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Hydrology and Earth System Sciences Discussions

Interactive comment on "Development of a method of robust rain gauge network optimization based on intensity-duration-frequency results" *by* A. Chebbi et al.

Anonymous Referee #1

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General comments

Reading the paper "Development of a method of robust rain gauge network optimization based on Intensity-Duration-Frequency results" was an interesting experience for me and it gave me a new perspective on the problems of practical hydrology. While reading the paper I came across several statements that, at least to me, were not at all obvious. Therefore I will use this review as an opportunity to seek clarification from the authors. I feel references to earlier works on sensor or weather station network design should be added, one such reference would be Hughes and Lettenmaier (1981) where

Kriging is also used in sensor network design.

Specific comments

- On page 14211 in line 19 you refer to Chilès et al. (1991) to support your statement that constant $r_{a(T)b(T)}(h)$ implies the variables are dependent. However, Chilès et al. (1991) merely states that in that case there is "intrinsic correlation", in other words the variables in question have the same relation at all scales (and it seems to me that that relation may be a weak correlation when $r_{a(T)b(T)}(h)$ is small Wackernagel (1994); Goovaerts (1994)), is that what you mean by dependent?
- In line 23 of page 14211, which definition of Kriging error do you use? In Bancroft and Hobbs (1986) it is defined as the distribution of the error in estimating a value at a point. In Pardo-Iguzquiza (1998) it is stated that "the square root of the estimation variance (the S.D. of the estimation error) known as Kriging error, or standard error...", see also Atkinson (1991). On the other hand in Delhomme (1978) the following formula is given:

$$\sum_{i=1}^{n} \lambda_i Z(x_i) - Z(x_0)$$

- On page 14212 you propose to use External Drift Kriging to improve the estimate of $a(T)$ by using $b(T)$. I fail to see how this can work. External Drift Kriging as described in Bárdossy and Lehmann (1998) assumes a linear relation between the two variables andHudson and Wackernagel (1994) states:

> "In certain applications a regionalized variable s(x) can be measured exhaustively in the domain D. If s(x) happens to be equivalent to

$E[Z(x)]$ up to a linear transformation ... When such a shape function is available, it is worthwhile to insert it as an additional constraint into the universal Kriging system."

These conditions do not seem to be satisfied here. Moreover, from the current text it is not clear to me why deriving a from b would be better than simply Kriging a.

- On page 14212 the objective function is defined in terms of itself in Eq. 8 and then on page 14213 it is redefined. The definition of $\mathrm{OF}_{\mathrm{ref}}$ would be clearer if given in formula form.
- In line 10 of page 14213 you state that "In all cases, the minimization problem is solved using a simulated annealing algorithm". What do you mean by "all cases"?
- In line 10 of page 14213 you state that "the minimization problem is solved", however you have not yet specified and parametrized the space of feasible solutions. Moreover, it is not at all clear to me how your objective function will work.
- In line 21 of page 14214, what do you mean by "overrun"?
- In the abstract and the introduction you promised a robust design. Please add a section that demonstrates that your design method (not just its outcome in this case) is robust.

Technical corrections

- On line 26 of page 14207 you state "Rainfall intensity is considered as a random variable". Given that you later implicitly make your rainfall intensity duration curve dependent on location, do you mean: "Rainfall intensity at a given location is considered as a random variable"?

- On page 14208 at line 14 you use the term "sparsely distributed", what do you mean by this?
- On page 14208 at line 16 you use the term "size of the initial network", does this refer to spatial extent, number of stations or both?
- On page 14209, you state that "To deal with hydrological risk, we would need data on the maximum rainfall intensities recorded for several events. However, the problem is that we do not have this type of information for the study area. Thus, the adjustment parameters of the intensity-duration-frequency (IDF) curves (Koutsoyiannis et al., 1998) are proposed as alternative." Is it correct that by "adjustment parameters" you mean the parameters $a(T)$ and $b(T)$ from Eq. 1?
- On page 14209 you refer to Eq. 1 as the Montana model, what distinguishes this model from a power law relation (as mentioned in Burlando and Rosso (1996, Eq. 2))?
- On page 14210 in line 3 you use the term "geostatistical variable" could you please either give a short definition or a reference to a definition?
- On page 14210 starting at line 9 you define the cross variogram by Eq. 2, which seems to be the experimental cross variogram Chilès and Delfiner (1999, page 334).
- On page 14211 why do you use the adjective "digital" in line 6?
- On page 14212 there seems to be a typing error in the subscript of the last term of Eq. 8.
- On page 14214 in line 3 you write "An erratic fluctuation about a fixed value", do you mean to say that there is no pattern to the fluctuation?

- In Eq. A5 on page 14217 the forward slash should probably be a vertical bar (Bárdossy and Lehmann (1998),Hudson and Wackernagel (1994),Chilès and Delfiner (1999)).

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