This is a timely and relevant contribution to the scientific literature and to broader understanding of water-energy-food nexus dynamics in India.

The team has done a solid job analyzing and integrating multiple data sources.

The text is, in general, well written and the figures are revealing and clearly presented. The findings from analysis of GRACE data as well electricity usage being uncorrelated to monsoon rainfall are novel and should be highlighted. The calls for judicious regulation are not in themselves new, but these implications of the study can be further strengthened.

We sincerely thank Prof. C. Scott, reviewer 1 for reviewing our manuscript and appreciate his efforts in providing comments for the improvements of our contribution. Here, we present our responses to the comments.

1/28 - lack of correlation found between electricity usage and monsoon rainfall is crucially important and requires further explanation

We sincerely thank the reviewer for pointing this out and we agree that this is a very important finding in the context of water-food-energy nexus that needs further explanation. The new additions will be made in the revised manuscript in Sect.4.3.2 as the following:

To test the hypothesis that normal or excess monsoon years should have a lesser energy consumption (due to lesser groundwater pumping), we present a scatter plot (Fig. 5c) between AIMR and electricity consumption for agricultural purposes. Energy use in agriculture has two major usages: pumping groundwater for irrigation (electricity) (Scott and Shah, 2004; Birner et al., 2007; Kumar et al.,2013) and mechanisation (diesel) due to the use of tractors (Jha et al., 2012). Nearly 83 percent of the available water resources is used for agricultural activity, wherein 91 percent of the groundwater abstracted is used for irrigation purposes (CGWB, 2014). The agricultural electricity tariffs in India have been kept low, keeping in mind the poor economic status of farmers to facilitate groundwater pumping (Badiani et al., 2012). Due to low tariff, farmers have considered groundwater as a continuous affordable source of freshwater leading to an uncontrolled use of the same even if there is a good amount of monsoon rainfall in a specific year. The irrigation is no longer agricultural demand driven but rather dependant on the availability of electricity at a lower tariff. The scatter plot between AIMR and electricity consumption for agricultural purposes represent the same with no statistically significant correlation between them. Further to this, the irrigation practice in India is mostly flood irrigation that has very poor irrigation efficiency. This has significant implications in terms of not only agricultural water management policy but also on hydrological simulations and modelling studies. Traditionally, state of art land surface models does not consider irrigation and even if they consider irrigation, the water use is demand driven. The situation of agricultural water use in India is far from the model assumptions and hence model driven studies often underestimate the agricultural water use and groundwater abstraction. Model derived groundwater abstraction shows high dependability on monsoon rainfall (Asoka et al., 2017); however, the same needs to be tested further with ground truth. Implications of uncontrolled flood irrigation in India have been reported by Devineni et al. (2013) and Fishman et al. (2015) and this needs to be further explored to understand and realistically simulate the water cycle of Indian subcontinent.

1/32 - what mechanisms are proposed for judicious regulation and control?

We sincerely thank the reviewer and we will add the following paragraph in Section 5.

We will elaborate on the following proposed methodologies that may be adopted for judicious regulation and control.

- **Soil Moisture Monitoring and irrigation practice:** Uncontrolled use of groundwater for irrigation attributes to the lack of monitoring of soil moisture and hence the irrigation practices in India are not demand driven. Recent studies (Devineni et al., 2012; Devineni et al., 2013 and Fishman et al., 2015) show that the application of irrigation based on soil moisture condition may result into conversion of significant area from water stressed to water surplus. Further to this, the irrigation practice in India is largely flood irrigation, which has very low efficiency. Changing of irrigation type from flood to drip may reduce significant water wastage and improve irrigation efficiency.
- **Considering seasonal and extended range forecast for better water consumption:** In India, the agricultural water management models exists in theory, but they are seldom used in practice. An agricultural water allocation model at a fortnight scale or at a seasonal scale considering the improved seasonal (Saha et al., 2012) and extended range forecast (Sahai et al., 2013; Shah et al.,2016) may be useful and this needs to be further explored in near future.
- **Tariff determination based on seasonal prediction (varying volume of water usage):** Based upon seasonal prediction, a farmer would be made aware of a good/bad/normal monsoon year. Demands should be calculated based on seasonal prediction and accordingly the required amount of groundwater irrigation may be obtained considering possible margin of errors from hind-cast data. This amount may be considered as an upper limit for the famers to be used freely or at a subsidized tariff. If this upper limit is crossed, then they would not be allowed to enjoy free water and cheap electricity. This would majorly reduce the over-exploitation of groundwater.
- **Groundwater usage metering:** Electricity has been made available at a subsidised rate (almost free), increasing the accessibility of groundwater (Badiani et al.,2012; Fishman et al., 2015). If a volumetric tariff on groundwater (Shah et al., 2004) usage at a local level or at least at a district level is put in place it would also help in estimating the groundwater abstraction and accordingly management of the same.
- **Water allocation and water pricing:** Water allocation system needs to be put in place depending on the productivity and yield of crops (Huh and Lall, 2013). Water allocation and pricing should follow an optimal cropping policy (Devineni et al.,2012). Cultivation should be carried out in an area where it is best suited for a specific crop. Hence, reducing the pressure on the resources to produce the crop.
- **More production of food grains rather than cash crops:** Farmers have an inclination of producing cash crops than food grains as they are economically more lucrative. Food grains have a minimum price policy that is fixed by the government, hence profit maximisation is low. Moreover, most of the cash crops used are water intensive. Policy interventions are required to manage the same for a sustainable water and food security.

2/29 - cite Scott, C. A., & Sharma, B.R. (2009). Energy supply and the expansion of groundwater irrigation in the Indusâ˘ARˇGanges Basin. International Journal of River Basin Management, 7(2), 119-124.

We thank the reviewer and we will include this very important reference in Section 1.

5/7 - while I find the selection of sub-regions to be appropriate, selection criteria should be described

We will now mention the selection criteria of each of the sub-region in Sect 2. Table-R1 presents the same (will be modified in the manuscript) stressing on the need to analyze these sub-regions further.

Table R1 shows the major food grain producing states and their percentage share to all India production. These states are among the major contributors to the total food grain production for the entire country from the northern and central part of India. It is important to note that these states face a crippling water-crisis (CGWB, 2014), either due to a bad monsoon or due to the over-use and misuse of water. They are also among the most densely populated states of India (Census 2011). Hence, the problems not only pertain to climate variability but also with the population (FAO, 2014). Thus, the following sub-regions have been selected based upon their contribution towards the total food-grain production for India, population density (increasing pressure of food security) and the stage of groundwater development (higher percentage of development implies that the consumption has exceeded recharge).

Table R1 Food grain production and groundwater development statistics of the sub-regions.

States	*Production (in million tonnes)	*Percentage Share of all India Production	#Population (in millions)	#Density (persons/ km^2)	**Stage of Groundwater Development (in percent)
Uttar Pradesh	50.05	18.90	199.81	829	72
Punjab	28.90	10.92	27.74	895	170
Rajasthan	18.30	6.91	68.54	200	135
Haryana	16.97	6.41	25.35	879	127
Maharashtra	13.92	5.26	112.37	365	50
Bihar	13.15	4.97	104.09	1106	43

Sources: *Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2013-14; #Census 2011; Groundwater Year Book 2013-14, CGWB.

7/16 - this is not my expertise area, but very good to see that validation has been conducted

We thank the reviewer for appreciating our work on validating GRACE data.

9/3 - expand further on "A grave situation has been created where food security is maintained at the expense of ground water and energy security" – very important point.

This statement has been made in relation to the explanation of Figure-1 in Sect 4.1, which we have revised as follows:

During the drought year of 2002-03, the food production was reduced by nearly 38 million tonnes as compared to the average production, but during the drought year of 2009-10, it the reduction was only by 16 million tonnes. This comes as a surprise as to what caused the restrained fall of total food grain production, despite a severe drought year. Area under irrigation has risen considerably from 18% in 1950 to nearly 50% in 2011-12. This increase in percentage of irrigated land has a high correlation with the total food grain production (R=0.99), the detrended correlation between the two is 0.46 as well. This is probably the reason behind a smaller drop in food production during the severe drought year 2009-10, as compared to other drought year 2002-03. Figure 2f shows the different sources of irrigation and the contribution of groundwater stands out clearly. CGWB (2014) report states that nearly 91 percent of the groundwater abstracted is used for irrigation alone. Sufficient groundwater for irrigation is made available to the farmers, along with energy with low or no tariff, no matter to what depth the groundwater may fall (Mukherji and Shah, 2005; Badiani et al., 2012; Fishman et al., 2015; Zaveri et al., 2016). Such schemes were in place during Green Revolution and there have been no major changes in them till date (Mukherji and Shah, 2005; Badiani et al., 2012; Fishman et al., 2015; Zaveri et al., 2016). The brunt of the availability of subsidised energy is borne by the Government of India (GoI) (Kumar, 2005; Rattan and Biswas, 2014). This causal relationship is clearly observed through the positive correlation (R=0.89) between the actual expenditure by the Department of Agriculture & Co-operation and the electricity used for agricultural purposes (Fig. 2g and h). This implies that with the increase in electricity consumption (pumping of groundwater), the expenditure incurred for agriculture also increases. Hence, a grave situation has been created where food security is maintained at the expense of groundwater and energy security (Rosegrant and Cline, 2003).

11/12 - this section is well done

We sincerely thank the reviewer for appreciating our work in Sect.4.3.2.

throughout the manuscript be consistent with usage of groundwater (single, compound word), not ground water (as two separate words)

We thank the reviewer for pointing out the inconsistency of usage of the term groundwater/ground water, it has been rectified to ‘groundwater’ now.

16/8 - this discussion of groundwater, cropping (cash crops vs. staples), etc. should be related to (and cited as): Shah, T., Scott, C.A., & Buechler, S.J. (2004). Water sector reforms in Mexico: Lessons for India’s new water policy. Economic and Political Weekly, 361-370.

We will be incorporating the above in Section 5, where we will mention about possible judicious regulation and control.

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