## 1 Responses to the Reviewer #1

In this paper, the authors attempt to investigate the effects of vegetation change on evatranspiration in shrubland area. Eddy-covariance measurement of three periods' data was analysed. The authors would like to conclude that 1) the cut-off of vegetation increased evatranspiration; 2) the soil evaporation consumes more water than canopy transpiration in this study site. Overall, the authors did lots of work on field experiment and data analysis. The kind of observation and experiment is very important and interesting for hydrologists and land surface modellers to understand the land surface water and energy processes. I appreciate what the authors have done.

**Response**: Thanks for the positive comments.

But I think the authors have to do more intensified and condense discussion to clarify and support these two main conclusions.

**Response**: We have revised and condensed the statements of Discussion part and revised the manuscript according to the reviewer's comments. Please see the detailed explanations in the following and the revised manuscript that marked as red.

In the section of "effects of land use change on ET" (4.2), we have deleted the following sentences:

1. "Vegetation coverage gradually decreased during the three periods because of the vegetation cut-off by human activities". Because we think this is repetitive.
2. "annual total ET increased from 375 mm to 478 mm". because we think this might make the reviewers confused.
3. "Li et al. (2009) have concluded that semiarid shrubland may produce more ET only when the vegetation coverage is above a certain threshold. However, when the vegetation coverage is under the threshold, ET might increase, and this finding corroborated the results of our research". After thinking about the second reviewer's comments, we found we have misunderstood the meaning of this finding of Li et al. (2009), so we deleted this sentence from the Discussion part.

For the first conclusion, the authors compared three years' observed ET data. It was found that the observed ET increased after the cut-off of original vegetation in this study site. But the authors should note that the increase of ET might be caused by several factors. Except for vegetation, meteorological condition is another important influence factor, especially the temperature. From Figure 4, it is clearly shown that from 2011 to 2014, the monthly temperature obviously increased. This could increase potential evaporation and then the actual evaporation, which is not related to vegetation change.

**Response:** Yes, meteorological condition is indeed an important factor affecting ET. In our study, we have considered the influence of meteorological condition on ET. However, our unclear statements in the section of method may make the reviewers confused. Therefore, we have rewritten the section of method (2.3.3). Please see lines 205-218 and the following explanations.

In this study, we used a simple equation to consider the controlling factors (the potential evapotranspiration ($E_{TP}$), vegetation condition ($f_v(vegetation)$) and soil water condition ($f_s(soil\ water)$) on ET. Among these factors, potential evapotranspiration is a measure of atmospheric water demand and includes the meteorological conditions. This equation is similar to the FAO single crop coefficient method (Irrigation and Drainage Paper No. 56 (FAO-56)) and is expressed as,

$$\mathrm{ET} = E_{TP} \times f_v(vegetation) \times f_s(soil\ water) \quad (1)$$

where $f_v(\mathrm{vegetation})$ represents the effects of vegetation change on ET, and $f_s(\mathrm{soil\ water})$ represents the effects of soil water content on ET. In order to analyze the control of vegetation change on ET, we excluded the other two influencing factors. Therefore, a transformation of Eq.1 was proposed to be regarded as normalized ET, and it can be expressed as the following formulation,

$$f_v(\mathrm{vegetation}) = \mathrm{E_T}/[\mathrm{E_{TP}} \times f_s(\mathrm{soil\ water})] \quad (2)$$

Thus, we used the normalized ET to study the impacts of vegetation change on ET.

Additionally, Figure 2 shows that the bare soil might be tilled in 2014, which could release more soil moisture as well. The difference between original bare soil and tilled bare soil should not be neglected.

**Response:** During the three study periods from July 1st 2011 to June 30th 2014, the bare soil is not tilled. We have added the explanations in the revised manuscript. Please see lines 117-118.

For the second conclusion, I suppose this statement is not quite clear. If the authors would like to discuss the total amount evaporation from soil is larger than the total amount of transpiration from canopy. I would agree with that. Because bare soil/sparse shrubland is the dominated land cover in this arid study site. If this is true, I do not see any relationship between this statement and the influence of land cover change on evapotranspiration. If the authors intended to say that the soil evaporation of each unit area is larger than the transpiration from each unit area covered by canopy. Firstly, the other influence factors should be excluded before doing analysis. More importantly, I suggest the authors explain the possible physical mechanism of this phenomena.

**Response:** Our study intended to say that the soil evaporation of each unit area is larger than the transpiration from each unit. When the area of land use change was $\Delta\mathrm{S}$, normalized soil evaporation and transpiration changed $+\Delta\mathrm{E}_N$ and $-\Delta\mathrm{T}_N$, respectively. The normalized evapotranspiration changed $\Delta\mathrm{ET}_N$ and was the sum of $+\Delta\mathrm{E}_N$ and $-\Delta\mathrm{T}_N$. We found $\Delta\mathrm{ET}_N$ increased during the three study periods, indicating that $|+\Delta\mathrm{E}_N|$ was more than $|-\Delta\mathrm{T}_N|$. Therefore, the normalized soil evaporation from each unit ($|+\Delta\mathrm{E}_N|/\Delta\mathrm{S}$) was larger than transpiration from each unit ($|-\Delta\mathrm{T}_N|/\Delta\mathrm{S}$). Due to the unclear statements in the Discussion part (4.2), we have revised the Discussion part to make our conclusion more clear. Please see lines 486-488.

We have excluded the impacts of other influencing factors on ET before the analysis. Our unclear statements of the method may make the reviewers confused, so we have rewritten the

Method part (2.3.3). Please see lines 205-218.

Since this does not quite match with our knowledge on evaporation that soil evaporation can only consume soil moisture in top layer; while vegetation can consume soil moisture in deeper root zone layers, especially in this arid area where the rooting depth could be over 1m. I would like to ask the authors to do more discussion on this issue.

**Response:** Our conclusions are the same as the reviewer's. We thought the vague description of vegetation in the "site description" part may make the reviewer confused. Therefore, we added the following statements into the "site description" part, please see lines 102-105.

"The vertical roots were surveyed to be mainly (90%) distributed within 100 cm (Yang, 2012), and they absorb the water from shallow soil of 60-80 cm (Liu et al., 2010; Yang, 2012)."

Thirdly, I am quite confused with the discussion on impacts of phonological change on ET and effects of land use change on ET. The authors mentioned that ET has positive relationship with NDVI on the influence of vegetation phonology. This indicates that the better vegetation it is, the larger ET it is in different seasons. Simultaneously, the authors mentioned that after the vegetation cut-off, annual ET increased. I would like to authors clarify this 'contradiction'.

**Response:** In our study, vegetation phenology was represented by Moderate Resolution Imaging Spectroradiometer (MODIS)-NDVI data when land use type was constant (lines 269-270). Vegetation cut-off represented the land use change, converting the vegetation to bare soil (lines 113-114). The phenological change and land use change have essentially different mechanisms on affecting ET. Therefore, the effects of variations in NDVI and vegetation cut-off are not contradictory. Due to the unclear expressions which may be confusing, we have revised some statements of Method, Results and Discussion parts to make our conclusions more clear. Please see lines 269-270, 287-301, 350-354, 364-370, 398-400, 423-429, 446-448, 459-461, 486-488 and the following detailed explanations.

In our study, we used the data of 2011-2012 to analyze the impact of phenological change on normalized ET, because in this period, the vegetation type was stable and there was not any land use change happened (lines 398-400). Seasonal NDVI during this year could reflect the vegetation phenology (lines 269-270), such as when the vegetation entered the growing season and so on (lines 350-354). In this case, normalized ET increased along with the vegetation greening (lines 423-429). The mechanism of this increase of normalized ET is due to the increase of leaf stomata, and more transpiration will be transferred to the atmosphere (lines 459-461).

However, the land use change represented the conversion of vegetation type and in our study, this conversion was from natural vegetation to bare soil. To discuss the impact of land use change on normalized ET, we firstly treated the land use condition of zone A (the area that has not encountered the land use change) as the reference, and the differences of vegetation coverage between zone A and zone B ($D_{lu}=M_A-M_B$) as the measure of land use change (lines 287-301). $D_{lu}$ represents land use change most exactly in summer than in winter, because M is a measure of the fraction of green vegetation and $D_{lu}$ in winter is meaningless and nearly zero. So we selected

$D_{lu}$ of July—September in each period as the measure of land use change (lines 364-370, Fig.1). We found that with land use change, the normalized ET increased (lines 446-480, 486-488, Fig.2). The mechanism of this increase ET is that the soil evaporation from each unit of increased bare soil is larger than transpiration from each unit.

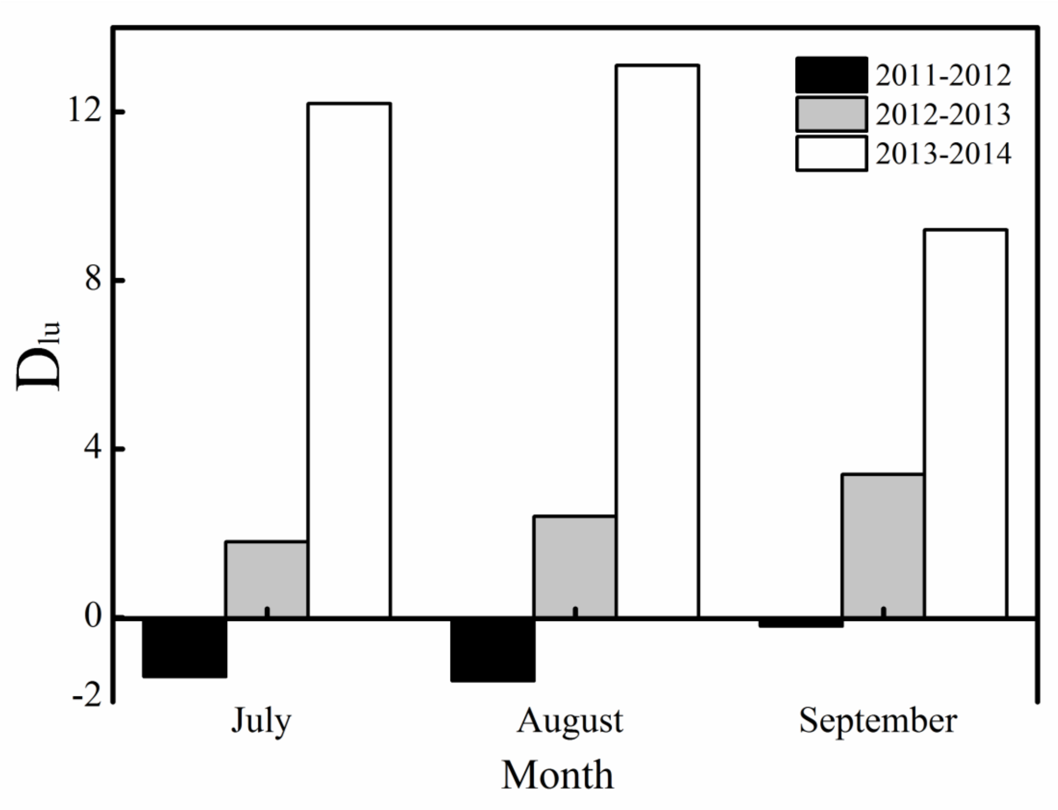


Figure 1 The $D_{lu}$ of July, August and September in each period.

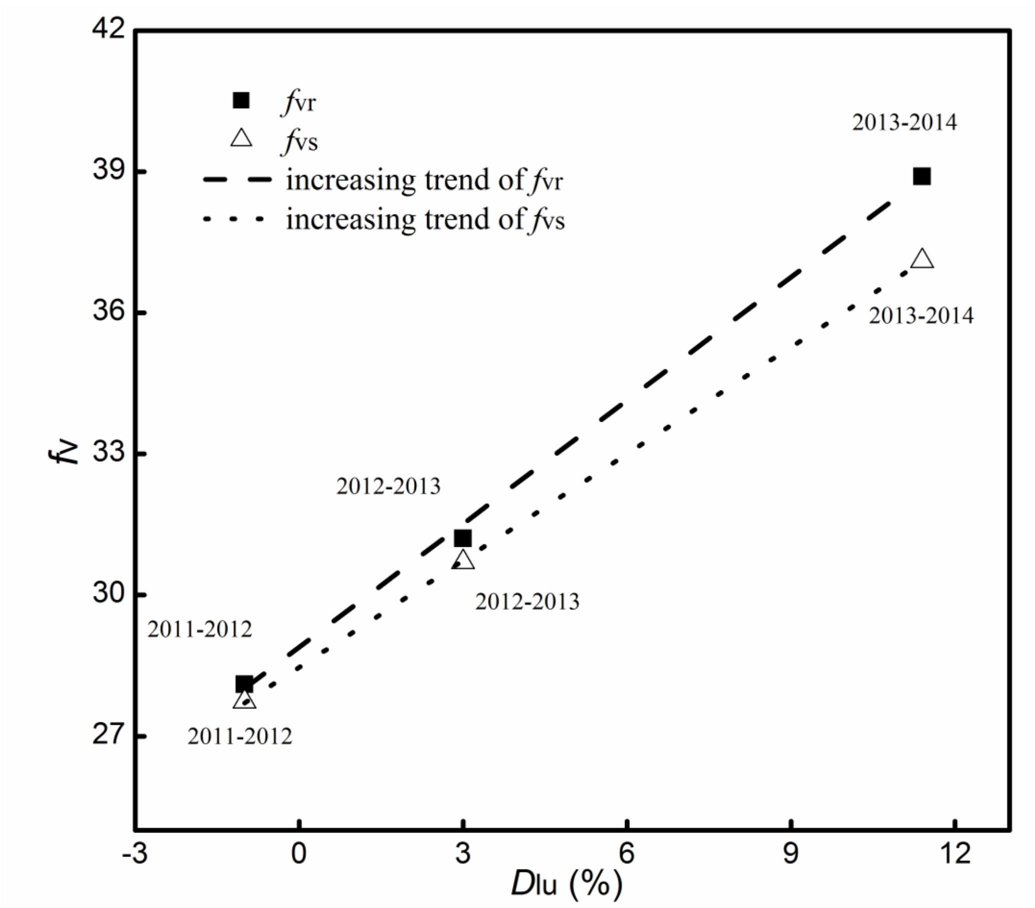


Figure 2 Quantitative analysis between $D_{lu}$ by human activities and ET ($f_{vr} = ET/(E_{TP} \times f_{sr})$, $f_{vs} = ET/(E_{TP} \times f_{ss})$) in July—September of each period.

Small comments:

P13572 (P72 hereinafter), L20: '. . .consumed by ET. . .', references are needed.

**Response:** We have added the references. Please see line 31.

P73, L17: references are needed.

**Response:** We have added the references. Please see line 57.

P80: Equation 7. It might be theta>thetak in the first line.

**Response:** We have corrected it.

**References:**


Jin, T. The growing research of *Salix psammophila* in the Mu Us sandy land. Practical Forestry Technolgy, 01, 7-9, 2009.

Liu, J., He, X., Bao, H. L. and Zhou C. J.. Distribution of fine roots of salix psammophila and its relationship with soil moisture in Mu Us Sand land. Journal of Desert Research, 30, 1362-1366, 2010.

Yang, F.. A study of the vadose zone water movement's law under the influence of vegetation—a case of the Mu Us Sand land. Chang'an University, Xi'an, China, 2012.