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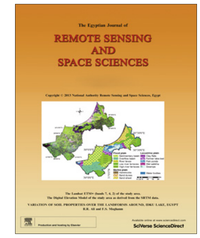

RESEARCH PAPER

Variation of soil properties over the landforms around Idku lake, Egypt

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Abstract The main objective of the current work is to investigate the variation of the soil properties along the landforms of the arid zone around Idku Lake, northwest of the Nile Delta. Remote sensing data and Geographical Information System (GIS) were used as the main tools in this study. Digital Elevation Model (DEM) and Landsat ETM+ image were used for mapping the landforms of the area. Field work has been completed to check the accuracy of the landform units, describe the land surface features and collect soil samples. The recognized landforms comprised; river terraces, river levees, basins, sand sheets, sand dunes, hammocks, clay flats, former lake-bed, fish ponds, sabkhas and swamps. Fifty top-soil samples (0–50 cm) representing the different landforms have been collected and analyzed. The laboratory analyses were linked with their relevant geographical locations, and then the thematic maps of the soil properties were produced using Arc-GIS 9.2 software. The spatial distribution of $CaCO_3$, EC, OM, pH, N, P, K, Fe, Mn, Cu and Zn over the different landforms was discussed in detail. The results indicate that the variation of $CaCO_3$, EC and OM is minimal in the landforms of sand sheets, hammocks, sabkhas, clay flats and former lake-bed. On the other hand the variations of macro and micronutrients are wide-ranging in the landforms of basins river terraces and levees. The interpretation of the spatial distribution could serve as the scientific basis for land use management and the application of variable rate technology in each landform.

1. Introduction

Soils are well-known as the essential portion of the landscape and their features are largely controlled by the landforms on which they are developed. The physiographic influence on soil properties is recognized and ultimately leads to evolution of the soil–landform relationship. In this context the landform is the key-feature because it can easily be recognized, and it is also formed by the same geomorphic processes that were

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responsible for providing the substrate material of the soils (Moore et al., 1991; Gessler et al., 1995; Florinsky et al., 2002; Park and Burt, 2002; Henderson et al., 2005; Mini et al. 2007). The use of remote sensing and spatial analyses allow producing multi thematic layers of soil properties, which offer a great source of data for the land use planners. The spatial distribution represents the correlation between the soil characteristics and the landforms and could be used in extrapolation of soil characteristics within different landforms (Ali et al., 2007). Information on spatial variance of topsoil properties becomes essential for estimating fertilizing needs throughout an area of interest. A normal method for mapping topsoil properties is to sample the investigated area by the grid sampling system. Then, a prediction map could be created through the interpolation of measured property values of each sample. The interpolation techniques commonly used in agriculture include "inverse distance weighting" and "kriging" (Franzen and Peck, 1995; Weisz et al., 1995). Both methods estimate values at un-sampled locations based on the measurements from the surrounding locations with certain weights assigned to each of the measurements. The "inverse distance weighting" is easier to implement, while "kriging" is more time-consuming and cumbersome. However, some studies found that "kriging" provides a more accurate description of the data spatial structure, and produces valuable information about estimation error distributions (e.g. Leenaers et al., 1990; Deutsch and Journel, 1998; Mueller et al., 2004).

The areas around Idku Lake are considered as problematic land, the cost of reclamation of such regions is rather high (MALR, 1994). Therefore multi-thematic mapping of soil properties is essential action in order to maintain the sustainable usage of such soils. The current study aims to (1) map the landforms of the areas around Idku Lake, (2) produce multi-thematic maps of the soil properties, and (3) investigate the spatial distribution of the soil properties within the landforms of the study area using an ordinary "kriging" model of ArcGIS 9.2 software.

2. Materials and methods

2.1. Study area

The study area is located to the West of the Nile Delta, and extended between 29° 51′30″ & 30° 31′08″ East, and 30° 59′15″ & 30° 26′45″ North, (Fig. 1). The area is characterized by a climate of Mediterranean Sea with hot arid summer and little rain winter. The mean temperatures are especially high in the dry season when they range between 25 and 30 °C with an average temperature of 21 °C. The rainfall distribution values occur in the cold season of November–February interval. The total annual rainfall is 193.0 mm per year. The maximum rainfall values are recorded in January and December ranging between 50.0 and 56.3 mm. The evaporation ranges between 3.3 and 4.8 mm/day. The lowest values are observed in January and December when the temperature is comparatively low, whereas the highest value of 4.8 mm/day is recorded in the period between June and September. The annual mean evaporation is 4.25 mm/day (Climatological Normal for Egypt, 2011). According to the US Soil Taxonomy System (USDA, 2010), the soil temperature regime could be defined as "Thermic" and the soil moisture regime as "Torric". The area is characterized by the Holocene deposits including (1) Sand beach, (2) Coastal lagoon, (3) Inland lake, (4) Coastal sand dune, (5) Alluvial deposits of desert wadies and (6) Recent Deltaic deposits (Said, 1993).

Figure 1 Location of the study area.