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METHODOLOGY FOR THE STUDY OF AN ACTUAL CASE OF MASS TRANSFER BETWEEN RIVER AND GROUNDWATER

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The following methodology was perfected and applied - for Strasbourg Urban Community Water-Department part - during works about the possibilities of water mass transfer between the Rhine and the alsatian groundwater, beside the main supply wells of drinking water of Strasbourg urban centre (le Polygone) on south east of the town (Collongues, 1979).

To mark the flows, we used a tracer which is present in the two media : chloride (mainly coming from discharges of alsatian potash mines).

Before trying to do any representation of the studied system, we first gave our attention to the information we had ; it seemed us essential because it conditions, in its totality, the treatment of the set problem.

So, in the pumping wells, there were series of punctual monthly values of the chloride content of water. In the Rhine, we had either values calculated from other data, in daily averages form, or punctual daily or fortnightly values, according to the place of data sampling.

First we need to evaluate these different nature series, which were disparate in time and space, even inaccurate and often unsufficient.

This was done with Student's homogeneity statistical tests (i.e. impossibility to rule out the concordance hypothesis for 95 per cent), experimental methods to generate data and mainly with the spectral analysis utilization. So we were lead to check physical hypothesis, to propound averaging values rather than instantaneous ones, to make homogeneous available series by discretization.

It results from this method that input and output chronological series we obtained, liable of involving a modelization of studied system, are relatively estimative ; the used processus enabled to validate them and to be sure of their coherence.

Consequently, an adequate and pertinent modelization from such data has no reason to be sophisticated.

Linked with the nature of series to modelize, simplifying hypothesis assert themselves : stationarity, linearity, lumped parameters representation, homogeneous medium equivalent to the actual medium... Coherence being ensured, we can either

choose a conceptual model (grey box) by making a structural hypothesis about medium or apply a classical deconvolution method (black box).

In the first case, if we consider the aquifer as a succession of N identical reservoirs in series, we get a response function with two parameters (K, N) :

$$h(t) = \frac{1}{\Gamma(N)K^N} t^{N-1} e^{-t/K} \qquad \text{(N is not necessarily integer)}$$

The mean of this function is $\mu = K.N$ and represents the average time of transfer given by the spectral analysis of input and output series. The obtaining of N and K becomes simultaneously during the calibration procedure aiming to minimize differences between the observed and computed data.

In the second case, the form of the response function is no more pressupposed (Collongues and al, 1980). It can usefully give information about constitutive elements of the medium. So, in this peculiar case, it enabled to examine and to check the part of preferential circulation played by an old arm of the Rhine which is filled up and situated between the river and the pumping field.

The representation of the system which was already satisfying, was yet improved by dissociating two seperate inputs : one, from the Rhine, and very variable in time, the other from the groundwater itself and corresponding to a basis-level of chloride concentration in aquifer.

Finally, we shall notice that it is a statistical method of data series analysis, spectral analysis, which rules all the propounded methodology, and this is easy to use and can be considered as a step which must precede any substance transfer study.

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