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Interactive comment on "Negative trade-off between changes in vegetation water use and infiltration recovery after reforesting degraded pasture land in the Nepalese Lesser Himalaya" by C. P. Ghimire et al.

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HESS Review 010414 David Tongway CSIRO Ecosystem Sciences, Canberra ACT This is a very impressive manuscript, with many very nice measurements and a very useful output summary. I am an applied ecologist interested in taking the findings of papers like this one and developing monitoring systems that local land managers can use to improve landscape functioning by modifying their behaviour. With colleagues in CSIRO, I have developed a monitoring procedure that might be put to use in the lands described in the Ms. This procedure is described in "Restoring Disturbed Landscapes: Putting Principles into Practice" by David J Tongway and John A Ludwig, Island Press, 2011. This book will direct people interested in implementing this landscape function procedure to a website where data sheets and spreadsheets can facilitate self-improvement in management. This procedure in no way calls into question the results of this Ms: rather the Ms underlines the usefulness of the monitoring for people who cannot do the experiments themselves. The functional differences between sites where local people harvest tree litter to the detriment of hillslope functioning might be modified by adopting leaving proportions of the hillslope litter intact. I have appended a few questions which, if attended to might make the Ms a bit more useful to a wide range of readers.

Reply: *We sincerely thank Reviewer#1 for being interested in and recognizing the value of our paper. In the following we respond to each comment one by one. Line numbers referred to pertain to the revised manuscript.*

1. When was the pasture created and what has been its grazing use?

Reply: *The exact date when the pasture was created is unknown. However, it has been heavily grazed for at least 150 years according to various local sources as mentioned in the text (lines 305-306).*

2. Temperature – evaporation differences?

Reply: *The investigated pine forest and degraded pasture were located close to each other and at almost the same elevation. Therefore, overall weather conditions* above the vegetation *at the two sites are likely quite similar. Although the natural forest site was located at a slightly lower elevation (1500 m vs. 1620 m) and can therefore be expected to be slightly warmer given the local temperature lapse rate of 0.6 ^{o}C/100 m, such an effect is also likely to be counteracted by the northwestern exposure of the NF site. Note that in view of the difference in slope aspect between the three sites corrections were made for its effect on incoming radiation loads as the main determinant of (dry-canopy) evaporation in the case of the two forest plots. We have added a sentence to this effect in Section 2.2.1 (lines 349-350). Any further differences in evaporation among the two forest sites are largely attributable to differences in Leaf Area Index and tree density through their influence on vegetation water uptake.*

3. Any recognition of differences in soil macro-faunal activities?

Reply: *Although no specific observations were made in this respect, the little disturbed natural forest had a well-developed litter layer plus (much) higher soil organic matter content and macroporosity judging by the much higher values obtained for* K_{fs}*, presumably due to greater soil macrofaunal activity compared to the planted forest and the degraded pasture. We have inserted an indication of this fact in the revised manuscript in lines 282-284.*

4. Need to acknowledge differences in precipitation (amount and rate, esp storms) and temperature between different sites. Maybe a table would assist here. The text is "too global" and doesn't distinguish between sites with very different rainfall/ evaporation/cultural/slope backgrounds.

Reply: *Amounts of precipitation differed little between sites. In an earlier analysis (Ghimire et al., 2012) it was shown that using daily rainfall totals recorded at the two forest sites in an analytical model of interception did not produce a difference in canopy hydrological functioning at either site. As such, we do not feel a detailed discussion of climatic differences between research plots that are located so closely to one another is really justified. For other climatic variables we refer to our response to comment #2. However, we have added a sentence on the similarity of rainfall distributions in Section 3.1 (lines 380-384)*

5. Yes, rainfall amounts, relative to soil infiltration capacity need to be more prominent in the text. P 3442, line 10.

Reply: *Information on seasonal rainfall totals in the study area at large is given in lines 257-262. Since it is not the rainfall amounts but rather the rainfall intensity relative to surface- and subsurface hydraulic conductivities that plays a key role in partitioning the rainfall into overland flow, lateral subsurface flow and deep percolation we have added some basic information on rainfall intensities at the study site and their frequency of occurrence early on in Section 2.1 (lines 262-265). Note that Figure 3 also contains information on the median and maximum 5-minute rainfall intensities at Dhulikhel.*

6. The objective in p3443, lines 5-8 needs to be related to a time period, as forest maturation takes some time to develop and equilibrate.

Reply: *This is a good point. We have added the age of the planted forest in line 219 as well as extended the central research question to take this into account more fully (line 222).*

7. P3443, last lines: need to say what vegetation type has replaced the forest and what soil disturbance has occurred.

Reply*: As implied by the original formulation, the forest was replaced mostly by agricultural cropping. Soil disturbances associated with the conversion include accelerated surface erosion and increased incidence of shallow landsliding but obviously the actual processes will vary in magnitude and intensity with slope gradient, underlying soil type, and land management (e.g. terracing and terrace maintenance, cover crops, etc.). However, we do not feel such degree of detail is necessary in a general description of the study area, more so because detailed descriptions of the study plots are given later.*

8. P3444, line 16: delivered to what exactly – a gauged stream perhaps?

Reply*: The term 'delivered' was simply used to denote rain falling. We have revised the text to avoid any possible misunderstanding (line 196, idem in line 260).*

9. Can differences in clay and sand content be attributed to differential erosion or just to innate differences?

Reply: *In view of the fact that the average silt contents of the soil at the three plots were very similar at 46% in the natural forest, 45% at the degraded pasture and 42% at the pine forest it would seem unlikely that differential erosion is important. In addition, the respective soil textural components at 0.5 – 1.0 m depth underneath the DP and PF are essentially the same whereas sand content at this depth beneath the NF is much lower and clay content much higher. It is concluded therefore that the somewhat different texture of the soil under the NF reflects a less sandy bedrock type (see Ghimire et al., 2013 for additional soils information with depth). We have added a reference to the latter paper (lines 301-302) for the interested reader.*

10. I would be interested to know to what extent litter harvesting etc gives rise to hardsetting or physically crusted soils, compared to soils where litter is retained and allowed to be decomposed by fungi and soil fauna.

Reply: *The removal of understory vegetation, the regular collection of litter from the forest floor and compaction by grazing cattle and people can all be expected to have an adverse effect on soil faunal activity and biomass and therefore on the incorporation of organic matter, with adverse effects, in turn, on soil aggregate stability, macro-porosity and pore connectivity as demonstrated by the infiltration and hydraulic conductivity measurements. Whilst it is possible that the erosive force of drip from the canopy (which typically is much greater than that of rainfall in the open) falling onto bare soil patches has led to hard-setting, slaking and crusting of the topsoil it is impossible to separate this effect from that imposed by multi-decadal grazing and trampling without additional detailed soil physical analysis which is beyond the scope of the present paper. Rather, the emphasis of the current paper is on the net effect of the various processes (i.e. reduced infiltration and percolation upon advanced soil disturbance). A similar case of multi-decadal intensive plantation forest usage not far from the Dhulikhel study sites is discussed in Ghimire et al. (2014) to which we refer repeatedly in the Discussion section.*

11. Is pattern of runoff examined outside the plot outflow context? Is runoff all inter-rill or are there rills and gullies involved?

Reply: *The overland flow in the more degraded parts of the study area (DP, PF) was largely concentrated in ephemeral micro-drainage networks around vegetation objects such as grass tussocks and the like rather than in well-developed rills and gullies. The connectivity of hillslope overland flow to the stream network in the area is mostly via the numerous footpaths as discussed more fully in Ghimire et al. (2013). Again, a detailed description of surface runoff processes in the current paper would detract from its central focus as per the previous response.*

Cited references:

Ghimire CP, Bruijnzeel LA, Lubczynski MW, Bonell M. (2012). Rainfall interception by natural and planted forests in the Middle Mountains of Central Nepal. *Journal of Hydrology* 475: 270-280. DOI: 10.1016/j/jhydrol.2012.09.051.

Ghimire CP, Bonell M, Bruijnzeel LA, Coles NA, Lubczynski MW. (2013). Reforesting severely degraded grassland in the Lesser Himalaya of Central Nepal: effects on soil hydraulic conductivity and overland flow production. *Journal of Geophysical Research, Earth Surface*, 118, 1-18, doi: 10.1002/2013JF00288, 2013.

Ghimire CP, Bruijnzeel LA, Bonell M, Coles N, Lubczynski MW. (2014). The effects of sustained forest use on hillslope soil hydraulic conductivity in the Middle Mountains of Central Nepal. *Ecohydrology* 7, 478–495.