Meta-Gaussian model - Alberto Montanari

PUB-IAHS Workshop
Uncertainty Analysis in Environmental Modelling
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a) Introduction:

The method is a statistically based technique for assessing the uncertainty of rainfall-runoff model when these are applied for simulating synthetic river discharge data. The method is based on inferring the probability distribution of the model error conditioned to the value of the simulated river flow. This goal is reached by analysing the statistical properties of the model error in simulating observed river flow data. Application is simple and very fast. The users need a time series of simulated river flow (possibly long) along with the time series of the corresponding model simulation errors. The two time series are transformed with the normal quantile transform in order to make them Gaussian, and a linear regression is computed in the Gaussian domain for relating the model error with the corresponding simulated river flows. This allows the probability distribution of the model error in the Gaussian domain to be derived. By applying back the normal quantile transform it is possible to derive the probability distribution of the model error in the not transformed domain.

Goodness of fit tests can be applied in order to check that the uncertainty is estimated reliably.

b) Advantages

- It is statistically based. The goodness of the fit can be verified in a objective way.
- It provides an objective estimation.
- Can be applied in conjunction with any rainfall-runoff model.
- Application is simple and fast.
- It is not computer intensive.

c) Disadvantages

- Needs to be calibrated by using historical river flow data.
- It is influenced by non-stationarity in time of the model performances.
- Not always applicable; the underlying assumptions might not be verified.
- May be unreliable for estimating the uncertainty of river flows that are outside the range of the river flows used for calibrating the method.

d) Assumptions

In the Gaussian domain, the regression of the model error on the contemporary simulated river flow is Gaussian.

Model performances are stationary in time.

e) Most appropriate application areas

Rainfall-runoff modelling in simulation. For instance:

*** Estimating the uncertainty of long simulations of synthetic river flows;**

*** Estimating the uncertainty of design flows derived by applying rainfall-runoff models;**

*** Estimating the uncertainty of generated design hydrographs.**

f) Reading list

Montanari, A., Brath, A., 2004. A stochastic approach for assessing the uncertainty of rainfall-runoff simulations. Water Resour. Res., 40, doi:10.1029/2003WR002540.

Montanari, A., 2004. Uncertainty assessment in rainfall-runoff modelling. A review. Proceedings of the workshop "Metodi statistici e matematici per l'analisi delle serie idrologiche", (Statistical and mathematical methods for the analysis of hydrological time series), Naples May 7 2004, edited by D. Piccolo e Lucio Ubertini, publication n. 2854 of the National Research Council of Italy, National Group for the Prevention of the Hygeological Disasters.

Both papers can be downloaded from http://www.costruzioni-idrauliche.ing.unibo.it/people/alberto

g) Software availability

A software for the application of the method is available for domnload from http://www.costruzioni-idrauliche.ing.unibo.it/people/alberto . Ir runs under the R environment (explanations are given at the web site).

h) Web links or other information

http://www.costruzioni-idrauliche.ing.unibo.it/people/alberto . I reported here a brief resume of my research activity about uncertainty estimation (work still in progress).

i) Figures

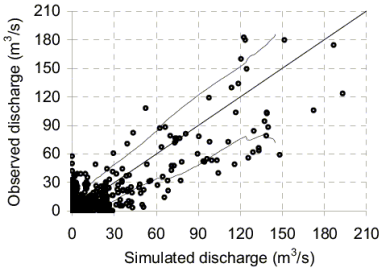

Figure 1: example of application of the meta-Gaussian model for estimating the confidence bands of two years (1994-1995) of simulated river flows on the Samoggia River basin (Italy). From Montanari and Brath, 2004.

j) Delegates Comments (please add !!)