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RESEARCH PAPER

The impact of informal irrigation practices on soil drainage condition, soil pollution and land suitability for agriculture in El Saf area of El Giza Governorate



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Abstract The study area was selected in El Saf District of El Giza Governorate in Egypt, covering 21461.4 ha of Nile sediments and their outskirts of alluvial higher and lower terraces. The aim of this study was to assess the impact of informal irrigation practices on drainage deterioration, soil pollution and land suitability for agricultural use using the satellite LDCM data 2013. From the lower alluvial terraces (partly cultivated using wastewater), the drainage flows westward via descending slopes resulting in land deterioration in both the alluvial lower terraces and alluvial plain of River Nile. The drainage conditions are excessively drained soils in the alluvial upper terraces within soils of *Typic Haplocalcids, sandy skeletal*, but in the lower terraces it partly occurred within soils of *Typic Torriorthents, sandy skeletal*. Moderately well drained soils occurred in soils of *Typic Torriorthents, sandy* in the alluvial lower terraces, while in the alluvial plain of Nile sediments are *Sodic Haplotorrerts, fine*. Poorly drained soils in the lower alluvial terraces have soils of *Typic Epiaquents, sandy* associated with *Sodic Psammaquents* and *Aquic Haplocalcids, coarse loamy*, while in the alluvial plain of River Nile the soils are *Halic Epiaquerts, fine*. Very poorly drained soils (submerged areas) are scattered spots in both the lower alluvial terraces and the alluvial plain. In the alluvial plain of River Nile, 1967.1 ha become not suitable for the traditional cultivated crops, while in the alluvial terraces 3251.0 ha are not suitable for the proposed cultivation of Jojoba plants. Heavy metals of Cadmium (Cd), Cobalt (Co), Lead (Pb) and Nickel (Ni) were added to the soil surface and sub-surface in the irrigated areas by wastewater in the lower alluvial terraces (moderately well drained soils), but Cd and Co exceeded the standards of permissible total concentrations in these soils. The same metals were added to soil sub-surface layers in the alluvial plain (poorly drained soils), but Co exceeded the total permissible concentrations. Continuing these informal irrigation practices, drainage condition will be deteriorated in extra areas and all heavy metal concentrations will exceed the standards of permissible levels. Improving the land qualities of drainage is

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required and Jojoba cultivation is proposed to replace the edible crop cultivation in the alluvial terraces to avoid the heavy metal contamination risk and to be used for developing a bio-fuel crop production of renewable energy.

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1. Introduction

The cultivated Nile alluvium must be kept to serve the national economy of Egypt to be a basis for the social system of the frequent generations. This land of a very high economical value is recently denaturing with uncontrolled planning within retreated networks of irrigation and drainage canals. The problem may occur as a result of disturbed knowledge uniformity concerning the importance of protecting the cultivated land according to our religious beliefs. This unique land requires to be well managed by a controlled system concerning a well maturing of the rural areas and correcting the approach of cultivated land conservation to realize its real profitable function. The State commits to protecting lands under cultivation according to the Constitution (*Destor*) of Egypt, which is highly required to be realized by an urgent strict law otherwise the crises will still be acting without solution (Afify et al., 2013).

The traced deteriorated areas were previously either under the demand of productive cultivation or under the natural balance as virgin soils. They are land resources, where the natural limitations can be currently overcome or corrected by better techniques. These deteriorated areas have good potentialities in their sites and have a unique value as their situation. This situation is characterized by an existing network of the infra-structure that realizes an easy access for the marketing activities within Greater Cairo and other regions. The informal irrigation practices of using wastewater for surface irrigated agriculture resulted in a wide spread deterioration concerning the land qualities of the study area. This cultivated land must be protected with its agricultural skinless, which according to Afify et al. (2008), is the ability of human practices that make such land more promising areas for agricultural use. This cultivated land requires small capital intensity for successful production as its minor problem can be overcome by individuals in small scale land tenures. Comparing with the new reclaimed areas the agricultural development needs a high capital intensity which is not easily available for small users that may be obliged to apply the minimum applications or to subject to failure.

According to Ali et al. (2007), most forms of degradation are man-made problems, as mismanagement. The active degradation features are mostly water logging, salinization, and alkalization. The main causative factors of human induced land degradation types are over irrigation, human intervention in natural drainage and the absence of conservation measures.

In the study area, wastewater is used as surface irrigation for growing most of the edible crops resulting in interacted problematic elements, which include soil drainage condition deterioration. The hazard of this informal irrigation practice is exaggerated when this land use leads to pollute the soils by heavy metals to pollute plants, which has a direct relationship with human health hazard.

Nagajyoti et al. (2010) considered this case of using wastewater for growing crops a reason of degrading soil quality, reducing crop yield and the quality of agricultural products integrating a negative impact on the health of humans, animals, and the ecosystem. The World Health Organization (1989) reported that flood irrigation by wastewater probably exposes field workers to the greatest health risk. This wastewater should not be used for producing vegetables.

According to Jarup (2003), these vegetables among the food system, are the most exposed food to environmental pollution due to aerial burden. They take up heavy metals and accumulate them in their edible and non-edible parts at quantities high enough to cause clinical problems to both animals and humans.

The aims of this study are to monitor soil drainage deterioration and its impact on land use changes on both the old cultivated areas and their outskirts of new cultivated ones. It is also to compile the spatial distribution of such deterioration, which associates with land suitability decrease and the risk of soil contamination. The study helps in formulating correlated spatial dataset using remote sensing data and GIS to be timely retrieved to serve irrigation practice reforms in certain areas of Egypt.

2. Materials and methods

2.1. Study area

The study area was located in El Saf District of El Giza Governorate east of River Nile covering 21461.4 ha (51078.1 feddans). It represents the old cultivated land of the Nile sediments as well as their outskirts of the new reclaimed land for the agriculture land use. The coordinates of the upper left corner include a latitude of 29° 44' 12" North and a longitude of 31° 15' 38" East, while the lower right corner is coordinated as latitude of 29° 34' 30" North and longitude of 31° 24' 37" East (Fig. 1).

2.2. Specifications of remote sensing data

The remote sensing data were acquired by Thematic Mapper (TM) 1984 and Landsat Data Continuity Mission (LDCM) (2013 with spatial resolution of 30 m. The spectral resolutions of TM 1984 are Green (510–590 nm), Red (610 nm–680 nm), Near-Infrared (800–890 nm). For LDCM, these spectral bands are Green (530–590 nm), Red (640 nm–670 nm), and Near-Infrared (850–880 nm). The scenes are indexed by the path 176 and row 39.

2.3. Processing of remote sensing data

Remote sensing data were corrected according to the Egyptian Transverse Mercator (ETM) with Spheroid name of Helmert

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