Assessment of Sampling Pattern Variation & its Effect on Variability of Spatial Prediction

T.P.Singh[1],Vidya Kumbhar[2]

[1]Symbiosis Institute of Geo-Informatics, Symbiosis International University, 5th Floor, Atur Center, Gokhale Cross Road, Model Colony Pune, Maharashtra, India-411016
tpsingh@rediffmail.com
[2]Symbiosis Institute of Computer Studies and Research, Symbiosis International University, 1st Floor, Atur Center, Gokhale Cross Road, Model Colony , Pune, Maharashtra, India-411016
*kumbharvidya@gmail.com

ABSTRACT

Agriculture is a backbone in Indian Economy. Crop production improvement is very important in agriculture management. To improve crop production microlevel planning of crop growth parameters is very much essential. Soil is an important parameter for crop growth. The soil quality has to be monitored by regular soil testing. For effective soil quality management soil sampling pattern plays an important role. Current study is an attempt to assess effect of soil sampling pattern on spatial prediction.

Keywords : Spatial Prediction,Sampling pattern , Geostatistics

1 INTRODUCTION

Prediction involves estimation of variables at un-sampled locations. Spatial prediction is to estimate values at un-sampled point locations [1]. Spatial Interpolation techniques are used for Spatial Prediction. It involves prediction of variables at unmeasured locations based on a sample at known locations and generate spatially continuous data [2][3][4]. Different factors such as sample size, sampling design, data properties, relative spatial density and method used for spatial prediction affect the prediction accuracy[5].Data Variation is a dominant impact factor which significantly affects the performance of the interpolation methods. It is observed that accuracy of prediction increases as the variation in the data decreases [4]. The sampling pattern is also one of the major factors which determine the prediction quality. Study shows that with the increase in sample spacing the interpolation accuracy is decreased for the soil properties [6]. It is observed that irregular spaced sampling design improves the accuracy of prediction [7]. The z-pattern-grid-cell sampling, with ordinary kriging and IDW interpolation, indicated a tendency to provide lower prediction errors than other types of sampling [8]. Though accuracy level of grid sampling is high, this technique is laborious and expensive [9]. It was observed that, most accurate digital representation of acid soils was obtained when soil samples were collected within the boundaries of prevailing soil group and previously determined soil pH group than grid sampling. Spatial distribution of acid areas depends upon the methods of soil sampling and data mapping [10].The study also shows that on the go soil pH mapping gave accurate results than grid sampling [11]. It was observed that, the soil properties with strong spatial structure were mapped more accurately than those with weak spatial structure [12]. The objective of the current study is to assess sampling pattern variation and its effect on spatial prediction of soil pH.

2. STUDY AREA

The area selected for current study is Koregaon taluka of Satara district, Maharashtra, India. The area lies between 17° 27'40 "N to 18°01'11 "N and 74°00'45"E to 74°15'46"E.The total area covered by taluka is 901.14 km2. The soil type of the area varies from Medium to deep black, shallow red, mixed red and red loamy [13].

3. MATERIALS AND METHODS

3.1 Soil point data:

Current Study has used three types of soil sampling pattern. The soil samples from, 53 villages were collected from “District Soil Survey and Soil Testing Laboratory, Satara, Maharashtra”. The details of three types of models of sampling pattern are discussed below:

3.1.1 Type1 model of sampling pattern - "Cluster based Model":

The model is designed as follows:

i. Each village is considered as a cluster.
ii. Maximum possible samples of soil pH were collected from each cluster.
iii. Ordinary kriging was used for prediction and cluster wise average prediction value for soil pH is calculated.
iv. Ordinary kriging was again applied, for cluster wise average prediction values and prediction map for the entire study area was prepared.

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3.1.2 Type2 model of sampling pattern - "Random Point distribution":

In Type 2 model of sampling pattern, one random sample from each village is selected and then prediction map for the entire study area is prepared. In this type of model, spatial density of sampling pattern is reduced.

3.1.3 Type3 model of sampling pattern - "Grid wise Pattern point Distribution ":

The Type 3 model includes grid based sampling with linguistic fuzzy logic approach. In this type of sampling, the study area was divided into grid size 5KM ×5 KM. Then grid wise and village wise distinct soil pH pattern was identified by giving linguistic fuzzy logic approach. These representation values were interpolated by using ordinary kriging to prepare prediction map for the study area. Soil samples from same villages were collected in all the three models.

3.2 Geo-statistical Analysis

The spatial variability modeling is done through prediction and simulation. Geostatistical methods are widely used for the same. [14][15].These methods involve fitting a mathematical function to a specified number of points , or all points within a specified radius, to determine the output value. For current study, Ordinary Kriging as a Geostatistical model is used. (Equation 1).

Equation 1 Ordinary Kriging

$$F(X,Y) = \sum W_i F_i$$

4.0 Results and Discussions

The result shows that, Type 1 model gives lowest minimum error and Type 3 model has highest minimum error. Type2 model has given highest maximum error and Type1 model has given lowest maximum error. There is no significant difference in Mean error of Type1 and Type2 model. The results also show that, Type1 model has resulted in lowest average standard error. There is no significant difference in Root Mean Square Standardized error in all the three models. The current study reveals that, cluster based model has given accurate prediction results than random point distribution and Grid wise Pattern point Distribution. The accuracy of cluster based model is more than other models as there is two step prediction processes in cluster based model has reduced data variation and which has resulted in accuracy of prediction model.

Table 3 Comparison Table of Errors in three models

Model Type	Type1 Model	Type 2 Model	Type3 Model
Minimum Error	-0.4138	-0.6269	-0.6488
Maximum Error	0.5668	0.7904	0.5822
Regression Equation	0.00453* x + 7.78173	-0.03464 * x + 8.07669	-0.00530 * x + 7.78687
Mean	0.00733	0.00784	0.01171
Mean Standardized	0.03282	0.02625	0.04090
Root-Mean Square	0.20316	0.29728	0.26329
Average Standard Error	0.19178	0.27646	0.25092
Root-Mean Square Standardized	1.05234	1.06899804	1.041753

5.0 Conclusion

The study is limited only to semiarid region and it concludes that, sampling pattern and variation in the data plays an important role in spatial prediction of soil parameters. Though random sampling (Type 2) model has given accurate results the method may not be useful for micro level planning in agriculture for different agro climatic regions. The Grid sampling being systematic and by reducting the size of the gird, it can be used for micro level planning.

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