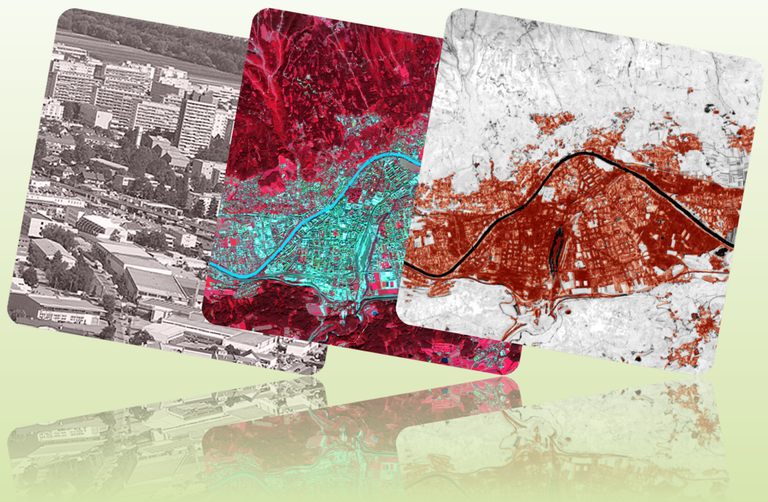

MONITORING OF BUILT-UP AREAS & IMPERVIOUSNESS

New urban monitoring standard using high resolution Sentinel data

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ABSTRACT

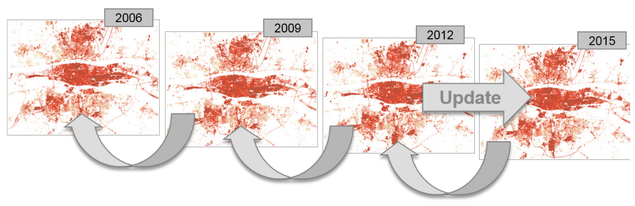
Urbanization and its irreversible land take impact is one of the major drivers of European policy makers. The impact of land take depends on the intensity of urban development in terms of sealing and population density. Because soil is a non-renewable resource the monitoring for environmental reporting is essential.

The Copernicus pan-European soil-sealing layers provide a comprehensive mapping of the urban development over the last decade in a three year cycle from 2006 onwards. Within the Copernicus initiative the imperviousness degree from 1-100% and its change was derived for the years 2006, 2009 and 2012 based on a limited number of IRS-P6, SPOT and RapidEye coverages. The current 2015 update already uses advanced time series approaches based on Landsat 8, SPOT-5 and Resourcesat-2 for the production and Sentinel-2 at this point for gap-filling.

These new opportunities derived from the Sentinel satellites need to be integrated more, in order to enter the next chapter of urban monitoring. The Sentinel-2A and Sentinel-2B satellites provide an advantage for future productions in terms of higher spatial and temporal resolution over large areas. The provided spectral information of Sentinel-2 will furthermore facilitate the classification based on optical data. Complementary Sentinel-1 radar data is being investigated to exploit the additional power of information. To benefit from these opportunities new and advanced algorithms for time series data analyses are currently in development and testing at GeoVille.

A consistent methodology based on available homogeneous input data is a prerequisite for urban monitoring, monitoring of changes and future decisions on national, European as well as on global level.

INTRODUCTION



Example Degree of Imperviousness time-series - Tours (France)

Source: European Environment Agency; Data produced by GeoVille GmbH

A consistent monitoring of urban development is significant for several topics in human and environmental policies. With the launch of the Sentinel satellites a new era has been introduced providing a dense coverage at global level. The availability of 13 spectral bands, a 10 m spatial resolution and the high temporal resolution of the Sentinel-2 data offers a new potential for implementing a fully automated approach to derive a consistent and harmonized HRL imperviousness time-series.

OBJECTIVES

- Consistent and harmonized products across EEA-39
- Thematic accuracies exceeding 85–90%
- 10 m high spatial resolution due to Sentinel-2
- Sentinel-1 for improved differentiation of sealed surface and permanent soil
- High automation of the classification process

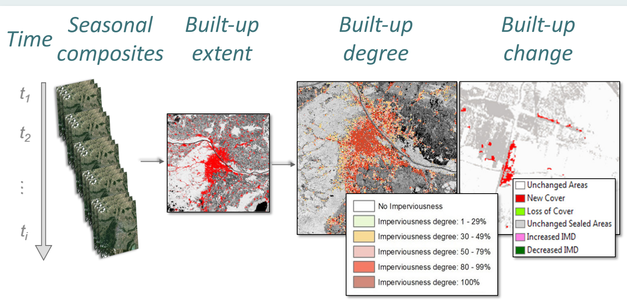
KEY CHALLENGES

For the operationalisation of Sentinel based urban mappings several challenges must be solved and handled.

- The Sentinel data means to stick to multi-temporal image processing procedures with large data volumes derived from the Sentinel time-series products (optical and SAR)
- The high amount of additional data requires high computing power and time as well as a high level of automation already for the pre-processing of the data
- To fully exploit the potential of the Copernicus Satellites a way to fuse the different sensors must be developed

METHOD

- M**ulti-temporal analysis** of seasonal image composites and cross-calibration of time-series imperviousness values
- Integration of **Biophysical and Texture Variables**
- Automated derivation of **reference samples**
- **Multi-parameter image classification**
- Density calibration using **linear regression methods**



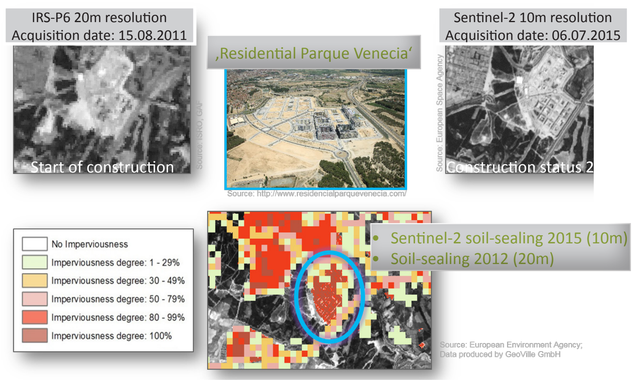
Workflow for the derivation of the Degree of Imperviousness Layers and the Built-Up Change Layers - Vienna (Austria)

Source: GeoVille GmbH

NEW STANDARDS USING SENTINEL-2

Source: GeoVille GmbH

Texture parameters derived from Sentinel-2 data - Arles (France). The combination of radiometric and texture parameters allows to clearly reveal artificial urban structures

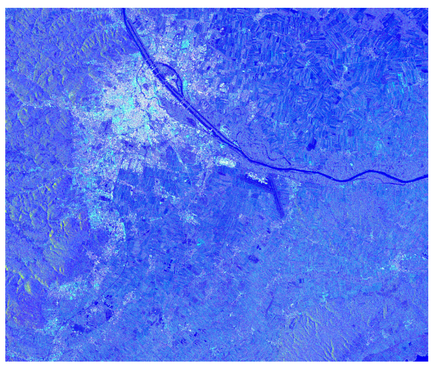


Sentinel-2 provides a higher level of detail compared to the previous pan-European soil-sealing layers - Zaragoza (Spain)

Source: European Environment Agency; Data produced by GeoVille GmbH

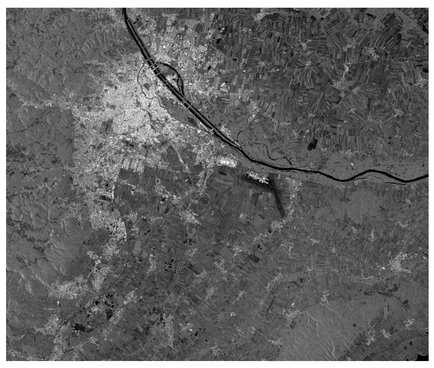
INVESTIGATIONS ON SENTINEL-1

Example of Sentinel-1 data - Vienna (Austria): The Sentinel-1 data provide a significant advantage for urban monitoring through a good delineation between sealed-surfaces and permanent soil at least in areas with a low relief



Sentinel-1 false colour RGB:

- *Band 1: VV*
- *Band 2: VH*
- *Band 3: Local Incidence Angle*



Sum of mean backscatter (total intensity) of both Sentinel-1 bands (VV and VH) to increase the effect of highlighting sealed-surfaces

Source: GeoVille GmbH

RESULTS

The additional spectral bands, the high spatial resolution and the repetition rate of the optical data as well as the cloud independent backscatter of the SAR data are an advantage for several parts in the production of the pan-European soil-sealing layer in terms of:

- Superior resolution & structural detail
- Full pan-European coverage & consistency
- More frequent updates
- Improvement of classification results in areas with a low relief due to the information derived from Sentinel-1

In conclusion, it can be said that with the Sentinels a consistent data basis for several production periods and for large areas is ensured to facilitate high quality and continuous monitoring of built-up and imperviousness.

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European Commission's Roadmap to a Resource Efficient Europe (COM(2011) 571)

"By 2020, ecosystems and their services are maintained and enhanced by establishing Green Infrastructure and restoring at least 15% of degraded ecosystems"

Target 2 of the EU Biodiversity Strategy to 2020