



Long-term monitoring of wetlands along the Western-Greek Bird Migration Route using Landsat and ASTER satellite images: Amvrakikos Gulf (Greece)

Liesbeth Bortels^a, Jonathan C.-W. Chan^{b,*}, Ronny Merken^a, Nico Koedam^a

^a Laboratory for Plant Biology and Nature Management (APNA), Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium

^b Cartography and GIS Research Group, Geography Department, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels, Belgium

ARTICLE INFO

Article history:

Received 5 April 2010

Received in revised form

20 December 2010

Accepted 19 January 2011

Keywords:

Landsat

ASTER

Coastal wetlands

Change detection

Fragmentation

Stopover habitat

Long-distance migratory waterbirds

ABSTRACT

The west coast of Greece is an important migration route for migratory waterbirds. The wetlands along this coast are important stopover sites during bird migration between wintering and breeding sites. The use of remote sensing methods for mapping bird migration habitats and for temporal monitoring of changes in these habitats was investigated. The Amvrakikos Gulf, a coastal wetland complex along the west coast of Greece, was selected as the study area. Landsat TM and ETM+ images and ASTER VNIR images were used to perform a post-classification change detection over a time period of 15 years (1989–2004). In order to assess the spatial quality of existing wetland patches, spatial metrics (such as patch area, distance between the patches, and proximity) were calculated. To study changes in the degree of fragmentation of the stopover area, a binary patch structure was used in which the focal patches were embedded in a neutral matrix. The results showed that Landsat and ASTER VNIR satellite images can be used to trace small wetlands of approximately 0.5 ha minimum. These data sources are suitable for monitoring changes in wetlands, in particular marshes and mudflats, which are important habitats for migratory waterbirds. In the 15-year period that has been studied there was an estimated 32% decrease in marsh and mudflat area. Among this decrease, 25% went to water surface and 7% to vegetation in the months of August and September. Within the same period of time, a higher degree of fragmentation of the potential bird migration habitat has also been recorded. For this purpose, the remote sensing approach used in this study where change detection is performed on freely available Landsat and ASTER satellite images could be an interesting tool for policy makers and managers, as they allow easy recognition and monitoring of changes in wetlands and therefore contribute to an evaluation of the efficiency of protection and management schemes applied by countries for their wetlands.

© 2011 Elsevier GmbH. All rights reserved.

Introduction

Migratory waterbirds depend on suitable wetland areas along their migration routes as assembly and staging (or stopover) areas (de Klemm 1994). During migration, they tend to be gregarious in relatively small areas for brief periods of time (Myers et al. 1987) and migration success depends on intact migratory routes with the availability of certain key food resources and resting opportunities at these stopovers (Moore et al. 2005). In order to protect migrants successfully, it is necessary to preserve essential habitats in all parts of an integrated species range. However, it is estimated that approximately half of all European wetlands which existed in the last century have now been lost due to agricultural activities, urban expansion and various management practices (European Commission 2007). For Greece, loss of wetlands is estimated at 63%

between 1950 and 1985 (European Commission 2007). A substantial portion of those are located within coastal regions related to bird migrating routes. It is not surprising then that many waterbird populations in Western Eurasia and Africa remain in long-term and considerable decline, since wetland loss and degradation continue to be the main cause for these population changes, probably now being exacerbated by severe and prolonged droughts and other impacts of climate change (Davidson & Stroud 2006). A flyway-scale analysis for African-Western Eurasian waders showed that 65% of populations were decreasing in the Black Sea/Mediterranean Flyway (International Wader Study Group 2003; Stroud et al. 2004, 2006).

Greece is part of the Black Sea/Mediterranean flyway (Davidson & Stroud 2004), one of the three main shorebird flyways over Europe. And the migration route in Greece that covers the western coastline is most important (Dimaki et al. 2006). Although many of the wetlands along this coast are protected as Ramsar sites, Important Bird Areas (IBAs), Natura 2000 sites, Greek National Parks, etc., many of the needed protection measures are not imple-

* Corresponding author.

E-mail address: cheuchan@vub.ac.be (J.C.-W. Chan).

mented and there are cases of evident deterioration (Bazigou 2007). Wetlands are not only ecologically fragile; their location usually puts them at the forefront of conflict with human priorities of land use (airports, tourism infrastructure, wind energy turbines, harbours...). Appropriate and effective management is the key factor for their successful conservation (Gerakis 1992). According to the Bird Directive (2009/147/EC) effective bird protection is a trans-frontier environment problem entailing common responsibilities. The Council of the European Communities (2009). Measures must be taken concerning the diversity and area of habitats of migratory birds in order to ensure their survival and reproduction. These measures should be coordinated in a coherent and consistent way. Under Article 17 of the Habitats Directive, EU member states have to assess and report the conservation status of habitats and species every six years. There is a general lack of data and the 'unknown' assessment is particularly high in countries of southern Europe (<http://biodiversity.eionet.europa.eu/article17/>). Understandably, information on the current status of wetlands, the extent of wetland loss and degradation, conservation procedures and the success of monitoring strategies is required for an efficient protection of stopover sites for migratory waterbirds. Some ongoing wetland inventory and monitoring programmes provide such information (Finlayson & Spiers 1999).

Loss and/or deterioration of number, area, quality and connectivity of wetlands along a flyway can result in a lack of suitable stopover sites for migratory birds. Monitoring of these sites, however, is often labour-intensive and costly. Remote sensing methods can be a time- and cost-effective alternative (Alexandridis et al. 2009). The use of remote sensing methods for mapping bird migration habitat along the west coast of Greece and for temporal monitoring of changes in these habitats has been investigated (Lagring 2008; Tsakiri-Strati et al. 1994). Previous studies, using SPOT and Landsat satellite images, and aerial photos to study changes of the Amvrakikos Gulf, have shown significant environmental degradations between 1945 and 1987 (Lagring 2008; Tsakiri-Strati et al. 1994). In this paper, we present a methodology using long-term satellite image archives intended to form a baseline for future research in this field and it deliberately aspires to do so in an easily accessible, low-cost and time-efficient manner. Our specific objectives are the following:

- To develop an inventory of recorded and known wetlands from the Amvrakikos Gulf. We wish to investigate the effectiveness of Landsat and ASTER VNIR (visible and near infrared) satellite images to trace small unknown wetlands.
- To develop a land use/land cover classification of the wetland area. This classification scheme should contain a list of habitats that are important for migratory wetland birds – which can be incorporated in ongoing wetland inventory – and the results of monitoring along the west coast of Greece and elsewhere.
- To identify the changes that occurred and the causes of those changes. The effectiveness of using Landsat and ASTER satellite images for post-classification change detection of wetlands for monitoring purposes concerning migratory birds has been investigated.
- To assess the habitat quality in terms of spatial configuration by means of a fragmentation analysis.

Methods

Study area

The Amvrakikos Gulf, located along the west coast of Greece (39°0'N, 21°0'E), is selected as our study area. This wetland complex is an Important Bird Area (GR081, BirdLife International 2009)

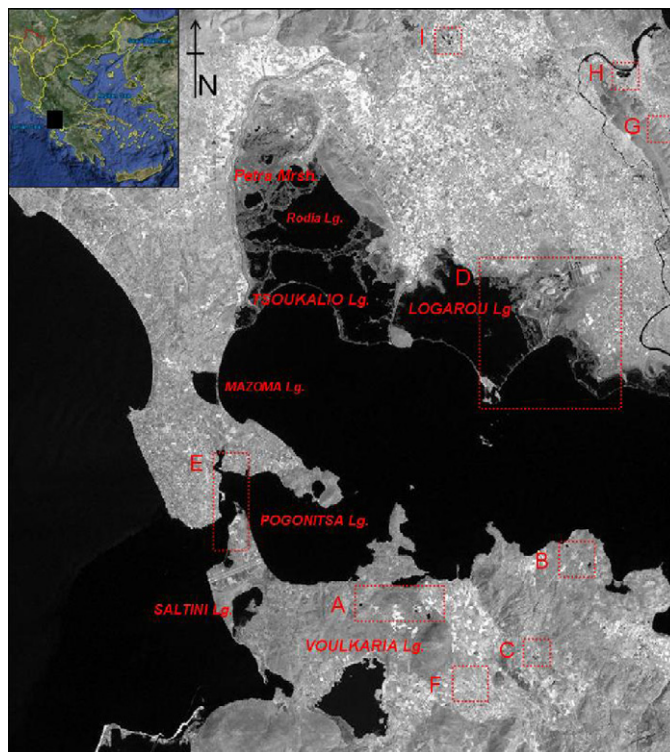


Fig. 1. Wetlands of the Amvrakikos Gulf. Overview of small recorded (A–E) and unrecorded (F–I).

that covers a surface of 25,000 ha. Part of the wetland is protected as Wildlife Refuge (10,500 ha), Ramsar site (23,649 ha) and Special Protection Area (GR2110004: 23,004 ha) (Hellenic Ornithological Society 2007). The Hellenic Ministry for the Environment, Physical Planning and Public Works (MINENV) proposed the establishment of the area as a National Park with special zones (Bazigou 2007). This has been approved since 2008. The area is situated in the prefectures of Árta, Preveza and Aetoloakarnania. It is one of the best legally protected wetlands, with high ecological value ecosystems both on a national and international level. The official website managed by the Hellenic Ornithological Society (http://www.ornithologiki.gr/page_iba.php?alD=81&loc=en) provides additional background on the site including descriptions of habitats and land use, and bird species active in the area. Conservation issues and threats were listed for this specific IBA. An estimation of the bird populations was also provided in the year 1996.

Here we can find all elements of a typical natural Mediterranean delta (Fig. 1). The northern section of the site is formed by the deltas of the Louros River and Arachthos River; this is one of the largest delta complexes of Greece. Three of the largest natural lagoons in Greece dominate the site: the Rodia Lagoon; Tsoukalio Lagoon; and, Logarou Lagoon. Extensive areas of salt marsh, reed beds and brackish water meadows border the lagoons. The Rodia Marsh is one of the largest reed marshes in SE Europe (European Environment Agency 2008).

Satellite images and reference data

Satellite images were chosen and evaluated following the framework of Phinn et al. (2000). The framework was developed for coastal environments due to the urgent need of effective monitoring programmes in these regions in response to their high population levels, resource utilisation and disturbance levels. ASTER Landsat TM and ETM+ images covering the Amvrakikos Gulf were gathered (Table 1). Free Landsat

Download English Version:

<https://daneshyari.com/en/article/4400098>

Download Persian Version:

<https://daneshyari.com/article/4400098>

[Daneshyari.com](https://daneshyari.com)