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DISPERING GROUNDWTER ANISOTROPHY USING SEMIVARIOGRAM: A GEOSTATISTICAL APPROACH

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Abstract:- Control of groundwater contamination in a contaminated site is very important. For this reason, the effects of transport and final fate of contaminants in the subsoil should be studied. Geostatistics is a spatial statistical technique that can be used to assess and represent the distribution of concentration over space and time. Semivariogram analysis is potentially useful for detecting scales of variability in spatial data. Directional semivariogram examines the patterns of anisotropy in the data set for pollution studies and deciphering groundwater transport behavior such as flow pathways, information on fluid flow behavior (both present and predicted) is needed to assess the contamination impact of spills and plumes and the planning and assessment of remediation efforts and locating the groundwater contamination sources. Anand block of old Kheda district, part of by Mahi Right Bank Canal (MRBC), the Mahi Kadana project of Gujarat state is taken as study area.

I. INTODUCTION:

The first law of geography is "Everything is related to everything else, but near things are more related than distant things.” It is natural that nearby places have similar climate as compared to places which are far apart. Amount of rainfall, groundwater, and iron ore deposits vary gradually over space. Such natural processes that vary gradually with respect to distance are said to be spatially correlated.

A spatial dependence structure is a function only of the distance separating the locations observed, and then the process that describes the spatial variability of the property is said isotropic. However, if this structure differs in relation to the direction, then the process is said anisotropic. Anisotropy is defined as the condition of having different properties in different directions. If the variable exhibits different ranges in different directions, then there is a geometric anisotropy. If the variable exhibits different sills in different directions, then there is a zonal anisotropy.

II. AREA

The Mahi Kadana project is one of major irrigation projects of Gujarat State. It has been developed in two segments. The first segment secured by Mahi Right Bank Canal (MRBC) comprise of 74.0 kms long canal system covering gross command area of about 3.16 lacks hectares extending over seven blocks of old Kheda District. The second segment of Mahi Left Bank Canal (MLBC) covers two blocks of Panchmahal district. The Irrigation command area of MRBC is located between Latitude 22º26’ N to 22º55’ N and Longitude 72º49’ E to 22º55’ E. Anand block of old Kheda district is taken as study area. Post monsoon season data of ground water levels (GWL) of year 1998 are taken as attribute data.

III. SEMIVARIOGRAM:

Spatially independent data show the same variability regardless of the location of data points. However, spatial data in most cases are not spatially independent. Data values, which are close spatially, show stronger correlation than data values, which are farther away from each other. The traditional measurement of spatial correlation is the semivariogram. Semivariogram analysis examines the contribution to the total sample variance made by the average semivariogram of all pairs of points that are separated by a specific lag distance. Thus, adjacent objects are compared first, then every other object, then every third, and so on; the separation or lag distance ranges from 1 (adjacency) to a possible maximum of one-half the spatial size of the data set (larger lags eliminate points from the analysis).

The standard equation for the semivariogram is:

$$\Gamma(h) = \frac{1}{2n}\sum_{i=1}^{n}\left[Z(x_i) - Z(x_{i+h})\right]^2$$

Where

The Γ (h) is an **experimental semivariogram** computed from the data.

h is the lag distance between data point pairs.

N. is number of pairs at xi …. Xi+1 … xi+h number of pairs separated by distance h;

xi are location of the sample;

Z(xi) are the data values,

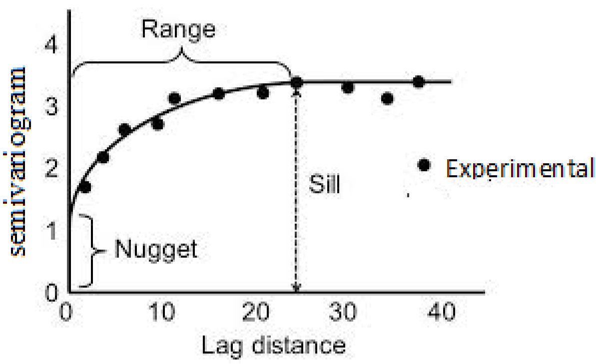

Fig 1 Semivariogram

Fig 1 shows semivariogram, which plot experimental semivariogram against lag distance, typically increase from a theoretical Y intercept of zero (the ‘nugget’), and level off at the maximum semivariogram (the ‘sill’), which occurs at and beyond a particular lag distance (the ‘range’). The range identifies the distance beyond which pairs of objects no longer exhibit spatial autocorrelation. Those objects separated by distances less than the range exhibit some degree of correlation. Summarizes this relationship as the first law of geography, which states that nearby objects are more likely to be similar than are widely separated objects. Semivariogram analysis assumes the data are both stationary (i.e., variance is due to separation distance alone).

IV. DIRECTIONAL SEMIVARIOGRAM:

The Semivariogram discussed above consider only the distance of separation among all pairs of sample points. However, for data with spatial dependence, it might be logical to consider even the relative direction between pairs of sample points as well. Semivariogram for assessing anisotropy in data are called directional semivariogram. To consider direction, the region of sample points is divided into classes based on angles. Then, a Semivariogram is plotted for each angle class.

V. ANISOTROPY

Anisotropy occurs whenever the spatial correlation pattern changes with the direction of orientation of pairs of sites. There are two types of anisotropy. (a) Geometric: This occurs when the range varies with the direction of the semivariogram, but the sill remains constant. (b) Zonal: This occurs when both the range and sill might vary with the direction of the variogram. This is sometimes also referred to as sill anisotropy to emphasize that the sill may vary with direction, unlike in the geometric case.

VI. THE EXPERIMENTAL SEMIVARIOGRAM

The experimental semivariogram approach is proposed for modeling regionalized variables in the groundwater variography. This semivariogram is defined as the successive summation of half-squared differences which are ranked according to the ascending order of distances extracted from all possible pairs of sample locations within a region. This procedure is useful especially when sampling points are irregularly distributed within the study area. Experimental semivariogram possess all of the objective properties of classical semivariogram.

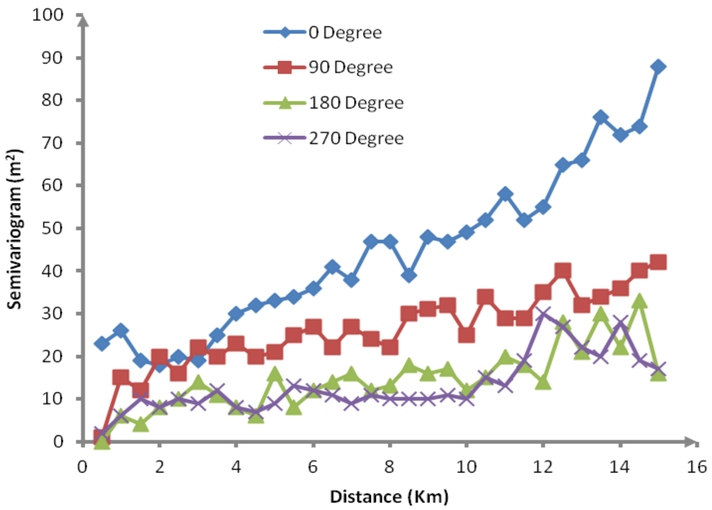

Fig 2 Anand, GWL, Postmonsoon 1998

VII. CONCLUSION

A through geostatistical data analysis includes a careful study of how the data's second order variation, as characterise by the semivariogram depends on the relative orientation of data locations. If the semivariogram depends on on the (Eucadian) distancebetween the locations, then the semivariogram is isotropic; otherwise, it is an anisotropic.

Fig.2 shows the directional semivariogram estimated from the data. The semivariogram is estimated in four directions 00. 900, 1800, 2700. In common with the semivariogram shown in figure 2, the directional variogram suggests continuity in 1800 & 2700 direction than in the 00 & 900 directions, for the other directions, the maximum semivariogram are larger than 00 & 900 directions. Thus, the semivariogram provides a summary of how a variable is structured at different spatial scales and for the different directions. In this case, models fitted to the semivariogram for different directions would have different sills thus a zonal anisotropy.

REFERENCES

[01] Armstrong, M. (1998). Basic Linear Geostatistics, Springer-Verlag Berlin Heidelberg, Germany

[02] ASCE Task committee on on Geostatistical Techniques in Geohydrology. 1990. Review of geostatistics in geohydrology. Journal of Hydraulic Engineering. 116(5):612-658.

[03] Cressie, N. (1993). Statistics For Spatial Data, John Wiley & Sons, New Jersey

[04] Chiles,J.P.,P.Delfiner,1999, Geostatististics, Modelling Spatial Uncertainty, Wiley-Interscience.

[05] De Marsily, G 1986. Quantitative Hydrogeology, Ground water Hydrology for Engineers. Academic press, California,

[06] Isaaks, E.H., and R.M. Srivastava. 1989. An introduction to applied geostatistics. 560 p. Oxford University Press, New York, USA.

[07] Matheron, G. (1963), Principles of Geostatistics. Economy Geology, vol. 58 : 1246-66.