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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "Applying PUB to the real world: rapid data assessment" *by* C. Jackisch et al.

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As we find repeating arguments from all reviewers we address these first in the majors section. This is the same reply to all reviewers. It is followed by additional replies to the specific comments of the reviewers. This reply contains some supplementary material briefly drafting the model verification and DSS application.

Thank you very much for your constructive comments. We clearly see the obligation to fully restructure the MS in order to comprehensively present the study as contribution to the PUB discussions.

MAJOR 1 :: The presented data and strategy cannot be evaluated without the

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model results

We agree with the reviewers. Our objective to present the data assessment alone has clearly failed and will be entirely revised and integrated with the model part, which we have done already. The results will show that the gathered data are applicable to parameterize the model without calibration and allow the setup of the decision support system (DSS).

This implies a complete re-organisation of the MS. We will consider all the reviewers' comments and re-structure the data presentation addressing the shortcomings and condensing the information. Moreover, we will carefully revise the title to better reflect how and why this study contributes to the PUB discussion.

MAJOR 2 :: The presented sampling strategy is ad hoc and poorly justified

In opposition to other approaches we present a clearly model- and hypothesis-driven sampling strategy. As we failed to show this in the MS it shall be drafted here. It comprises the three central objectives of the study: 1) validating the assessment strategy through the setup of a hydrological model; 2) assess hydro-meteorological input data and a suitable approach to estimate potential evaporation; 3) extension towards a hydrology based land use DSS.

Objective 1: Derivation of a functional soil map for model setup

We hypothesize that Horton overland flow is the dominant process for the catchment under study. Hence we bias the measurement campaign to address a) infiltration capacity and b) characteristic catena topologies. Simultaneously, the model WASA is found most applicable for the given landscape and purpose. This pre-defines data needs to considerable degree.

To assess the catchment's soil hydraulic parameters and their variability we seek to combine a bottom-up approach aiming at representative samples and hillslopes/catenas with top-down remote sensing connecting the singular samples to the entire catchment. Parallel, WASA needs definitions of specific soil columns, which are referenced in the catena and subbasin expressions.

The bottom-up sampling strategy reduces the number of samples with increasing complexity of the analytical method. We implicitly hypothesize that first-order (with respect to assessability) characteristics (e.g. soil texture and colour), local observations of infiltration capacity and second-order characteristics (grain size distribution) are sufficient to cover hillslope scale heterogeneity. This is further linked back to third-order characteristics (van Genuchten parameters α, n, Θ_r; Cation exchange capacity, C_{org}), which are treated as homogeneous within a given soil class. We admit that this is a strong assumption, which needs to be discussed and will be verified by presenting hydrological model results in the revised MS.

The top-down analysis (remote sensing) yields spatial distribution and spectral classification information. The supervised classification of Landsat data was trained with ground truths (large, quasi-homogeneous representatives of a certain class identified on site) of the soil classes. It was further validated with the field sample sites (which have been independently classified based on their soil properties). The validation will be presented in the revised MS. We finally obtain a functional soil map that is suitable to parameterise the WASA model by assigning the second and third order characteristics from the bottom-up approach to spatial distribution of soil classes in the catchment. We again agree, that the feasibility of this regionalisation approach has to be tested by presenting and discussing hydrological model results in the revised MS.

We preferred to rely all parameterization on real measurements in opposition to approximations through transfer functions (e.g. Rosetta) or standard values from literature (e.g. van Genuchten parameters defined by soil class). The feasibility of this approach will be verified by presenting the hydrological model results (compare supplementary material). Additionally, we will compare directly measured van Genuchten-Mualem parameters from soil samples with estimates from pedo-transfer functions to underpin the

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value of local observation.

Objective 2: Meteorological input data for the model and a suitable approach to estimate potential evaporation

Concerning meteorological data we admit that using data from a station that is located 140 km west from our catchment is a potential error-source concerning timing and amount of precipitation events; which should be reflected in systematic timing errors of simulated discharge events.

During model verification spatial rainfall distribution was estimated by means of inverse distance interpolation of local rain gauge data, if available. The other necessary data to calculate potential evaporation (we tested Shuttleworth-Wallace and Hargreaves) were taken from the Indore climate station. In the revised MS this procedure will be explained. We had objections to use remote sensing data for estimating precipitation inputs, because to our experience these data a) are strongly biased and b) do not provide all data needed to run the model. Again we agree, that this approach has to be justified by presenting and discussing the related hydrological model results.

Objective 3: Data on land use and land use potentials to set up the DSS

As land use is of concern for our study we analysed soil samples for organic carbon and cation exchange capacity as proxy for soil fertility. Unfortunately we were not able to establish a reference to data on agricultural productivity because this data lacks geographical reference. However, this data is used in the DSS. The top-down step to characterise the spatial distribution of land use relied on remote sensing (post-monsoon Landsat images) and on site mapping. Rules for cropping practice were inferred from interviews with farmers, NGOs and GOs and contributed to the DSS setup by means of a cropping agent. This will be further explained in the revised MS.

MAJOR 3 :: Justify the selection of models that are not totally compatible and get specific about the DSS

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To test land use strategies under certain constraints (e.g. maximum yield, minimal risk, water use concerns) we developed a DSS for the lower mesoscale, which consists of a model representing the catchment hydrology (WASA) including crop dynamics (SWAP/Wofost subroutine) to be able to account for feedbacks (water demand/use, productivity). It is driven by a cropping agent (single actor, deciding on given optimality rules on land use and cropping for each element) and a simple weather generator (to test different cropping strategies on longer time scales and to avoid any bias from a singular realisation). This will be further explained in the revised MS.

Since we aim on model parameterization with non-exhaustive measurements a fully physically based hydrological model is out of scope (not to mention the numerical problems at this scale). We thus selected a semi conceptual model that a) resolves the dominant structures and processes of the study catchment (catena and spatially explicit treatment of Hortonian overland flow) and b) already provided a link to vegetation dynamics (WASA). To account for bidirectional feedbacks between land use and the water cycle we fully integrated the SWAP/WOFOST crop routines into WASA, replacing the original look-up tables which have been used at the level of “soil vegetation components” (quasi soil columns). The revised MS will underpin that the model performs reasonably well without parameter calibration, at least in cases of not too wet kharif seasons. Presenting cropping agent and weather generator will further clarify the DSS and concerns of especially non-physical data.

MAJOR 4 :: Selection of catchment – too data scarce but still not PUB

We fully agree with the reviewers that we indeed have to point out a) how we consider the catchment being a PUB example and b) how to show the feasibility of the presented rapid data assessment strategy. Concerning a) we agree that the catchment is not totally ungauged. However, with respect to the DSS, we consider this site as very data scarce. Moreover, the existing gauge time series was not used for any model calibration but validation of the hydrological model, which implies testing the feasibility

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of the presented approach to derive a functional soil map (with a strongly limited project budget). Furthermore, available maps (from the 70s and 80s) where used as priors for the transect selection and had to be discarded during the process, because they were out-dated. The fact that 2/3 of the world's catchments are indeed ungauged is for us justification to look for cheap and rapid data assessment approaches.

We agree that there are different approaches to derive the minimal amount of data that is necessary to setup such kind of model and DSS: For instance working at a very well investigated site and successively reducing the amount of information for the DSS setup. However, in contrary to the reviewers' statements we are not aware of such a study in NW India. The fact that one of the co-authors (Dr. Singh) has excellent contact to local NGOs und farmers in the study area and the fact that such a DSS is urgently needed in this area justifies the site selection.

MAJOR 5 :: The MS is chaotic and uninformative and lacks an overview of existing knowledge in semi arid hydrology.

Through the reviews we clearly see that major points of our study have not been conveyed in the MS. We will adapt the proposals and restructure the paper to crisply present the complete study condensing the discussion in an appropriate section.

ADDITIONAL SPECIFIC REPLY TO REVIEWER 1

Point 3: We are aware of some of the mentioned studies and will carefully study the others. The revised MS will include a review of semi arid hydrology. Clearly, findings from similar studies should guide the sampling and of cause we see lots of possible adjustments to the presented methods after having done the study. Hence we intend to convey this knowledge gain through our revised MS to the community.

Point 4: We will revise the structure throughout and embrace the given suggestions.

Point 6: Thank you very much for this reflection. As pointed out remote sensing (RS) is used and important for the study. The misleading statement was on parameter derivation solely based on RS over large, integrating entities. We will adjust the argumentation to this and condense the scale discussion to a minimum.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/8/C4642/2011/hessd-8-C4642-2011-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 7499, 2011.

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