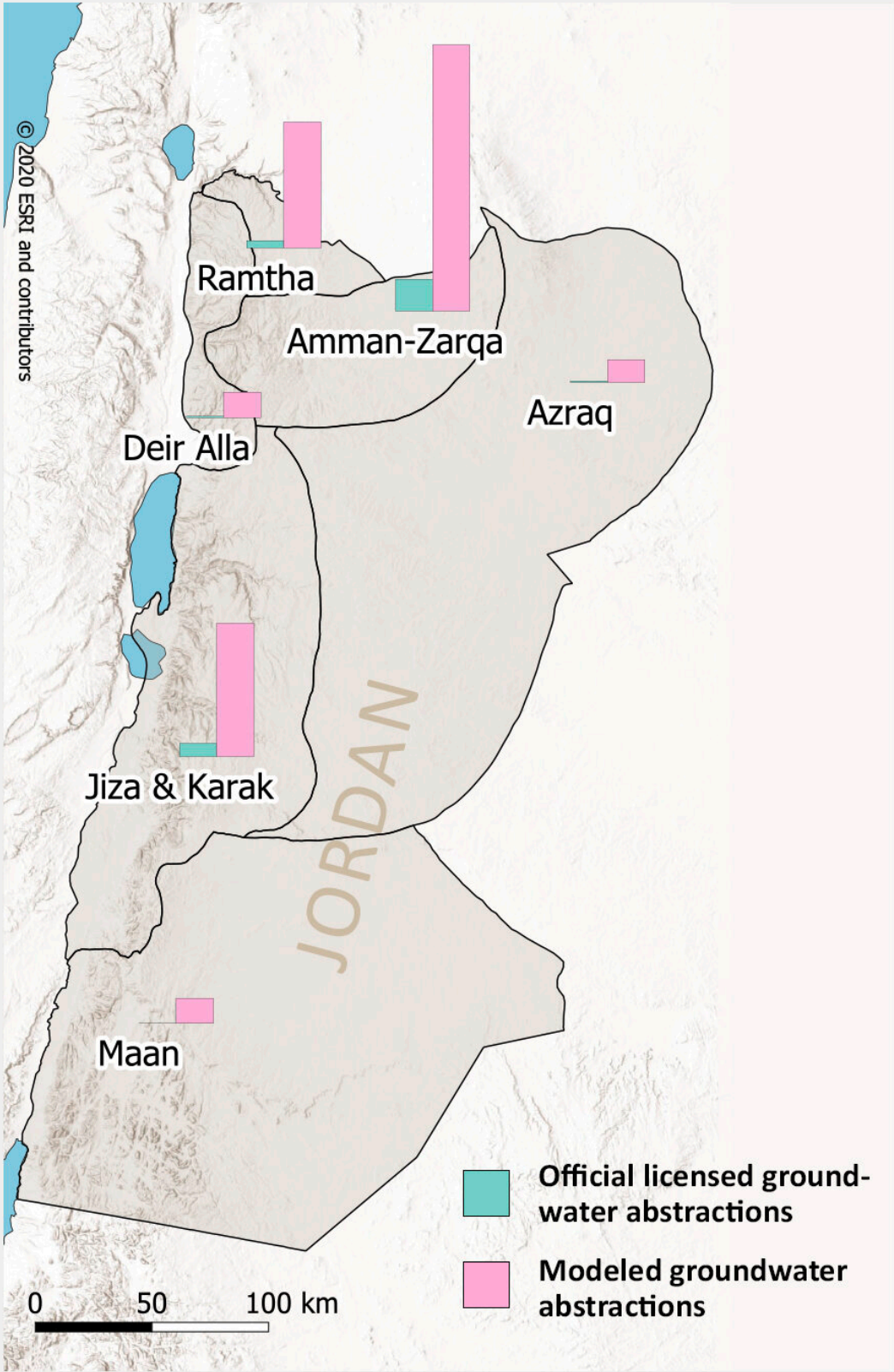


# Researchers analyze the illegal trade in supply of drinking water in Jordan

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The pairs of bars show that the full groundwater abstractions for tanker deliveries estimated with the UFZ model for 2015 (pink) substantially exceeded the licensed groundwater abstractions (green) in Jordan's six monitored groundwater basins. The difference is particularly large in the Amman-Zarqa basin. According to the UFZ model, over seven times more tanker water was illegally abstracted than well licenses permit. Credit: UFZ

Water scarcity is a basic problem in many regions of the world. The consequences of this are black markets for drinking water, unauthorized water extraction from private wells, and the uncontrolled decline of groundwater supplies.

For Jordan, one of the world's most arid countries, a team of international scientists coordinated by the Helmholtz Center for Environmental Research (UFZ) has analyzed the role of water markets and discusses the increasing dependence of the population on illegal water trade in an article published in *Nature Sustainability*. The article identifies solutions with which the state would be able to stabilize the supply of water in the face of climate change.

In more than 30 cities around the world, millions of people obtain their drinking water from storage tanks—because tap water is often available for only a few hours at any one time. When the public water supply is insufficient, households and businesses mostly resort to private providers.

Trucks bring drinking water—often tapped from groundwater wells—from the countryside to the cities and sell it there. This is partly licensed by the state but largely takes place illegally. "In Jordan, these

water deliveries by tanker truck make up for the deficit of the public water supply network," says UFZ economist Dr. Christian Klassert, lead author of the study. But the role that these (largely) illegally traded [water supplies](#) actually play in the Jordanian water market was unclear until now. "The official data on well extractions for truck water deliveries does not reflect the actual situation. They are considerably lower because the [black market](#) for water from tanker trucks had so far not been quantified."

Moreover, as long as private water markets compensate for the weaknesses of the public water supply, there is little pressure for the state to take measures to improve it. However, groundwater supplies will eventually be depleted, so a greater insight into such black markets is required. With the increasing threat posed by climate change, more information on the contribution of these black markets to water security and their impact on society, the environment, and especially on groundwater supplies, as well as the possible consequences of stricter state regulation of the markets, is urgently needed.

The UFZ scientists, together with hydrologists from Stanford University, therefore developed a socio-economic computer model of the Jordanian water sector that links the human-driven water cycle with the natural water cycle. They extended the model by simulating the black market for water. This was a difficult undertaking because there were hardly any reliable data available for this until now.

In order to be able to reliably model the amount of water traded in Jordan and the effects on groundwater levels, energy consumption, and greenhouse gas emissions, the researchers asked well owners and tanker water truck drivers from which wells they extract how much water, how great the distances between the well and the sales market are, and how frequently they take these routes.

With this modeling approach, the UFZ economists were able to quantify the extent of the black market for 2015 as an example. According to the model, the amount of water traded illegally exceeded the amount that was officially allowed to be traded by a factor of 10.7. This means that in 2015, 91% of the water delivered by truck was extracted illegally from wells. "The implications of illegal water deliveries by tanker truck have been completely underestimated so far," says Klassert.

According to the projections of the researchers, the importance of water deliveries by tanker truck will continue to increase. "Household dependence on water tanks will increase 2.6-fold by 2050—from 4.6% of the population to 12%", says co-author and UFZ economist Prof. Dr. Erik Gawel. The main reasons for this are high population growth and decreasing groundwater supplies. Some households will also no longer be able to use this type of water supply because of increasing water prices.

Because the average distances between wells and sales markets have increased from 13 to 20 km and water extraction is becoming more costly, the price for water could increase from US\$3/m<sup>3</sup> in 2016 to US\$ 4/m<sup>3</sup> in 2050. Poorer households will thus reach their financial limits—especially because the price for this is already almost five times higher than for [tap water](#).

"However, the prices are not arbitrarily inflated but rather realistically reflect the production, personnel, and transport costs," says Gawel. For poorer sections of the population living in areas with an insufficient [public water supply](#), the high water prices will become a growing problem. "In these cases, the state would have to intervene. For example, by improving the state water supply or subsidizing the purchase of water for these populations," he says.

However, the uncontrolled extraction of drinking water not only has social consequences but also affects groundwater supplies. In regions

where the proportion of illegal wells is particularly high (e.g. around the capital Amman and the city of Zarqa), the groundwater level is dropping rapidly—and in some places by 3.5 m per year. Even now, wells have to be drilled to a depth of 220 m in order to still be able to extract water from them.

In the north of the country, the groundwater available in some regions will have decreased by up to 60% by 2100 according to the modeling of the UFZ economists. The extraction of well water for tanker trucks greatly contributes to this development and, in some parts of the country, accounts for one third of the over-extracted water.

The UFZ scientists also investigated how the state can intervene in order to curb the negative effects of the black [market](#). There are a few possibilities. For example, the Jordanian government is currently shutting down illegal wells. "Although this stabilizes the decline in the groundwater table, it has negative consequences for the poorer sections of the population, who are dependent on the supply of drinking water via tanker trucks and can thus no longer afford the water," says co-author Prof. Dr. Bernd Klauer, a water economist at the UFZ who researches [water scarcity](#) and water quality problems.

The trucks increasingly have to drive to more remote wells. This, in turn, increases transport costs and makes it more difficult for the authorities to control water transports. Other measures are also possible. These include the construction of large desalination plants for seawater or greater regulation of the supply of water for commercial uses. According to the UFZ scientists, repairing the water pipes from which a considerable amount of water is lost because of leaks would be quite efficient.

"If the state were to invest in the deteriorating water pipes, this could curb the increase in uncontrolled groundwater extraction to 19% by

2050. That's because not only would less water be lost but the water supplied would also be distributed more equitably," says Klauer. Coupling this with the large-scale expansion of desalination plants could decisively curb the demand for water deliveries by tanker truck. For the UFZ economists, there is no question that the state should act.

"The scale of the [water deliveries](#) shows how insecure access to drinking water already is in Jordan. The population is also growing rapidly—especially because the country has taken in many refugees from Iraq and Syria. The problems of drinking [water](#) supply will not disappear but rather become increasingly more pressing," says Klassert.

**More information:** Unexpected growth of an illegal water market., *Nature Sustainability* (2023). [DOI: 10.1038/s41893-023-01177-7](https://doi.org/10.1038/s41893-023-01177-7)

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