Potential Water Efficient Technologies in the Face of Water Scarcity in Azerbaijan

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UN Water projections suggest that global water demand will continue to rise at a similar rate until 2050, with an anticipated 20-30 percent increase above current levels. This increase is mainly driven by higher demands in industrial and domestic sectors. In light of water scarcity, increasing water demands, and climate change, Azerbaijan faces this challenge by re-arranging its freshwater resources management to ensure that water needs are met for social, economic, and environmental purposes. The country is going through water sector reforms and launching pilot projects to identify new sources of water and engage in better water resources management. Prevention of water losses and considering new and unconventional sources of freshwater are one of the aspects of Action Plan on Ensuring Efficient Use of Water Resources in Azerbaijan, which was adopted in July 2020.

Is There Any Other Way to Obtain "New" Source of Water?

In Azerbaijan, up to 30-40 percent of freshwater is lost in distribution networks in Azerbaijan. Water loss is happening because of leakages from the distribution network, wastages, and unauthorized consumption. It is a common occurrence in all distribution systems, but the extent of this loss can vary significantly. Achieving a zero-water loss is not technically and economically feasible, however minimizing is possible. The variation depends on several factors, including the characteristics of the water network, local conditions, metering policies, operational practices, and the level of technology and expertise applied to manage and reduce this loss. The actual volume of water lost differs greatly from one country to another and even within different regions of the same country. Moreover, the components contributing to water loss and their respective significance also differ among countries.

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One of the main components of water loss from the distribution network is leakage. Leakage results in significant losses because it squanders purified water that has been produced with considerable labor, time, and cost. Leakages not only cause financial losses to water utilities, but also lead to secondary accidents like traffic accidents and property damage through flooding. Leaks also introduce contaminants into the water distribution system, which can lead to water quality incidents. When polluted water infiltrates the pipes, it can compromise the safety and quality of drinking water, potentially harming public health. In a 2022 paper titled "Do People Appreciate Economic Value of Water in Baku City of Azerbaijan?" Pasquale L. Scandizzo and Rovshan Abbasov, observe that, despite provision of clean municipal water that adheres to both national and international water quality standards, tap water is often not recommended for drinking in Baku. They attribute this to issues such as water leakages and the deterioration of the distribution network. Wastage and unauthorized water use is another component and are indeed significant concerns for water management in Azerbaijan. These can be as harmful as leakages as it leads to resource depletion and increases stress on ecosystems and biodiversity.

Water losses lead to the over-extraction of water from natural sources, contributing to land subsidence and other environmental problems. Effective water loss control can be seen as a means of developing new water resources. To put this into perspective, *the annual volume of water lost through network distribution (3.3 billion m^3) in Azerbaijan is more than the capacity of Shamkir reservoir (2.6 billion m^3)*—the second largest water reservoir in the country. Therefore, controlling water losses is not only about preserving a valuable resource but also about safeguarding the environment, infrastructure, and public safety while ensuring the delivery of safe water.

A fundamental element of any strategy aimed at addressing water loss needs to comprehend the relative importance of each component involved—to determine, in other words, in which sectors water loss is prevalent and why. This understanding ensures that each aspect is measured or estimated with precision, enabling the establishment of priorities through a series of action plans.

Water Saving Technologies in Agriculture

Approximately 70 percent of the extracted freshwater is used in agriculture sector in Azerbaijan. The main water losses are happening during the irrigation process, as the current practice involves the utilization of traditional surface irrigation techniques like flood and furrow. Traditional irrigation methods are both labor-intensive and costly. They involve surface spraying of water, typically around the soil rather than directly targeting the plant roots and tend to result in uneven water distribution among the crops.

Consequently, this provides limited benefits to the plants. Therefore, in the context of water loss management in Azerbaijan, improving the efficiency of irrigation system and increasing water use efficiency in agriculture sector needs to be reviewed first.

In various World Bank studies, the economic advantages of improving water efficiency through investments in efficient irrigation technologies have been demonstrated across all analyzed climate change scenarios. Furthermore, the benefit-cost ratio generally increases as higher efficiency targets are pursued in Azerbaijan. This underscores the economic benefits of prioritizing and investing in water-efficient irrigation technologies in the context of agricultural adaptation to climate change.

Drip Irrigation. Drip irrigation systems offer substantial water savings, typically reducing irrigation needs between 20-70 percent compared to surface irrigation methods. In addition to water conservation, these systems also bring about significant economic advantages, including increased crop yields. For instance, in the context of horticultural products, the implementation of drip irrigation can enhance productivity by 20-40 percent. This underscores the significance of optimizing irrigation practices to achieve the best possible crop productivity and economic returns. It is useful to note that within the realm of drip irrigation, subsurface drip irrigation is recognized as the most efficient method.

Sprinkle Irrigation. Sprinkle irrigation is well-suited for a wide range of crops, including row crops, field crops, and trees. It is particularly well-suited for use in areas with shallow sandy soils and uneven terrain (where leveling the land is impractical). Additionally, it proves advantageous in regions where both labor and water resources are scarce. In comparison to surface irrigation, sprinkle irrigation demonstrates superior water productivity, which means it can achieve higher yields per unit of water applied, especially in crops like wheat, maize, sorghum, sugarcane, and cotton. It is important to note that while sprinkle irrigation is more water-efficient than certain methods like flood irrigation, it is not as water-saving as drip irrigation, which delivers water directly to the root zone of plants.

Land Lasering. The unevenness of the soil surface can have a notable impact on crop germination, stand establishment, and overall yield. As opposed to conventional land leveling methods, which are labor-intensive and time-consuming, a laser land leveler is a machine equipped with a laser-guided drag bucket and is highly effective at achieving a flat and uniform field surface. When this process is executed correctly, there should be no need for comprehensive re-leveling of the entire field for at least eight to ten years. Laser leveling not only results in a more even field, but also reduces irrigation time and conserves water, typically achieving water savings of approximately 25-30 percent. According to a paper published by Iskandar Abdullaev and others in 2007, a three-year experiment involving laser leveling of cotton fields in small private plots in Tajikistan led to a significant reduction in runoff, specifically by 24 percent. This resulted in substantial water savings, ranging from 333 to 1,509 m^3 per hectare. Consequently, farmers experienced a notable increase in net income, amounting to 22 percent, and gross margins were substantially higher (92 percent), compared to fields that did not undergo laser leveling.

Conservation Tillage. Individual and small farmers are widely using traditional tillage in Azerbaijan and up to 90 percent of the farms are smallholdings, occupying 85 percent of agricultural land. Traditional tillage disrupts the natural soil layers and can lead to increased denitrification, resulting in the release of GHG emissions rather than preserving soil quality. Additionally, it also requires significant energy from the tractor for pulling. Conservation tillage is a tillage approach or a combination of tillage and planting methods that maintains a cover of crop residue on the soil surface at 30 percent or more. Specific definitions of conservation tillage depend on factors such as the crop type, soil characteristics, local conditions, and climate. Zero tillage (no-till, minimum-tillage, or direct seeding), ridge tillage, and mulch tillage are methods of conservation tillage. These avoid inverting the uppermost soil layer, thereby facilitating the long-term retention of moisture within the soil. Such methods establish an environment that enables the upward movement of moisture from the deeper soil layers to the surface, while also allowing the soil to maintain its natural aeration.

Studies have indicated that water use efficiency is notably higher in soils subjected to reduced tillage practices and no tillage systems, in comparison to conventional tillage. Additionally, water use efficiency was significantly improved in zero-tillage when compared to both conventional and ridge tillage methods. Various studies funded by GIZ Azerbaijan and the FAO also recommend minimum- and no-tillage for Azerbaijan, as the conservation tillage represents a sustainable approach to farming, offering both environmental and economic benefits while contributing to long-term soil health and productivity. This is particularly important given that the issue of supplying irrigation water is becoming more pressing and challenging in the country.

Other Solutions. Irrigation using magnetized water results in increased soil moisture levels when compared to non-magnetized water irrigation. It enables the use of lower-quality water sources, such as recycled or saline water, for agricultural purposes. However, it should not be considered an efficient water-saving irrigation technique because it does not substantially reduce the overall water consumption. Therefore, it can be more efficient if combined with treated drainage water reuse.

The issues of pollution abatement and water recycling in Azerbaijan can be discussed in upcoming IDD Analytical Policy Briefs, as they involve many different aspects.

Challenges and Recommendations

The primary systematic obstacle to ensuring efficient use of water resources in Azerbaijan is that water resources management in the country is based on supply management, as opposed to demand management. I discussed this in an earlier IDD Analytical Policy Brief (HERE). As the demand is managed, it often involves the development and enforcement of policies and regulations that promote water conservation and the use of efficient technologies. These policies serve to incentivize the adoption of water-efficient practices and technologies by individuals, industries, and businesses. One aspect of these policies is the proactive identification and repair of leaks in water distribution systems. This reduces water losses and ensures that water-efficient technologies, such as low-flow fixtures, can operate optimally.

Another substantial obstacle is related to land ownerships in the country; the wider implementation of drip/sprinkle irrigation and land lasering require substantial upfront capital requirements by farmers. The scattered location of their land is also a challenge, in this context. The factors preventing the adoption of minimum- and zero-tillage methods are attributed to farmers' limited access to information, technology, as well as the high costs associated with purchasing or renting the necessary equipment. One promising way forward is the establishment of cooperatives, as suggested by my IDD colleague Nazrin Baghirova in her Winter 2022-2023 *Baku Dialogues* essay (HERE). Combining the efforts of several neighboring farmers can reduce overall investment costs and improve capital efficiency through improving the operational efficiency and effectiveness of existing infrastructure. Such improvements would result from good operation and maintenance of infrastructure, creditworthiness of water operators, and demand management.

Underdeveloped metering system—specifically in the irrigational areas—is another challenge with regards to efficient water use and loss prevention in Azerbaijan.

Therefore, any strategy for preventing and managing losses should encompass these key elements following the above-mentioned systemic changes: monitoring through metering, the implementation of advanced technology for leak prevention, the prompt identification and repair of leaks, and the strategic replacement of main and service pipes with durable alternatives.