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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Temporal-dependent effects of rainfall characteristics on inter-/intra-event stemflow variability in two xerophytic shrubs" *by* Chuan Yuan et al.

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The authors report on a detailed study of stemflow in two dryland shrub species, and its relationship with rainfall properties. The data come from field observations of selected branches that were equipped with stemflow collecting collars, and exposed to a number of natural rainfall events. Seven branches were instrumented for each of the two shrub species. The stemflow was recorded by directing the flow into tipping-bucket rain gauges having a 0.2 mm sensitivity.

Although the work appears to be generally thorough, there are some significant issues with it that I consider require clarification before the work could be accepted for

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publication.

The authors are concerned with the relative timing of rainfall and of the resulting stemflow. The difficulty here is that the relative timing is affected by the size of the collecting areas that contribute either rainfall or stemflow to the measuring gauges. The canopy of S. psammophila for instance is reported as 21.4 m2 (line 170), whilst the collecting area of the pluviography TBRG in the open is just 0.018 m2. Thus the canopy area of the shrub is more than 1,000 times larger. Therefore, the tiny tipping bucket (capacity about 3.65 mL, by my estimation) can potentially be filled more rapidly by stemflow than by rainfall in the open. In this way, the time until first tip (regarded by the authors as the onset of stemflow) probably occurs closer to the onset of rainfall as a function of canopy area and its effect in reducing the bucket filling time. Therefore, among the seven instrumented branches, the timing of stemflow initiation should vary, and it might be possible to relate this to the plant morphology. However, the authors do not report the canopy collecting area for the 7 branches that they monitored for each of the two shrub species. Therefore, calculations of the kind just sketched cannot be made nor the results evaluated properly. This imposes uncertainty in the interpretation of the stemflow timing data. The ideal, of course, would be for the collecting area of foliage and branch to be as close as possible to the collecting area of the open-field raingauge.

Indeed, the manuscript lacks any detail of the foliar area on the branches that were monitored for stemflow. For instance, leaf area and leaf wettability are not mentioned or reported. Likewise, there are no data on the shrub canopies as a whole, such as leaf area index (LAI) or canopy gap fraction. The lack of such information again makes the results somewhat difficult to interpret or to compare with results from other taxa and environments.

Data processing is poorly explained. Stemflow intensity, given in mm h-1, requires that the volume of water delivered to the TBRG used to record stemflow (recorded in mL per bucket tip) must be associated with the area over which the equivalent stemflow depth is evaluated. I could not see this explained anywhere in the manuscript, and it needs

to be made clear. If it was the cross-sectional area of the branch being monitored (typically about 3 cm2 by my rough estimation) then this needs to be set out in the manuscript. If the authors did use basal branch cross-sectional area, then of course the stemflow intensity can easily exceed the rainfall intensity, as a function of the very small area over which the stemflow is recorded as arriving - far smaller than the collecting area of the rainfall pluviograph. If this area were to be doubled, then the stemflow intensity would be halved (and so on). Therefore, the area used by the authors in their calculation needs to be stated (and justified by some relationship to plant water availability).

Data processing is also poorly explained in terms of the data on stemflow volume presented by the authors (e.g. in Table 3). Are the stemflow volumes reported there, and discussed at many places in the paper, the sum of the stemflow on the 7 monitored branches, or the arithmetic mean of the stemflow from the 7 branches, or are the figures scaled-up to estimate the stemflow delivered by the entire test shrub? (The test shrubs had a total of 180 and 261 branches (line 173) only 7 of which were monitored for each shrub species (amounting to a sample of $\sim$ 4% and $\sim$2.6% of the branches, the adequacy of which is not discussed by the authors). Whatever the authors did, it is not made clear and this needs to be corrected. Especially in relation to stemflow, all relevant parameters used in data processing must be set out clearly and systematically.

Without knowing the details of the calculation procedure, the relative intensity of the stemflow and the open-field rainfalls are difficult to interpret. No formulae are presented by the authors that would allow this to be checked. My own feeling is that the stemflow flux would be a more useful figure - that is, the flow rate delivered to the base of the branch, expressed for instance in mL/minute or L/hour. If this is accompanied by a clearly-stated area over which the flow is tallied, then a stemflow intensity can be calculated.

In summary, what I find to be missing from the manuscript includes

- some discussion of why 7 stems were studied and whether this is a sufficient sample - some consideration of the filling time of the buckets in the tipping-bucket gauges used for rainfall and stemflow measurement, and the effect of this on the lag time before the start of stemflow (and the cessation of stemflow after rain ends) - more detail on the shrubs - including the variability of canopy size etc across the population from which the two sample shrubs were drawn, and some information on leaf area and wettability, if available - a proper accounting of how stemflow flux was calculated and how the area over which the intensity was scaled was selected.

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More detailed comments:

lines 49-50: it is difficult to generalise from these few data to all "water stressed regions" (and need to define what a water-stressed region is)

line 57: mL/g of what? biomass?

line 61: a flow in units of mL/min is a flux, not a speed

line 69: should presumably say 'not until AFTER canopies became saturated'

line 70: need to define RA when this contraction is first used. It is used again in line 138 before being defined.

line 76: missing a space before 0.4

lines 77-78: need to include branch surfaces also

line 83: need to state which measure is maximised

line 85: explain why time lags are important: presumably the last stemflow would occur as a very small (negligible) flux, so why is the timing of the last stemflow important? More generally, the authors could say something about why the time variation of stemflow during rainfall is important. Do peaks of stemflow flux exceed soil infiltration

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capacity, perhaps? Otherwise, why is this important?

line 100: no need to repeat the number of rainfall events here, and again in line 222 and again in line 248. Once is sufficient.

line 106: please define 'stemflow intensity' and provide a formula somewhere in the paper

line 139: please explain what 'analogue' means here

lines 147-148: all these timing data are a function of the tipping-bucket filling time (see discussion earlier in this report). When using a TBRG, it is difficult to tell precisely when rain begins or ends, owing to the time that might be required to fill the first tipping-bucket.

line 153: how Is raindrop morphology reflected in this? please explain

line 160: why is mean intensity used here?

line 168: since this paper reports a study of branch stemflow only, the title of the paper should be amended to indicate this clearly (i.e., not a study of stemflow on an entire plant)

line 171: to what extent were the studied shrubs representative of the wider population? please present some data.

lie 181: please explain what is meant by 'canopy skirt locations'. The photos suggest that there were many overhanging leaves and branches. Some of the stemflow collars were placed quite high off the ground (as far as can be judged from the photos, as no quantitative information on this is included in the paper). How do the authors know that the stemflow at these heights would actually reach the ground, and not drip off the branches?

line 189-190: what was the external diameter? this should be included as the dimensions of the stemflow collars are critical - it does not seem sufficient simply to assert

that they caught no rainfall or released drips of throughfall from above.

line 270: how were rainfall intensity peaks identified? What makes one peak an intensity peak?

line 292: is the reference to the volume from a single branch or the total from the 7 branches?

lines 300-310: this is difficult to read, owing to the need to recall the meaning of the very many contractions. Some reminders of what these mean would be useful here.

line 342: a stemflow intensity of 1232 mm h-1 is large. What was the flux? I presume that in the case of the authors own work in the present study, the flux was within the capacity of the tipping-bucket gauges (typically a few hundred mm h-1 at maximum) since the rainfall was not very intense. Some comment on this would be worthwhile.

lines 383-384: but these fluxes would surely depend on the antecedent leaf and branch wetness, and on meteorological conditions such as wind speed and vapour deficit (the latter is not reported, incidentally).

Table 2: why are only 3 rainfall events listed here? More than 40 more are simply lumped under "others" and no details are provided. Why?

Figure 4 shows units of m/h which I presume should be mm/h

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