GIS-GPS based Soil Hardness Mapping for Agricultural Land

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(1) **Introduction:** A compacted layer of soil builds up below the soil surface as a result of ploughing or cultivation activities using machineries, which is called plough pan. The plough pan lets less water through than the soil above or below it. Due to forming this plough pan, agricultural field loose its productivity and fertility gradually. Again, if the land is fellow for a long a time, gradually loose the productivity of soil and become hard and compacted (Fig.1). To measure efficiently the spatial and temporal variant of soil hardness GIS–GPS visual interpretation helps to identify quickly and accurately the soil hardness status with different crop practices. Thus the objective of this present study to find out hardness of soil at different depths to identify the gradual formation of plough pan with GIS spatial analysis for visual interpretation and GPS to locate the geographical points.

Fig. 1. Fellow Land

Fig. 2 Sampling of CPT

(2) **Methodology:** Cone Penetration Testing (CPT) was conducted to measure geotechnical parameters of shear strength for breaking soil. 33 samples were collected from Amakuba, Hanabatake and Kaname area of Tsukuba City. Mostly agricultural land, fellow land were choosen for CPT. The information of agricultural land, soil color, crop practice, soil hardness from 0 to 60 cm depths was taken. Figure 2 shows the sampling process uses of handy GPS for sampling point location.

(3)Data: Zenrin Tsukuba feature databases for settlements, roads and waterbodies were taken. The projection and cordinate was CGS Tokyo 9 zone. Another polygoan of 500 m by 500 m feature shape file was prepared with the projection of same cordinate mentioned above (Fig. 3).

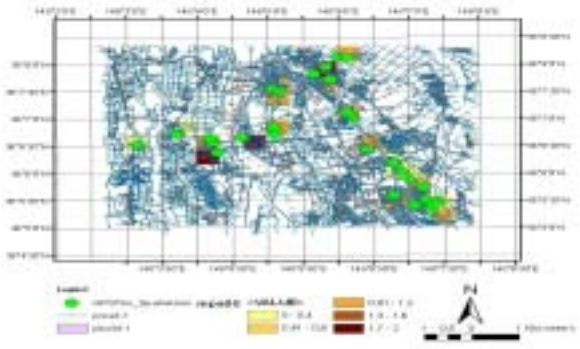

Fig. 3 GPS waypoint for surveyed area, CPT for soil hardness in a 500 m by 500 m mesh

(4)Software and Analyzing Data: Arc GIS 9.2 was used to map and spatial analysis. 500 m by 500 m polygoan attribute Table was appended to the layers of GPS points. The spatail analysis was used to convert the feature data to raster data. CPT test data to pentrate the soil of distances 0 to 50 cm were converted to raster data.

(5)Results: The graduated color shows the soil hardness conditions based on presure to pentarte into soil at different depths (Fig 3). Figure 4(a,b) represents crop practices and classified land color on the basis of organic matter present in top soil. We found that compaction was occurred for most of the sample

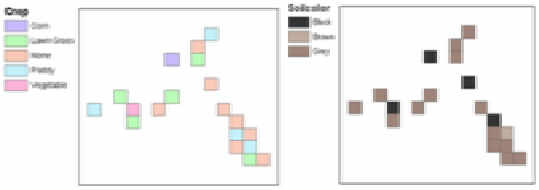

Fig. 4(a, b) crop practice and soil color

between 20 and 40 cm depth. The uses of machinery ploughed always in a limited depth of 20 cm. Thus the compaction of soil was raised. The crop practices have significant impact in the hardness of soil. Figure 5(a, b) shows the major penetration pressure for the crop has similar nature to penatrate inside the soil.

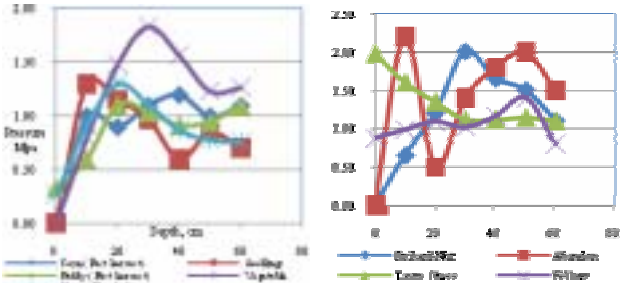

Fig. 5 (a, b) Cone penetration pressure for crops

Few lands were fallen long time without cultivation; the top layer from 10 to 30 cm become hard then the other type of crop practices. The lawn grass cultivation made the top soil hard then the other practices of soil. In the fellow and abandon land, the penetration pressure was also higher. From the CPT, we fitted the approximate characteristics curve for the different crop with soil conditions. We have found mostly 4 order polynomial curve are best fitted with R^2 value in the range of 0.89 to 0.99. It can be recommended that plough pan breaker or depth of ploughing could be increased to break the pan to improve the productivity of soil. Intercropping pattern need to be practiced. Land must be practiced with crops, and must not fellow or abandon. Social approach of consolidation for fellow land needs to be taken by government.