Assessment of performance of the MAVI Product and description of the evaluation methodology

Issue 0.1

SEN3APP

Processing Lines And Operational Services Combining Sentinel And In-Situ Data For Terrestrial Cryosphere And Boreal Forest Zone

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Document History

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Introduction

Maaseutuvirasto (MAVI, Agency of Rural Affairs) is responsible for the use of agricultural aid and rural development funds of the European Union in Finland. They operate as the Finnish paying agency, administering EU and domestic subsidies of over EUR 2 billion annually. Remote sensing was used until 2003 and stopped because of lack of good imagery and large amount of uncertainty in the classification results, which required further on-site visits.

The MAVI product of SEN3APP consists of monthly estimates of vegetation cover, soil cultivation practices, agricultural plant type classification and detection of anomalous parcels for specific conditions to be met in the subsidies reporting.

The product can have also other users, additionally to MAVI, for example in nutrient leaching modelling at SYKE. In order to apply the satellite derived data product the user needs information on the uncertainty related to the interpretation and understanding how the uncertainty information was derived.

This document describes the current status in the validation of the MAVI products. These products are still under development and therefore the interested user is encouraged to follow the development of the document or contact the respective authority for further detail of the status of the product.

1. Document Identifier

SEN3APP_SYKE_MAVI_VR_V1.0

2. Title

Assessment of performance of the MAVI Product and description of the evaluation methodology.

3. Authority and Contact Information

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4. Abstract

The uncertainty information related to the MAVI product is presented. The derivation of the quantitative measures of uncertainty is presented in such detail that the user can track back the procedure and repeat the analysis or use the same procedure to similar satellite data product.

5. Keywords

#Sentinel-1, #Sentinel-2, #Landsat-8 #optical satellite, #vegetation cover, #soil cultivation #plant classification #anomaly detection #agriculture

6. Key terminology

LPIS	Land Parcel Information System
Land parcel	A parcel, which has natural (defined by legislation or geographic boundaries) borders or borders a parcel with different subsidies procedure. A base parcel can host several agricultural parcels
Agricultural parcel	Agricultural parcel is uniform land area, which is used to grow a single crop for single purpose, or is currently not cultivated for agricultural purpose or is used for another purpose. The size of an agricultural parcel is at maximum the size of land parcel and is associated only to a single land parcel.

7. Background, Context and Scope

The MAVI satellite data product has been developed in SEN3APP EU-FP7 project. The project aim was to develop existing or new satellite data products in collaboration with potential service users and to establish data processing and delivery services for these products. In the beginning of the project a comprehensive list of satellite data products was generated by the project partners. Then key users were identified and focus was given to the data products that meet their needs.

The MAVI product is still under development and therefore the data and results presented here should be considered preliminary. The document addresses three products that are currently piloted for MAVI: 1) vegetation cover, 2) soil cultivation practices and 3) agricultural plant type.

This is the first version of the validation documentation that should be made easily available where the MAVI product is also made accessible and delivered together with the data.

8. Product performance and uncertainty

Agricultural plant type classification

The overall classification accuracy was about 93% for selected agricultural plant types. It should be kept in mind that number of parcels as well as geographical area was rather limited. On the other hand, this result was based on the use of SAR-imagery only. Combined use with optical imagery like NDVI time series would most likely enhance performance.

Vegetation cover estimate

At the moment there is not in-situ material for validation of vegetation cover estimates.

NOTE: Accuracy assessment using aerial images will be added later.

Soil cultivation practices

At the moment there is not in-situ material for validation of soil cultivation practices.

Detection of anomalous parcels

At the moment there is not in-situ material for validation of detection of anomalous parcels.

9. Inputs

Input	Description	Link
SYKE MAVI data products	The following variables are interpreted from medium resolution optical satellite data (Landsat-8 and Sentinel-2) and from SAR satellite data (Sentinel-1): 1) Vegetation cover; 2) Soil cultivation practices; 3) Agricultural plant type classification	The data is not yet openly available, as the product is still in the development phase.
LPI for current year	The land parcel information is delivered for development and validation of the	
Aerial images for current year		

10. Standards and Traceability

Standard/ Documentation	Description	Link
SYKE MAVI Product Description	Document describing the algorithm used to create MAVI products	
LPIS codes	Agricultural plant codes of LPIS	

11. Methodology, Processing

Agricultural plant type classification

1. Group agricultural plant information to agricultural plant types.
2. Divide farmer's notifications about plants to training and test data. If there is small amount of data, use leave-one-out estimation method.
3. Classify test data using training data.
4. Compare the classification of test data and farmer's notifications of test data by forming confusion matrix.
5. Compute accuracy measures overall accuracy and class wise user's and producer's accuracies.

Vegetation cover estimate

1. Acquire aerial images, preferably including near-infrared band and less than 1 meter pixel size
2. Classify pixels of aerial image to vegetated / non-vegetated pixels
3. Compute average vegetation cover for same grid as satellite image from aerial image
4. Form linear regression model between vegetation cover estimate from aerial image and satellite image, and compute statistical descriptors (correlation coefficient, R2, RMSE, Bias).

12. Evaluation of Performance

Agricultural plant type classification

The temporal target of plant type classification is that the classification of growing season should be made during August, so the imagery should be acquired before early August. This classification has been tested using Sentinel-1 SAR imagery for growing season 2015 (Törmä et.al. 2016).

Final plant groups, their LPIS classes and number of samples in classification are presented in following table.

Final plant groups	LPIS classes	Number of parcels
1. Winter cereals	1110 Winter wheat 1230 Winter rye	90
2. Spring cereals	1120 Wheat 1310 Fodder & 1320 Malt Barley 1400 Oats	658
3. Peas	2110 & 2120 Peas 2200 Broad bean	53
4. Potato	3120, 3130 & 3190 Potato	29
5. Rapeseed	4110 & 4210 Rapeseed	48
6. Grasses, pasture, fallow	6121 Multiyear fodder grass 6122 Multiyear pastures 6123 Multiyear grass for seeds 9402, 9403, 9404 & 9405 Fallows	144

Classifications were made using k-Nearest Neighbour classifier, and the number of nearest neighbors, k, varied from 3 to 9. The used accuracy estimation method was leave-one-out estimate, in which data is divided to training and test sets so that one feature vector is test set and the rest training set. Then test set is classified using training set and checked if it was classified correctly. This is repeated so that each vector in data is once in test set, and final estimate of overall accuracy is the number of correctly classified test sets divided by the number of vectors in data. The best overall accuracy of classification was 93.4%.

The class wise producer's accuracies varied 80 - 100%, the best being spring cereals and potato (about 100%), then peas (95%), winter cereals and grass (90%) and the worst was rapeseed (80%). The user's accuracies varied 90 - 98%, the best being spring cereals and potato (about 98%), then winter cereal (95%) and the worst peas, rapeseed and grass (about 90%).

NOTE: 95% confidence limits will be added later

13. (Evidence to Support Performance Indicator)

NOTE: possibly will be added later.

14. References

Markus Törmä, Anders Munck, Olli-Pekka Mattila, Pekka Härmä, Ali Nadir Arslan, SENTINEL-1 SAR IMAGERY FOR FINNISH AGRICULTURAL SUBSIDY CONTROL, ESA

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