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Title : MEDUSA, Multidate Earth Observation Data for Urban Sprawl Aftercare

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The concept of "big data" has emerged during the last few years in almost all areas, including that of sustainable management of city, or smart cities. But in this context, remote sensing data are rarely investigated. However, in this area too, we talk about big data since the concept emerges particularly at the European Space Agency and through the recent organization of a dedicated workshop "Big Data for Earth Observation" in 2014.

This new context is also illustrated in particular by the Earth Observation Copernicus program, which includes the launch between 2014 and 2020 of a network of satellites called Sentinel, which already acquire images that are immediately worldwide distributed as open data.

Meanwhile, data hubs provide free and open access to rolling repositories of Sentinel products, while exploitation platforms are also developed to allow image processing directly in virtual workspaces with the general platform capabilities.

This new context of big data for Earth observation, particularly the field of urban development has led Onera to launch a new research project, called "Medusa". The acronym stands for "*Multidate Earth observation Data for Urban Sprawl Aftercare*".

In this project, big data is understood by its common definition by "4V":

- The V of Volume refers to the increasing size and number of images;
- The V of Variety refers to the diversity of sensors (optical, radar, lidar, etc.), for different frequency bandwidths, different modes and resolutions;
- The V of velocity refers to the ever shorter revisit times;
- The V of veracity refers to our ability to provide feedback on the quality of data and the processed outputs.

Medusa project is designed to bring together and promote processing of remote sensing images in the current context of big data, with a focus on developing a demonstrator. This prototype is intended to show how temporal data stacks obtained from a variety of sources are an opportunity for new application frameworks. The main idea is to start from an existing 3D GIS database that best describes the scene, and to enrich the pool of information that is necessary for enlightened policy decisions. As soon as a new image will be acquired, we will try to answer the question: what is the best way to improve the product for our application using this image.

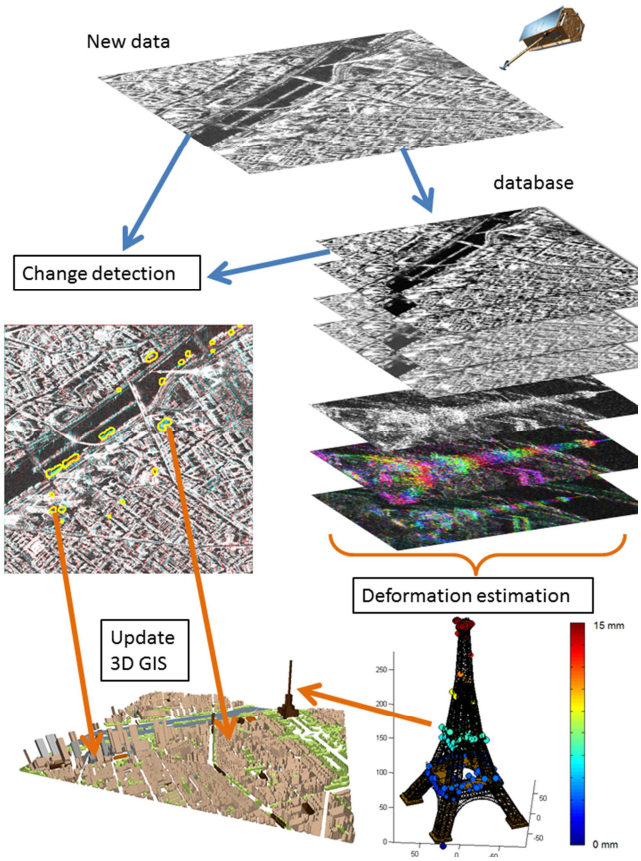

FIGURE 1 - SYNOPTIC FOR A DEMONSTRATOR

The type of information update concerns different application areas:

- monitoring the development of the urban extension, both in 2D (ground cover) and 3D (volume representation);
- monitoring traffic;
- monitoring of ground deformations and structure deformations;
- urban heat islands.

For each of these applications, some processing will be related to the specific application concerned, and also may be combined with other more local types of information: for example traffic monitoring will be based on detection algorithms, relating to types of sensor, and may supply traffic flow models. Monitoring terrain and building deformation will be based on interferometric techniques specific to the radar sensors.

Monitoring the development of the urban areas can also be achieved by 3D radar tomography techniques, and characterization of changes can be driven by a search for images published on the unrestricted public Internet.

But in a number of cases, efforts will be carried on generic treatments meeting the double challenge of the huge volume of data, but also their inhomogeneity. These treatments will be:

- multi-mode change detection
- data coregistration
- learning methods on large data sets, such as recent deep learning methods
- Super-resolution techniques

In this presentation, we will present first results on one of our test site, Paris and agglomeration of the Plateau de Saclay, concerning:

- our method of heterogeneous data coregistration, suitable for large temporal stacks of data;
- the structural deformation monitoring, including as a reference object the Eiffel Tower;
- the monitoring of urban extension by change detection.