Interactive comment on "Reviving the "Ganges Water Machine": where and how much?" by L. Muthuwatta et al. (Anonymous Referee #2)

This is an ambitious paper that has potential to attract many hits. It deals with the evaluation of Ganges sub-basins to commit excess monsoon flows for recharcing the aquifer in order to tackle water scarcity and flood risnk downstream. It falls within the scope of HESS, and has adequate innovation to merit publication. However, there are some issues that should be addressed first:

Q1. Authors should explore further the results, and explain their findings. At least some notable sub-basin examples should be provided in more detail in each chapter of the results.

Complete new section (Potential sub-basins for SSS) was added to the manuscript describing the suitability of different sub-basins for developing sustainable SSS solutions. Table 2 (Table 3 in the previous version) was modified by adding new information on potential irrigated areas under 2 scenarios.

Potential sub-basins for SSS

To assign potential sub-basins for sustainable groundwater solutions, current water use and the available uncommitted water is important. Therefore, in addition to dependable runoff presented in Table 2, we have estimated the sub-basin wise groundwater resources based on CGWB (2013) and compared those values with the current level of evapotranspiration (ET) (Amarasinghe et al, 2015) from surface water and groundwater withdrawals separately. The ET includes the consumptive water use (CWU) from irrigation, domestic and industrial withdrawals, and water evapotranspired from reservoirs, homesteads and bare surfaces etc. These estimates were used to calculate sub-basin wise uncommitted water resources and is presented in Table 4.

Table 4: Groundwater resources, total ET and the uncommitted water resources in different sub-basins.

	Sub-basins	Groundwater resources in 2008-2011 (Bm^3)	Total ET (2008-2011) (Bm^3)		Uncommitted water resources in 2008-2011 (% of SR_{75} and GW resources (Bm^3)	
			SW	GW	SW	GW
1	Upstream of Ramganga confluence	5.2	0.8	5.6	85.5	-7.7
2	Banas	2.6	0.4	3.0	91.4	-15.4
3	Bhagirathi	21.7	1.8	2.7		87.6
4	Chambal Lower	1.3	0.4	0.8	66.7	38.5
5	Chambal Upper	4.0	0.7	3.1	89.4	22.5
6	Damodar	9.7	1.0	1.1		88.7
7	Gandak and others	13.0	1.4	3.4	88.1	73.8
8	Ghaghara	20.5	1.8	10.5	92.7	48.8
9	Between Ghaghara and Gomti confluences	7.7	2.2	2.9	33.3	62.3
10	Gomti	8.5	1.8	4.8	81.6	44.7
11	Kali Sindh	5.9	1.9	4.0	81.9	32.2
12	Kosi	6.3	0.5	1.8	92.6	71.4
13	Ramganga	7.8	1.0	7.8	90.1	0.0
14	Son	9.3	1.3	1.1	90.8	87.1
15	Tons	1.6	0.5	0.7	90.4	56.3
16	Upstream of Gomti confluence up to Muzaffanagar	9.7	2.2	6.8	61.4	28.9
17	Lower Yamuna	16.9	4.9	7.6	67.8	55.0
18	Middle Yamuna	5.4	1.3	6.3	42.9	-16.7
19	Upper Yamuna	8.5	3.7	8.9	17.8	-4.7

Sub-basin wise uncommitted surface water resources range from 17.8% 92.7% of the SR_{75}. This indicates that the surface water use for agriculture is at low level in most of the sub-basins, except *for the middle and upper Yamuna and Ghaghara Confluence to Gomti confluence sub-basins. This could be mainly due to the un-utilizable high runoff during the monsoon season. Therefore, sufficient surface runoff is available to meet additional ET demand by additional irrigated areas if appropriate storage options are available. However, many basins have substantially high level of groundwater use. The estimated uncommitted water resource shows that overexploitation of the groundwater resources are taking place in five sub-basins already. These sub-basins have widespread or large pockets of overexploited groundwater resources. Of these, the middle and upper Yamuna sub-basins have very high groundwater and surface water depletions. Any further increase of ET in these sub-basins would cause disturbance to ecosystems, and only aggravate the unsustainable water use. Therefore, the middle and upper Yamuna sub-basins seem to have no potential to implement the SSS concept in practice. The other 3 sub-basins: above Ramganga confluence, Banas, and Ramganga have high groundwater consumption while the surface water consumption is low with respect to the renewable water resources. In these sub-basins, there is a potential to have programs to reduce overexploitation and increase their groundwater storage capacity. In number of other basins groundwater usage needs to be increased in order to increase the sub-surface storage space and capture part of the uncommitted surface runoff.*

As presented in Table 3, the potential increases in irrigated area in Rabi and hot-weather seasons under scenario 1 and 2 are 31.1 Mha and 59.3 Mha respectively. The corresponding unmet irrigation demand under the two scenarios is 55.0 Bm^3 and 108.4 Bm^3 respectively. However, the realization of this potential in some sub-basins is difficult given the current water use and availability. For instance, Upper Yamuna sub-basin has the potential to increase irrigated area by 2.24 Mha under scenario 1 (Table 2) and the corresponding additional water requirement is 3.72 Bm^3 (Table 3). The sub-basin has already exhausted its annual groundwater resources and a substantial portion of its surface water resources (Table 4). Any further increase in irrigation water use will reduce the uncommitted surface runoff available for other purposes such as environmental use. On the other hand Ghaghara sub-basin has a potential to increase irrigated area by 3.56 under scenario 2 and it requires 7.49 Bm3 of additional ET. The uncommitted surface water resources is more than 90% of the surface runoff and that is more than 20 Bm^3. Based on the potential increase in irrigated area, and the uncommitted surface and groundwater use, the sub-basins were categorised into four groups. Figure 5 presents the sub-basins belonged to different categories.

fo5. Estimated potential for application of the SSS concept in the GRB sub-basin.

Although the above grouping shows the broad picture of the potential for application of the SSS concept, there is a substantial spatial variation of groundwater development and recharge within sub-basins at present. Even the sub-basins in Groups 2 and 3 can have locations where natural interactions are sufficient to recharge the SSS created through groundwater depletion. The identification of these locations requires further analysis.

Q2. Should the summer growing season be called "Kharif", similar to "Rabi" for the winter growing season?

No, this is not possible. In this case, the summer season is from April to May but the Kharif season is from June to October.

Q3. p.9750, line 7: Coefficient of determination. - Table 2 is covered by Table 3. Table 2 can be removed if the ID numbers of the sub-basins are included in Table 3.

Figure 5 is removed from the manuscript and the ID numbers are added to Table 3.