Geophysical Research Abstracts,
Vol. 11, EGU2009-10587, 2009
EGU General Assembly 2009

Accounting for irregular support in spatial interpolation – analysing the effect of using alternative distance measures

J. O. Skøien (1), L. Gottschalk (2), and E. Leblois (3)

(1) Dept of Physical Geography, Utrecht University, The Netherlands; j.skoien@geo.uu.nl, (2) Dept of Geosciences, University of Oslo, Norway , (3) Cemagref, Lyon, France

Whereas geostatistical and objective methods mostly have been developed for observations with point support or a regular support, e.g. runoff related data can be assumed to have an irregular support in space, and sometimes also a temporal support. The correlations between observations and between observations and the prediction location are found through an integration of a point variogram or point correlation function, a method known as regularisation. Being a relatively simple method for observations with equal and regular support, it can be computationally demanding if the observations have irregular support. With improved speed of computers, solving such integrations has become easier, but there can still be numerical problems that are not easily solved even with high-resolution computations. This can particularly be a problem in hydrological sciences where catchments are overlapping, the correlations are high, and small numerical errors can give ill-posed covariance matrices. The problem increases with increasing number of spatial and/or temporal dimensions.

Gottschalk [1993a; 1993b] suggested to replace the integration by a Taylor expansion, hence reducing the computation time considerably, and also expecting less numerical problems with the covariance matrices. In practice, the integrated correlation/semivariance between observations are replaced by correlations/semivariances using the so called Ghosh-distance. Although Gottschalk and collaborators have used the Ghosh-distance also in other papers [Sauquet, et al., 2000a; Sauquet, et al., 2000b], the properties of the simplification have not been examined in detail. Hence, we will here analyse the replacement of the integration by the use of Ghosh-distances, both in sense of the ability to reproduce regularised semivariogram and correlation values, and the influence on the final interpolated maps. Comparisons will be performed both for real observations with a support (hydrological data) and for more hypothetical observations with regular supports where analytical expressions for the regularised semivariances/correlations in some cases can be derived.

The results indicate that the simplification is useful for spatial interpolation when the support of the observations has to be taken into account. The difference in semivariogram value or correlation value between the simplified method and the full integration is limited on short distances, increasing for larger distances. However, this is to some degree taken into account while fitting a model for the point process, so that the results after interpolation are less affected by the simplification. The method is of particular use if computation time is of importance, e.g. in the case of real-time mapping procedures.

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