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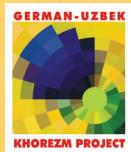
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When too much water is not enough – understanding irrigation in Khorezm, Uzbekistan

Summary

Irrigated agriculture in Khorezm depends entirely on water from the Amu Darya river. Increased water use in upstream areas, together with a trend of lower water availability due to global warming, creates an urgent need to raise the efficiency of irrigation water use. Here we briefly examine the impact of efficiency gains on the groundwater situation in Khorezm.

Current situation and problem setting

In Khorezm, 4.5 km³ water are brought in from the Amu Darya river annually on average. Canal losses typically amount up to 23-26%, and field-level losses are up to 53-63%, as assessed by scientists of the ZEF/UNESCO project. The major part of the losses at field level consists of percolation below the root zone, recharging the groundwater.

When the groundwater table is high, water starts to be sucked up to the soil surface by capillary forces. Here it evaporates, leaving behind the salts. This is the feared secondary salinization of irrigated agricultural soils that greatly affects crop productivity and farm income.

Reducing soil salinity by leaching takes place in spring in Khorezm, before the crops are sown. High amounts of leaching water contribute to filling up the groundwater reservoirs. Losses from canals and over-irrigation further raise the groundwater level. A lack of equipment for discharge control and farmers expecting water scarcity are the main reasons for over-irrigation, creating a vicious cycle: higher groundwater increases salinization, which requires more leaching, which increases the groundwater levels even more, and so on.



Picture 1 and 2: Blocking of a collector to raise groundwater level and enhance capillary rise



Picture 2

Thus, we typically see shallow groundwater levels during the early vegetation season in regions such as Khorezm and many other irrigated regions along the Amu Darya and Syr Darya rivers.

Currently, in Khorezm many farmers rely on shallow groundwater. When irrigation water is not supplied in time, this groundwater provides a "safety net": it is an "underground water reservoir" often enabling crops to endure periods without water supplied by the irrigation network. In other words, the water "lost" by seepage and percolation is actually not totally lost - it is stored in the aquifer and contributes via capillary rise to meeting crop water requirements. Project scientists observed that many farmers actively integrate groundwater into the "irrigation budget" by blocking drainage ditches and collectors to raise groundwater level.

Approach

In Khorezm, this water supply from the groundwater contributes as much as one fifth (19%) of the crops' water needs. This information was gained from a novel approach developed in the ZEF/UNESCO project in Khorezm and applied in a Water Consumers Association (WCA). The approach linked irrigation scheduling, groundwater and soil water flux models to estimate the impact of reduced irrigation water losses on groundwater levels and capillary rise. The researchers then compared various possible situations of efficiency gains by reducing losses ("scenarios"; see Figure 1). The "current situation" is characterized by losses of 24% in the irrigation canals and 57% at field level. The combined overall losses amount to 67%. In the scenario "canal losses improved" the researchers assumed that the losses in the canals could be reduced to 16% while field level losses were kept at their actual level (overall losses: 64%). In the third scenario („field losses improved“), the losses in the farmers' fields were assumed to be lower, at 33%, while now the canal water losses were kept at their current level (overall losses: 49%). Finally, the combination of reduced losses at field (33%) and canal system level (16%) (combined losses: 44%) was analyzed („canal and field losses improved“).

Impact assessment

Achieving those efficiency gains would lower the groundwater table from current levels by 12 cm with canal losses improved, by 38 cm with field losses improved, and by

even 44 cm with both canal and field losses improved. The groundwater contribution to the crops, currently at 19% of crop evapotranspiration, would be reduced to 17, 11 and 9%, respectively, for the various scenarios. This confirmed what farmers already had perceived: that a decline in groundwater level will reduce the contribution of groundwater to the crops' water needs. Thus, with the alternative scenarios, farmers would have to increase net irrigation amounts; they would depend more on surface water from the Amu Darya river, which is expected to become more variable in future.

With cotton, the typical crop in Khorezm, capillary rise at sites with sandy loam and average groundwater level would decrease from 140 mm (current scenario) to 74 mm (both canal and field losses reduced). Once the impact of the scenarios on the temporal dynamics of the groundwater level is understood (Figure 1), the time-depending capillary rise can be estimated accurately, and in turn, irrigation timing can be adapted. This is a pre-requisite to secure crop water needs under any efficiency-raising measures.

Therefore, assessing the groundwater level under the influence of water management practices can support higher level decision-makers when introducing measures to increase irrigation efficiency. Furthermore, knowing about the connection between spatio-temporal groundwater level and capillary rise can help the water managers at WCA-level and the farmers to adapt their irrigation schedules to groundwater dynamics (ZUR 13).

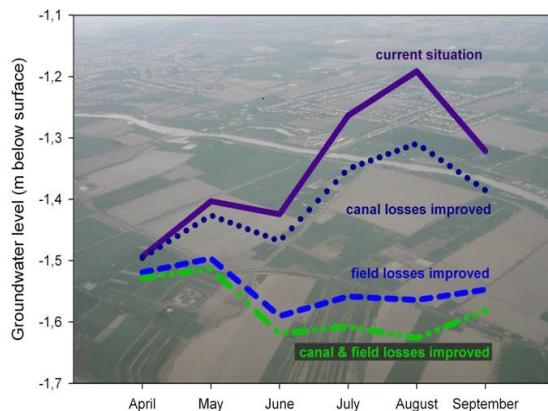


Figure 1: Model results show that reducing water losses at field level and in the irrigation channels would lower groundwater tables in Khorezm

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