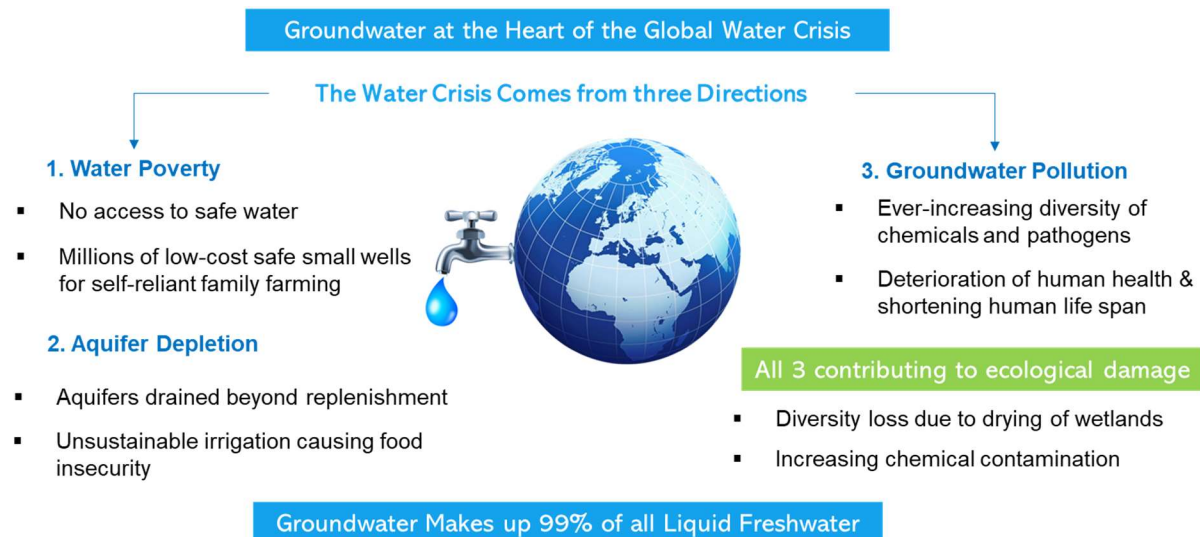


An Essay:

THE GLOBAL GROUNDWATER CRISIS- A PERFECT STORM FROM THREE DIRECTIONS: POVERTY, DEPLETION AND POLLUTION

John Cherry, Leader of the Groundwater Project, July 30, 2023

There is a global freshwater crisis that threatens our food supply and societal stability. Groundwater is at the heart of the crisis because groundwater makes up 99% of all liquid freshwater and becomes 100% in some regions when drought occurs. According to UNESCO (2020), groundwater serves as an essential foundation for the achievement of eight of the seventeen United Nations Sustainability Goals. The year 2022 was designated by the United Nations as the Year of Groundwater, which culminated with the UN-Water Summit on Groundwater in Paris in December 2022, where groundwater was recognized as the hidden cause of the water crisis. Further recognition of the importance of groundwater to humanity came in 2023 with the World Bank report: *The Hidden Wealth of Nations: Groundwater in Times of Climate Change*. But if there's a crisis, why aren't we doing anything about it? One reason is complexity. It is little understood that a perfect storm has arrived from three directions: water poverty, aquifer depletion and groundwater pollution; together these cause immense human misery, ecological damage and diversity loss. This essay summarizes recent findings with sources listed at the end.



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Water poverty, which is defined as a lack of safe drinking water or having to walk too far to fetch household water, is commonly perceived only as a rural problem. However, water poverty is growing and encompasses about 40% of the world's 8 billion people. The long-standing migration of rural people to megacities has somewhat relieved rural water poverty although drought has exacerbated it for those remaining. More than 80% of large cities now rely on groundwater as their main water source. The megacities subject the migrated poor to another form of miserable water suffering that includes scarcity but also pollution and flooding. Hence, more migration is not a solution for rural water poverty. In the megacities along coastal areas in the developing countries, flooding has become common. In 44 of the largest 48 cities in the world, flooding is

caused by the land sinking due to excessive groundwater extraction from coastal aquifers, much more than the smaller effects of sea level rise due to rising temperature.

There are alarming rates of groundwater depletion worldwide because agriculture consumes 70% of all freshwater use with 73% of this for irrigated food production. This is the percentage when we include both extraction from aquifers (43%) and extraction from river baseflow sustained by groundwater (30%). However, it is this misleading 43% not 73% that is used in all official listings of the degree of global food dependency on groundwater. The immense Ogallala aquifer that underlies the High Plains in the United States is being massively depleted with no end in sight. This has global implications because this aquifer supports about one-sixth of the world's annual grain production. A vast majority of the world's population lives in countries sourcing nearly all their staple crop imports from other regions where groundwater is being depleted to produce these crops, which highlights the risks for global food and water security. Some countries, such as the USA, Mexico, Iran, and China, are particularly exposed to these risks because they both produce and import food irrigated by groundwater from depleting aquifers. Other countries such as Saudi Arabia, where the aquifers are nearly totally depleted, are now fully dependent on imported food. This is precarious because reliance on imported foods contributes to aquifer depletion. The globalized food system is now in unprecedented insecurity due to several factors but those most ignored and moving beyond repair are the interdependent problems of disappearing groundwater and soil. These have already triggered societal instabilities contributing to war (e.g., Syria).

Groundwater pollution minimizes the value of freshwater. In megacities where groundwater is the lifeblood, groundwater pollution is often a result of poor sanitary facilities (i.e., pathogens), irresponsible disposal of hazardous liquids, by natural contaminants (e.g., arsenic) or by salinization by over-pumping causing seawater intrusion. In the northern hemisphere, there is also widespread contamination caused by the infiltration of road deicing salts. To further complicate matters, each of the three directions of the freshwater crisis (poverty, depletion, pollution) is on its own an independent trajectory towards disaster. To reverse the trajectories, different solutions are needed for each. Eliminating water poverty needs the drilling of tens of millions of safely constructed low-cost, private wells capable of small but adequate yields for drinking water, sanitation, and cultivating crops to support a family. This needs to be done in combination with widespread expansion of rainwater harvesting with attention to family agriculture appropriate for the local conditions. To reverse depletion, there will need to be much less groundwater used by agriculture in some of the important food producing parts along with using efficient irrigation techniques. To reduce groundwater pollution, the excessive applications of agricultural chemicals and releases of industrial chemicals must decline in combination with more protective well construction, improved sanitation, and sustainable land-use practices.

No proposals have been announced from leading world organizations for reversing any of these trajectories. Instead, policy initiatives are focused on mitigating climate change through the reduction of emissions of anthropogenic greenhouse gases. Climate is perceived as the existential threat to humanity while the water crisis takes a back seat even though two thirds or more of humanity suffer from severe and continuing water problems with the number only growing. This is the magnitude when we total up those in water poverty, the water poor in sinking

cities, those suffering from anthropogenic groundwater pollution and from arsenic and fluoride poisoning from natural sources, and those on rural family farms in developing countries who suffer from hunger and malnutrition due to their water-deficient existence.

All this is proceeding on a much shorter time scale than the increase in mean global temperature predicted by climate models. The most immediate threat to human well-being is whether those suffering water poverty will live or die because of the expanding water crisis. From the perspective of water availability, humanity is poorly distributed across the globe but, by and large, this cannot be changed; we can only change how we manage the available water. That water poverty, depletion, and pollution each has its own trajectory with its own complexity presents the need for unprecedented policy challenges. For survival of our civilization as we know it, each trajectory must be reversed. In the policy realm, the avoidance of action on water at a time when people are suffering, fertile soil and the ocean fishery are disappearing is a denial of the most evident reality.

We are in this water crisis because of failures in policy. For example, two hundred thousand dams have been built in the past 100 years (8700 in the USA and 8600 in China) and building more will not solve today's water problems when drought is the primary threat. Dam building as the focus of nearly all water management did not consider climate or loss of fertile valley soils, while the most essential need is for water storage in aquifers. This storage avoids evaporation loss and ecosystem damage. That groundwater is key to the water crisis should not be surprising given the 99% of freshwater is groundwater, fact has long been known but largely ignored before 2022.

Solving water problems and especially groundwater problems is not conducive to top-down governance. Each of the three trajectories can only be solved by problem specific understanding and actions framed within broad policies developed with stakeholders' input, applied at the local scale supported by the will of the people at the scale of the watershed, aquifer, city, or town. The solutions are tied to our choices of land use for urbanization, agriculture, or forests. Governments can play a pivotal role in the application of subsidies to drive change, but for this, the problems and the trajectories will need to be understood by all stakeholders. For all these reasons, the Groundwater Project (www.gw-project.org) is essential. It is unique, philanthropic and innovative aimed at the understanding freshwater problems and solutions for all segments of society. The Groundwater Project is unprecedented in its groundwater knowledge synthesis to cover an entire scientific discipline, freely accessible for everyone. This is a contribution by the expert groundwater community and related disciplines working as volunteers from 70 countries to synthesize their knowledge into hundreds of books and other learning materials for availability at the website (PDF format). All are peer reviewed and are being translated into many languages.

In a world where hundreds of millions of water wells service basic needs for drinking water, food production, and industry, it is a near universal experience that top-down management of groundwater does not work because most wells are privately owned, which conveys a sense of water ownership. Government officials have no appreciation of the important role of groundwater in eliminating water poverty, for food security, and for human and ecological health. The groundwater crisis is a tragedy of the commons because groundwater is a shared resource, but the sharing is unseen. Groundwater management demands the active participation of all

stakeholders and takes patience, persistence and good will to build a consensus for collective action (World Bank, 2022). As a starting point, an international panel on the groundwater-dependent freshwater crisis needs to be established on par in effort with the International Panel on Climate Change (IPCC). The IPCC is focused on reversing the trajectory of anthropogenic greenhouse gas emissions. The freshwater panel would be focused on reversing the trajectories for water poverty, and aquifer depletion and pollution. However, better understanding of groundwater by all stakeholders is essential, and for this, the Groundwater Project is leading the way. It is an act of hope in a troubled world. However more support and expanded partnerships are needed to meet the global demand for knowledge and action.

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