Hydrol. Earth Syst. Sci. Discuss., author comment AC3
https://doi.org/10.5194/hess-2021-48-AC3, 2021

Reply on RC2

Isaac Kipkemoi et al.

Author comment on "Climatic expression of rainfall on soil moisture dynamics in drylands" by Isaac Kipkemoi et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-48-AC3, 2021

Reviewer 2

We welcome the comments provided by Reviewer#2. However, we would like to note that the Reviewer does not comment on the rationale for the study or the results and implications (impact of rainfall resolution on soil moisture). Their three comments refer to minor points (one of which we addressed in our response to Reviewer 1) and the other two are brief comments which lack clarity and justification. We address all three comments below in **bold**.

This research is interesting, but at the same time this was a very mature research area. It does not make much sense to continue to use this HYDRUS model for research on HAD, for there are lots of related studies.

We feel that the reviewer has misrepresented our study. It was not simply a case study use of HYDRUS, but rather an investigation of the potential interactions between rainfall and soil moisture, which are inherently nonlinear. HYDRUS is indeed commonly used in the literature because it has been shown in numerous studies to capture the essence of vertical flow through porous unsaturated media. We disagree with the reviewer that 'there are lots of related studies' on investigating the impact of temporal resolution of rainfall delivery in drylands on soil moisture. In these environments, it is important to characterise the effects of rainfall delivery (rainfall intermittence, high intensity, and short duration storm events)

- There are some errors in Figure 2, generally speaking, the roots can absorb water Approximately below the root layer with a capillary water holding height depth, it seems that the authors do not understand the basic principles of ecological hydrology in arid areas.

In Fig 2, we have simply provided the conceptual model as originally outlined in the HYDRUS manual. While capillarity may be an important consideration in locations where the water table is close to the surface, we have assumed a deep-water table, well below the full soil depth. Therefore, we assume no vertical interaction between water table fluctuations and capillarity. Thus, capillary

water is NOT available to roots. This is often the case in dryland environments, especially at locations distant from channels. We can clarify this point in the figure caption.

- The author did not consider the runoff confluence process during precipitation.

We addressed this issue in our responses to Reviewer 1. To summarise here: indeed, overland flow, transmission losses into dry channel beds, focused recharge, surface crusting, sediment transport etc. are all important processes in drylands. Our team has published on these dryland processes extensively – including in Walnut Gulch (e.g., Chen et al., 2019; Michaelides et al., 2018; Singer & Michaelides, 2017; Jaeger et al., 2017; Michaelides & Singer, 2014; Singer & Michaelides, 2014; Michaelides et al., 2012; Michaelides & Martin, 2012; Michaelides et al., 2009 etc.). However, this paper focuses on the 1D vertical distribution of rainfall into the soil profile only – there is no representation of 2D processes of water flow over hillslopes and in channels. We are interested in understanding how soil moisture dynamics vary with rainfalls of different temporal resolutions. Therefore, we are simplifying the representation of this problem in a 1D model of a 1m deep soil profile on a flat surface (similarly to a column experiment performed using typical land surface models).

- The results of using Penman's formula to calculate ET have not been verified by measured plot data, which may lead to the converse results.

The comment from the Reviewer is not clear. Converse to what? In this study, we used AZMET ETO data calculated by a well-established organization by a well-respected method using regionally available data. This data was downloaded from the link provided in table 1 (https://cals.arizona.edu/AZMET/). We also provided the formulae used to calculate ETo, which is based on the Penman-Monteith Equation (Eq. 1). The equation derivation and calculation procedures for the standardized ETo including testing and validation is provided in Brown (2005). This method is a well-established one for characterising evaporative demand from the atmosphere for a wide range of hydrological analyses (Vicente□Serrano, et al 2020.).

References

Brown, P. (2005). Standardized reference evapotranspiration: A new procedure for estimating reference evapotranspiration in Arizona.

Chen, S-A., Michaelides, K., Grieve, S.W.D. and Singer, M.B. (2019) Aridity is expressed in river topography globally. Nature 573–577, doi.org/10.1038/s41586-019-1558-8.

Jaeger, K., Sutfin, N., Tooth, S.E., Michaelides, K. and Singer, M.B. (2017) Geomorphology and sediment regimes of intermittent rivers; in Datry, T., Bonada, N., Boulton, A. (eds.), Intermittent Rivers: Ecology and Management, Elsevier.

Michaelides, K. and Martin, G.J. (2012) Sediment transport by runoff on debris-mantled dryland hillslopes. Journal of Geophysical Research-Earth Surface, doi:10.1029/2012JF002415, 117, F03014.

Michaelides, K. and Singer, M.B. (2014) Impact of coarse sediment supply from hillslopes to the channel in runoff-dominated, dryland fluvial systems. Journal of Geophysical Research–Earth Surface, doi:10.1002/2013JF002959, 119 (6) 1205 – 1221.

Michaelides, K., Hollings, R., Singer, M.B., Nichols, M., Nearing, M. (2018) Spatial and temporal analysis of hillslope-channel coupling and implications for the longitudinal profile in a dryland basin. Earth Surface Processes and Landforms doi:10.1002/esp.4340

Michaelides, K., Lister, D., Wainwright, J. and Parsons, A.J. (2012) Linking runoff and erosion dynamics to nutrient fluxes in a degrading dryland landscape. Journal of Geophysical Research-Biogeosciences, doi:10.1029/2012JG002071, 117, G00N15.

Michaelides, K., Lister, D., Wainwright, J. and Parsons, A.J. (2009) Vegetation controls on small-scale runoff and erosion dynamics in a degrading dryland environment. Hydrological Processes, doi:10.1002/hyp.7293, 23: 1617 – 1630.

Singer, M.B. and Michaelides, K. (2014) How is topographic simplicity maintained in ephemeral, dryland channels? Geology, doi:10.1130/G36267.1.

Singer, M.B. and Michaelides, K., (2017) Deciphering the expression of climate change within the Lower Colorado River basin by stochastic simulation of convective rainfall. Environmental Research Letters, 12,104011 doi:10.1088/1748-9326/aa8e50.

Vicente□Serrano, S.M., McVicar, T.R., Miralles, D.G., Yang, Y. and Tomas□Burguera, M., 2020. Unraveling the influence of atmospheric evaporative demand on drought and its response to climate change. Wiley Interdisciplinary Reviews: Climate Change, 11(2), p.e632, https://doi.org/10.1002/wcc.632, 2020.