

[Home](#) > [Journal](#) > [Earth & Environmental Sciences](#) > [IJG](#)
[Indexing](#) | [View Papers](#) | [Aims & Scope](#) | [Editorial Board](#) | [Guideline](#) | [Article Processing Charges](#)
[IJG](#) > Vol.3 No.3, July 2012



Improving the Prediction Accuracy of Soil Mapping through Geostatistics

PDF (Size: 5615KB) PP. 574-590 DOI: 10.4236/ijg.2012.33058

Author(s)

El-Sayed Ewis Omran

ABSTRACT

This research aimed to implement and compare the accuracy of different interpolation methods using cross validation errors for interpolating the spatial pattern of soil properties. This paper investigates whether the use of kriging, instead of traditional interpolation methods, improves the accuracy of prediction of soil properties. To this end, various interpolation (kriging) techniques that rely on the spatial correlation between observations to predict attribute values at ensampled locations are studied. Geostatistics provides descriptive tools such as semivariograms to characterize the spatial pattern of continuous and categorical soil attributes. The maps obtained from Ordinary Kriging, Inverse Distance Weighting and splines show clearly that the map from Universal Kriging (UK) is better than the other three interpolation methods. Therefore, UK can be considered as an accurate method for interpolating soil (EC, pH, CaCO₃) properties.

KEYWORDS

Soil Maps; Geostatistics; Soil Properties; Prediction Accuracy; Cross Validation; Interpolation Methods

Cite this paper

 E. Omran, "Improving the Prediction Accuracy of Soil Mapping through Geostatistics," *International Journal of Geosciences*, Vol. 3 No. 3, 2012, pp. 574-590. doi: 10.4236/ijg.2012.33058.

References

- [1] D. G. Rossiter, " Methodology for Soil Resource Inventories," ITC Lecture Notes SOL.27, 2nd Edition, Enschede, 2001.
- [2] El E. Omran, " Is Soil Science Dead and Buried? Future Image in the World of 10 Billion People," *CATRINA*, Vol. 3, No. 2, 2008, pp. 59-68.
- [3] El E. Omran, " Spatial Data Infrastructure to Support Land Evaluation Applications in Egypt," MSc Thesis Report GIRS-2005-016, Centre for Geo-Information, Wageningen Univesity, Wageningen, 2005.
- [4] El E. Omran, J. Crompton and A. K. Bregt, " Benefits and Bottlenecks for SDI Development in Egypt," *GIS Development*, Vol. 2, No. 1, 2006, pp. 32-35.
- [5] L. Stroosnijder, " Measurement of Erosion: Is It Possible?" *Catena*, Vol. 64, No. 2-3, 2005, pp. 162-174. doi:10.1016/j.catena.2005.08.004
- [6] S. Ordu and A. Demir, " Determination of Land Data of Ergene Basin (Turkey) by Planning Geographic Information Systems," *Journal of Environmental Science and Technology*, Vol. 2, No. 2, 2009, pp. 80-87. doi:10.3923/jest.2009.80.87
- [7] F. K. J. Rabah, S. M. Ghabayen and A. A. Salha, " Effect of GIS Interpolation Techniques on the Accuracy of the Spatial Representation of Groundwater Monitoring Data in Gaza Strip," *Journal of Environmental Science and Technology*, Vol. 4, No. 6, 2011, pp. 579-589. doi:10.3923/jest.2011.579.589
- [8] B. Minasny and A. B. McBratney, " Spatial Prediction of Soil Properties Using EBLUP with the Matérn

- [Open Special Issues](#)
- [Published Special Issues](#)
- [Special Issues Guideline](#)

[IJG Subscription](#)
[Most popular papers in IJG](#)
[About IJG News](#)
[Frequently Asked Questions](#)
[Recommend to Peers](#)
[Recommend to Library](#)
[Contact Us](#)

Downloads:	165,253
------------	---------

Visits:	393,875
---------	---------

[Sponsors, Associates, and Links >>](#)

- [9] W. J. Shi, J. Y. Liu, Z. P. Du, Y. J. Song, C. F. Chen, and T. X. Yue, " Surface Modelling of Soil pH," *Geoderma*, Vol. 150, No. 1-2, 2009, pp. 113-119. doi:10.1016/j.geoderma.2009.01.020
- [10] J. Negreiros, A. C. Costa and M. Painho, " Evaluation of Stochastic Geographical Matters: Morphologic Geostatistics, Conditional Sequential Simulation and Geographical Weighted Regression," *Trends in Applied Sciences Research*, Vol. 6, 2011, pp. 237-255. doi: 10.3923/tasr.2011.237.255
- [11] O. Falivene, L. Cabrera, R. Tolosana-Delgado and A. Saez, " Interpolation Algorithm Ranking Using Cross- Validation and the Role of Smoothing Effect: A Coal Zone Example," *Computers & Geosciences*, Vol. 36, No. 4, 2010, pp. 512-519. doi:10.1016/j.cageo.2009.09.015
- [12] A. Kravchenko and D. G. Bullock, " A Comparative Study of Interpolation Methods for Mapping Soil Properties," *Agronomy Journal*, Vol. 91, No. 3, 1999, pp. 393- 400. doi:10.2134/agronj1999.00021962009100030007x
- [13] T. Panagopoulos, J. Jesus, M. D. C. Antunes and J. Beltrao, " Analysis of Spatial Interpolation for Optimising Management of a Salinized Field Cultivated with Lettuce," *European Journal of Agronomy*, Vol. 24, No. 1, 2006, pp. 1-10. doi:10.1016/j.eja.2005.03.001
- [14] N. C. Wollenhaupt, R. P. Wolkowski and M. K. Clayton, " Mapping Soil Test Phosphorus and Potassium for Variable-Rate Fertilizer Application," *Journal of Production Agriculture*, Vol. 7, No. 4, 1994, pp. 441-447.
- [15] C. A. Gotway, R. B. Ferguson, G. W. Hergert and T. A. Peterson, " Comparison of Kriging and Inverse-Distance Methods for Mapping Soil Parameters," *Soil Science Society of America Journal*, Vol. 60, No. 4, 1996, pp. 1237- 1247. doi:10.2136/sssaj1996.03615995006000040040x
- [16] G. Matheron, " The Theory of Regionalized Variables and Its Applications," *Technical Report 5*, Paris School of Mines. Les Cahiers du Centre de Morphologie Mathématique De Fontainebleau, Paris, 1969.
- [17] P. Goovaerts, " Geostatistics in Soil Science: State-of- the-Art and Perspectives," *Geoderma*, Vol. 89, No. 1-2, 1999, pp. 1-45. doi:10.1016/S0016-7061(98)00078-0
- [18] T. Hengl, G. B. M. Heuvelink and A. Stein, " A Generic Framework for Spatial Prediction of Soil Variables Based on Regression-Kriging," *Geoderma*, Vol. 120, No. 1-2, 2004, pp. 75-93. doi:10.1016/j.geoderma.2003.08.018
- [19] J. Triantafyllis, I. O. A. Odeh, B. Warr and M. F. Ahmed, " Mapping of Salinity Risk in the Lower Namoi Valley Using Non-Linear Kriging Methods," *Agricultural Water Management*, Vol. 69, No. 3, 2004, pp. 203-231. doi:10.1016/j.agwat.2004.02.010
- [20] K. H. Kamble and P. Aggrawal, " Geostatistical Analyst for Deciding Optimal Interpolation Strategies for Delineating Compact Zones," *International Journal of Geosciences*, Vol. 2, 2011, pp. 585-596
- [21] R. Webster and M. A. Oliver, " Sample Adequately to Estimate Variograms of Soil Properties," *Journal of Soil Science*, Vol. 43, No. 1, 1992, pp. 177-192. doi:10.1111/j.1365-2389.1992.tb00128.x
- [22] D. D. Webster and E. J. Englund, " Evaluation and Comparison of Spatial Interpolators II," *Mathematical Geology*, Vol. 26, No. 5, 1994, pp. 589-603. doi:10.1007/BF02089243
- [23] A. N. Kravchenko, " Influence of Spatial Structure on Accuracy of Interpolation Methods," *Soil Science Society of America Journal*, Vol. 67, No. 5, 2003, pp. 1564-1571. doi:10.2136/sssaj2003.1564
- [24] R. H. G. Jongman, C. J. F. Ter Braak and O. F. R. Van Tongeren, " Data Analysis in Community and Landscape Ecology," Cambridge University Press, Cambridge, 1995. doi:10.1017/CBO9780511525575
- [25] R. Webster and M.A. Oliver, " Geostatistics for Environmental Scientists," John Wiley and Sons, West Sussex, 2001.
- [26] T.P. Robinson and G. Metternicht, " Testing the Performance of Spatial Interpolation Techniques for Mapping Soil Properties," *Computers and Electronics in Agriculture*, Vol. 50, No. 2, 2006, pp. 97-108. doi:10.1016/j.compag.2005.07.003
- [27] T. X. Yue, Y. J. Song and Z. M. Fan, " The Multi-Grid Method of High Accuracy Surface Modelling and Its Validation," *Ecological Modelling*, 2008.

- [28] M. L. Jackson, " Soil Chemical Analysis," Connaught Circus, New Delhi, 1973.
- [29] A. L. Page, R. H. Miller and D. R. Keeney, " Methods of soil analysis. Part 2. Chemical and Microbiological Properties," Agronomy, No. 9, Soil Science Society of America, Madison, 1982.
- [30] A. L. Page, " Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties," 2nd Edition, American Society of Agronomy, Madison, 1982, pp. 149-430.
- [31] M. Meuland and M. Van Meirvenne, " Kriging Soil Texture under Different Types of Nonstationarity," Geoderma, Vol. 112, No. 3, 2003, pp. 217-233. doi:10.1016/S0016-7061(02)00308-7
- [32] B. B. Trangmar, R. S. Yost and G. Uehara, " Application of Geostatistics to Spatial Studies of Soil Properties," In: N.C. Brady, Ed., Advances in Agronomy, Academic Press Inc., Orlando, Vol. 38, 1985, pp. 45-94.
- [33] P. A. Burrough, " Sampling Designs for Quantifying Map Unit Composition," In: M. J. Mausbach and L. P. Wilding, Eds., Spatial Variabilities of Soils and Landforms, SSSA Spec. Publ. 28, SSSA, Madison, 1991.
- [34] ESRI, " ArcMap Version 9.3 User Manual," Redlands, 2008.
- [35] S. Arlot and A. Celisse, " A Survey of Cross-Validation Procedures for Model Selection," Statistics Surveys, Vol. 4, 2010, pp. 40-79. doi:10.1214/09-SS054
- [36] M. Voltz and R. Webster, " A Comparison of Kriging, Cubic Splines and Classification for Predicting Soil Properties from Sample Information," European Journal of Soil Science, Vol. 41, No. 3, 1990, pp. 473-490. doi:10.1111/j.1365-2389.1990.tb00080.x
- [37] T. G. Mueller, N. B. Pusuluri, K. K. Mathias, P. L. Cornelius and R. I. Barnhisel, " Site-Specific Soil Fertility Management: A Model for Map Quality," Soil Science Society of America Journal, Vol. 68, No. 6, 2004, pp. 2031-2041. doi:10.2136/sssaj2004.2031
- [38] T. G. Mueller, F. J. Pierce, O. Schabenberger and D. D. Warncke, " Map Quality for Site-Specific Fertility Management," Soil Science Society of America Journal, Vol. 65, No. 5, 2001, pp. 1547-