*"**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 #2:

Rev 2. Comment 1: 19% Plagiarised document was found it can be reduced.

Reply: We respectfully disagree with the reviewer's concern. The present version of the manuscript is checked with state-of art similarity diagnostic software, and only negligible similarity is found. Even the similar texts are technical words/phrases or nouns or our generic writing in previous publications. We believe the HESS Editorial Office has also done a thorough check and are now satisfied with the level of any potential similarity.

Rev 2. Comment 2: There are various controlling factors in Indian context which are required to be considered for the recharge potential calculation.

Reply: We have not studied the recharge potential calculation, we have computed recharge estimates from field data. We have also compared the recharge estimates from two different estimates.

Rev 2. Comment 3: Hydraulic conductivity, Transmissivity, Rainfall and Recharge variability needed to be calculated.

Reply: We would like to thank the reviewer for his/her concern. We have added a paragraph in Section 3.2.

" Comparatively higher rates of precipitation partly explain the high recharge rates in IGB basin. Precipitation data show high annual variability in all of the basins (Figure 9). Highly fertile sedimentary formations of IGB basin facilitate both direct and indirect recharge. Higher agricultural groundwater withdrawal in the IGB basin (Figure 4b) leads to decreases in water storage, which can result in increased recharge by generating more recharge space. Subsequently, recharge rates are not homogenous through the IGB basins (Figure 5, 6). The unconsolidated formations of the IGB basin are highly transmissive for water flow (transmissivity values varies from 250 to 4000 m^2/day; Figure 3). Horizontal hydraulic conductivity values are found to be higher in the IGB basin (hydraulic conductivity varies from 10 to 800 m/day; Figure 3). As a result, intense groundwater withdrawal at a region within IGB basin would have profound impact on the groundwater storage on the surrounding regions (particularly the areas within the periphery of the pumping influence). This would facilitate the creation of the additional recharge space within the entire region. On the other hand, comparatively lower transmissivity and hydraulic conductivity values in aquifers of the western, central and southern India, restrict water to flow in the horizontal direction (Figure 3). This inhibit horizontal flow of water after a pumping event in those region. Basin-wide mean recharge rates are found to be variable over the years (Figure 9). Highest inter-annual variability has been obtained in basins 2b, 2c and 14 (Figure 9); the basins are also experiencing highest precipitation rates (Table 1, Figure 9). On the other hand, basins located in Indian craton, i.e. basins 3, 4, 5 and 19, exhibit lowest inter-annual variability (Figure 9). Lower recharge rates are found in central and southern parts of India (Figure 5, 5). The crystalline aquifers in these regions (Mukherjee *et al.,* 2015) are not conducive enough for precipitation-based infiltration through subsurface. The observation is consistent with Sukhija *et al.* (1996), who also found lower recharge rate in fractured regions. Deeply weathered, lateritic soils that have developed on cratons often have low matrix permeabilities due to concentration of kaolinite and development of ferricretes/alucretes (laterites) (Taylor and Howard, 1999). These low matrix permeabilities promote infiltration via discontinuities. Soil permeabilities are substantially less than those of the sorted alluvial soils in the IGB basin."

We have already discussed the influence of precipitation on recharge in Section 3.4.

" Recharge rates are significantly (*p value* <0.01) correlated with precipitation in 10 out of the 22 basins. Non-linear trend analysis between basin-wide recharge rates and precipitation show good match in basins 2a, 3, 4, 12 and 20 (Figure 8). In contrast, recharge and precipitation trends are negatively correlated in basins 2b, 2c, 7, 16 and 18 (Figure 8). In order to study the relationship in more detail, we used the Granger causality analysis (Granger, 1988). Results show precipitation significantly (*p value* <0.01) causes R_g in 6 basins, i.e. 8, 11, 12, 13, 15 and 16. Most of these basins are not intensively irrigated; groundwater withdrawal rates are found to be lower in these regions, irrigation groundwater withdrawal found to be less than 75 mm in all of the basins (Figure 4b). Therefore, natural processes i.e. precipitation still influence recharge rates in those basins. Alternatively, the relationship between recharge and precipitation is statistically insignificant in other basins, which are more intensively irrigated (50 mm to more than 300 mm; Figure 4b). As a result, precipitation influence is found to be less dominant on recharge in these regions."

The following new figure is added in the revised version.

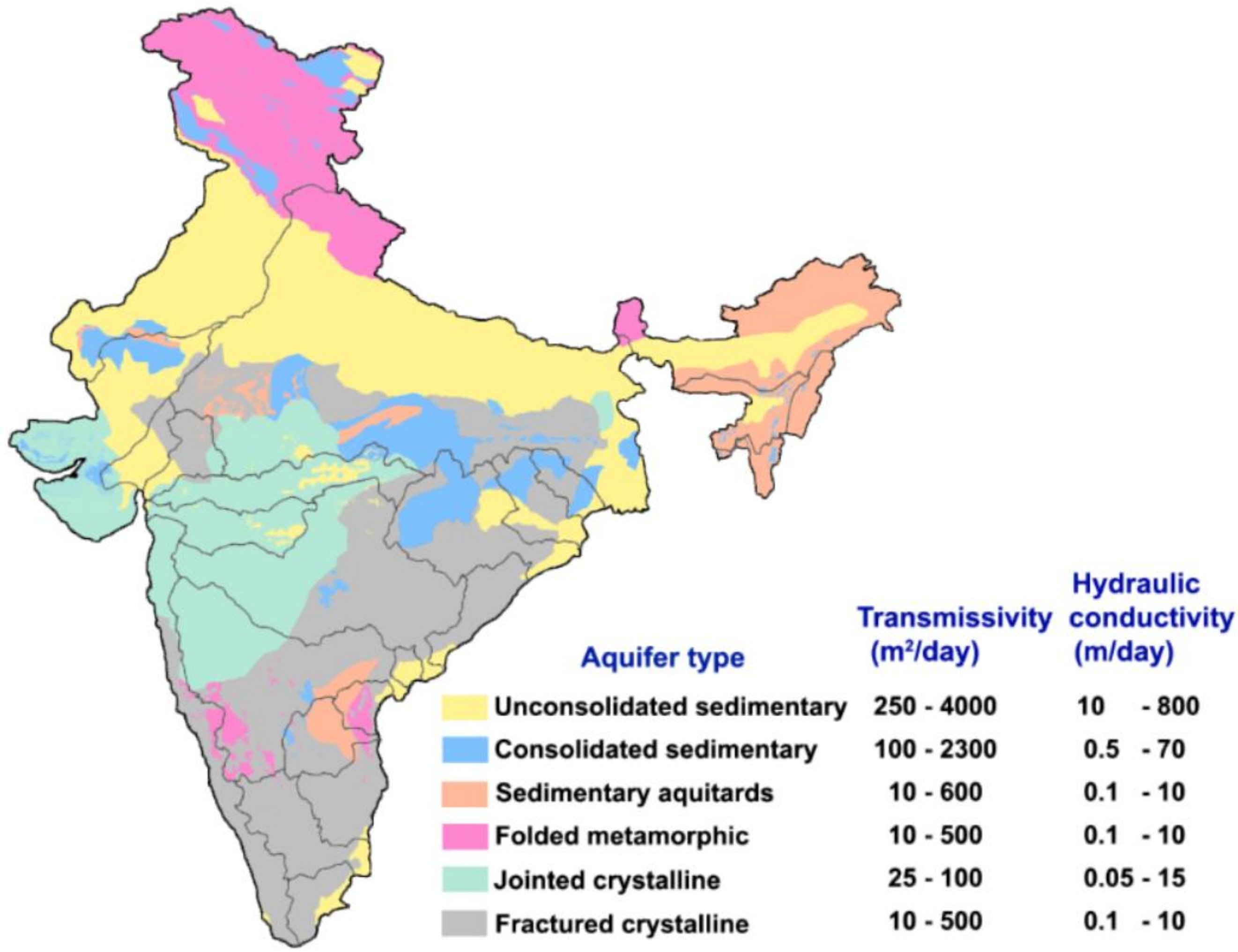

Figure 3: Aquifer types, transmissivity (m^2/day) and horizontal hydraulic conductivity values (m/day). Transmissivity and horizontal hydraulic conductivity values are obtained from CGWB (2012) and GREM (1997).

Rev 2. Comment 4: The paper can be resubmitted

Reply: We are looking forward to resubmit.