Random errors	1%	10%
θ [m^{6}s^{-3}]	2.0×10^{-2}	1.0×10^{-2}
σ_R^2 [m^{6}s^{-2}]	1.7×10^{-1}	9.3

Table 6.1. Reverse routing: estimated structural parameters .

An example application of reverse flood routing in open channels is presented in this section (D’Oria and Tanda, 2012). Reverse flood routing is useful to obtain hydrographs in upstream ungauged stations by means of information available at downstream monitored sites. The considered channel was prismatic and 20 km long; the cross sections (spaced by 100 m) were trapezoidal in shape with bottom width of 10 m and side slope of 2/1. A longitudinal channel slope of 0.001 and a Manning coefficient of 0.033 m$^{-1/3}$s were adopted. The upstream and downstream boundary conditions were a discharge time series and the uniform flow condition, respectively. The initial condition was set consistent with the steady-state of a constant flow rate equal to the first value of the upstream hydrograph. The BASEChain module of BASEMENT (Faeh and others, 2011) that solves the De Saint Venant equations for unsteady one dimensional flow was adopted as forward model. A flood wave with time to peak of 2.5 hours, peak discharge of 164 m^3/s and base flow of 25 m^3/s was considered to obtain the corresponding downstream outflow subsequently corrupted with multiplicative random errors and used in the inverse procedure. The simulation time was equal to 15 hours; the input and output hydrograph time discretization was constant and equal to 5 minutes resulting in 181 values. The initial flow condition and the downstream discharge time series (181 observations) were then used to estimate the inflow hydrograph (181 parameters). The initial parameter values were set to the mean value of the observations. The sensitivity (Jacobian) matrix was evaluated by means of a finite difference calculations using the python linkage and PEST, as capable in the released version of bgaPEST. The epistemic error term σ_R^2 and the linear variogram slope parameter θ were estimated by the restricted maximum likelihood value algorithm.

In Figure 6.1 the actual input hydrograph, the actual downstream hydrograph, assessed by applying the forward model, and the error corrupted one used for the inversion are reported along with the reproduced inflow and the corresponding outflow. Table 6.1 summarizes the estimated structural parameters. In the first case the downstream hydrograph was corrupted with a 1% multiplicative random error (Figure 6.1a), in the second case a 10% multiplicative random error was used (Figure 6.1b). In both the inversions, there is a good match between the estimated input hydrograph and the actual one; the peak discharge and time are properly reproduced. The estimated epistemic error variance increases in the second case taking account of the higher erroneous observations (Table 6.1).

Apostrophe is needed

References Cited

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Faeh, R., Mueller, R., Rousselot, P., Vetsch, D., Volz, C., Vonwiller, L.R.V., and Farshi, D., 2011, System manuals of BASEMENT, version 2.1: Zurich, Switzerland, ETH Zurich Laboratory of Hydraulics, Glaciology and Hydrology (VAW).

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