Supplementary Material to

Large-Sample Hydrology: A Need to Balance Depth with Breadth

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Review of Large Sample Hydrology studies

To illustrate the growing interest in large sample studies during and since the 1980's, we present here a list of 84 published rainfall-runoff modeling studies that have used more than 30 catchments. The criteria used to select these catchments included:

a) Focus on rainfall-runoff modelling
b) Use of more than 30 catchments
c) Published as journal articles only (i.e. excluding grey literature)

Studies were ordered chronologically. However those based on the same (or very similar) catchment sample were grouped with the first publication that used the sample.

The samples ranged from 30 to 1508 catchments, with a median of 140, and generally included a variety of physical, climatic and hydrological conditions. While some studies were limited to national data sets, others included catchments from several countries (although typically less than five). The studies focused on a range of spatial and temporal scales: catchment areas ranged from 1 to 130 000 km^2 and models were run at hourly, daily, monthly, annual and inter-annual time steps. The study goals included a variety of purposes, most commonly being related to:

a) Model development, application and comparison
b) Estimation of model parameters (calibration and regionalization techniques)
c) Evaluation procedures and criteria
d) Sensitivity and uncertainty analysis
e) Impact studies

Most of the studies were carried out using '*conceptual-type rainfall-runoff*' (CRR) models, probably due to their being easier to implement on large samples than so called '*physically-based*' models because of lower data and computing requirements. In general, these studies used large catchment samples for three reasons:

(1) To achieve conclusions that were more general than could be achieved using a single catchment (e.g., about the relative merits of various methods)
(2) To define the range of applicability, or expected level of efficiency, of methods/models, or
(3) To ensure sufficient information to enable statistically significant relationships to be established (e.g., between catchment descriptors and model parameters in regionalization studies).

Reference	Modelling objective	Time step	Number of catchments	Countries	Size range [km^2]
(Nathan and McMahon, 1990a) (Nathan and McMahon, 1990b)	Application of the SFB model	Daily	168	Australia	1-250
Kabouya and Michel (1991)	Development and evaluation of conceptual model	Annual, Monthly	63	Algeria	71 - 1935
Vandewiele et al. (1991)	Regionalization of model parameters	Monthly	60	Belgium	16 - 3160
Vandewiele et al. (1992)	Comparison of five models	Monthly	79	Belgium, China, Burma	16 - 3190
Makhlouf and Michel (1994)	Development and evaluation of conceptual model	Monthly	91	France	315 - 5560
Xu and Vandewiele (1995)	Model comparison and sensitivity to the type of input data	Monthly	91	Belgium, China	16 - 3626
Vandewiele and Elias (1995)	Regionalization of monthly models	Monthly	75	Belgium	19 - 1597
Nathan et al. (1996)	Regionalization of the MOSAZ model	Daily	195	Australia	4 - 8400
Tung et al. (1997)	Regionalization of unit hydrograph parameters	Hourly	42	Taïwan	53-3076
Abdulla and Lettenmaier (1997)	Regionalization of VIC model	Daily	40	USA	285-5278
Sefton and Howarth (1998)	Regionalization of the IHACRES model	Daily	62	UK	8-893
Edijatno et al. (1999) Michel et al. (2003); (Michel et al., 2005)	Development and evaluation of conceptual model; Test of model formulation	Daily	140	France	1.4 - 9387
Fernandez et al. (2000)	Regionalization of monthly models	Monthly	33	USA	155 - 39847
Etchevers et al. (2001)	Hydrological modelling of the Rhône basin	Daily	145	France	250 - 86496
Perrin et al. (2001) Perrin et al. (2003)	Model comparison; Model development and evaluation	Daily	429	France, USA, Australia, Ivory Coast, Brazil	3 - 50600
Beldring et al. (2003)	Regionalization of the HBV model	Daily	184	Norway	4 - 5693
Merz and Blöschl (2004) Parajka et al. (2005)	Regionalization of the HBV model; Comparison of regionalization	Daily	320	Austria	~10 - 9770

Parajka et al. (2007b) Parajka et al. (2008) Parajka et al. (2007a)	approaches; Multi-objective calibration; Regional calibration of models				
Parajka et al. (2006) Parajka et al. (2009)	Assimilation of soil moisture data	Daily	320	Austria	~10 - 9770
Hundecha and Bárdossy (2004)	Regionalization of the HBV model	Daily	95	Rhine basin	~400-2100
Andréassian et al. (2004b)	Sensitivity to potential evapotranspiration	Daily	62	France	5 - 89
Andréassian et al. (2004a)	Theoretical study on the sensitivity to spatial aggregation	Daily	271	France	5 - 3900
Oudin et al. (2004) Oudin et al. (2005c) Oudin et al. (2005b) Oudin et al. (2005a) Oudin et al. (2006)	Characterization of low-pass properties of catchments; Test of Bouchet's hypothesis; Sensitivity of models to PE formulation; Improved PE formulation for hydrological modelling; Multi-parameter modelling approach	Daily	308	Australia, France, USA	5 - 9387
Lohmann et al. (2004) Xia et al. (2012)	Streamflow and water balance inter-comparisons in the NLDAS project	Daily and Monthly	1154	USA	~23-1353270
Anctil and Rat (2005)	Test of artificial neural networks for flow forecasting	Daily	47	France, USA	~500 - 7000
McIntyre et al. (2005)	Ensemble prediction in ungauged basins using PDM	Daily	127	UK	1 - 1700
Kay et al. (2006)	Comparison of regionalization approaches for the PDM and TATE models	Hourly	119	UK	~1 - 1200
Young (2006)	Regionalization of the PDM model	Daily	270	UK	~3 - 1510
Mouelhi et al. (2006b) Mouelhi et al. (2006a)	Development and evaluation of conceptual model	Monthly Annual	410	France, USA, Australia, Ivory Coast, Brazil	3 - 50600
Boughton and Chiew (2007)	Regionalization of the AWBM model	Daily	213	Australia	50 - 2000
Le Moine et al. (2007) Oudin et al. (2008b)	Test of model formulation for inter-catchment groundwater flows; Comparison of regionalization	Daily	1040	France	10 - 9390

Oudin et al. (2010) Velazquez et al. (2010) Boldetti et al. (2010) Pushpalatha et al. (2011) Pushpalatha et al. (2012) Andréassian et al. (2012) Lerat et al. (2012)	approaches; Evaluation of the concept of similarity; Test of multi-model approach; Data-set cleansing and regionalization; Model development for low-flow simulation; Analysis of efficiency criteria; Test of neighbour catchment model; Test of multi-site calibration approach				
Oudin et al. (2008a)	Link between vegetation type and long term water balance	Inter annual	1508	France, UK, USA, Sweden	1 - 10329
Payan et al. (2008)	Simulation of catchments influenced by dams	Daily	46	France, USA, Brazil	12 - 50600
Perrin et al. (2008)	Test of a discrete parameterization approach	Daily	900	France, USA, Australia	10 - 10330
Reichl et al. (2009)	Definition of similarity measures	Daily	184	Australia	53-2062
Viviroli et al. (2009b) Viviroli et al. (2009a)	Regionalization of the PREVAH model	Hourly	140	Switzerland	~10 - 1000
Berthet et al. (2009) Berthet et al. (2010a) Berthet et al. (2010b)	Comparison of continuous and event-based approaches for flow forecasting; Analysis of quadratic criteria behaviour	Hourly	178	France	10 - 5940
Randrianasolo et al. (2010) Randrianasolo et al. (2011)	Evaluation of ensemble forecasts; Ensemble forecasting at ungauged sites	Daily	211	France	Not provided
Valéry et al. (2010)	Water balance in mountainous areas	Daily	188	France, Sweden	1 - 15000
Javelle et al. (2010)	Sensitivity of flash flood warning to initial moisture conditions	Hourly	160	France	7 - 2550
Vaze et al. (2010)	Model testing in non-stationary conditions	Daily	61	Australia	50-2000
Samaniego et al. (2010)	Predictions in ungauged basins	Daily	38	Germany	70-4000
Merz et al. (2009) Merz et al. (2011)	Scale effect in hydrological modelling; Parameter stability in non-stationary conditions	Daily	273	Austria	10-130000

Coron et al. (2012)	Model testing in non-stationary conditions	Daily	228	Australia	~70-1240
Brigode et al. (2013)	Quantification of parameter uncertainty in non-stationary conditions	Daily	89	France	32-109930
Stromqvist et al. (2012)	Test of the HYPE model	Daily	318	Sweden	~1-1000
Nester et al. (2012a)	Analysis of snow melt in a forecasting model	Hourly	57	Austria, Germany	70 - 25600
Nester et al., (2011) Nester et al. (2012b)	Analysis of flood forecasts and ensemble spread	Hourly	57	Austria, Germany	70 - 25600
Samuel et al. (2011) Samuel et al. (2012b) Samuel et al. (2012a)	Regionalization of the MAC-HBV model; Climate change impact study	Daily	111	Canada	~100 - 100000
Viglione et al., (2013)	Comparison of runoff model with Top-kriging	Daily	213	Austria	15 - 6000
Livneh and Lettenmaier (2012, 2013)	Parameter estimation for Unified land model	Daily and Monthly	260	USA	~100-1353269
Kumar et al. (2013)	Implications of model parameterization on water fluxes	Daily	45	Germany	~100-13000

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