Sustainable Environment

Optimized Groundwater Extraction

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Abstract

The current crisis of groundwater depletion is not a new concept. However, the problem is aggravated because of visible variation in climate and ongoing human activities world wide. India, in particular, is hit hard due to its high population density, unique monsoon, and agriculturally dominated economy. What is to be blamed and to what extent, numerically and spatially? Answer to these questions will define the fate of policies and actions India will take keeping in mind her exhausting groundwater resources on one hand, and the target of reducing agrarian pressure on her farmers by 2022 on the other hand. The present work highlights the role of innovative industrial solutions based on revised safe extraction limit to address the goal of sustainable development.

Introduction

Several studies have been attempted to quantify the contribution of two main factors, namely, climate and anthropogenic activities on the groundwater dynamics across India, as a whole and basin wise, using various statistical techniques, machine learning and models (Asoka et al.,2017; Bhanja et al., 2017; Chinnasamy et al., 2016; Maheswaran et al., 2016; Pavelic et al., 2012; Saha et al., 2014; Tiwari et al., 2009). Yet, the question remains ambiguous due to lack of theoretical and numerical accuracy. Present work (being at the initial stage) is aimed at understanding the lacuna in the theoretical framework adopted by existing studies over Ganga Basin.

Materials and Methods

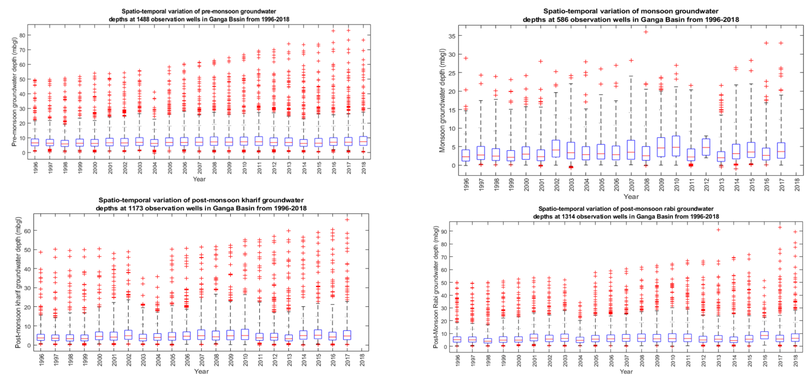
Data used:

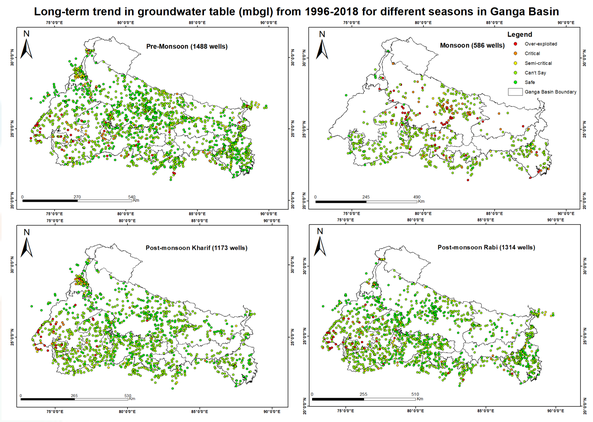
1. 0.5° X 0.5° Gridded precipitation data (1901-2016) for Ganga Basin obtained from the Indian Meteorological Department .
2. Groundwater level data for four seasons, Pre-monsoon, Monsoon, Post-monsoon Kharif and Post-monsoon Rabi (1996-2016) for Ganga Basin obtained from the Central Groundwater Board of India.

Methods used:

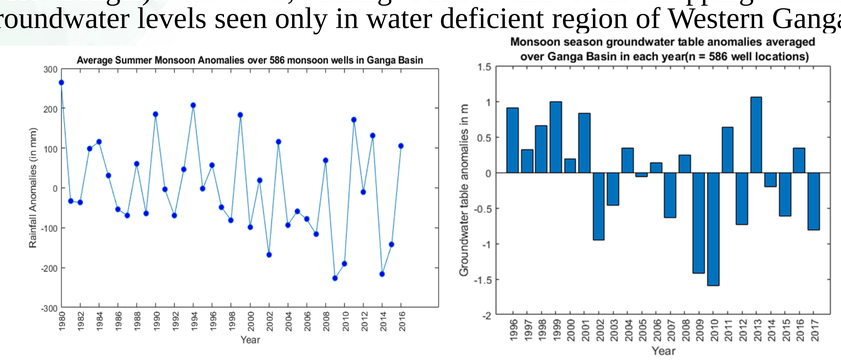
1. Statistical trend analysis (Mann Kendall test),
2. Simple statistics (boxplots, anomalies)

Result

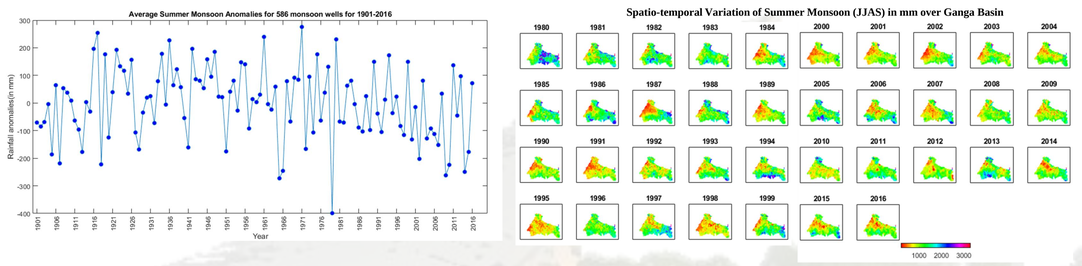




1. Pre-monsoon and Monsoon levels are depleting primarily in water deficient parts of Western Ganga Basin (Rajasthan, Haryana, Western UP, MP) and relatively higher rainfall regions in Central and Eastern Ganga Basin (Central and Eastern UP, Bihar, West Bengal). However, during Kharif and Rabi cropping seasons, depleting groundwater levels seen only in water deficient region of Western Ganga Plain.



2. The water table has hardly come back to or above normal post 2000 (except for years 2011, 2013 and 2016).
3. Groundwater response appears to be in sync with increase in climate extremes (especially drought years) in the epoch of past sixteen years (2000-2016).



4. However, if the time window is extended back by twenty – thirty years, one can see that rainfall has betrayed us quite often in the past as well.
5. The stress on groundwater, thus, seems to be more pronounced today than it did in the past.
6. Hence, there is more to the present groundwater dynamics than the 'recent' climate change and groundwater extraction.

Conclusion

The critical findings of the simple work done show a missing perspective while investigating the larger question of "Who is to be blamed for our vanishing groundwater reserves?" The missing piece is that of the past. The Green Revolution travelled to India with huge promises and commitments in mid 1960s. The need for irrigation was amongst the essential pre-requisites for High-yielding Varieties. Food security was the top most priority. From dug-wells to submersible pumps, farmers and the government policies left no stone unturned to achieve the target. The wave of Green Revolution lasted a decade (1966/67-1976/77) but is it possible that its tremors are still being felt? If it is so then we would have a new dimension to the blame game theory and the policies thereafter. Moreover, it would also provide for a much needed industrial intervention in this field.

Industrial Significance

The final stage of the present research aims at quantifying a safe groundwater extraction limit based on risk to aquifer, food crops and food prices. The results would open the doors for efficient irrigation systems as well as "smart" irrigation pumps(for example, automatic alarms for breaching the limit and data linked with government records), thereby, deriving benefits from state-of-the-art practices of artificial intelligence.

Technology Readiness Level: Initial stage

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