Reply to Reviewer 1 Comments

This study by Lee and colleagues is of large interest for an improved understanding of water and carbon cycles on land. The authors aim at (i) partitioning evapotranspiration at catchment scale into the component fluxes soil evaporation, interception and transpiration, and (ii) estimating gross or net primary production based on the relationship of both carbon and water fluxes (water use efficiency). Such study would complement existing large-scale water and carbon flux estimates, such as derived from remote sensing of the vegetation or inversion of the transport of atmospheric CO_2 content. This is a highly relevant scientific question within the scope of BG. However, there are some major issues that need to be thoroughly addressed prior to a publication in Biogeosciences.

(1) In the title, abstract and introduction it was make clear that one major objective of the study is to estimate *GPP* or *NPP* by combining the estimated catchment-scale transpiration with a mean water use efficiency value. In contrast to this aim no such results were presented but only a discussion of estimated *WUE* values in the region. Either you redefine the objectives of the paper, e.g. only concentrating on the water flux partitioning, or you add upscaled *WUE* fields to your results and use it for estimating the mean *GPP* or *NPP* of the whole watershed. In any case, the first strategy would decline a scientifically very interesting result.

Reply:

In Abstract, we outlined the result related to the estimation of carbon uptake capacity as (page 2 line 18~19), "we examined the possibility of using *T* as a relative measure for…" And this was attempted using Fig. 5 to examine the relationship between the Wood Biomass Production (WBP) and *T*. Since the WBP/*T* ratios varied annually by ~100% (while *T* varied only by ~62%), we concluded that the *T* alone cannot serve as a relative measure of *GPP* (page 23 line 23 to page 24 line 2).

In objectives (3), we changed the expression as, "(3) examine the possibility of using derived *T* as a relative or absolute measure of *GPP*." (page 5 line 3~4)

(2) Estimation of *Es* is based on theories from open water bodies. It is totally unclear to me if the concept can be directly transferred to catchments or not and you also do not discuss this issue. For example, do transpiration and interception also fractionate ^{18}O? And if so, does this not influence *Es* towards an overestimation? In line 4 of page 11406 it is stated that such method was applied for a number of catchments. If so, please give at least 3 good references, and please enhance the discussion about your water flux results.

Reply:

As the reviewer pointed out, the isotopic techniques to estimate *Es* at various evaporative settings are entirely based on the formulation suggested by Craig and Gordon (1965) from their work on open water evaporation (more specifically, formulation for δ_E, the isotopic composition of evaporated vapor). The formulation has been applied for the estimation of evaporation rates from lakes (e.g., Gonfiantini, 1986; Gibson and Edwards, 2002) and for evaporation studies on various forest ecosystems (i.e., evaporation from soils) (e.g., Wang and Yakir, 2000; Yepez et al., 2003; Tsujimura et al., 2007). Catchment is a mixed system with evaporation from both open water bodies and soil/ecosystem. A few examples of catchment scale evaporation studies are as follows: Gat and Matsui (1991), Gibson et al. (1993), Telmer and Veizer (2000). To improve our discussion as suggested by the reviewer, we added the above references with more elaborate explanation. (from page 7 line 23 to page 8 line 4)

Transpiration and interception are non-fractionating processes in terms of isotopic compositions since those are considered as total evaporation on a long-term basis. The references regarding this assumption are those cited above and especially for interception, the Ph.D. thesis of Kendall (1993) provides a good field-based example. We added a brief explanation on this comment in the revised manuscript. (from page 6 line 20 to page 7 line 8)

<References>

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Gat, J.R., and Matsui, E.: Atmospheric water balance in the Amazon Basin: An isotopic evapotranspiration model, *J. Geophys. Research*, *96*, 13179-13188, 1991.

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Gibson, J.J., Edwards, T.W.D., Bursey, G.G., and Prowse, T.D.: Estimating evaporation using stable isotopes: Quantitative results and sensitivity analysis for two catchments in North Canada, *Nordic Hydrol.*, *24*, 79-94, 1993.

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Canada. *Global Biogeochemical Cycles*. DOI: 10Ð1029/2001GB001839.
Kendall, C., 1993, Impact of Isotopic Heterogeneity in Shallow Systems on Stormflow Generation, Ph.D. dissertation, University of Maryland, College Park, 310 p.
Telmer, K., and Veizer, J.: Isotopic constraints on the transpiration, evaporation, energy and NPP budgets of a large boreal watershed: Ottawa River Basin, Canada, *Global Biogeochem. Cycles*, *14*, 149-165, 2000.
Tsujimura M., L. Sasaki, T. Yamanaka, A. Sugimoto, S.-G. Li, D. Matsushima, A. Kotani, M. Saandar, 2007: Vertical distribution of stable isotopic composition in atmospheric water vapor and subsurface water in grassland and forest sites, eastern Mongolia, Journal of Hydrology, 333, 35– 46
Wang, X., and D. Yakir, 2000: Using stable isotopes of water in evaporation studies. Hydrological Processes, 14, 1407-1421.
Yepez, E.A., D.G. Williams, R.L. Scott, and G. Lin, 2003: Partitioning overstory and understory evapotranspiration in a semiarid savanna woodland from the isotopic composition of water vapor. Agricultural and Forest Meteorology, 119, 53-68.

(3) Estimation of interception. Please, explain more carefully equation 4. What are β and D, how did you estimate it, what is the variability among plant species and LAI? I would expect LAI to having a large effect on interception.

Reply:

According to the suggestion by the reviewer, we added detailed explanation on Eq. (4) and the methods to estimate D and β in the text. And, a large part of the explanation in the 'Results' section has been moved to the method section (page 9 line 2~20).

Currently, in the study site, the daily interception threshold (D) can only be determined for selected forest areas where interception measurements have been conducted (Kim et al., 2005). We chose the data from a natural mixed forest. It is expected that LAI affects D but the effect cannot be quantified with currently available data.

<Reference>

Kim, K., Jun, J., Yoo, J., and Jeong, Y.: Throughfall, stemflow and interception loss of the natural old-growth deciduous and planted young coniferous in Gwangneung and the rehabilitated young mixed forest in Yangju, Gyeonggido(I) – with a special reference on the results of measurement, J. Korean For. Res., 94(6), 488-495, 2005 (in Korean with English abstract).

(4) You present long data series of water fluxes in the tables which is quite interesting. But it seems that these are just based on the *P* and *Q* time series and isotope measurements were taken from a much shorter time period but applied to the full period from 1966-2007. Please clarify. I think you can just present the time period where all measurements are there.

Reply:

We used the annual *P*, monthly *P*, and mean monthly *P* for the period from 1966 to 2007. *Q* and *Es* data do not cover the entire period discussed in this study. *Q* was measured from 1966 to 1979 and the representative of the natural discharge unaffected by anthropogenic effects. In the revised manuscript, we examined and discussed uncertainties associated with the temporal change in *P*-*Q* relationship to complement application of the relationship derived from data with limited temporal coverage. The isotope data to estimate *Es* were for the period from 1991 to 1997 and 2005~2006. For the estimation of *Es*, we chose the highest proportion of *Es* relative to annual *P* from the available data to be representative of the study period.

(5) Please, revise your paper in terms of its partition into methods, results and discussion. For example, section 3.3 starts with methods.

Reply:

As indicated in the reply for comment (3), the beginning part of section 3.3 has been moved to the method section. (page 9 line 2~20)

Minor comments: The area is highly populated (P11404 L 11) thus can you really assume dS=0? I would expect a great water usage of the people, e.g. also for irrigation?

Reply:

Approximately ~5 billion ton (15% of annual *P*) of fresh water is being used (and in large part returns to the river system) annually for various purposes in the study area. Household usage is the largest and the irrigation is the second largest. Among these water use practices, total evaporation (such as crop transpiration) does not leave a visible sign in the isotope composition of water and therefore will not be identified by isotopic method. We used the annual sum of *P* and *Q* to avoid confusion related to tracing detailed water pathways and to simplify the catchment water cycles. From this catchment scale isotope survey, the isotope composition did not show sizable evaporation related to water utilization. However, the reviewer comment deserves further consideration regarding water cycles in urban and agricultural areas. According to the reviewer's comment, we have added sentences addressing the issues related to urban water cycle. (from page 19 line 21 to page 20 line 6)

Tab 1: Source of *P*, *Q*?

Reply:

P is from WAMIS database and *Q* is estimated based on the RivDis database, as explained in the text (Both data sources are explained in section 2.4 Auxiliary Database). We indicated the data source in the table caption.

Tab 2,3; Fig 3, 4, 5: Valid for which time period?

Reply:

Table 2, 3 and Fig. 3 -> valid for 2005~2006

Fig. 4 -> valid for 1971~2000

Fig. 5 -> valid for 1991~2005

Above information was added to each Fig/Table caption.

Why is Fig 5 needed if no further application of this relationship is presented?

Reply:

The main reason to show Fig. 5 was to examine and confirm the relationship between transpiration and a productivity measure, and to estimate possible variability of *WUE*. Without having the *WUE* data by independent methods (i.e., micrometeorological), the cited 'WBP (Wood Biomass Production)' data are the only long-term productivity estimate that can be used for this purpose. The explanation on Fig. 5 was rephrased accordingly. (from page 23 line 12 to page 24 line 8)