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Sustainability of Water Bodies of Edku Lake, Northwest of Nile Delta, Egypt: RS/GIS Approach

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Abstract

In this paper, Edku Lake was selected as a case study to apply the RS/GIS techniques to investigate the water body sustainability. It is one of the northern coastal lakes in Egypt, located at the northwestern part of the Nile Delta. Edku Lake is an important fishing area in Egypt and receives its water from two sources. One of sources is the drainage water of Kom Belag and Bersik drains and second is the sea water. Remote sensing and GIS software are used in this study for processing of the images and managing the database of each image. The different techniques of classification were tested, the results showed that the maximum likelihood supervised classification technique was more accurate to monitor changes in the water bodies of the Lake. The technique was applied to subsets of the Landsat TM, ETM+ and OLI/TIRS images acquired on 1984, 1990, 1998, 2003 and 2015, respectively to monitor changes in the Lake. The results showed that the water bodies of the lake decreased during the period from 1984 to 2015. The extracted data from the images have been used to develop statistical models for the different classes to predict the future situation of each class. The results of prediction indicated that the water body of the lake will be more decrease in 2030. The results indicate that the water body of the lake is not sustainable. The results of this study will act as warning for the decision makers to take the necessary actions/policy to reduce the environmental risk and maintain the healthy environment of the lake.

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Keywords: Edku Lake; land use and land cover; Sustainability; Water bodies; Remote sensing; ERDAS and ArcGIS software.

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1. Introduction

Sustainability can be defined as the ability to continue a defined behavior indefinitely. In ecology, sustainability is how biological systems remain diverse and productive indefinitely. This study provides a practical method to assess the sustainability of the surface water body by computing the sustainability of water body indicator (area of the water body at particular year/area of the water body at the reference year). High concentrations of nutrients from agricultural and urban runoff are the main cause of algal blooms in many estuaries and coastal waters [1]. Edku Lake is an example of the wetland in Egypt. Edku Lake is the smallest in area comparing with Manzala Lake or Burullus Lake. Bughaz El-Meadia connects the lake to the Mediterranean Sea. Edku Lake is a typical delta edge lagoon, with a history of steady contraction from 200 km^2 before the 1940 to some 150 km^2 in the 1950 to some 70 km^2 in the 2008. It is estimated that a reduction of some 30% of the lake area has occurred in the last 20 years by the development of drainage and irrigation schemes in the eastern portion [2]. The water chemistry and productivity of this lake is generally controlled by the drainage water reaching it through the two main drains namely Kom Belag and Bersik [3]. Edku Lake changed due to the discharge of agriculture wastes and municipal wastes into the lake without appropriate treatment. Discharging the agriculture wastes and the municipal wastes into the lake without proper treatment causes an increase in the floating vegetation and decrease in water bodies. This increase of floating vegetation effects the functioning and biodiversity of Lake ecosystem negatively and consequently threaten the lake sustainability. Conditions of darkness and anoxic under floating vegetation leave little opportunity for animal or plant life. Remote sensing is considered a cost-effecitive way to detect change detection in LULC over wide geographic areas [4]. Also, the use of RS/GIS techniques can provide useful information on spatial and temporal changes in aquatic vegetation in the lakes [5]. Satellite images are suitable for wetland mapping and monitoring in developing countries where funds are limited and information on wetland areas, and wetland losses over time are not available [6].

Wetland management encompasses mapping and monitoring so that public managers and decision makers can be provided with credible and relevant information [7]. Change detection of LU/LC leads to the impact on the socio-economic, biological, climatic and hydrological systems [8]. Change in LU/LC is one of the most important indicators for global and regional environmental change [9]. To guarantee the sustainable management of natural resources, it is important to monitor and control the processes of change in LULC [10]. Change detection in LULC across spatial and temporal scales is indispensable to achieve sustainable environmental management [11]. Providing sufficient information on what kind of changes occur and where/when they occur, in addition to the rate of occurrence is essential in planning process. Also, the physical and social forces that drive these changes to understand the effects of LU/LC on the ecosystems [12]. Classification and mapping the types of LULC by high accuracy is an important issue to support the sustainable management of natural resources. To find the changes in LU/LC with a proper accuracy, the suitable classification system should be used. Also, division of all objects into different classes according to the requirements of the study should be adopted [13]. This study aims to provide an accurate estimate of the LU/LC in Edku Lake and assessment the sustainability of water bodies of the lake using remote sensing and GIS approach.

2. Study Area

Edku Lake is a brackish lake and located in the northwestern part of the Nile Delta to the west of Rosetta branch. Geographically, it is located between longitudes 30° 8′ 30″ and 30° 23′ E and latitudes 31° 10′ and 31° 18′ N (see Fig. 1). The lake is connected to the Mediterranean Sea through Bughaz El-Meadia, a 20 m wide, 100 m long and 2 m deep channel. The actual surface area of the lake has been decreased due to reclamation of a large area for cultivation purposes. Water depths in the lake are ranging between 10 to140 cm, the maximum depths being in the central and eastern parts [2]. Two main drains discharge their water into the lake. The first drain namely Kom Belag receives its water from three subdrains; Bosily, Edku and El-Khairy where they are connected at about 3 km to the east of the lake. The drainage water of kom Belag drain is discharged at the eastern part of the lake. The second main drain connected to the lake is Bersik drain which outlets its water at the southern central part of the lake. Lake water is mainly affected by the growth and creeping of floating vegetation on the water bodies.