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Increased rainfall alone will not help groundwater recovery PREMIUM

The projected increase in groundwater use for irrigation can cancel the benefits of increased rainfall from warming climate

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A farmer at his paddy field in Kenasemma as a borewell extracts groundwater. File | Photo Credit: S. DAMBADI



north India. Groundwater use and summer monsoon rainfall variability are the two main drivers of groundwater storage. Climate change can throw new challenges for the sustainability of groundwater as a result of increased groundwater pumping to meet irrigation demands for crops.

Also, a warming climate will increase the frequency of hydroclimate extremes — floods and droughts; already such hydroclimate extremes have manifested across the world, India included, and such events will become more frequent with further increase as the world gets increasingly warmer. A less discussed aspect is the role of increased evapotranspiration due to warming climate, which will limit water availability for groundwater recovery. But the role of evapotranspiration in negatively impacting groundwater recovery will be less as increased groundwater use for irrigation will be the main driver of groundwater usage.

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Warming climate will also increase the amount of summer monsoon rainfall that north India will receive, and the enhanced precipitation could help recovery rates of groundwater. But so far it has been unclear if stronger summer monsoon rainfall alone in the future will be sufficient to compensate for increased water demand for irrigation and loss due to evapotranspiration.

A two-member team from IIT Gandhinagar used observational groundwater well data, and satellite observations from the Gravity Recovery and Climate Experiment (GRACE) and hydrological model simulations under future emission scenarios to understand the variability of groundwater storage under the warming climate. The team found that the projected increase in summer monsoon due to climate change notwithstanding, recovery of the depleted groundwater in north India will be insufficient if there is continued use of groundwater at current levels for irrigation.

“Climate warming and unsustainable groundwater extraction are likely to amplify the challenges related to groundwater sustainability,” they write in a study published in the



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The team led by Dr. Vimal Mishra from the Department of Civil Engineering at IIT Gandhinagar found that excessive pumping from nonrenewable groundwater storage will aggravate groundwater loss. While most of the current observation wells are in the shallow aquifer, pumping of groundwater for irrigation in the Indo-Gangetic Plain is predominantly from deeper aquifers. So a warming climate may not have sufficient control over the overall groundwater storage variability in the region.

The study provides two critical insights — the periods of high precipitation will help in partial recovery of groundwater even when groundwater extraction continues or even increases. However, **the projected increase in precipitation may not directly translate to an overall increase in groundwater storage.** The opposing influence of evapotranspiration will become dominant in the far period and at higher warming levels.

Imperative to reduce groundwater use for irrigation

The projected increase in monsoon will be insufficient if there is continued use of groundwater at current levels for irrigation



Caution: Increased rainfall can only help recover about 50% of groundwater lost in the last two decades. SPECIAL ARRANGEMENT

- Between 2002 and 2022, about 95% of India's groundwater depletion occurred in north India

- Warming climate will increase the frequency of floods and droughts

- Warming climate will also increase the amount of summer monsoon rainfall that north India will receive

- Summer monsoon rainfall, which is projected to increase by 6-8%, can help recover the lost groundwater

- Use of groundwater from

- deeper aquifers in the Indo-Gangetic Plain will make it hard for its recovery from increased rainfall

- So recovery of the depleted groundwater in north India will be insufficient if groundwater is not conserved

- There is a crucial need to restrict unsustainable groundwater use for irrigation

As per climate projection, the summer monsoon rainfall is projected to increase by 6-8%, and this increase is expected to help recover the lost groundwater. “But even in the most optimistic scenario, the highest projected groundwater recovery (about 260 cubic km) in the near period (2021-2040) will only help recover about

50% of groundwater lost in the last two decades. It is not possible to recover the groundwater that we have already used up,” says Prof. Mishra. **“So relying on increased rainfall alone for favourable groundwater recovery may not help. There is a compulsion to look at other available measures to help in groundwater recovery.”**

He says that till such time we reduce groundwater usage, a warming climate alone cannot solve the problem. **“There is a crucial need to restrict unsustainable groundwater use for irrigation.** The projected increase in groundwater use to meet irrigation water requirements can cancel the benefits of increased precipitation in the future. Only then



Also, the possibility of increased frequency of droughts cannot be ruled out. While the impact of droughts at longer frequencies may be less, consecutive years of drought can adversely affect groundwater storage as recharge will be less while extraction of groundwater for irrigation will be higher than when summer monsoon rainfall is normal.

“There can even be more challenging situations in future despite the projected increase in rainfall due to climate change. There is a compulsion to make irrigation more efficient and shift crop growing and procuring areas,” he says. “The focus should thus be to promote groundwater conservation to ensure long-term sustainability as it plays an important role especially during periods of drought. This applies even when increased rainfall can increase the recharge of groundwater.”



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