A Sampling Approach for Advanced Multi-Temporal Classification of Sentinel-2 Data

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Abstract

Sentinel-2 Global Land Cover (S2GLC) is an ESA SEOM project with the aim to define a scientific roadmap and recommendations for creating a Global Land Cover (GLC) database based on Sentinel-2 data. The database will bring a new quality of information to the Remote Sensing user community by exploiting Sentinnel-2 capabilities. The project began in 2016 comprising four partners: CBK PAN, IABG, EOXPLORE UG and FSU.

When fostering methods of satellite image analysis according to the increasing technological capabilities new satellite technology offers, these methods should systematically build on previously achieved efforts. Simultaneously, they should continue recent methods and take advantage of the new technology's temporal, thematic and spatial capabilities.

After an extensive review of currently available Global Landcover (GLC) databases, as an initial step of this project a preliminary hierarchical legend of land cover classes was defined, which intends to benefit from the high temporal, spatial and spectral resolution of Sentinel-2 in combination with Sentinel-1.

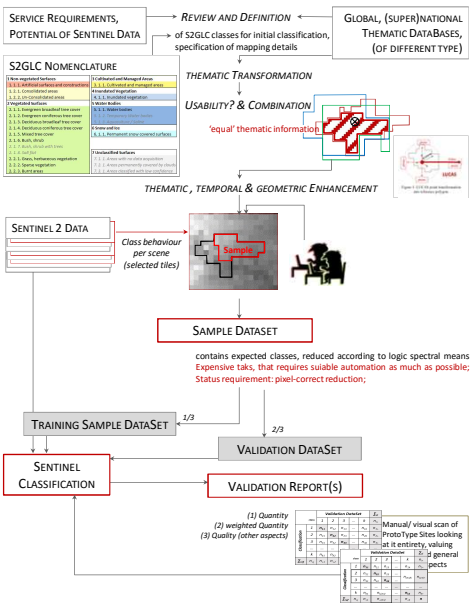
Subject of this presentation is the preparation of suitable reference data used in the classification and validation process performed within this study and beyond. For this purpose, five test sites were selected globally, enabling us to react sensible towards regional variety. The test sites are of significant extent and heterogeneous in their environmental character resulting in heterogeneous land cover classes. They are located in: Italy, Germany, Namibia, Colombia and China.

Quantity and quality of already existing classification results is very heterogeneous. Supplementary regional data sets (for example LUCAS, CORINE) with different accuracy than the envisaged data set but of higher accuracy than existing GLC data sets were considered as additional thematic information.

Recent investigations took place on selected subsets. Overall goal is to identify and develop strategies to combine available GLC data and additional thematic layers in order to reduce manual effort. The latter concentrates on providing significant input for the set-up of an overall roadmap regarding a Global Sampling Database.

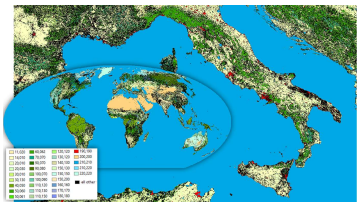
Investigations consider available global classification and validation results in combination with the coarse analysis of up-to-date Sentinel2 data supporting information extraction suitable for classifications and validation issues. Main aim within the project is to support the multi-temporal classification process, which is subject of a different presentation.

Overall Concept



GLC datasets

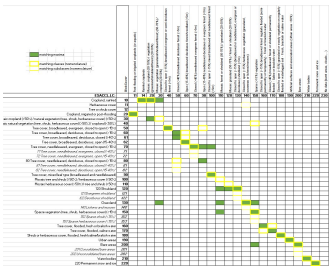
Within the review of global datasets, Global Validation Datasets (GLCV) were considered but rejected due to insufficient coverage regarding this project and date. Alternative a wide range of GLC were reviewed observing thematic and geometric suitability. A combination ***GlobCover 2005*** and ***CCI-LC 2010*** had been selected, accomplished by Globe Land30 (except Europe).



GlobCover 2005 and CCI-LC 2010 (color: matching results, based on original nomenclature; black: discrepancies)

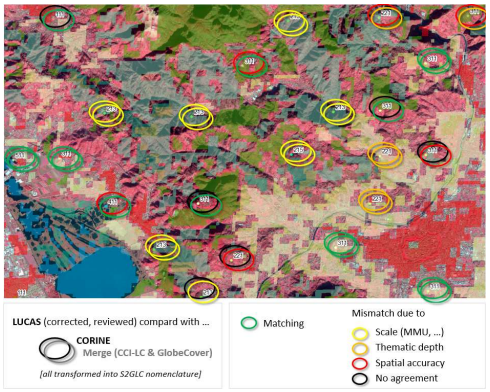
The shown result values more than 64% with comparable classification (not considering water bodies). However, there are uncertainties regarding nomenclature issues. It can be stated that GLC show local variation in accuracy and thematic emphasis [Tsendazar, 2015].

The ***Global Urban Footprint (GUF)*** [DLR 2016; Esch et.al., 2012/13] could compensate temporal limitations in the reference data regarding artificial structures.



Regional datasets

Regional datasets are of severe interest, especially within a conceptual phase of a project: they are in general of higher spatial and thematic resolution. Test sites under investigation were chosen considering European CORINE, LUCAS, as well as a Colombian CORINE layer as additional ground information. Comparison of information layer illustrates the overall

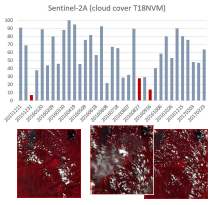


Comparison of potential reference data sets; site: Italy

challenge: matching class results represent matching spectral characteristics of a class according to mapping rules, which in GLC context is 0.9ha. As a consequence classes are often mapped as mixed whereas terrestrial LUCAS data identifies mixed rather than unique features. Following this finding LUCAS was reviewed & modified before further analysis.

Site examples - challenges

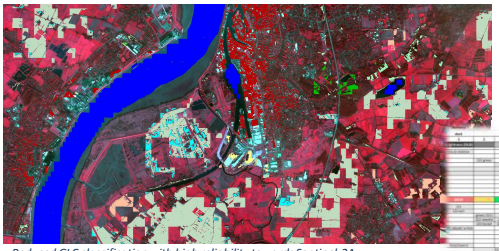
Colombia



... was chosen due to previous project activity in South America. On the other hand data availability is a challenging issue on most tropic and sub-topic regions (see table).

Best data available is highly disturbed by clouds and scattered shadow. So far it was not possible to distinguish between the different vegetation types as well as to validate reference data (GLC/ available national). Acquisition dates are distributed adverse that low and elevated vegetation types can not be to distinguished appropriately.

Germany



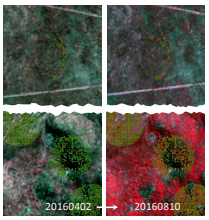
Reduced GLC classification with high reliability towards Sentinel-2A

... is characterized by a high degree of artificially embossed landscape. Data availability is sufficient, even though influenced by strong atmospheric effects. At present a feature aggregation model is set up on one fifth of the Germany site (referring to three S-2A scenes/ tile). Focus is to optimize and reduce manual impact towards semi-automatic procedures that can be transferred to larger extent.

Namibia

... shows very low agreement within the GLC comparison. This is also a result of the landcovers sensible behavior towards water, soil and (ex)position. The S-2A data pair shows how spectral features change after rainfall, hence characteristics of single vegetation classes cannot be described within a seasonal manner. The site of Namibia was investigated by virtual truth (google.earth) and it became clear, that for some vegetation classes (grassland, trees, shrub) within acquisition range no specific spectral behavior could be identified.

On the other hand co-registration of the African S-2A data sets is exceeding general quality standards of 1 pixel and makes it difficult to model objects on pixel level. Here, general approach may need to be reviewed.



Before rain event and after; comparable shrub land; 5km distance

Summary and Outlook

Generation of training and validation data is an important task and has significant impact on quality of the classification and its evaluation. The project presented here consists of two phases in which (1) selected subsites are reviewed in detail. Here experiences are made and strategy gets developed, which will then (2) be transferred onto the entire sites for which increasing the degree of automation will be focus of development.

At present the classification process of our partner CBK is supervised, pixel-based and therefore highly dependent on availability of "pure" training data. However, within the process of increasing efficiency and reducing manual impact within the sampling task it needs to be identified which features and thematic classes do not require individual knowledge.

With respect to significant characteristics of the Sentinel-2 data available as well as the anticipated workflow the project had to re-structure issues regarding spatial accuracy, data preprocessing and data handling.

Training and Sample point selection so far is done on Sentinel-2A pixel level. A random sampling procedure is settled on top of this. This process needs to be investigated in more detail in order to specify suitable amount of training and sampling points as well as its spatial distribution.

Overall goal will contribute to the set-up of a global sampling and validation data concept. Requirements in providing such database will increase significantly, aslo within the context of the growing number of free EO data available.

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