Technical note 2

Sampling of representative digital photographs and reference fractional vegetation coverages

Dr. Markus Möller

Halle (Saale), den 14. November 2014

Zuwendungsempfänger Martin-Luther-Universität Halle-Wittenberg · Institut für Geowissenschaften und Geographie · Fachgebiet Geofernerkundung und Kartographie | Von-Seekendorff-Platz 4 · 06120 Halle (Saale)

Unterauftragnehmer geoflux Thomas Koschitzki & Daniel Wurbs GbR

Förderkennzeichen 50EE1230

Laufzeit 1.8. 2012 bis 31.07.2015

Kontakt Dr. Markus Möller · mail: markus.moeller@geo.uni-halle.de · Tel. (0345) 552 60 26
1 Subject

The DynaC framework aims at the up-to-date derivation of a parcel-specific cover-management or C-factor as a temporally dynamic input parameter for soil erosion modeling. The estimation of parcels' fractional vegetation coverages (FVC) and Crop Residue Coverages (CRC) is based on the analysis of multi-spectral and multi-temporal satellite imagery.

The FVC and CRC modeling results are validated by digital photographs taken from representative samples on selected field blocks. In this report, the underlying procedure for the selection of the samples’ locations as well as the principle photo classification approach is described.

2 Test site

The study area is situated in the German Federal State of Saxony-Anhalt near the city of Halle (Saale) and corresponds to 9 RapidEye image tiles (Fig. 1a). For the red emphasized tiles, two images acquired on 5th May 2013 are available in the RapidEye Science Archive (Fig. 1a and b). The RapidEye system provides imagery with high repetition rate, a spatial resolution of 6.5 m, and five multi-spectral bands which cover blue (RE1: 440 – 510 nm), green (RE2: 520 – 590 nm), red (RE3: 630 – 685 nm) and the near-infrared spectral value ranges (RE5: 760 – 850 nm). In addition, a red-edge band is available which is assumed as sensitive to the abrupt reflectance rise caused by vegetation’s chlorophyll (RE4: 690 – 730 nm) [Tyc et al. 2005].

Abbildung 1: Location of the test areas in Germany (white), Saxony-Anhalt (grey) and the extent of the available RapidEye imagery (a) as well as two RapidEye acquired on 5th May 2013 (band combination 5-4-3) overlayed by LPIS field blocks, test sites (yellow) and sample points (green) (b). On the red framed field block, the applied terrain analysis procedure is exemplified.

The yellow colored field blocks visualized in Figure 1b have been mapped regarding vegetation coverage whereas the green-colored sample points show the locations where photographs of vegetation coverage have been taken. The yellow colored field block is used for the exemplary visualization of the FVC results and is characterized by a size of about 87 ha, Loess parent material as well as a complex topography (Fig. 1b and 2a).

1 http://paradigmaps.geo.uni-halle.de/dynac/
2 The RapidEye Science Archive (http://resaweb.dlr.de/) is maintained by the German Aerospace Center (DLR) and funded by the Federal Ministry of Economics and Technology (contract no. FKZ: 50EE0701). This study is supported within the project 634.

– vertraulich –
Abbildung 2: Photographs of the test block taken on 19th June 2013 (a) and 3rd May 2013 (b).

Abbildung 3: Workflow (a) for the selection of representative vertical surface photograph taken from the test block on 3rd May 2013 (b).
3 Sampling of representative digital photographs

Since 2013, photographs have been taken regularly from specific physical blocks within the test site area during the vegetation period. The selection of physical blocks was guided by the existence of complex terrain conditions and the observation of soil erosion events in the past. For instance, the test block is characterized by repeatedly occurring erosion phenomena like rills and accumulation (Fig. 2a). The samples’ locations have been chosen within classified topographic positions for which a relation to FVC degrees – especially in early phenological phases – is assumed. For instance, a photograph of the test block taken on 3rd May 2013 shows terrain-related vegetation cover differences during the emergence of winter wheat (Fig. 2b). The actual workflow for the selection of representative photographs can be distinguished in five steps (Fig. 3a):

- The workflow is based on the state-wide available digital elevation model (DEM) with a resolution of $10 \times 10 \text{ m}^2$ which was originally generated by the digitization of elevation contours of topographic maps in a scale of 1:10,000. The terrain attribute Mass Balance Index (MBI) enables the detection of soil-related process domains where soil loss and accumulation dominate (Möller et al., 2008, 2012). The $MBI$ results from the combination of the transformed relief parameters slope ($S$), total curvature ($C$) and vertical distance to channel network ($D$; Eq. (1)). Potential sediment accumulation is more likely to be assumed at concave curvatures and flat areas in a small distance from channel network. The soil erosion risk increases with more convex curvature and slope steepness as well as increasing vertical distance from the channel network.


- The region-growing segmentation algorithm FNEA has also been proven as suitable for detecting objects having meaning for soil-terrain-related issues (Drăguţ & Eisank, 2011). A crucial point is the determination of an optimal segmentation parameter setting (Drăguţ et al., 2009). Similar to Drăguţ & Blaschke (2006), we have compared different segmentation results with significant known landforms like valleys and slope positions representing minimal object sizes.

- Clustering belongs to the standard techniques of unsupervised learning and aims at the grouping of similar objects. In contrast to the above mentioned FNE algorithm, similarity only refers to feature space of data points (here: explaining relief parameters). The applied K-means algorithm uses the squared Euclidean distance as dissimilarity measure. The algorithm is described in detail by Hastie et al. (2009). Starting with a user-defined number of initial K centroids, each data point is iteratively assigned to the nearest cluster centroid. The maximum number of iterations and desired classes must be specified by the analyst. In this study, five classes should be clustered.

- The classified terrain positions define the representative areas within photographs should be taken by surveyors. The photos have been taken in a vertical and downward manner (Yan et al., 2012) and cover a defined and referenced surface subset.

- Similar to Liu et al. (2012), the extraction of the photo-specific FVC has been realized by a supervised classification using the maximum likelihood method implemented in ENVI software. The classification is based on samples of the target classes vegetation and bare soil which has been selected by expert-knowledge.

In Figure 4, the procedure is illustrated on the example of a field block (see Fig. 1b). The color composite of three terrain attributes illustrates the physical block-specific terrain complexity (Fig. 4a). Their classification leads to soil-related process domains ranging from depressions (blue) to convex and sloped topographic positions (red; Fig. 4b). The green colored dots represent sampling points on which photographs has been taken (Fig. 4c–f). Classification results are visualized in figures 4g–j.
Abbildung 4: Field block-related color composite of the terrain attributes $D$ (red), $MBI$ (green) and $S$ (blue) (a), location of photo samples within classified topographic positions of an example field block (see Fig. 1b) (b), corresponding photos taken on 03rd May 2013 (c-f) and FVC degrees results (g-j).

Literatur


