SURFACE CHARACTERISTICS AND COVERAGE PATTERN OF THE NEW DAMIETTA PORT AREA, AS MAPPED BY HIGH RESOLUTION REMOTE SENSING

WAHID M. MOUFADDAL

National Institute of Oceanography & Fisheries (NIOF)
wahid_moufaddal@gawab.com

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ABSTRACT

The New Damietta port area has been subjected to large landscape changes and reformations since construction of the port in early 1980s. The area still under development and is expected to experience some more changes during the next few years. This reveals the urgent need for assessment of the present coverage pattern and land-uses of the port area. The present study attempts to determine details of land cover and land use information of the New Damietta port and surrounding area using high resolution remote sensing in conjunction with results of the ground survey and field observations. A recent image from QuickBird has been used for this purpose. Land cover types and surface characteristics were described and their areas estimated and mapped using the standard remote sensing methods. Results of this study show that the landscape of the New Damietta port area is dominated by man-made cover types and infrastructures, rather than natural land cover types. The most prominent surface features of the study area include: port area, bare land, water bodies, road and rail network, built-up area, and sand dunes. The area includes also various types of land use e.g. commercial and industrial, agriculture and mixed crops, residential fabrics and dump sites.

1. INTRODUCTION

The New Damietta port is located on the northeastern part of the Nile delta along the Egyptian Mediterranean coast, about 37 km west of Port-Said and about 9 km of Damietta city (Fig. 1). The port has been established in early 1980s and began its operation in July 1987 for the purpose of improving trade facilities and fostering flow of trade-traffic across the Mediterranean coast of Egypt. It handles export of agricultural products, fertilizers, and furniture and receipt imported goods such as petrochemicals, cement, grains, flour, and general cargo with a total capacity of about 5.6 million tons annually.

The port occupies an area of about 13 km² and is subdivided into two main parts; the shipping area, which is an inland section containing 16 berths and quays, and the water area which is composed of an access channel connecting the shipping area with the Mediterranean Sea and the main basin. In order to facilitate access to inland navigation, the port’s basin has been connected to the Rosetta branch of the River Nile through a man-made barge canal of 4.5 km long and 5 m depth. There are some ambitious plans for development of the port and improving its trade facilities. In this respect, the Port Authority is planning to make a new extension south of the existing grain berth (Fig. 1). This is part of the third phase of development of the port which is expected to be completed by year 2010.
Fig. (1): Generalized map showing limits of the New Damietta port and location of the new proposed extension.
The primary purpose of this study is to assess the environmental condition in regard with the existing land uses, coverage patterns and surface characteristics of the port area using high spatial resolution remote sensing. This has been achieved through visual interpretation of remote sensing data and on-screen raster-to-vector digitization of the image features. A recent satellite image from QuickBird has been used for this purpose.

To the author's knowledge there is no published remote sensing study on land use and land cover types of the port area or its vicinity. Literature review reveals that most remote sensing studies carried out on the study area were focused mainly on coastal changes and shoreline erosion and accretion during the short timescale of 1984 to 1991. These include studies of Klemas and Abdel Kader (1982), Frihy (1988), Smith and Abdel Kader (1988), Blodget et al. (1991), Frihy et al. (1998), El-Raey et al. (1999), White & El-Asmar (1999), El-Asmar (2002), and El-Asmar and White (2002).

Importance of this study arises from the fact that the port area is still under development and is likely to be subjected to further spatial changes and reformation during the next few years. Mapping of the existing land cover types therefore is of paramount importance for documentation of the present situation, as well as, for assessment of future changes. Assessment of the present surface characteristics is also very important for the future development and land-use planning of the area.

2. MATERIALS AND METHODS

2.1. Data acquisition and collection

The primary data used in this study was satellite imagery. There are a variety of imagery types can be used and, normally, images with higher spatial and/or spectral resolutions are preferred for coastal land-use and land-cover mapping. For this purpose, a high resolution image from QuickBird was utilized for study of the port and its vicinity area. The QuickBird spacecraft, owned and operated by Digital Globe Inc., collects the highest resolution imagery commercially available (Volpe 2004, Digital Globe 2006). It acquires images in 4 multispectral bands of 2.44 m resolution and one panchromatic band (pan) of 61 cm resolution.

The selected QuickBird image covers an area of 38 km$^2$ and acquired on 4 December 2005. The image was delivered in GeoTIFF 8-bit enhanced standard format and georeferenced to the Universal Transverse Mercator (UTM) Zone 36 as projection and WGS 84 as datum. In addition to satellite data, a 3-days field visit to the port and surrounding area was conducted during 24 to 26 July 2006 in order to acquaint with prevailing important cover types and land-uses. During this visit, not less than 40 sites were checked and described. Prominent surface characteristics and other important information relevant to land uses and activities were also described in the field so as to aid the process of image and remote sensing interpretation.

Other supplementary information utilized for this study included: (1) generalized land-use map produced by the Port Authority showing the main features and amenities of the port, and (2) topographic map of scale 1:25 000 covering the study area.

2.2. Image preprocessing and analysis

The image processing steps which applied in this study included: preparation of the satellite data for viewing and analysis, merging multispectral bands (2.4 m) with the pan band (0.6 m) to enhance spatial details while preserving the spectral information, determination of the classification scheme, visuals interpretation and digitization, editing of the image classes and categories, and finally producing spatial map for the study area.

Initially, the image was subjected to enhancement and information extraction
procedures through standard remote sensing techniques e.g. false color composite, principal component analysis, unsupervised classification. Ground truth information which collected from ground survey, and collateral maps was also combined to results of remote sensing analysis for evaluation of the descriptive characteristics of the port area and its vicinity. All of the digital image processing and subsequent mapping of remotely sensed data was performed using ER Mapper 7.1. Vector layers produced through remote sensing mapping have been gathered and edited using ArcView GIS.

2.3. Classification scheme design

Due to some logistics and financial limitations, classification of the land-cover and land-use types of the study area was based essentially on visual interpretation and digitization of the QuickBird image. Computer assisted classification (unsupervised) was conducted in some cases, as necessary.

A modified version of CORINE classification scheme (European Community, 1993) was developed specifically to tune with purposes of this study. In this context, the land cover in the study area was classified at two hierarchical levels. The level I classification scheme contained six categories; built up area, waste lands, bare lands, water bodies, vegetation, and sand dunes. Subsequently, each class has been subcategorized in level II classification into number of discrete classes depending on importance of the land cover and spatial details of the image.

3. RESULTS AND DISCUSSION

Through application of methods of image interpretation and raster-to-vector representation together with other information collected from field survey, it was possible to describe the main coverage pattern and land uses of the study area. Results of this step show that the most prominent surface features of the area include: port area, bare land, waste lands, water bodies, built-up area, agriculture and mixed crops (corn, green leafy, bananas, etc.), and sand dunes.

3.1. Surface characteristics of the port and surrounding area

3.1.1. Physiographic setting

The port and surrounding area is flat in general, as it is part of the coastal plain of the northeastern part of the Nile Delta. Elevation varies between 0.2 m near the coastline but it increases to 3 m above mean sea level (MSL) at the southern and eastern limits of the port.

The Port was constructed in a coastal embayment some distance inland in order to be protected from winter storms and hence, can be used year-round and avoid shipping delays (El-Asmar & White 2002). The port entrance from the seaside is protected against the littoral drift by two jetties (breakwaters); the western jetty is 1640 m long and the eastern jetty is 760 m (Fig. 1). The total area of the port now is 12.88 km$^2$, of which 3.8 km$^2$ is water, and the rest area is land.

The port can be broadly subdivided into 5 main divisions (Fig. 2). These include the Petrochemicals and Liquefied Natural Gas (LNG) complexes at the west and the industrial free zone at the east, this in addition to the water area (port basin) and the surrounding platforms and berths. The southern parts contain most amenities and services of the port e.g. administration buildings, fire station, water pumping station, agricultural quarantine and accommodation houses. Berths and quays of the port occupy the central area and include the containership and general cargo berths to the west and the bunkering and grain berths to the east.

The port area was originally a large field of fertile agriculture land backed by a wide zone of coastal sand dunes. Establishment of the port necessitated clearing and dredging all
of vegetation habitats and land-uses which used to occur in the area. This resulted in huge quantities of dredging materials. Excavation works for the port's access channel only resulted in not less than 5 million m$^3$ of dredged sediments (Frihy et al., 1991).

The area surrounding the port is comprised of agriculture land that is cultivated with seasonal crops and fruit farms, with exception of the northeastern parts which comprised of abandoned land put under development and planned for some industrial and tourism activities (Fig. 2).

3.1.2. Land-cover and land-use types

The final land cover map produced by remote sensing analysis and GIS is demonstrated in Fig. (3). It is comprised of six level II land cover classes, in addition to some important landmarks of the area. Description of theses classes is given as follows:

3.1.2.1. Built up area

3.1.2.1.1. Port area

The port itself is a built up area established in the region through reclamation and clearing of the coastal dunes and agriculture which used to occur in the area before the port. More than two thirds of the total port area is comprised of a built-up land, whereas the rest area is water (see Figs. 1 and 2).

Coverage patterns prevailing in the land section of the port include administrative and commercial buildings, industrial units, horticulture and natural vegetation, services and emergency facilities, residential buildings and accommodation houses, road and rail network, undeveloped land, storage tanks and bins, storage open yards, waste lands and dump sites.

3.1.2.1.2. Residential fabrics

Except of Damietta city which is located far about 9 km far from the port, other residential fabrics in the port area are very limited both in size and population, in general. Only three discontinuous residential communities were reported in the port area and its immediate vicinity. These include one residential area inside the port itself, definitely at the middle of its southern side. It comprises about 35 residential houses that are being used for residence and accommodation of the workers and technicians of the Port Authority. The total area occupied by this fabric is about 74,000 m$^2$.

The other two residential areas are located outside the port area and composed of two small villages inhabited by local people and farmers of the area. The first village is located very close to the port, definitely at a place facing its southern fence-wall. It is composed of a small village (namely "Izbaet Nasr Allah") of a total area of 10,560 m$^2$ and lies on the outer port road far about 1.5 km from Ras El-Barr gate. The second residential area is composed also of a small village, namely "Izbaet Khamsa", of an area of 34,300 m$^2$, and lies west of the port area about 3.5 km far from the port’s main gate. In addition to this, there are some other discrete living- and farm-houses scattered randomly throughout the agricultural land around the port area.
Fig. (2): Road and railway network of the port area. Vectors in blue = main (asphalted) roads, red = unpaved roads/tracks, yellow = railway lines.
Fig. (3): Land use and cover types of the study area as resulted from manual digitization and computer-assisted classification methods.