APPLICATION OF GEOSTATISTICS FOR THE ASSESMENT OF BEDROCK AND WATER TABLE DISTRIBUTIONS

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Introduction

Infrastructure development needs in-depth engineering judgments. Geotechnical investigations are the prerequisite for such judgments and used in order to assess the subsurface stability. These investigations are costly; therefore prior judgments before carrying out infrastructure projects with parameter based guidelines would be an asset. Hence, a need has aroused in order to obtain cost effective predictions on subsurface parameters, which can be conventionally obtained by drilling or indirectly by geological, geomorphological and geophysical field investigations. To obtain such predictions, especially outcome based on less data or random generation of low cost data points, geostatistics could be applicable.

The objective of the study is to obtain spatial maps of depth to bedrock and depth to water table using geostatistics.

Methodology

The project was carried out by two phases with data sets organized as follows. The first phase was based on 121 borehole data collected in 2009 from the geotechnical engineering component of the Kandy City Wastewater Disposal Project (KCWDP) in Sri Lanka. Subsequently the second phase was carried out with supplement low cost raw data collected from 365 locations. A geostatistical software package; Geostatistical Environmental Assessment Software (GEOEAS) has been used in developing spatial maps (Englund and Sparks, 1988). Kriging, as a statistical interpolation method to estimate values on a regular grid using irregularly spaced data (Issaks and Srivastava, 1989), were used in order to obtain bedrock and water table contours. Using the sub programme *VARIO* several semivariogrammes were analyzed. Subsequently with the aid of subprograms *KRIGE* and *CONREC* contour maps of depth to bed rock and depth to water table were obtained.

Results

The sub programme *VARIO* generated semi-variogrammes with different nugget, sill and range values (Table 1). These values were used for the kriging interpolation which result contour maps of depths to bedrock and water table (Figs.1 and 2).

Table 1. Models applied for variograms obtained with 22.5 tolerance

Variable	Direction	Nugget (c)	Sill (w)	Range (a)	Model
Depth to bed rock	45^0	3	11.7	4500	Exponential
	45^0	3	11.7	3000	Spherical
	45^0	2	11.7	3000	Gaussian
Depth to water table	45^0	2.8	3.5	3000	Exponential
	45^0	2.8	2.7	2500	Spherical
	45^0	3.2	2.8	2500	Gaussian

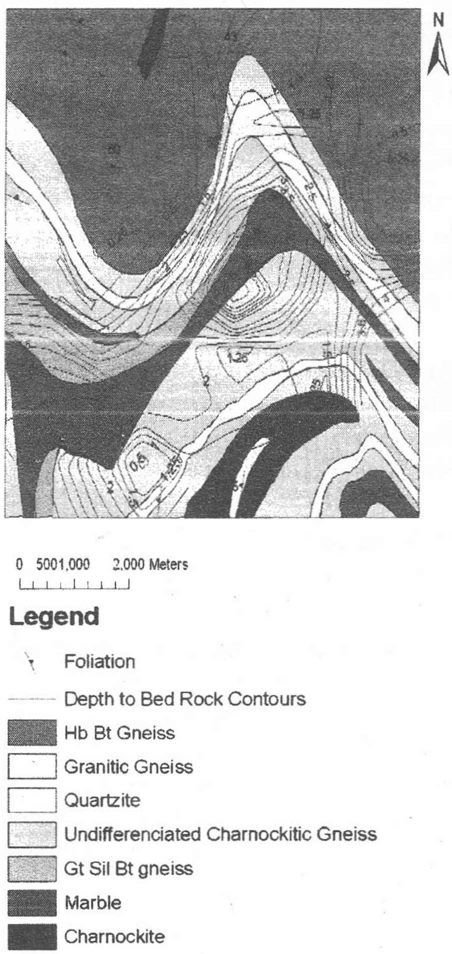

Fig. 1. Depth to bedrock contours over geology of the area

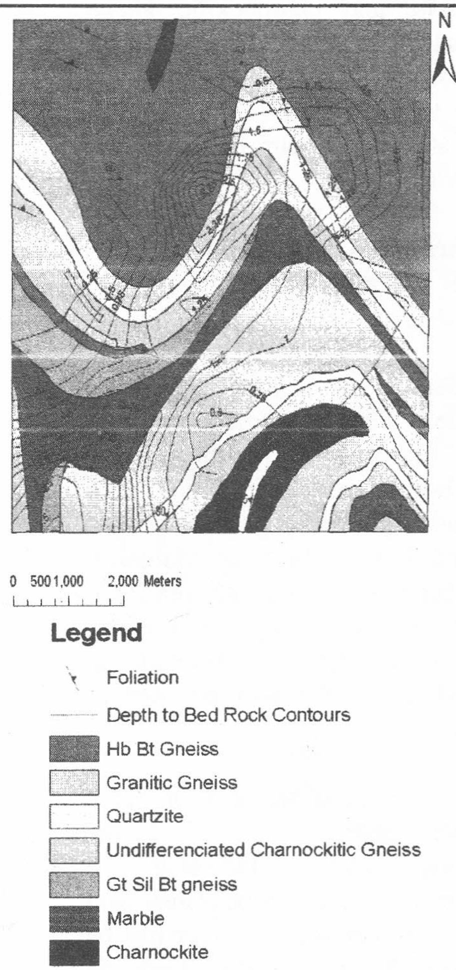

Fig. 2. Depth to water table contours over geology of the area

Discussion

The depth to bedrock contours (Fig. 1) displays deeper values with the marble and could be considered as showing a relationship with the lithologic units. The ground underlying by quartzite shows shallow depths to bedrock, while garnet sillimanite biotite gneiss shows relatively deeper depths to the bedrock. Moreover, undifferentiated charnockite and charnockitic gneiss gave shallow depths. The deepest depth to bedrock around Suduhumpola may be due to the colluviums since it is located at the lower part of the Hantana ridge with steep slopes. Geologic reasons for deep values at following places are given. Suduhumpola due to landslide debris; Getambe, due to fluvial deposits at the confluence of Meda Ela and Mahaweli River; along Meda Ela and the William Gopallawa road, due to alluvial sediments and land fillings. Although the hornblende and biotite bearing migmatites may have high tendency to chemical weathering, the rapid flow of the river Mahaweli could have washed away the weathered products and fluvial deposits resulting in shallower depths to bedrock as observed around the northern part of the area.

There is no relationship between depth to water table (Fig. 2) and the underlying rocks. However, a relationship with the topography and the existing hydrologic sources can be envisaged. Moreover, the depth to water table decreases in the northern part close to the River Mahaweli, and at the centre associated with local water bodies.

Conclusion

The depth to bedrock contour map show better relationship with the geology, fracture pattern and the topography of the area although some localities gave higher error values. The deepest values are found in the areas where marble is located as the basement and along with sites having alluvium, colluvium and landfill. Shallower values are concentrated along with the valleys where erosion due to fluvial action is high. The depth to water table contours does not show any relationship with geology, and fracture pattern. More improved and controlled data collection with respect to water table fluctuations is required to formulate an acceptable depth to water table prediction.

Acknowledgements

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References

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