Evaluation and Comparison of Spatial Interpolators II\textsuperscript{1,2} 

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The performance of several variations on ordinary kriging and inverse distance estimators is evaluated. Mean squared errors (MSE) were calculated for estimates made on multiple resamplings from five exhaustive data bases representing two distinctly different types of estimation problem. Ordinary kriging, when performed with variograms estimated from the sample data, was more robust than inverse-distance methods to the type of estimation problem, and to the choice of estimation parameters such as number of neighbors.

KEY WORDS: kriging, geostatistics, spatial estimation, inverse-distance estimation.

INTRODUCTION

Spatial interpolation is important in many environmental studies. The U.S. EPA Environmental Monitoring Systems Laboratory–Las Vegas has been investigating the performance of various interpolators, especially as they apply to sampling, estimation, and remediation of contaminated soils and sediments. Previous studies by the authors have investigated the effects of various estimation parameters on the quality of spatial estimates. Englund (1990) showed that the variability was high among estimates (obtained primarily by kriging) by 12 different statisticians working with two common sets of data. Englund et al. (1992) investigated the effects of sample size, grid type, and sampling error on estimation accuracy, by using 54 sample datasets drawn from a single large

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exhaustive database. The most important parameter proved to be the number of samples per dataset, where the estimation accuracy improved with increasing number of samples.

Weber and Englund (1992) evaluated the relative accuracy of 15 different spatial estimators by using the same 54 sample datasets drawn from a single exhaustive database, showing that the inverse-distance and inverse-distance-squared interpolators performed slightly better than ordinary and simple kriging. The authors concluded that these results, while provocative, did not mean that inverse-distance methods are superior to kriging estimators for all types of data; different types of data and kriging methodology could be imagined wherein kriging would be expected to have a distinct advantage over the particular inverse-distance algorithms used. The nature of the database may have fortuitously favored inverse-distance. Both the kriging methods and variogram modeling were relatively simplistic; changing either might have significantly altered the results. Finally, strong anisotropy and clustering of samples, which favors kriging, were not present in the data.

In this paper, we address these issues with a more extensive comparison of several inverse-distance and kriging interpolators. We evaluate their relative performance on five exhaustive databases that represent distinctly different types of physical phenomena.

**DATABASE DESCRIPTIONS**

The five databases, like the Walker Lake database used in the earlier studies, were taken from digital elevation models obtained from the National Cartographic Information Center. The goal was to select several databases representing surfaces that have different characteristics. Three of the databases use elevation data, and two of them represent the local variance of elevation data. Each variance was calculated from a 2 row by 2 column grid of a larger set (86,400) of the original elevation data.

Each database contains 21,600 data on a common grid of 120 rows by 180 columns. Corresponding 20 by 30 arrays of block averages were generated from the arithmetic means of 6 by 6 arrays of points in each of the databases. Statistical parameters are given below in Table 1. Figures 1a-1e show three-dimensional perspective views of the five databases, and Figs. 2a-2e show the corresponding histograms. The elevation databases are relatively unskewed, with fairly smooth, continuous surfaces. We believe that they can fairly represent other phenomena sharing these characteristics: geological structural surfaces; thickness of lithologic units, hydraulic head, surface water temperature, barometric pressure, etc. The variance databases are highly skewed, and present discontinuous, noisy surfaces. These distributions are similar to those of con-