Assessment of grassland and other agricultural land management practice in Latvia using optical and SAR satellite data

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Extended technical abstract

Introduction

Grassland covers around 35% of the agricultural land area in Latvia (CSB Latvia data, 2014). Grassland is not just a storehouse of nutrients for livestock, but it is also wildlife habitat and plays important role in biodiversity protection. Grassland requires appropriate management – undisturbed habitat development with regular grass cutting witch sometimes doesn't meet the needs of their owners. On the other hand, grassland is a subject of the EU and state support for rural areas and agriculture that depends on the management practice and grassland quality. The Rural Support Service controls activities of agriculture land management practice on regular bases randomly choosing objects and visiting ~5% of the fields. High resolution satellite data is also used for checking of selected areas, but its coverage is limited. Landsat and Sentinel data are of interest due to its availability on regular bases and free of charge. Optical and radar satellite data compliments each other and allows cross-validation. Temporal data stacks are of great interest for assessment of grassland management practice due to possibility to detect grass cutting and other temporal changes in agricultural land.

The aim of this study is to test possibility for assessment of grassland and other agricultural land management practice (cutting of the grass, detecting of plowing and mismatch between declared and actual agricultures) combining optical (Landsat-8 and Sentinel-2) and radar (Sentinel-1) satellite data as well as airborne data.

Pilot territories

Two study areas were selected in Latvia near the towns of Sigulda and Cesis where agricultural land covers respectively 38% and 30% of the territory [CLC 2012]. Data on grassland and other agricultural land use were provided from the Rural Support Service indicating agricultural cultures submitted by farmers to get EU and state support. Most of the agricultural land in these areas is used as the permanent grassland (43%) and the grass in arable land (15%). Strong fragmentation of agricultural land is specific for Latvia, and it can be seen also in pilot territories – around 40% of grassland polygons were smaller than 1 ha.

Remote sensing data

Landsat-8 optical and Sentinel-1 SAR temporal data were chosen due to its availability on regular bases and free of charge. Sentinel-1 SAR temporal data stack consisted of 18 bands acquired between 1st January and 29th August 2015. Landsat-8 multispectral images were used to produce temporal NDVI data stack. Only four cloud free Landsat-8 scenes were available over pilot territories during vegetation season 2015, but it can be considered as a good result for Latvia.

Airborne data was acquired on 8 August 2015 using ARSENAL (Airborne Surveillance and Environmental Monitoring System). ARSENAL is developed by the Institute for Environmental Solutions and consists of five mutually operable sensors – three hyperspectral sensors covering 380-5000nm spectral range, LiDAR and high resolution RGB camera. Hyperspectral sensors were used to simulate Sentinel-2 spectral data and test classification limits for agriculture lands. LiDAR data and RGB aerophotos (30 cm/px) were used for sampling and validation purposes.

Assessment of grassland management practice

Cutting date of the grass was assessed by both optical and SAR data. An example of two permanent grassland fields with different cutting dates can be seen in Figure 1. Field #1 appears green in aerophoto from August 8 (Figure 1a) while field #2 is brown and without vegetation. NDVI decrease was observed on July 5 for field #1, and on August 6 for field #2 indicating cutting of the grass, see false color Landsat NDVI RGB composite in Figure 1b. VV polarization backscattering intensity radar data was used to detect cutting of the grass. Grasslands usually are bad reflectors of radar intensity (see Figure 1c), therefore appears dark in intensity images during all the year. Plowed arable lands usually highlight in spring while grasslands are dark. All agriculture lands are week backscatters during vegetation maximum in mid-June. Cutting of the grass usually appears as increase in radar intensity – in June 30 for field #1 and July 12 for field #2. Observed cutting dates from optical and radar data corresponds and could be used for cross-validation.

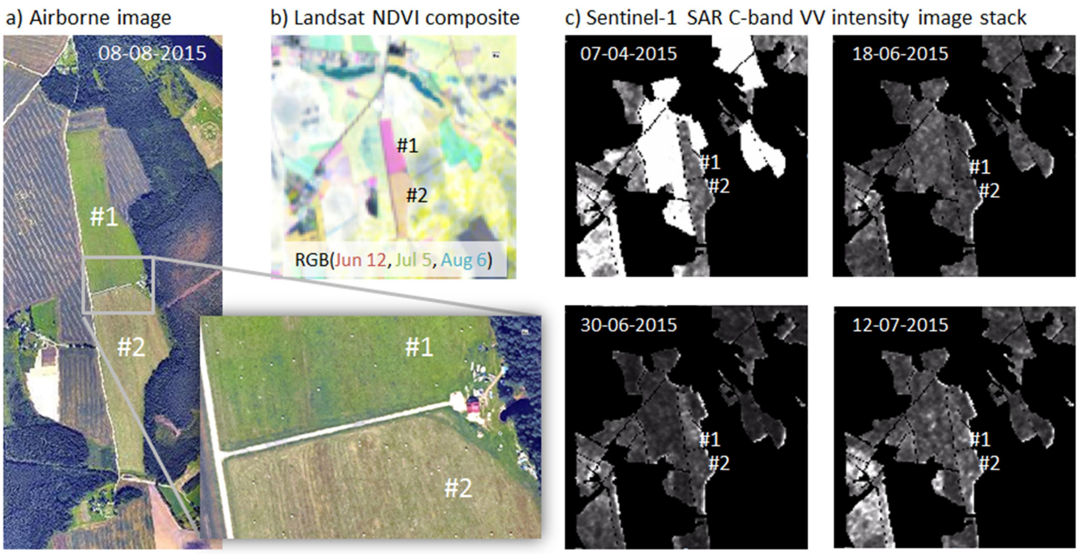

Figure 1. Example of two permanent grassland fields (#1 and #2): high resolution (30 cm/px) RGB aerophoto from August 8 (a), Landsat NDVI RGB (June 12, July 5, August 6) composite image, and Sentinel-1 SAR C-band VV intensity images from April 7, June 18, June 30 and July 12 (c). Note: non-agriculture lands are masked out of SAR intensity images.

The advantage of radar data is its availability on regular bases regardless to weather conditions, but it suffers from speckle noise. Backscattered intensity is also sensitive to moisture. It is expected that more frequent (every 6 days) Sentinel-1 data after launch of Sentinel-1B will improve detection accuracy of grass catting date.

Optical data seems more reliable to the end-users due to its straight forward interpretation. It is also less affected by noise, but is limited by weather conditions. Landsat-8 temporal (every 16 days) and also spatial resolution (30 m/px) is to coarse to fulfill requirements for precise assessment of grass cutting. It is planned to test also Sentinel-2 optical data after its release in mid-October 2015.

Classification of agricultural land use to support control activities of management practice

Classification of agricultural lands was performed by both optical and radar data. Official data from the Rural Support Service was used for training of supervised classifiers and further on checked for outliers. It was expected to find mismatches between declared and actual cultures to support control activities of agriculture land management practice.

An example of mismatch between declared permanent grassland and actually used rapeseed field is shown in Figure 2. The mismatch was primary detected in SAR temporal data. Declared permanent grassland field appeared as plowed (incorrect management practice) – high backscatter radar intensity in spring, see Figure 2b. It was also classified as rapeseed from SAR temporal data – rapeseed is characterized by high radar intensity in late summer and has the most distinctive temporal SAR intensity signature between the cultures examined in pilot territories. Visual inspection in high resolution aerophoto from August 8 (see Figure 2a) approved that declared permanent grassland field corresponds to neighbor rapeseed field by color and also texture.

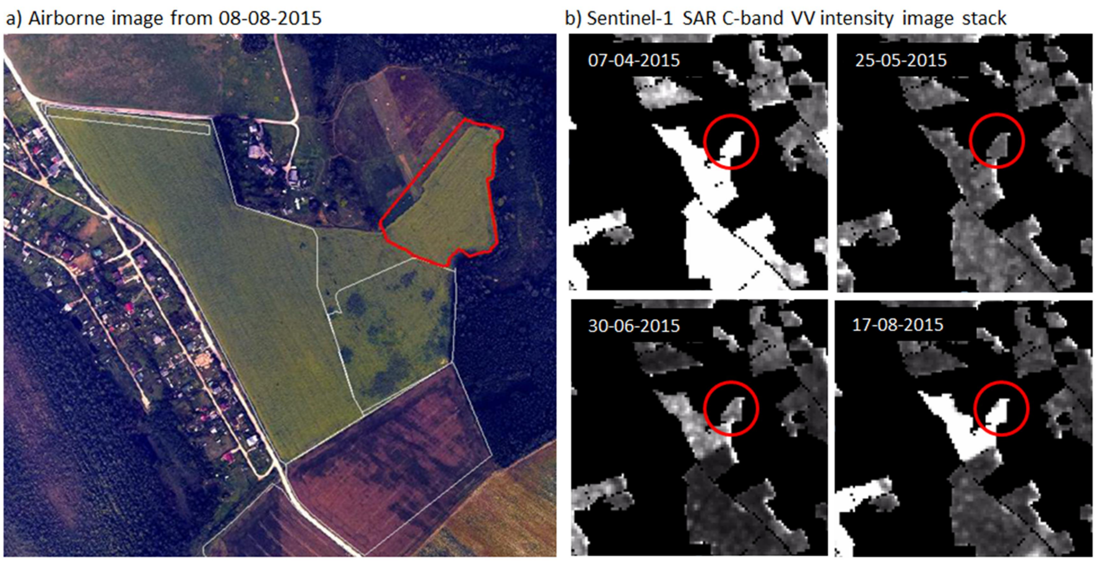

Figure 2. An example of mismatch (red polygon is declared as permanent grassland, but used as rapeseed): high resolution (30 cm/px) RGB aerophoto (a), Sentinel-1 SAR C-band VV intensity images from April 7, May 25, June 30 and August 17 (c). Note: non-agriculture lands are masked out of SAR intensity images.

Control activities of agriculture land management practice are held on regular bases randomly choosing objects and visiting ~5% of the fields. Remote sensing techniques allow checking larger areas and identify suspicious objects thus moving towards more targeted control. Optical and radar satellite data compliments each other and allows cross-validation.

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