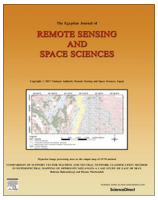
The Egyptian Journal of Remote Sensing and Space Sciences xxx (2017) xxx–xxx

HOSTED BY

Contents lists available at ScienceDirect

The Egyptian Journal of Remote Sensing and Space Sciences

journal homepage: www.sciencedirect.com



Research Paper

Minimizing labeling ambiguity during classification process of the geological units covering the central part of the Suez Canal Corridor, Egypt using their radar scattering response

Mamdouh M. Abdeen [a,*], Ahmed Gaber [b], Mohamed Shokr [a], Omnia A. El-Saadawy [a]

[a] National Authority for Remote Sensing and Space Sciences, Egypt
[b] Port-Said University, Dep. of Geology, Port-Said, Egypt

ARTICLE INFO

Article history:
Received 27 July 2017
Revised 4 November 2017
Accepted 10 December 2017
Available online xxxx

Keywords:
Radarsat-2
Full-polarimetric SAR
Landsat-8
Scattering response
Classifications
Geological mapping

ABSTRACT

Deriving information about the geometrical and dielectrical characteristics of objects using optical and radar satellite sensors is valuable for delineating and classifying surficial sediments. In the present study, unsupervised and supervised classifications of the Landsat-8 and the full-polarimetric Radarsat-2 data were used to map the different geological units and to reduce labeling ambiguity during classification processes. The study covers the central part of the Suez Canal Corridor in northeast Egypt. The full-polarimetric Radarsat-2 image was decomposed, filtered and geo-referenced to extract the scattering response of the different land cover and geological units covering the study area. In addition, polarimetric target decomposition and Wishart unsupervised classification with 5 classes were performed. The extracted polarization signatures show significant correlation with the obtained classes in terms of their geometrical (surface roughness) and dielectrical (mineral composition) characteristics. These characteristics are related to physical properties and to some extent, to the grain size and degree of weathering. The results show that the integration between the radar scattering responses and the optical reflectance information of the classified land cover and rock units is appropriate for precise objects discrimination.

1. Introduction

Classification process is one of the most widely used methods for extracting information and mapping surface features from remotely sensed data. In supervised classification each training pixel is associated with a single class label, while in unsupervised classification the class labels are not known (Richards, 1993). On the other hand, the optical, thermal and radar satellite sensors provide different levels of information about the imaged targets. However, the optical sensors provide the response of the targets when they are subjected to the visible and short wave-infrared range, the reflected spectrum can be then attributed to physical and chemical properties of the target. The microwave (Radar) sensors can collect tremendous information about the geometrical and the dielectric characteristics of the objects. The integration of data obtained from different satellite sensors definitely will help in reducing the ambiguity during labeling the different classes. The labeling ambiguity is usually occurred when rocks of different mineral composition have relatively close spectral reflectance and hence assigned to the same class.

Basically, the radar scattering response is controlled by the geometrical (i.e., local incident angle and surface roughness) and the dielectric parameters (i.e., composition and moisture content). The surface roughness and soil moisture are the main scattering factors of flat areas (Evans et al., 1992; Archer and Wadge, 2001; Paillou et al., 2003). Synthetic Aperture Radar (SAR) imagery provides a unique mapping capability for terrain categorization and can penetrate dry sand and image shallow sub-surface features (Abdelsalam et al., 2000).

The Polarimetric SAR (PolSAR) data have been used recently to discriminate the different surface land cover based on their scattering response (Van Zyl et al., 1987; Van Zyl, 1989; Papathanassiou

Peer review under responsibility of National Authority for Remote Sensing and Space Sciences.

* Corresponding author at: Egypt's National Authority for Remote Sensing and Space Sciences (NARSS), Egypt.
E-mail address: mamdouh.abdeen@narss.sci.eg (M.M. Abdeen).

https://doi.org/10.1016/j.ejrs.2017.12.001
1110-9823/

and Buchroithner, 1993; Cloude and Pottier, 1996, 1997; Lee et al., 1999; Zhang et al., 2011; Gaber et al., 2015). The early and most important classification method based on scattering mechanisms is that proposed by Van Zyl (1989) and Cloude and Pottier (1997) and led to the introduction of a widely used unsupervised classification scheme. This method was developed and improved by Lee and Grunes (2004). Radar remote sensing is frequently combined with optical remote sensing to obtain hybrid images carrying information from both sensors (Abdeen, 2002, Kusky and Ramadan, 2002; Gani and Abdelsalam, 2006; Gaber et al., 2010, 2015; Brahmi et al., 2012). Classification based on radar scattering decomposition using PolSAR data have been explored by many researchers (e.g. Rignot et al., 1992; Chen et al., 1996; Cloude and Pottier, 1997; Lee et al., 1999; Ferro-Famil et al., 2001; Barnes and Burki, 2006; Cameron and Rais, 2006; Alberga, 2007). Consequently, some polarimetric decomposition theorems have been introduced (Cloude and Pottier, 1996; Freeman and Durden, 1998; Yang et al., 1998; Yamaguchi et al., 2005).

In the present work, the geometrical characteristics of each geological unit have been taken into account during classification. This was performed using the full-polarimetric Radarsat-2 dataset through examining the radar scattering response of each geological unit. The polarimetric work products were integrated with the optical data and field work for reducing labeling ambiguity during classification and hence better geologic mapping.

2. Geology of the study area

The study area is located in the central part of the Suez Canal Development Corridor in northeast Egypt. The area is limited by latitudes 30° 22′ N and 30° 41′ N and longitudes 32° 10′ E and 32° 25′ E (Fig. 1). It is covered by sedimentary rocks and sediments, which range in age from middle Miocene to Quaternary (Fig. 2). The middle Miocene is represented by El Shatt Formation, which is widely exposed to the east of the Bitter Lakes. This formation includes sandstone, claystone, limestone and gypsum. The late Miocene is represented by Hagul Formation, which consists of non-marine sediments composed of sands, sandstone, flint pebbles and gravels, and occasionally sandy limestone. The Quaternary sediments cover a considerable part of the investigated area and are composed mainly of clay, salt marshes, sabkhas, eolian sand and gravels in the form of gravel plains, sand dunes and wadi deposits.

3. Material and methods

3.1. Remote sensing datasets

3.1.1. Optical data (Landsat-8)

The Landsat-8 image that is designated by path/row: 176/039 and acquired on November, 10th, 2014 at 08:24:05 was

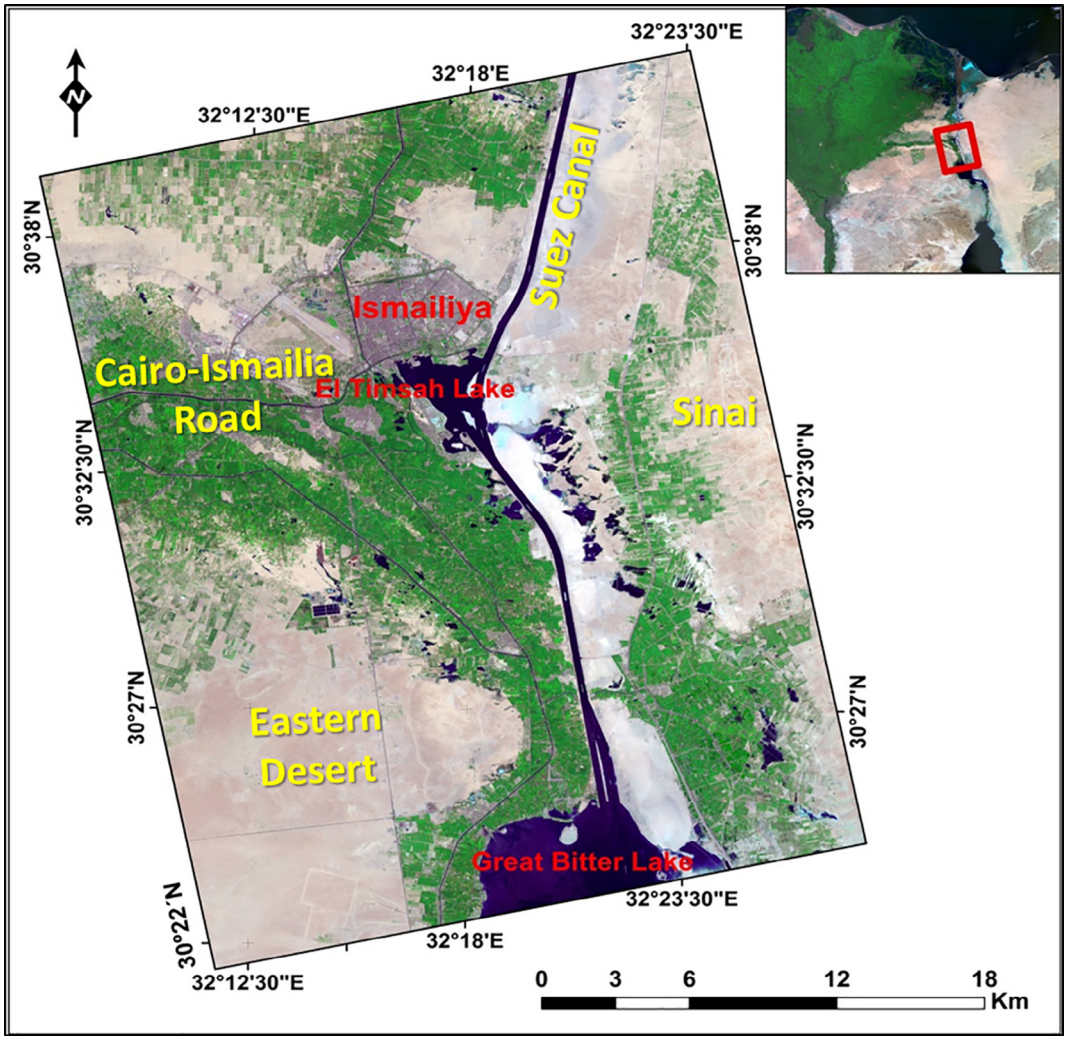


Fig. 1. A subset of the Landsat-8 image covering the study area.