

Response to Comments of Referee #1

We appreciate the valuable and constructive comments provided by Referee #1. The comments are helpful to the improvement of the manuscript, and will be incorporated into the revision of the paper. Our responses to the comments are listed below:

1. The first main concern of referee #1 is that the functionality of the interrelation between stem flow and preferential flow as the rainfall intensity varies is not clearly demonstrated in the manuscript. We indeed neglected the discussion of the effect of rainfall intensity on preferential flow in the text. After further analysis of the original data, we found that the stemflow tended to decrease with rainfall intensity whereas preferential flow was more pronounced for higher rainfall intensity. In figure 8, the rainfall event with small amount but high intensity (4.9 mm and 19.60 mm h⁻¹) showed apparent deeper wetting front (dye stain area), followed by rainfall events of 32 mm (rain intensity: 1.60 mm h⁻¹) and 9.1 mm (rain intensity: 0.76 mm h⁻¹), these suggest that high intensity rainfall may be more prone to trigger stemflow as preferential flow; however, the process of stemflow and preferential flow may compensate at certain rainfall intensity as stemflow decreases with rainfall intensity while preferential flow increases. We have included this discussion in the revised paper.

2. The second main concern of referee #1 is whether the flow channelized by root is all stemflow or all stemflow becomes preferential flow through roots. This reviewer suggested that we add precise definitions of fundamental variables (such as stemflow) and skipping few non supported statements. We agree with this. We have included precise definition of stemflow in the Introduction as precipitation intercepted by leaves and branches and subsequently flow down the trunk or stem of the plants (Crockford & Richardson, 2000; Carlyle-Moses and Price, 2006). We did not mean that all stemflow becomes preferential flow through roots, but root channels are preferential pathways for movement of most stemflow water into the soil (as indicated by the distribution of *rhodamine-B* dye and soil water content). In the revised paper we will clarify this. However, the interesting points raised by referee #1 deserve discussion. As we know many studies have measured stemflow on desert shrubs and showed that the process of stemflow is effective in concentrating water at the shrub base, but it is less clear what this water becomes after it reaches the shrub base (Abrahams et al., 2003). Many

researchers (e.g., Pressland, 1973, 1976; Mauchamp and Janeau, 1993; Dunkerley and Booth, 1999) reported that most, if not all, stemflow infiltrates in the immediate vicinity of the shrub base. Pressland (1976) found that all stemflow infiltrates into the soil within the area of 50 cm around large trees with circumferences larger than 40 cm and within the area of 30 cm around the smaller trees with circumferences less than 20 cm. Tanaka et al. (1991) also observed the areal extent of stemflow-induced infiltration water and found that stemflow inputs are concentrated over more localized circular areas at the tree base. Since we conducted experiment in sandy soil with high infiltrate rate, we observed all stemflow infiltrated into the soil around the shrub base during the experiment. Dye tracer experiment evidence showed that preferential flow occurred due to the presence of roots, thus we speculate that a part of stemflow became matrix flow but most became preferential flow (as compared with bare area). Martinez-Meza and Whitford (1996) also observed stemflow moved along root channel via preferential pathways using dye experiment under simulated rainfall.

The following paragraphs respond to the specific comments of Referee #1, the original review comments are listed first in their originals (in italic), followed by our itemized responses.

(1) Page 1552 lines 15 to 17: How can the authors be sure that the flow channelized by roots is all stem flow? Could it be just preferential flow from soil surface different from the base of the trunk?

We revised this sentence as: Analysis of rhodamine-B dye distribution under the shrubs showed that root channels were preferential pathways for movement of most stemflow water into the soil.

(2) Page 1553 lines 9 to 17: I would suggest to add a precise definition of stem flow at the beginning of the Introduction. Here stem flow seems to be flow through stems and along roots (below ground) whereas, on the base of the experimental setup and previous definitions it should be that stem flow is the flow of water down the trunk or stem of the plants. Also, Page 1555 lines 6 to 10, support this assert. Thus, the manuscript seems to contain contradictory tenets.

We have done this in the Introduction: Stemflow is the precipitation intercepted by leaves and branches and subsequently flows down the trunk or stem of the plants (Crockford & Richardson, 2000; Carlyle-Moses and Price, 2006).

(3) Page 1554 line 29 to Page 1555 line 5: I would expect that soil characteristics, depth of the bedrock and frequency of rainfall events have an impact on the storage capacity of the deep soil layers. After rain soil moisture redistributes, possibly toward deeper soil layers and thus, water that has been channelized at the base of the root apparatus may not be there when the plant needs it. The authors should comment on that.

We agree with Referee #1 at this point and will add comments on the effect of stemflow on soil moisture redistribution, groundwater recharge and their impact on plant use in the revised paper.

(4) Page 1558 lines 15 to 17: The description of the experimental setup is not clear to me. What does the sentence: "The other one was treated as no stem flow" mean?

The above sentence is revised as: For the other plant, stemflow was prevented from channeling into the soil using stemflow collector.

(5) Page 1561 lines 11 to 15: What do the authors mean with "major rainfall"? ... (I imagine that 4.9, 9.1, and 32 mm are amount of daily rainfall, and thus that the three event correspond to case studies with decreasing rainfall intensity...the authors should clarify this point).

Please see comment 1 above

(6) Page 1562 lines 21 to 23: None of these asserts is supported. See previous comment.

Since we have clarified that most of the stemflow became preferential flow along roots (see comment 2 above), then this sentence would be valid as stemflow is conducive to concentrate and store water in deep layers in the soil profile, suggesting that stemflow creates favorable soil water conditions for plant growth under arid conditions.

(7) Page 1563 lines 5 to 6: How could the authors attribute the increase of soil moisture to stem flow, when they just evidenced an increase of preferential flow with rainfall amount, leading to higher soil moisture in the deep soil layers with any considered amount of rainfall.

We attribute the increase of soil moisture to stem flow based on our experimental results on difference of soil moisture content between the treatments with and without stemflow under different rainfalls as indicated in Figure 11 and 12, not based on the evidence of an increase of preferential flow with rainfall amount which proposed by reviewer.

(8) Conclusion: conclusion are just conjecture, unless the authors postulate

that all stem flow becomes preferential flow through roots.

The scope of this paper is to make an attempt to connect ecohydrology and hydrogeology through an integrated study of stemflow generation and subsequent water movement in soils. The intent is to elucidate the effects of rainfall variability and shrub species on stemflow generation and then the impact of stemflow on preferential flow induced by the presence of roots. We merely tried to state the linkage of the “processes” between stemflow and preferential flow, rather than to claim all stem flow becomes preferential flow. So we disagree with this comment, however, we have rewritten the conclusion using specific results obtained from the experiments in the revised paper instead of making some general extrapolations of our results.

(9) Page 1552 lines 12 and 13: replace “tree” with “shrub”.

We have changed “tree” as “shrub”

Reference:

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