.

In Mexico, political agendas and discourses began to include the environment and the concept of sustainable development in the late 1980s. This was the most important push toward linking technical-scientific knowledge with practice in the form of instruments for managing resources like water, soil or biodiversity.[2]

Among the definitions best known worldwide of sustainable development is that of the Brundtland Commission, which defines it as that which "meets the needs of the present without compromising the ability of future generations to meet their own needs."[3] In Mexico, the term is defined in the most recent amendment to the Law on National Waters as "the process that can be evaluated using water, economic, social and environmental criteria and indicators that tends to improve people's quality of life and productivity...in such a way that does not compromise the satisfaction of water needs of future generations."[4]

It remains to be seen, however, based on what the law and its regulations have to say, what concrete indicators could be formulated to evaluate

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sustainable development. It is widely accepted throughout the world that it is very difficult to achieve success with proposals for water management. For example, the Comprehensive Assessment of the Freshwater Resources of the World confirms that despite efforts in different parts of the globe, patterns of development and management of water resources are not sustainable from the social, economic or environmental perspective or as a whole.[5]

One of the very important but little heeded reasons for this is that decision makers continue to apply misconceptions or obsolete paradigms about the behavior of transformed natural systems or with intensive management of the resource. This can be more clearly seen if we use various disciplinary focuses to contrast the quality and relevance of the indicators used to evaluate and monitor the environment, like their integration into more complex models.

Then, it should be recognized that one of the clearest challenges in the new Law on National Waters is the lack of indicators to objectively evaluate the sustainability of the management actions that stem from it.

One of the most important indicators for evaluating the impact on the environment of water resource management is the term "over-exploitation." For example, it is not very appropriate for referring to the negative impact of intensive groundwater development because it does not allow us to consider the complexity of the physical systems, the complex answers to different regimes of extraction, or the uncertainty of technical models for evaluating aquifers. It also does not allow for including a series of very important social components.

In the Law on National Waters, the term "over-exploitation" alludes to unacceptable uses of water sources, while in other documents this term refers to when the extraction of water surpasses "10 percent of the capability of natural annual and long-term renovation." At first glance, this definition is understandable and precise, as it may refer to an unacceptable decrease in water levels that precede or indicate a non-renewable decrease in water storage. But the term "over-exploitation" is also used to point to the loss that can cause or worsen one or more of the following processes: 1) the decrease in the base flow of surface runoff; 2) the reduction of wells' pumping chambers; 3) a change in the quality of the water; 4) a change in the regimen of groundwater flow; 5) land sinkage (subsidence). All of these processes are linked in turn to more complex problems, difficult to evaluate, that range from an increase in production costs and ecological imbalances to social conflicts and health problems. To this we should add that phenomena like the salinization of the soil and the increase in the concentration of elements like arsenic and fluoride, and the induction of non-renewable groundwater flow —commonly called fossil water— also exists in areas with intensive development of the resource that can not be considered over-exploitation strictly speaking.

To deal with this complex series of interactions, current water management policies are based only on the criteria of the rate of safe yield, which means a rate of extraction that does not cause over-exploitation. It should be recognized that many specialists are aware that it is not possible to obtain this rate with an acceptable degree of uncertainty, but they all use this criterion since, for the moment, it is the only indicator that exists to distribute water to different consumers.

At the same time, there is great uncertainty about how much and what quality of water different ecosystems need and, consequently, how this requirement varies with the seasons, for example in the cases in which natural groundwater flows that need more time for renewal (thermal springs or those with special mineral composition) are valuable for maintaining certain types of ecosystems.

Despite the fact that the safe yield rate is an indicator that has many desirable characteristics like geographic scope, relevance and utility for potential users and even being understandable for non-specialists, its scientific validity and representativeness of the entire territory analyzed are limited by the number of environmental responses and by the differences in the threshold value and interpretations it has. In addition, the negative effects of over-exploitation present themselves regardless of whether the capability of natural renovation of the aquifer, river basin or any other territorial unit being analyzed has been surpassed.[6]

All this brings to the fore the need to review the prevailing paradigms in institutions; if we thoroughly assess recent environmental diagnoses with regard to water, there are no national or regional indicators comprehensive enough to evaluate these complex interactions.

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There is insufficient capability to manage groundwater jointly and integrally with surface water. Proof of this is the fact that in 2004, water statistics in Mexico still mainly focused on surface water, which represented 65 percent of the 79.4 cubic kilometers of total annual extraction (which includes both surface and groundwater), mainly for agricultural use. This is despite the fact that many regions have intensive development of groundwater, more than 70 percent of which is channeled into urban and industrial use.[7] This weakness in the focus of water management can be more clearly seen when we take into consideration that more than half of the country has important potential for developing groundwater given three specific conditions: 1) the arid (31 percent) and semi-arid (33 percent) conditions that exist mainly in the North that make it impossible to form surface runoff, do allow for the presence of aquifers with different annual renewal rates; 2) the generalized contamination of surface water; and 3) geographical conditions that make for a lack of surface water despite high precipitation (for example, in Yucatán). Nevertheless, this potential for the country's development of groundwater resources is limited by the technical, scientific and institutional difficulties in measuring, evaluating and managing them appropriately.[8]

A generalized trend among decision makers regarding the use of groundwater is to consider it a resource that causes great number of environmental problems. But this is true only to the extent that it is more difficult to manage and evaluate because of its greater number of non-linear responses compared to surface water. Also, because of the difficulty in controlling the volume of extraction or given that extraction from wells can cause adverse environmental effects like land sinkage or desiccation of bodies of water, in addition to other reasons, priority was given to hydraulic works that tapped into and measured surface water, despite the fact that in many territories, more importance should have been given to appropriate management of groundwater.

However, intensive exploitation of wells has become more and more frequent for public and industrial use in Central and Southern Mexico, and for agricultural use in the North. This trend in northern regions can be reversed given that current policies offer incentives for transferring water from less productive agricultural uses to more productive ones like urban or industrial uses.

Another focus that should be questioned is attributing the water crisis mainly to the country's physical conditions aggravated by demographic growth, when there is no reliable estimate of the state of the hydrological system under these conditions of pressure. Among other reasons this is because the network for monitoring climatic and hydrological seasons and of aquifers is incomplete and technical studies specifying groundwater behavior and its different levels of interaction with ecosystems and the population are very inadequate. To make these hydrological and water quality studies, 37 hydrological regions that group 314 basins are taken into consideration, and for groundwater management, a conventional definition of 653 aquifers has been established. All these delimitations suffer from the restriction that they must incorporate complete municipalities in order to internalize costs and benefits on a municipal scale. This delimitation of territorial units for management causes a high degree of fragmentation and implies placing little attention to surface and groundwater interaction, given that these interactions can be better observed using a larger spatial unit.

The need for greater integration of the indicators to evaluate the progress toward sustainability of water resources is clear when analyzing how the notion of "a scarce resource with a cost that must be covered" jibes with the statistics. For example, Mexico's National Water Commission (CNA) calculates that an excess of between five and six cubic kilometers of water per year are extracted from the country's aquifers, an amount which cannot be renewed and contributes to the degradation of the water sources. It has also been estimated that 102 aquifers, including the country's main ones from which 50 percent of the water used is extracted, suffer from some degree of over-exploitation. However, this scenario of "physical scarcity" contradicts the figures for potable water coverage nationwide, according to which the southern states have more water available but suffer from greater scarcity, while the states with "over-exploited aquifers" enjoy higher than 90 percent coverage.

This discrepancy between natural availability and water coverage could reveal what many authors have already warned: that a "water crisis" has been created based on indicators that most times do not cover appropriate theoretical expectations.

Finally, many studies emphasize the limited organizational and human resources capabilities for dealing with the "water crisis". I add my voice to those who point out the urgent need to educate and train engineers and administrators working in institutions related to water management about the social and environmental consequences of their decisions, "not only in water planning and management, but also of associated natural resources, human health and social well-being."[9]

FINAL REMARKS

In Mexico, like in many other countries, erroneous conceptions prevail among decision makers and even among specialists that at the very least limit the advance of more profound research for the complete development of water resources in a more environmental-friendly way that would also contribute to the well-being of the population. At the same time, how the discrepancy between environmental and social analyses plays out in the tendency to environmental deterioration or improvement has not been explored very deeply. If it were, the necessary indicators could be developed to show more clearly how a specific policy or regulation comes close or not to goals of sustainable development. Given this panorama, we can anticipate that many of the negative environmental effects throughout the country may be related to the intensive development of groundwater but not necessarily to the over-exploitation of aquifers or any other indicator of deterioration currently used to create regulatory and control policies for the extraction of groundwater. VM

NOTES

[1] In China, for example, the enforcement of a law to replace traditional irrigation with very efficient, water-saving high-tech irrigation caused the expansion of cultivated land, and with it the increase in vapotranspiration, thus accelerating the depletion of the aquifer. Eloise Kendy, "The False Promise of Sustainable Pumping Rates," *Ground Water* 41, pp. 2-3.

[2] Due to the Earth Summit and other international conventions, political consensuses were reached with regard to the meaning of "sustainable development," a term that spread rapidly.

[3] World Commission on Environment and Development, *Our Common Future* (New York: Oxford University Press, 1987).

[4] "Decreto por el que se reforman, adicionan y derogan diversas disposiciones de la Ley de Aguas Nacionales," *Diario Oficial de la Federación* (Mexico City), April 29, 2004, pp. 27-69.

[5] C. Sullivan, "The Potential for Calculating a Meaningful Water Poverty Index," *Water International* vol. 26, no. 4, pp. 471-480.

[6] A very complete study of the limits of the conceptual models for quantifying water sources can be found in J. Bredehoeft, "The Conceptualization Model Problem-Surprise," *Hydrogeology Journal* 13, pp. 37-46.

[7] Comisión Nacional del Agua, *Estadísticas Nacionales del Sector Agua* (Mexico City: Comisión Nacional del Agua, 2004).

[8] J.J. Carrillo-Rivera, "Lack of a Conceptual System View of Groundwater Resources in Mexico," Editorial, *Hydrogeology Journal* 1, pp. 519-520.

[9] C. Tortajada, "Capacity Building for the Water Sector in Mexico. An Analysis of Recent Efforts," *Water International* vol. 11, no. 4, pp. 9-26.