

"Long-term groundwater recharge rates across India by in situ measurements", by Soumendra N. Bhanja, Abhijit Mukherjee, Rangarajan Ramaswamy, Bridget R. Scanlon, Pragnaditya Malakar, Shubha Verma

General Comment from Authors and highlights of revision:

Following the suggestion of the Reviewers, we have done a complete revision of the manuscript. We have diligently tried to respond to all of the reviewer concerns in the previous version of the manuscript, the responses are stated below. We believe, the manuscript have improved to a great respect.

In summary, we have:

1. Inserted a new hydrogeology map, Figure 3
2. Included more discussions based on the reviewers' suggestions
3. Modified several figures based on the reviewers' concern

Reviewer #1:

Very interesting paper and should be published but I have some minor comments that should be addressed.

Reply: We would like to thank the reviewer for his/her appreciation.

Rev 1. Comment 1: Figure 6 – why not show recharge gain and loss on the same figure?

Reply: Following the reviewer's concern, we have modified the Figure 6.

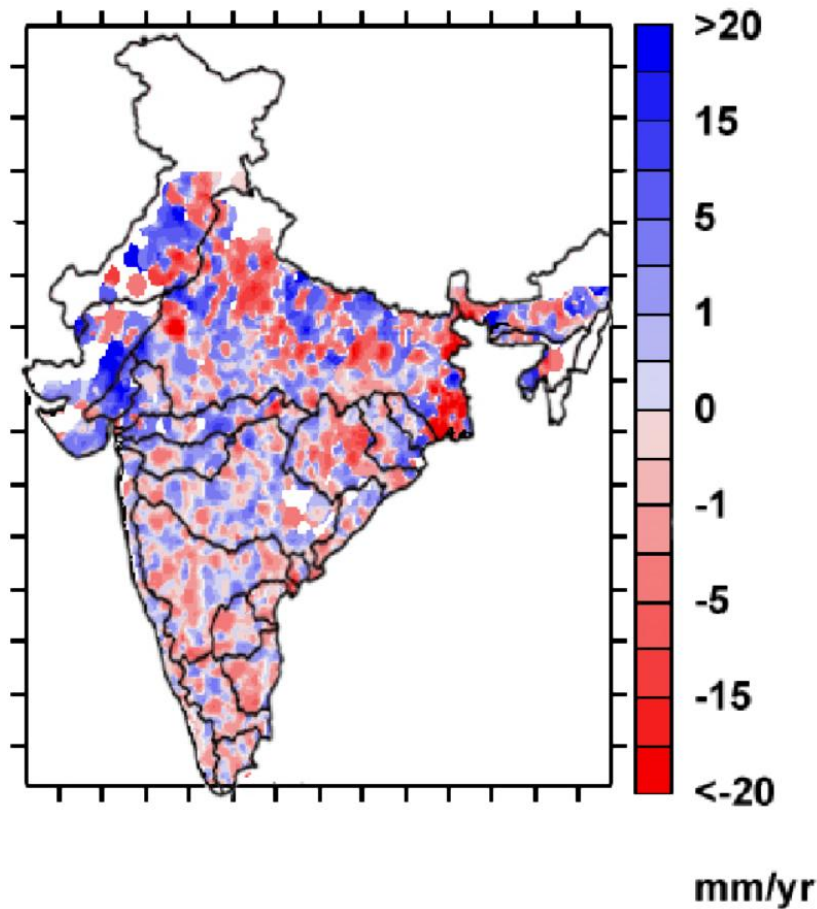


Figure 6: Maps of positive and negative trends of groundwater recharge in 1996-2015. Basin boundaries are overlaid. Blank area represent areas of no data availability.

Rev 1. Comment 2: Figure 9 – The Rn corresponds to some limited time period: : :can you compare the same time period for your estimation rather than provide the ranges?

Reply: Some of the Rn values are measured before the study period (Rangarajan et al., 2000). Due to scarcity of Rn data availability, we have provided the range of the recharge rates obtained through the WTF approach in order to show the magnitudes of the two different recharge estimates.

Rev 1. Comment 3: How does this relate to the GRACE estimates in Rodell paper? I recall seeing huge losses of water in Northeast India (Punjab) – are there similarities or differences in the loss/gain of groundwater?

Reply: Comparing groundwater recharge rates with GRACE-based storage is out of the scope of this study. Details regarding in situ and satellite-based groundwater storage could be found in Bhanja et al. (2016, 2017, 2018), in two of them Dr. Rodell is also a co-author.

Rev 1. Comment 4: Figure 8 – can you make it bigger and put recharge and precipitation on the same plot?

Reply: We would like to thank the reviewer for his/her comment. Following the reviewer’s suggestion, we have modified the Figure 8 to include precipitation and recharge both.

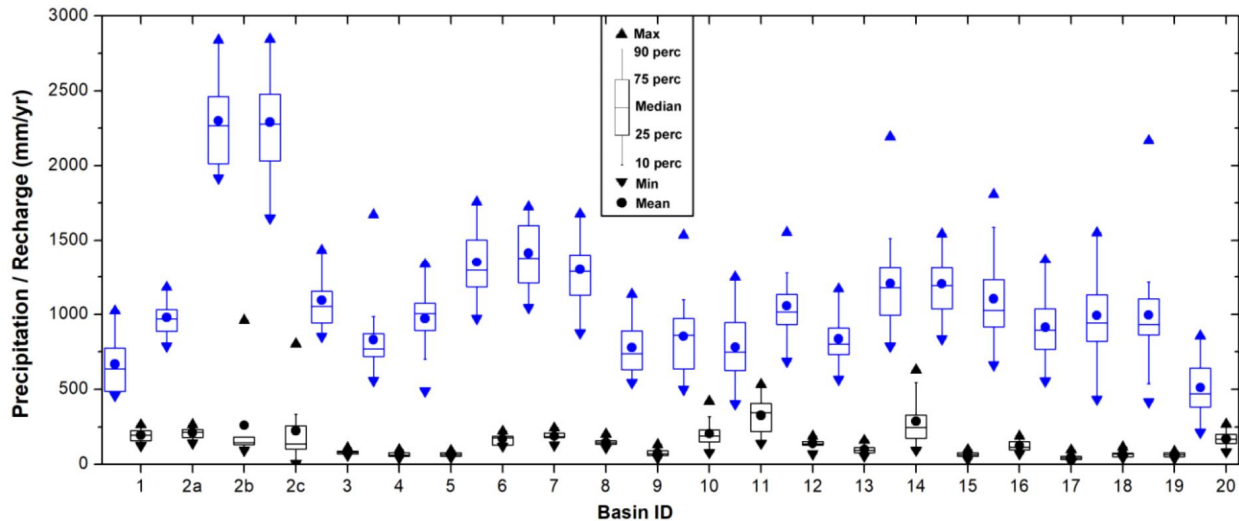


Figure 8: Basin-wide box-whisker plot of precipitation (blue) and recharge rates (black). Symbols representing mean, median, maximum value (Max), minimum value (Min), 10th percentile, 25th percentile, 75th percentile and 90th percentile are shown in inset of the bottom figure. Recharge estimates exceeded 700 mm/yr data were indicated on the top of the column.

References

- Bhanja, S. N., A. Mukherjee, M. Rodell (2018). Groundwater storage anomaly in India. In: A. Mukherjee Ed. Groundwater of South Asia. Springer Verlag publishing house.
- Bhanja, S. N., A. Mukherjee, M. Rodell, Y. Wada, S. Chattopadhyay, I. Velicogna, K. Pangaluru, and J. S. Famiglietti (2017). Groundwater rejuvenation in parts of India influenced by water-policy change implementation. Scientific Reports, 7, 7453.
- Bhanja, S. N., A. Mukherjee, D. Saha, I. Velicogna, and J. Famiglietti (2016). Validation of GRACE based groundwater storage anomaly using in-situ groundwater level measurements in India. Journal of Hydrology, 543(B), 729–738.