G Model
JAG-991; No. of Pages 7
ARTICLE IN PRESS
International Journal of Applied Earth Observation and Geoinformation xxx (2014) xxx–xxx
Contents lists available at ScienceDirect
International Journal of Applied Earth Observation and Geoinformation
journal homepage: www.elsevier.com/locate/jag

Using information layers for mapping grassland habitat distribution at local to regional scales

Oliver Buck*, Virginia E. Garcia Millán, Adrian Klink, Kian Pakzad

EFTAS GmbH, Oststrasse 2-18, 48145 Münster, Germany

ARTICLE INFO

Article history:
Available online xxx

Keywords:
Natura 2000
Biodiversity monitoring
Information layer
Grassland
Article 17 reporting
Habitat Directive

ABSTRACT

The Natura 2000 network of protected sites is one of the means to enable biodiversity conservation in Europe. EU member states have to undertake surveillance of habitats and species of community interest protected under the Habitat Directive. Remote sensing techniques have been applied successfully to monitor biodiversity aspects according to Natura 2000, but many challenges remain in assessing dynamics and habitat changes outside protected sites. Grasslands are among the most threatened habitats in Europe. In this paper we tested the integration of expert knowledge into different standard classification approaches to map grassland habitats in Schleswig Holstein, Germany. Knowledge about habitat features is represented as raster information layers, and used in subsequent grassland classifications. Overall classification accuracies were highest for the maximum likelihood and support vector machine approaches using RapidEye time series, but results improved for specific grassland classes when information layers were included in the classification process.

© 2014 Elsevier B.V. All rights reserved.

Introduction

The Natura 2000 network of protected sites is the main policy strategy to address biodiversity conservation in Europe. This ecological network was set up based on the legal requirements of the European Habitat Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, short HabDir) and the Birds Directive (Council Directive 2009/147/EC). The HabDir requires EU member states to undertake regular monitoring and reporting on the status and future prospects of the protected habitats and species. A set of parameters has to be evaluated for the protected sites and for the total potential range of a given habitat within the territory of each member state. Spatially explicit and updated information is thus needed which up to now is mainly collected through field surveys by experts in floristic and ecology.

Earth observation (EO) has been applied successfully in biodiversity monitoring (Nagendra et al., 2013; Turner et al., 2003; Strand et al., 2007; Wang et al., 2010). The ability of EO to provide relevant information depends on the land type investigated (e.g. dry grassland, tropical forest, alpine mires), the applied scale (local to continental) and the quantity and quality of sensor data (active, passive sensor, spectral, spatial and temporal resolution) (Nagendra, 2001; Strand et al., 2007). To monitor Natura 2000 habitat changes, multi-temporal optical or radar satellite image data (Weiers et al., 2004; Bock et al., 2005; Franke et al., 2012) with very high spatial and spectral resolution have been applied (Förster et al., 2008; Hall et al., 2012; Spanhove et al., 2012). Object-based classification approaches were proposed as especially suitable to map habitats, due to the ability to include ancillary information such as shape or proximities at different spatial scales in one classification logic (Langanke et al., 2007; Díaz Varela et al., 2008; Blaschke et al., 2011).

The application of EO to monitor biodiversity can be grouped into direct and indirect approaches (Turner et al., 2003). Advanced sensors such as hyperspectral and very high spatial resolution sensors have aided the direct identification of individual species (Gillespie et al., 2008), but are often considered as too costly by monitoring experts (Vanden Borre et al., 2011). It is therefore common to study indirectly biodiversity through ecological indicators. Duro et al. (2007) classified these indicators into four groups measuring: (a) physical conditions, such as climate and topography, (b) vegetation production, productivity or function (c) habitat suitability with respect to its spatial arrangement and structure and (d) metrics of disturbance indicating biodiversity changes. The identification of a habitat according to the HabDir requires an integrated view, spanning across these categories. It involves not only the definition of land cover (addressed through its observable

* Corresponding author. Tel.: +49 251 133070; fax: +49 2511330733.
E-mail addresses: oliver.buck@eftas.com (O. Buck), virginia.garcia@eftas.com (V.E.G. Millán), adrian.klink@eftas.com (A. Klink), kian.pakzad@eftas.com (K. Pakzad).

http://dx.doi.org/10.1016/j.jag.2014.10.012
0303-2434/© 2014 Elsevier B.V. All rights reserved.

Please cite this article in press as: Buck, O., et al., Using information layers for mapping grassland habitat distribution at local to regional scales. Int. J. Appl. Earth Observ. Geoinf. (2014), http://dx.doi.org/10.1016/j.jag.2014.10.012

vegetation form) but also the occurrence of key species and other biophysical parameters such as topography, aspect or soil characteristics (European Commission, 2007). Therefore, EO based habitat monitoring needs to be adaptive to the characteristics of each habitat type, rather than following a single uniform image processing approach. The use of information layers (IL) presented in this paper takes this into account. Ecological expert knowledge about habitat definition and distribution is related to observable ecological features using EO.

The term IL used here refers to image features extracted from EO or other geodata, stored as standardized raster data sets and used in subsequent classifications (Buck et al., 2013). Depending on the extracted feature, IL can represent:

- Spectral IL: information derived from the original spectral data sets through further processing steps, other than pre-processing (like atmospheric correction, top-of-atmosphere reflectance conversion), e.g. band combinations to calculate vegetation indices, variance reduction through principal component analysis.
- Temporal IL: multi-temporal information derived from image time series.
- Structural IL: information about 2D and 3D visible structures within the image, e.g. lines which give a hint for tracks from agricultural machines, slope directions, plant height.
- Non-image IL: geo-referenced information derived from non-image data sets, e.g. rainfall intensity, animal stock rates or soil type maps.

In this paper, IL was applied to classify grassland habitats in Schleswig-Holstein, Germany. Grassland habitats are an important component of biodiversity in Europe (Silva, 2008; Halada et al., 2011). The intensification of agricultural land use as well as the abandonment of traditional management practices put these habitats under increasing pressure (Henle et al., 2008; Navarro and Pereira, 2012). Protective legislation such as the Cross Compliance regulations (EU regulation 73/2009) could not stop the regional decline of grassland (Nitsch et al., 2012). Regional authorities require regular and up to date information on grassland distribution and quality to better monitor these habitat changes.

Methods

Defining the grassland habitats and corresponding information layers

The study site (625 km^2, 9°32′ E, 54°15′ N) is part of the Atlantic biogeographical region located in the federal state of Schleswig-Holstein, Germany. It is framed by the lowland rivers Eider, Treene and Sorge, and dominated by farming and agricultural lands (Fig. 1).

The following Natura 2000 grassland habitat types are declared by the regional monitoring agency (*Landesamt für Landwirtschaft, Umwelt und ländliche Räume*, LLUR) as of special concern: Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (habitat code 6210), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) (habitat code 6410), lowland and lowland hay meadows (habitat code 6510). In the Natura 2000 guidelines, these habitats are mostly defined by their plant species composition (European Commission, 2007), a gradient which is difficult to detect with EO techniques (Schmidtlein and Sassin, 2004; Feilhauer et al., 2013). The high spatial within-class variability, the spectral similarity of classes and their temporal variation (Feilhauer et al., 2013; Schuster et al., 2015) make the classification of grassland vegetation challenging. Species composition of grassland is highly related to land use intensity (Waldhardt and Otte, 2003) and previous studies classified grassland habitats by using land use intensity parameters (Jacobsen et al., 2000; Schuster et al., 2012; Franke et al., 2012). In our study we adopted a grassland classification system using ecological and land use features. Four different grassland classes were defined together with the LLUR monitoring experts (Table 1). They are characterized by features used by the LLUR in a visual interpretation of grassland using aerial photographs and vector information on soil distribution.

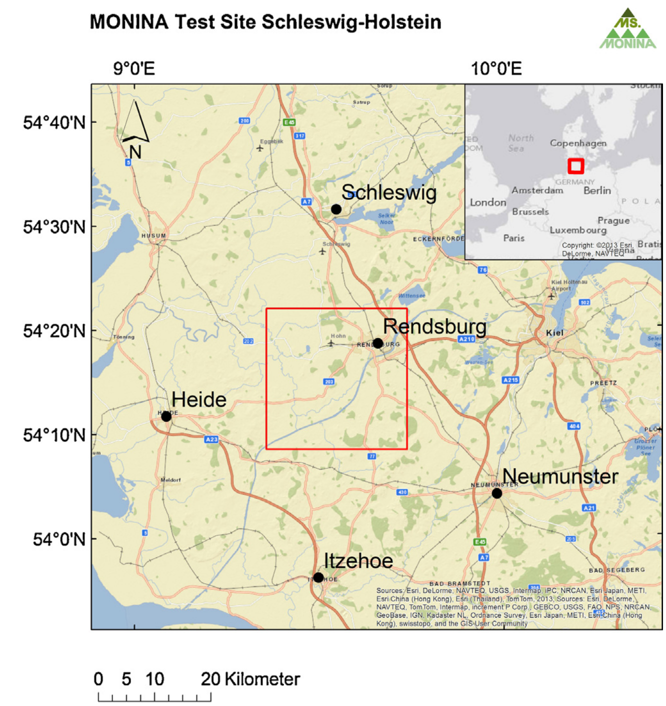

Fig. 1. Test site (red square) in Schleswig-Holstein, Germany. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Compared to other grassland habitats, intensive grasslands experience a higher number of mowing events (up to four) over a given vegetation period. Dry grasslands are never mowed, while wet and mesophilic forms are cut only once at different times during the summer season. Field checks showed that dry grasslands often do not form a homogeneous vegetation cover but are a composite of bare soil, small shrubs and herbs. Wet grasslands are moderately homogeneous in terms of coverage, while mesophilic

Table 1
Definition of grassland classes.

Grassland type	Biomass	Mowing season	Homogeneity	Soil moisture	Slope orientation	Line structures
Dry grassland 62xx	Low-medium	Not applicable (n/a)	Low-medium	Very low	South	n/a
Wet grassland 64xx	Low-medium	August	Low-medium	High	n/a	Low occurrence
Mesophilic grassland 65xx	Medium-high	June	Medium-high	Medium-high	n/a	Low occurrence
Intensive grassland GI	Medium-high	2–4 times (May, June, August, September)	High	Low-medium	n/a	n/a or low occurrence

Adapted from Buck et al. (2013).

Download English Version:

https://daneshyari.com/en/article/6348785

Download Persian Version:

https://daneshyari.com/article/6348785

Daneshyari.com