Response to Comments of Referee #2 – Wang et al.

The authors thank the referee for very useful and informative comments for improvements. Replies to the comments are listed below.

General Comment:
Based on my reading of the manuscript, I would distinguish two parts, with different remarks. The first part: The introduction and experimental sections are quite well structured. The introduction of the paper illustrates clearly the rationale and the objectives of the work. It provides an exhaustive literature review covering the major topics related to the issue of stemflow in arid areas. The experimental conditions are well explained and are based on field measurements.

No response needed.

The second part: I am not sure the experimental setup and the resulting data set are suitable for supporting the objectives. Especially the results summarised in table 1 seems contradictory. In the following, I have described the reasons for my general comments in more detail.

Equation 2. It is not clear to me what the authors mean with "cumulative" infiltration. Looking at the equation, it seems that the subscripts e and i refer to the final and initial water contents during a rainfall period and thus the term cumulative should refer to that single period. If so, the authors should explain why they use the factor 10 in the equation (Zf and I are both in mm).

Response – The referee is correct. We measured the Z_f in cm, but in the text we made a mistake for showing the unit of Z_f in mm. We would like to change the unit of Z_f in cm. The factor 10 in the equation is to transfer the infiltration in unit of cm into mm.

Table 1. In the text, the authors emphasise that a rainfall higher than 2.2 mm is necessary in order to observe any effect of stemflow on soil water storage. Actually, in the table the rain of September 8th does not produce any changes in cumulative infiltration fluxes in the soil. If so, it is quite difficult to me figuring out why a quite insignificant increment in the rainfall (3.2 mm measured on September 23rd) produce a completely different behaviour, with significant flux increments up to 40 cm depth (column 5 in the table). This behaviour is even more strange if one considers that a rainfall of 3.5 mm (>3.2mm) only produces cumulative infiltration changes (last column in the table) comparable to those for the 2.2 mm rainfall, even in presence of a significant antecedent rainfall. Moreover, all the rainfalls but one (the 13.7 mm rainfall in the 7th column) only produces soil moisture increases along the whole soil profile, which are always lower (at best equal – see column 2) than the rainfall height, even when the latter is significantly higher then the threshold value of 2.2 mm. Should

the stemflow significantly increase the water fluxes to the soil compared to the rainfall height in non vegetated areas? In presence of shrubs, a rainfall of, say, 3.5 mm should at least produce a storage increase of 3.5 mm (by neglecting evapotranspiration and deep percolation fluxes).

Response – We calculated the precipitation that initiating stemflow according to the linear regression (Eq. 4) and stated that 2.2 mm precipitation were necessary for the generation of stemflow (page 5214, lines 9 to 10; page 5220, lines 8 to 9; page 5222, lines 2 to 3). Based on the data in Table 2, we calculated that a rainfall higher than 4 mm is necessary in order to observe any effect of stemflow on soil water storage below the soil layer of 5 cm. In other words, it is "A threshold value of corresponding rainfall of 4 mm is required for stemflow water to replenish the soil moisture at the stem basal area (page 5223, lines 23 to 24)".

The referee read the first version of the manuscript uploaded on 27 Mar 2010, but we uploaded a revised version on 20 Jul 2010 in accordance with the editor's comments. Hence, the former Table 1 is changed to Table 2 with correction of the individual events rainfall amount according to the standard for identifying individual rainfall events in accordance with the condition of dry desert environments in Shapotou, where an individual rainfall event was defined as a rainfall separated by dry intervals of at least 6 h (page 5217, lines 24 to 26). The rainfall of 3.2 mm measured on September 23rd was from 7:00 to 14:50 LT, and another rainfall of 0.8 mm measured on the same day from 20:10 to 22:40 LT was not included as a single rainfall event, as we checked it again by the criteria dry intervals of 6 h, we thought that the 0.8 mm rainfall should be included into the antecedent 3.2 mm rainfall, because the interval between 14:50 and 20:10 LT is less than 6 h. So, the rainfall was 4.0 mm on September 23rd with a duration from 7:00 to 20:10 LT (Table 2).

The stemflow will significantly increase the water fluxes to the soil in certain rainfall height (a rainfall of, say, 4 mm) compared to that in non vegetated areas. In presence of shrubs, the rainfall produces a storage increase in soil moisture, but the quantity depends on the properties of rainfall and the canopy interception loss. If there is a significant stemflow, the soil moisture increment should be equal or larger than rainfall. But for a rainfall of less than 4 mm, which is the threshold value required for stemflow water to replenish the soil moisture at the stem basal area, storage increase should not be the same of rainfall, usually less than that, or even non storage increase.

Based on the authors' findings, these values should be ten or even hundred times the rainfall height.

Response – These values represent the "Funneling ratios" (Eq. 1, page 5215, line 11), it can be ten or even hundred times the rainfall amount that may reach the

root area by stemflow as compared to an open area (page 5220, lines 10 to 14; page 5222, lines 12 to 14).

Of course, there is the possibility that some of what I see as major shortcomings may instead only be the absence of a complete presentation of what was done in the analysis. If, to the contrary, I am right, the authors should give reasons for these strange values, which clearly contradict their main results. In this case, it is my opinion that a likely reason for this behaviour could be some preferential flows causing water at the stem basis to partly bypass the TDR probes. Thus, the water fluxes calculated by using the TDR probes would result underestimated. Even in absence of any preferential flows, one should consider that a TDR probe only allows estimating average water contents in the whole probe observation window. In other words, the water content "seen" by the probes the authors used (20 cm length) is only partly originated from the stemflow and is, to the contrary, significantly determined by fluxes characteristic of no-shrubs areas. The only way to estimate the actual contribution of the stemflow to the storage increases in the soil profile would have been to measure storages in non-vegetated areas to be compared to those coming from the "shrubs-TDR".

Response – The TDR instrument is capable of measuring volumetric soil moisture between 0% and 100%, with an accuracy of ≤ 0.1%. The wetting front location and cumulative infiltration are detected by measuring changes in soil moisture in the soil profile (Noborio et al., 1996; Wang et al., 2007). Noborio et al. (1996) found that the cumulative infiltration estimated by TDR compared favourably with observed infiltration, and the distance to the wetting front from the soil surface estimated by TDR agreed well with the observed values. All data were collected simultaneously during and directly following rain events sufficient to trace wetting front changes at hourly intervals (page 5218, lines 12 to 19).

We compared our results to those coming from the no-shrubs areas in the same site under identical bioclimatic conditions of the following two articles (see Reference section):

1. Chen, W.R., 1991. Water balance in the revegetated area along the railway in Shapotou area. In: Shapotou Desert Experimental Research Station, Chinese Academy of Sciences (Eds.), Study on Shifting Sand Control in Shapotou Region of the Tengger Desert (2). Ningxia People's Publishing House, Yinchuan, pp. 66–75.
2. Zhao, X.L., 1991. Problems of revegetation on sand dunes in Shapotou area. In: Shapotou Desert Experimental Research Station, Chinese Academy of Sciences (Eds.), Study on Shifting Sand Control in Shapotou Region of the Tengger Desert (2). Ningxia People's Publishing House, Yinchuan, pp. 27–57.

We discussed that stemflow water can effectively refill the soil profile and increase the cumulative infiltration for medium- and large-sized rainfall. According to previous research, from the point view of soil moisture

replenishment in this particular artificially re-vegetated sand dune area, only when an individual rainfall event has a rainfall amount > 8 mm (Chen, 1991; Zhao, 1991), with average rainfall intensity > 0.5 mm h^{-1} (Wang et al., 2008), it is an effective rainfall for the vegetated soil. While for the stem basal area of *C. korshinskii*, the corresponding threshold value is about 4 mm (Table 2, on 23 September 2008) which replenish the soil moisture at the profile deeper than 5 cm, comparing to the rainfall of 3.5 mm that limited the soil moisture increment within the upper layer of 5 cm (Table 2, on 3 October 2008) (page 5222, lines 23 to 29; page 5223, lines 1 to 3).

Then, we concluded that "A threshold value of corresponding rainfall of 4 mm is required for stemflow water to replenish the soil moisture at the stem basal area (page 5223, lines 23 to 24)", the stemflow significantly increase the water fluxes to the soil compared to the rainfall height in non vegetated areas.