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Detecting vegetation changes in a wetland area in Northern Germany using earth observation and geodata

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Summary

Monitoring land use and landscape dynamics in conservation areas is important to understand and influence nature and restoration processes. Earth observation data can help to detect changes automatically in extensive areas. In a wetland area in Northern Germany different change detection methods have been tested to detect wetland restoration processes, especially succession of wetland and moorland vegetation over 11 years. Therefore a change detection method based on a selective principal component analysis followed by a fuzzy membership function introduced by Weiers et al. (2001). was tested with dual date Landsat TM/ETM+ images. As comparison vegetation maps and Colour-infrared (CIR)-aerial photographs were analysed. The main objectives were to find out (1) if changes, especially vegetation changes, can be detected on the study area by the method as described by Weiers et al. (2001), (2) which changes can be detected and (3) which is the best method on the study area, respectively: the Landsat change detection method, the analysis of vegetation maps or the interpretation of CIR-aerial photographs. For detecting vegetation changes the most detailed information were achieved by interpreting CIR-aerial photographs, while the Landsat change detection method turned out to be more suitable for detecting changes of wetness.

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Introduction

Regarding aspects of land use dynamics and habitat changes the development of spatial explicit and thematic consistent monitoring concepts for the assessment of local site-specific conservation strategies is becoming more and more important. This has lead to an increasing demand on change indicators and the development of new advanced classification and change detection approaches integrating remote sensing data on different scales.

Local authorities in particular are confronted with the development and realisation of legally binding monitoring concepts for individual nature conservation sites and selected habitats, regulated in European, e.g. Habitats Directive/Natura 2000 network, and national nature conservation legislation. Therefore the availability of cost and work effective instruments for change detection and change analysis is strongly requested. The applied methodologies should provide the user with spatially explicit information on the direction and intensity of change. Their suitability for a regular assessment of specific management concepts and reporting obligations should be ensured.

The concept of the SPIN[1] project explicitly aimed to provide classification, change detection and monitoring methodologies at several spatial scales. However, user acceptance for (satellite) remote sensing data for local level nature conservation applications is still limited due to a spatial resolution that tends not to match the requirements of the detailed monitoring tasks at hand.

The following case study is focused on a methodological comparison and suitability analysis of three different change detection approaches, covering the "traditional" field survey concepts, the integration of CIR-aerial photograph interpretation and the use of advanced earth oberservation-based spectral change analysis.

Study area

The study area is part of a wetland area called Eider–Treene–Sorge lowland (located in Northern Germany). Before the lowland was drained and cultivated it consisted of a mosaic of wetlands, fens, swamps and raised bogs between the three rivers Eider, Treene and Sorge. Today most of these wetlands have been destroyed and are used as pastures and semi natural wet grasslands (about 80%). Only some parts of the original landscape could be maintained. However it constitutes still one of the largest coherent wetland areas in Northern Germany and is a RAMSAR designated site. The bogs of the lowland, as relics of a primary wild landscape with their rare vegetation and biotopes, are mostly protected by the EU Habitats Directive and Wild Birds Directive. To detect vegetation changes in wetlands and bogs only the designated areas of the Habitats Directive were used for this study, especially the raised bog "Wildes Moor" (631 ha), the fen "Süderstapeler Westerkoog" (242 ha) and the wetland area around the lake "Hohner See" (838 ha). Over the last 10–20 years restoration management such as halting drainage, intense cultivation and peat cutting has been applied in an attempt to reverse the damage from cultivation. Since then, restoration towards a natural wetland vegetation has started. It is following the course of successional stages such as wet grassland, fallow land, heathland, degradation stages of bogs and moorland vegetation. At the present time all the succession stages are present at the site.

Data used

Remote sensing data

Because of its consistent series two Landsat TM/ETM+ images (15/07/1990 and 05/07/2001) were used to observe vegetation changes over 11 years. The geometric correction was carried out with an accuracy of 0.5 pixels using the topographic map scaled 1:100.000 for the full scene and a local fine image-to-image rectification using the ATKIS geometry (German topographic information system). In two stages the images were radiometrically corrected. First the digital numbers (DN) were converted into reflectance at top at the atmosphere (rtoa) as described in Chander and Markham (2003) to remove annual and diurnal variations of the reflectance. In the second step a relative radiometric correction with a reference image – in this case Landsat ETM+ 05/07/2001 – was applied using the method described in Hall, Strebel, Nickeson, and Goetz (1991). As similar atmospheric conditions prevailed in both images, only two Landsat bands needed to be transformed. The images were cut into the size of the protected wetland areas of the Habitats Directive. Following that, bands 1 and 6 were deleted because of their expected low information content, high noise content (band 1) and low geometric resolution (band 6). The ratios normalised difference

[1]SPIN—Spatial Indicators for Nature Conservation www.spin-project.org