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Hydrology and Earth System Sciences Discussions

Interactive comment on "A channel transmission losses model for different dryland rivers" *by* A. C. Costa et al.

A. C. Costa et al.

alexandrecunhacosta@yahoo.com.br

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Dear Reviewer,

We appreciated very much your in-depth comments and suggestions. Please find our response below:

1. The first major problem I have with this paper is that there is apparently no consideration given to the accuracy of the component approximations or the various numerical schemes. The processes are highly non-linear and there is nothing in the paper to convince the reader that the approximations are appropriate in representing the component processes for this application, or that the spatial and temporal discretization

and numerical approximations are such that the model is numerically stable and accurately representing the governing equations. For example, infiltration in a multi-layer alluvium under transient flow is a highly complex area for numerical simulation, and careful attention must be given to the numerical performance. In fact the paper gives no information on the space and time steps used, let alone any discussion of numerical issues.

We agree that numerical stability is an important issue. In the current manuscript, we have provided information about spatial and temporal discretization on page 8923 L10-24, on page 8926 L21-28 and on page 8927 L1-4. We also considered the numerical stability issue for the flood wave routing, i.e. the Courant Criterion (Eq. 4). However, we confess that discussion of numerical issues was not a major point of concern in this manuscript, even though we have empirically checked numerical stability during model development by testing theoretical examples for each sub-component of the model. We decided not to show the results of these test here, because it would turn the manuscript too big and a bit cumbersome. Nevertheless we are planning to write a new section of this paper where we discuss several model uncertainty and reliability issues, and one sub-section will summarize our experiences referring numerical issues.

2. A second area of concern is the fact that a complex model is used in situations where there are very limited data. Of course this is a generic problem for this topic, but without any validation of the internal processes, the information content of the data is too limited to draw conclusions about the validity of the process representation.

We agree that data availability is not high. Unfortunately, data scarcity is a particular feature of most dryland regions and rivers. This made it impossible to validate all internal processes or sub-components of the model by comparing a series of process measurements with model results on, e.g., unsaturated flow and groundwater interaction with the river. However, we were able to compare measurements on discharge in the river, runoff reduction in the river and response of groundwater levels in adjacent aquifers. For instance, we have been monitoring daily groundwater level close to N3

stream gauge in the Jaguaribe river (Fig. 3). The first results of this monitoring are presented in Costa et al 2011, Hydrol. Proc. (in review). Such observations enable us to test hypothesis on river water infiltrating into the river bed and groundwater flow in the underlying alluvium parallel to the river. The model application showed that these processes are very plausible and their inclusion in the model improves the prediction of stream flow and channel transmission losses, the former process being more relevant than the latter, in the Jaguaribe river.

In future we plan to collect more data about channel transmission losses and the adjacent groundwater responses, in cooperation with other research groups. Therefore, further work will set a focus on the verification of different internal processes and model components. This comes along with a recommendation of Reviewer 1, who suggests that it should be further tested on more events and river reaches with different hydrological controls. In any case, one has to face the fact that data are always limited.

3. A related point is that there will inevitable be large uncertainty in characterising the surface system – due to lack of data and the spatial heterogeneity that is referred to in the literature review. A plausible way forward would be to develop alternative equally feasible interpretations of the surface and in particular subsurface heterogeneity and explore the associated model sensitivity. I would guess for example that alternative equally plausible realisations of subsurface profiles would give very different results.

We agree with that point of view and we plan to discuss different possible subsurface structures as a certain source of uncertainty in a new section about model reliability in the revised version of the manuscript. We want to make clear that the development of equally feasible interpretations of the surface and subsurface heterogeneity is on the one hand a plausible way to analyse modelling uncertainties arising from surface and subsurface characterisation. However, a full simulation of this kind of analysis is beyond of the objectives and range of our manuscript. We think it would be more appropriate to analyse these issues in a separate paper in depth.

4. A further area of concern is that some of the model results for Walnut Gulch fail to capture basic characteristics of the observed hydrograph. There would need to be extensive discussion and analysis of these results if the authors are to convince the reader that the model is physically plausible.

Because of this comment (a similar one is given by Reviewer 1), we will explain further in the introductory paragraph of section 3 our objectives with the developed model and, consequently, what we mean with prediction. That is we intend to demonstrate the general applicability of the model for water planning and management in dryland rivers, not for flood forecasting. Since we are mainly interested in water management purposes, a reliable prediction means to approximate stream flow volume and related losses. We are less aiming for a “best” fit of a full hydrograph by model calibration. Instead, we try to represent the process mechanisms without parameter calibration. We will elaborate on this strategy more in the coming paper version. We will also discuss the uncertainty in routing process (timing of the hydrograph).

Kind Regards, A.C.Costa

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