

## Towards an Improved Scientific Exploitation of EO Data Sources in Support of Vegetation Monitoring

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The sustainable management of natural resources and climate action requires sophisticated and timely information. Similar information needs exist to support agriculture/food production effectively, which can be extracted from various EO-data available from space-borne and air-borne sensors. Today, we already have extended timeseries of data from missions as SPOT-VEGETATION, MERIS, MODIS, etc. In the near future, these data will grow drastically, thanks to new sensors with increased data volumes such as PROBA-V, Sentinel-3 and Sentinel-2. Furthermore heterogeneous data, which cannot be available anymore at one single data centre, need to be analysed simultaneously and on-demand processing of high-resolution data becomes more and more a need. To address these challenges from an infrastructure point of view, VITO and SPACEBEL collaborate in the ESA/ESRIN funded project 'European Support Environment Enhancements (ESE)'.

The Belgian research institute VITO has been active in the vegetation/agricultural domain since many years, both on a global as on a local scale introducing e.g. innovative information feeds for precision agriculture. VITO also hosts since 1998 the production and archiving facility (PAF) of the SPOT-VEGETATION missions and will host the PAF of the PROBA-V mission from 2013. These missions provide every day a near global multispectral image of land masses. VITO hosts also an operational centre for the production of various bio-geophysical parameters. This ESE project aims to build on those achievements by building an image processing and information extraction system allowing to generate user-ready information on vegetation with the final aim to build a platform for the research and operational community to foster open innovation. The ambition of the ESE project is to add innovative information-retrieval and on-demand processing services on top of the existing data distribution services. This will contribute significantly to the scientific exploitation of the data and will open the data to a broader community of users.

SPACEBEL is a Belgian SME that has a proven experience in software engineering, system integration, EO application and Web-based software development for the space industry. In particular, SPACEBEL has lead, on behalf of ESA, the development of the Service Support Environment (SSE) which provides a simple, fast and economic access to Earth Observation (EO) services. SPACEBEL also developed the EO-DAIL, being a core part for the GMES Space Component Data Access (GSCDA) infrastructure. SPACEBEL is also contributing to the interoperability and standardisation of interfaces to EO ground segments through Web services, OGC and Heterogeneous Missions Accessibility (HMA) standards. In the Grid Enabled Service Support Environment (SSEGrid) project, SPACEBEL and VITO have developed a processing on-demand infrastructure allowing scientific users to deploy and execute custom vegetation processing chains on a Grid located at VITO. The processing chains consist in hierarchies of enhanced OGC Web Processing Services (WPS) that encapsulate all forms of processing (workflow and Grid processes).

During the last decade, interoperability standards for Web-based access and visualisation of EO-sensor data and derived products have been adopted. One of the more recent evolutions is the emergence of standards related to Web-based GeoProcessing, which empowers users with processing-on-demand capabilities.

This evolution allows to provide more advanced services to both an EO expert and non-expert users, to allow extraction of information from our extensive portfolio of EO-products, rather than providing only data. This allows the user to:

- Analyse time-series of data in a convenient way. GEO themes as climate, biodiversity, agriculture and ecosystems require long time series and integration of other data sources to analyze changes and trends to better predict the future and adapt their policies. A huge amount of data and algorithms are required both from EO and modelling perspectives.
- Prototype algorithms by including new components into EO-processing chains with immediate access to the data; this provides a more efficient way to design EO-applications from the research phase into an operational service.
- Design and deploy multi-mission applications, invoking data at different archiving centres, by connecting to infrastructures of other providers via open standards.

With this ESE project we aim to provide processing-on-demand capabilities on two levels:

- Software level: by providing interactive Web-based processing applications, ready to be used by any non-expert user.
- Platform level: by providing a platform for EO-specialists which allows them to design EO-applications as workflows, involving processing services and data from VITO or third-parties, as well as algorithms and data from the user themselves. Hence we provide a research platform with near real-time access to the extensive data archive at VITO.

The ESE project will develop a single end-to-end solution with tools for data visualization and analysis, on-demand data processing, EO data access and e-collaboration. Hereby we integrate as much as possible existing components into one solution:

- Array database technology is used to provide fast access to the large time series of EO-data and derived products for on-the-fly statistical analysis and calculation of vegetation indices for user-defined regions.
- Hadoop, as a software framework for data-intensive distributed applications according to the MapReduce software paradigm, is designed to process large amounts of data by separating the data into smaller chunks and performing large numbers of small parallel operations on the data. It's applied in this context for the on-demand processing of EO-data.
- Cloud computing technology will enable dynamic resource provisioning and, therefore, providing a performing and scalable solution. The system will be demonstrated both on private and public cloud resources. A key item here is to discover and access the data on a (public) cloud or to move the processing towards a cloud where the data is available.
- The ESE project will offer interactive Web-based dashboards to retrieve user-tailored information from the EO-data archives of VITO and other providers, by combining existing Business Intelligence (BI) and GIS solutions. The combination of both BI and GIS components and allowing interactions between these components, applied on data available in disparate data stores, will offer powerful Web portals to the users.

The ESE project will design an infrastructure to ease the exploitation of massive amounts of EO-data. The system will be generic in nature and can be used for rapid realization of Web-based EO Applications. During the project, demonstrations are done in collaboration of three pilot projects.