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WetSpa model application with and without calibration

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Background of this research

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HESS Opinions: Advocating process modeling and de-emphasizing parameter estimation

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of search by optimization, and proce
ginning with some reasonable initial
known catchment characteristics, (b
refine the reasonable initial values, a
pose some meaningful and sensible
eter relational rules. I find that, muc
parameter values (and hence model
tained in only a few attempts and without considerable effort. With some degree of practice, and after gaining some understanding about how the hydrological processes are represented in the model and how the parameters relate to observable or conceptual catchment characteristics, the process of model calibration is eased to such an extent that it would imply that the model needs no parameter calibration but only a kind of parameter "allocation" (i.e., a logic-based specification); I will discuss parameter allocation in detail later in this paper.

According to Beven (2000, 2006a), Beven et al. (2011) and McDonnell and Beven (2014), the importance of uniqueness

calibration for hydrological prediction in mesoscale Alpine catchments. In the latter, the calibration method uses hydrological process knowledge to extract useful information from a very heterogeneous data set available in the region (see also Schaefli et al. 2005, and Schaefli and Huss, 2011).

In other work, Vidal et al. (2007) reviewed the process of calibrating physically based models such as river hydraulic models and distributed hydrological models, with a special emphasis on knowledge base calibration. They criticize the fact that calibration is often done without any or with only minimal physical consideration. They advocate a definition of parameter calibration "on the basis of heuristic knowl-

WetSpa Model

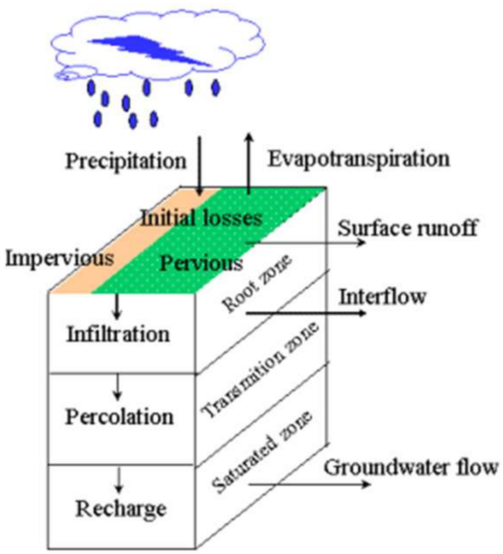
GIS-based distributed hydrological model

Physics based

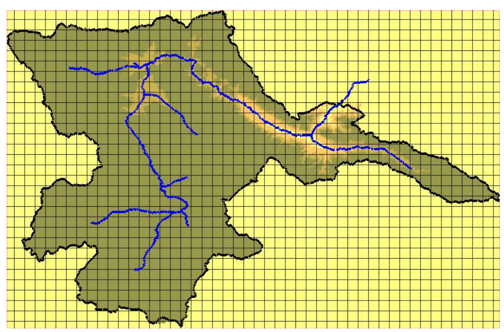
Processes and components: *precipitation and snowmelt, interception, depression, evapotranspiration, surface runoff, interflow, groundwater flow, flow routing, water balance.*

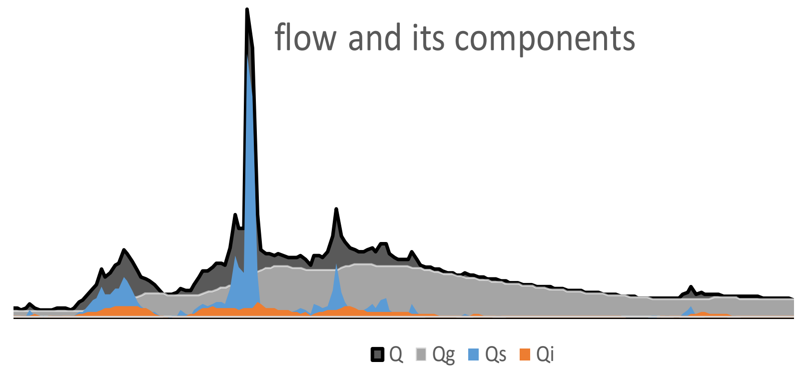
developed by:

Vrije Universiteit Brussel



Grid based model





1. Distributed parameters: 28 distributed parameters **not** subjected to calibration
2. Global parameters: 11 parameters **are** subjected to calibration

In this research, the model has been applied to few watersheds with two different approaches:

1. **Parameter allocation** (logic based specification of parameters)
2. Parameter auto-calibration (using PEST program)

Parameter allocation

How the parameters are determined in the WetSpa model:

1. The distributed parameters are derived using the basic maps and lookup tables, and the generated parameter maps are kept constant (intact).

2. The global parameters can be calibrated (manual calibration and auto calibration) or **can be allocated** (logic based specification)

How?

How the 11 global parameters were allocated in this research:

1. Ki (scaling factor for interflow): based on previous studies: Forest =2-3 (depends on the vegetation density), Rangelands=1-2, sparsely vegetated= 0.5-1
2. Ks: initial condition of soil moisture: this parameter just affects the results of the first month of simulation, so we can confidently fix it on 1.
3. Kg (base flow recession coefficient)= the slope of master curve of the recession limbs
4. g_0 (initial effective ground water storage): 10% of annual rainfall is the best guess, and for several years simulation, such guess is enough for good results.
5. gmax: using cumulative curve of flow
6. K-ep (correction factor for evaporation measured data): this can be determine either using precipitation and flow observations or a Budyko curve of the region (always needs a bit of tuning, and the most sensitive parameter of the model).
7. Krun and Pmax: these two parameters via a relationship represents the rainfall intensity. Pmax can be fixed on the largest value of rainfall time series, then Krun can be estimated by looking at the small noises of the observed hydrograph. If the sharp noises are a lot the value of this parameter is around 3, if the noises are not sharp and frequent then the parameter value can be a number between 5-7.
8. T_0: the snowmelt threshold. We start by a value of 0 centigrade but later it needs tuning.
9. Ksnow: it is the degree day factor: it normally changes between 1.5 to 3 centigrade/day. Normally for the forested area it is 2.5 and for bare lands it is 1.5.
10. Krain: this parameter represents the effect of rainfall on snow: its value is slightly bigger than zero (0-00.5). The modeler can start with zero, if needed later it can be tuned to a positive value smaller than 0.05.

Study areas:

Mountainous watersheds in Iran: Jajrud (435 km^2), HerowChay (582 km^2), Alemut (602 km^2)

Also,

in few catchments in Gorganrood river basin, Karkheh river basin in Iran.

\+ Goldstream river basin in Canadian Rocky Mountain

Data:

Daily hydrometeorological observations

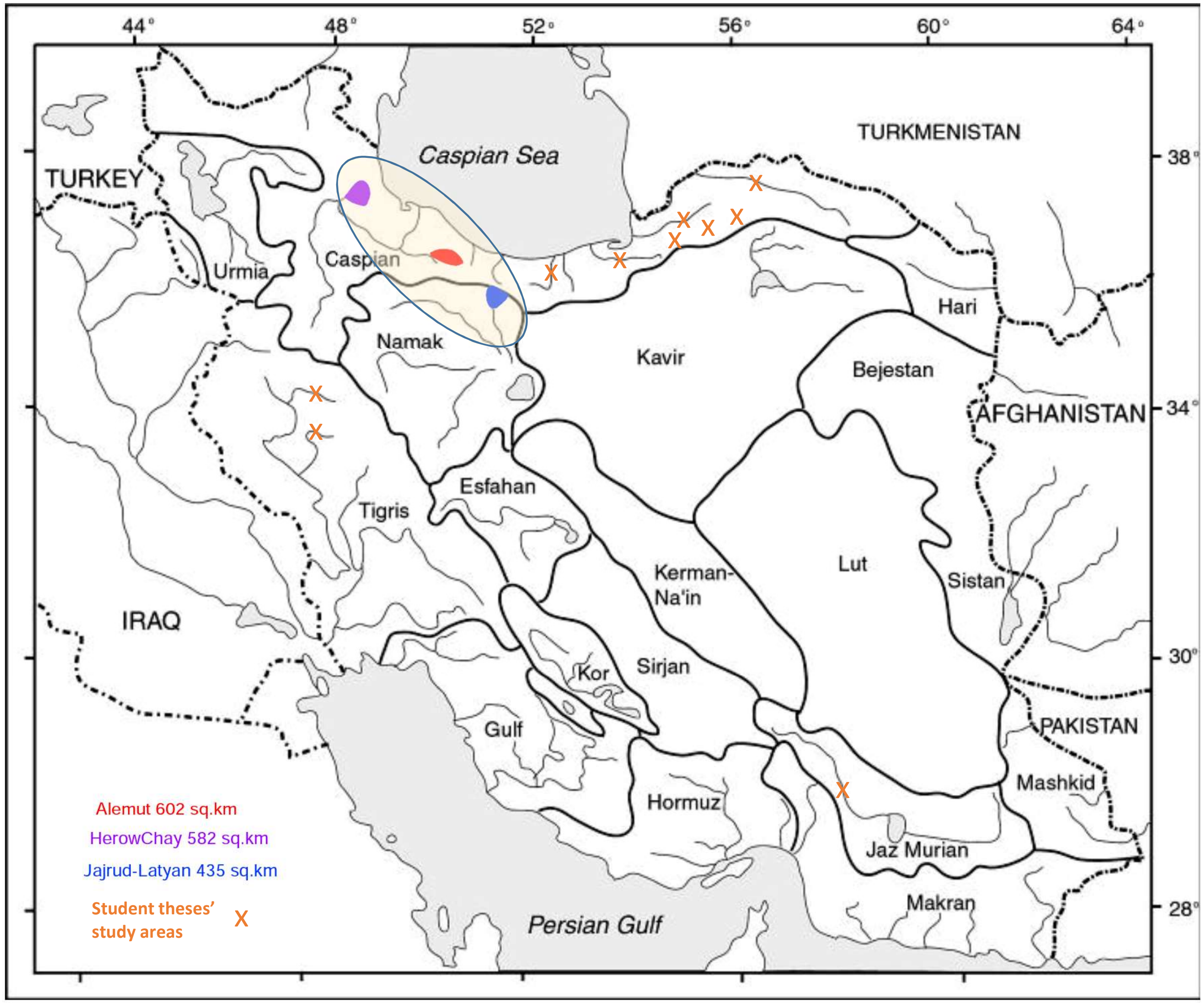
The longest data set for the Iranian catchments= 12 years

Cell size: 50 m

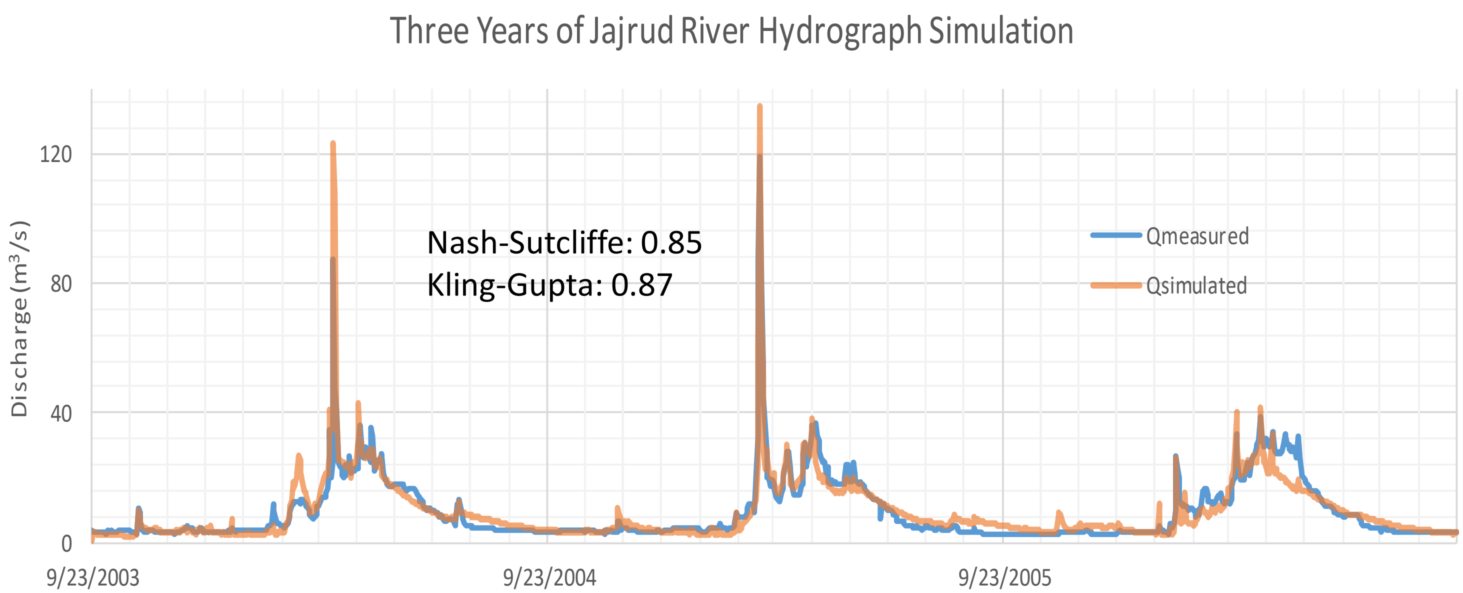
Methods:

The data split in two periods (one for parameter estimation, second for validation)

1. Parameter allocation
2. Parameter auto-calibration by PEST (Gauss Marquardt Levenberg algorithm)



Summary of Primary Results



<u>Average NS</u> for the study areas (Jajrud river, Alemut river, HerowChay river)

	Estimation period (Allocation/Calibration)	Validation period
Parameter allocation procedure	0.68	0.66
AutoCalibration Procedure	0.72	0.38
AutoCalibration with allocated initial parameters	0.70	0.68

Conclusive remarks:

1. **Allocation procedure** resulted in a **consistent** parameter set which gives good results for validation period as well
2. **Autocalibration procedure** resulted in **unreasonable** values for 2 to 4 parameters
3. The results implies that there is equifinality, and via parameter allocation we decide on a reasonable parameter set and narrow the equifinality to the reasonable set (certainty in decision despite the uncertainty of results, Bahremand, April 2016, Bertinoro workshop, Italy)

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THANK YOU VERY MUCH!