The "Urban Geomatics for Bulk Information Generation, Data Assessment and Technology Awareness" Project: Detection, Representation and Analysis of the Urban Scenario Changes

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ABSTRACT

About 54% of world population nowadays lives in urban areas and this percentage is expected to increase up to 66% by 2050. Therefore, it is crucial to manage this social and cultural change by collecting, integrating and sharing reliable and open spatial information concerning the urban environments where we leave in. The present availability of huge archives of synthetic aperture radar (SAR) data collected since 1992 by ESA, in conjunction with the available Earth-Observation (EO) optical data, represents a unique possibility to derive valuable information for understanding the ongoing urban processes. In this framework, the three-year project financed by the Italian Ministry of Instruction, Research and University, entitled "URBAN GEOmatics for bulk information generation, data assessment and technology awareness" may play a role for the assessment and the development of new replicable methodologies for the study of soil consumption and mobility in urban zones. This work aims to present some preliminary results achieved during the project, clarifying how the new emerging technologies for managing big EO data are proficient for the investigation of urban processes.

INTRODUCTION

Earth's landscapes are rapidly changing, and the human activities represent the main forces that drive such sudden modifications. Vital information is being gathered by land, sea, air and space-based EO systems. However, the current process of collecting, storing, analyzing and distributing this information remains fragmented, incomplete or redundant [1]. The project URBAN GEOmatics for bulk information generation, data assessment and technology awareness" aims to improve the knowledge of the state-of-the-art and proposes innovative solutions for managing geospatial data. It benefits from the huge availability of EO data sources, in terms of integration assessment and awareness, with a particular interest in the urban context. Key aspects of the project concern the application of geospatial methods to data gathered from multiple sources, at different scales and with different temporal repeatability [2]. The project focuses on the mobility and soil consumption, which represent two critical aspects in the urban context. ESA is moving towards Open Data and sharing to support the European Commission Copernicus Programme. Data collection and validation require a standard data model and architecture, which is coherent with the latest indications from expert groups and agencies. Collection and validation of spatial data, which have the characteristics of big data, of course require new approaches and solutions. Furthermore, digital reconstruction of the environment and its visual representation is also important to allow augmented reality (e.g. CityGML) and support decision makers.

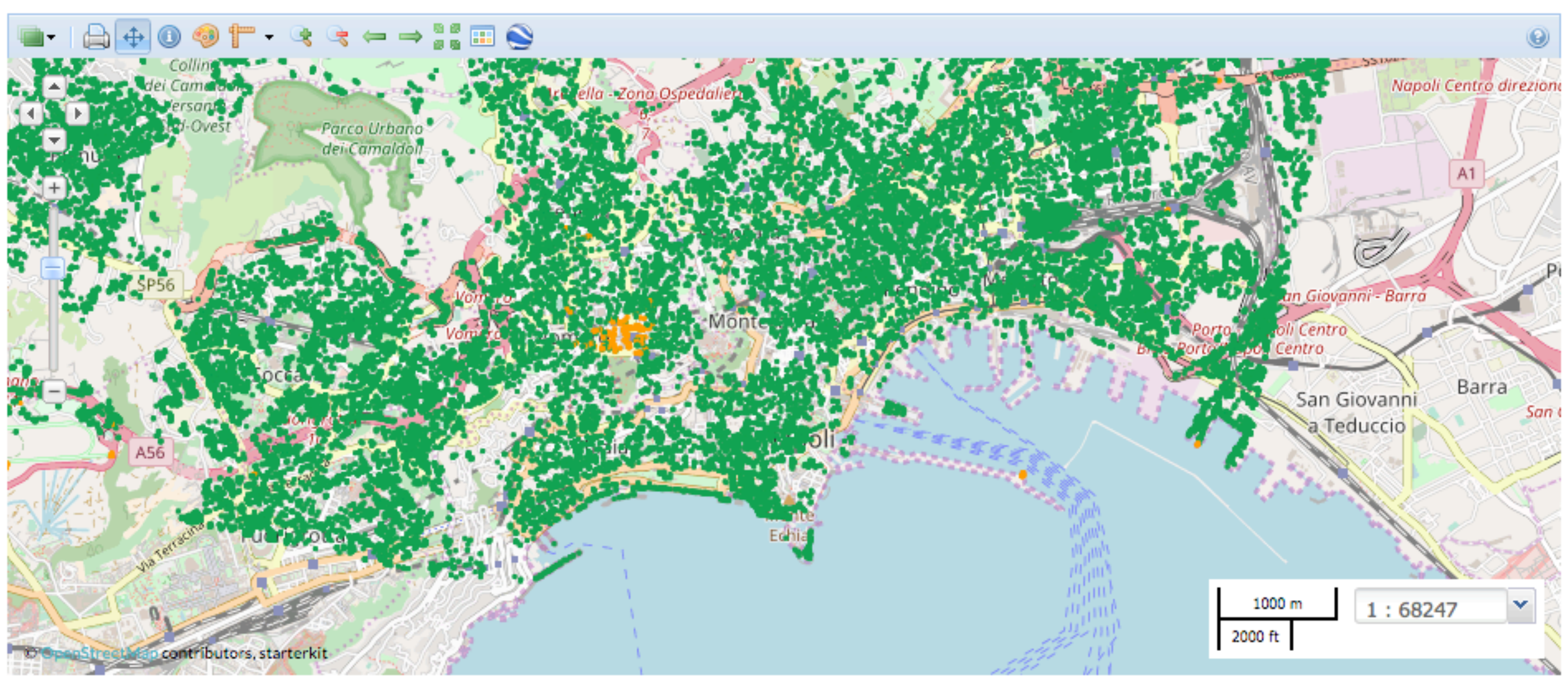

Figure 1. Map of the mean surface deformation velocity occurred from 1992 to 2010 over the urban area of the city of Naples, Italy. The map is superimposed on a GIS platform of the investigated area. The area depicted in orange corresponds to the Vomero quarter that has experienced a significant deformation (on the order of 5 mm/year) during the observation 1992-2010 time period.

DInSAR EXPERIMENTS

We present the preliminary results of the project. Focus has been placed on the development of the end point node of the SDI whose objective is to generate and then share on the Web the deformation time-series, obtained through InSAR measurements pertaining the urban zones. To this aim, InSAR data have been supplemented with relevant metadata, describing the principal used InSAR parameters (e.g., the number of used SAR images, the adopted thresholds for the identification of the small baseline InSAR data pairs, etc). Figure 1 shows the results achieved over the urban area of Naples, Italy. The used SAR data were acquired at C band by the ESA ERS and ENVISAT SAR satellite platforms. The applied technique allows performing detailed analyses in urban areas, and permits to detect very spatially localized deformation signals, such as those related to single buildings and public, large infrastructures, highlighting the relative displacements of coherent structures with respect to the average movement of the ground. The process has involved 164 SAR images, corresponding to Track 36 (descending orbits), acquired from June 1992 to September 2010. Starting from these images, 485 InSAR SB data pairs have been selected, with a maximum perpendicular baseline of 400 m. Geospatial data produced within the project are collected and coherently organized, visualized and made available via a properly developed web-based tool based on the use of open-source GET-IT platform [5]. GET-IT allows the storage, display and sharing on the network of different types of geographical data, whether digital images, processed maps, data acquired from sensors (observations) or text documents. This is the first open source tool that allows integrated management for these different categories, providing the users with a single working interface allowing personalized protection of the shared data. GET-IT also includes a working environment (EDI) for the creation of metadata and the publication of the same according to INSPIRE standards, thus improving the search and discovery of data and its re-use by organizations and research organizations. Figure 3 shows a screenshot of the discovery service implemented for the visualization/handling of the project results.

PROJECT ACHIEVEMENTS

The achievements of the project are attaining, among others, the investigation of the soil consumption in urban zones as well as the surface deformation that can be linked to urban expansion. The selection of this topic is due to the fact that the modifications induced by soil consumption mechanisms evolve over long-term period of times (20-30 years) and are distributed over wide areas. These characteristics made soil consumption principally suitable to be analyzed by sequences of EO data. The retrievable information can be enhanced through the use of Volunteered Geographic Information (VGI) data, i.e. the historical archive of the OpenStreetMap project. More specifically, the Small BAseline Subset (SBAS) technique [3] is applied to ESA archives of SAR images that have been collected since 1992 by the ERS, ENVISAT and, more recently, by the new Copernicus Sentinel-1 constellation, with the aim to generate long-term time-series of deformation. Furthermore, the temporal changes of the scattering properties (evaluated in terms of normalized radar cross section of the extended scene) of the ground are also investigated. In this framework, the synergic use of SAR and optical data (e.g., collected by the new Sentinel-2 ESA platform) is beneficial. Urban areas of five major Italian cities have been selected for our investigations: Naples, Milan, Padua, Rome and Turin.

SOIL CONSUMPTION RETRIEVAL

Considering the soil consumption theme, information on the spatial and temporal evolution of urban scenarios can be retrieved with high levels of details through SAR- and InSAR-based analyses. This information are used in conjunction with that recovered on urban land cover and soil consumption in urban areas by using optical EO data classification methods [4] through specific indicators. Soil consumption maps are usually based on the semi-automatic identification of artificial land cover exploiting the spatial and spectral resolutions of optical EO data as Sentinel-2 images (see Figure 2); in addition, ancillary data, such as regional topographic databases, VGI and in situ data, as well as manual photointerpretation of high resolution images are needed to improve the identification of artificial areas.

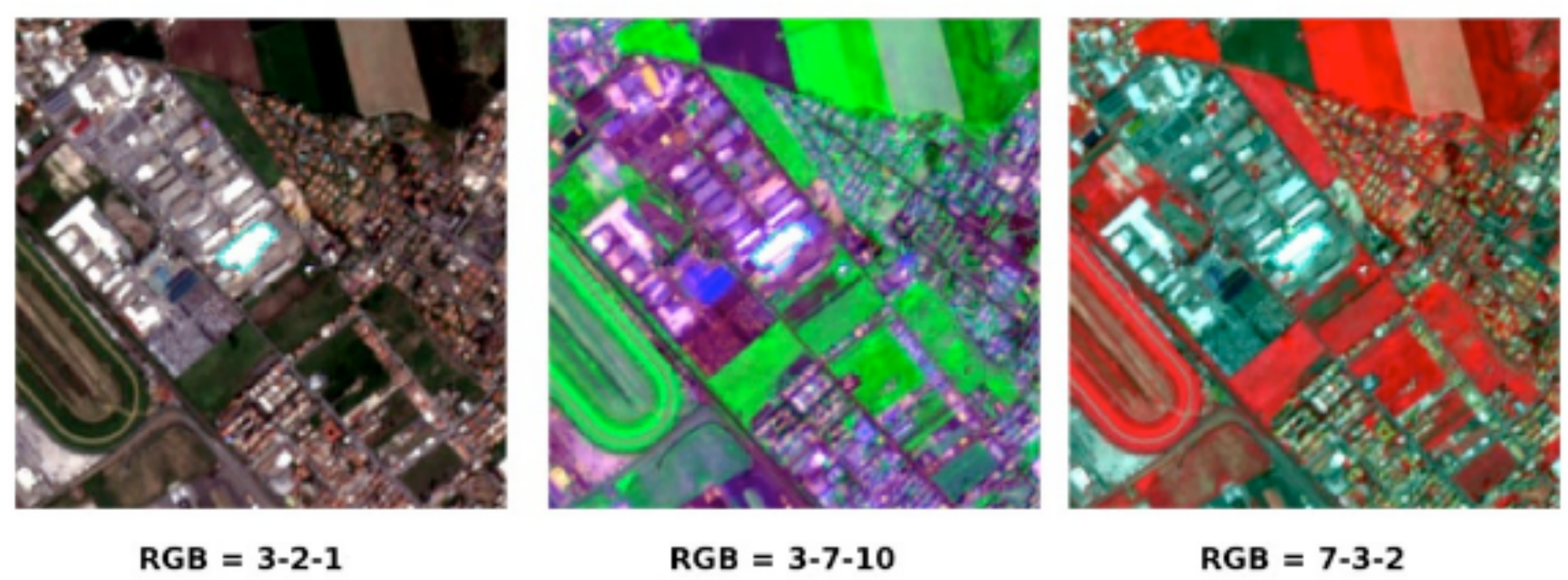

Figure 2. An example of a new building mapped in an urban area with Sentinel-2 images. The numbers of the used bands for the creation of the RGB images are indicated.

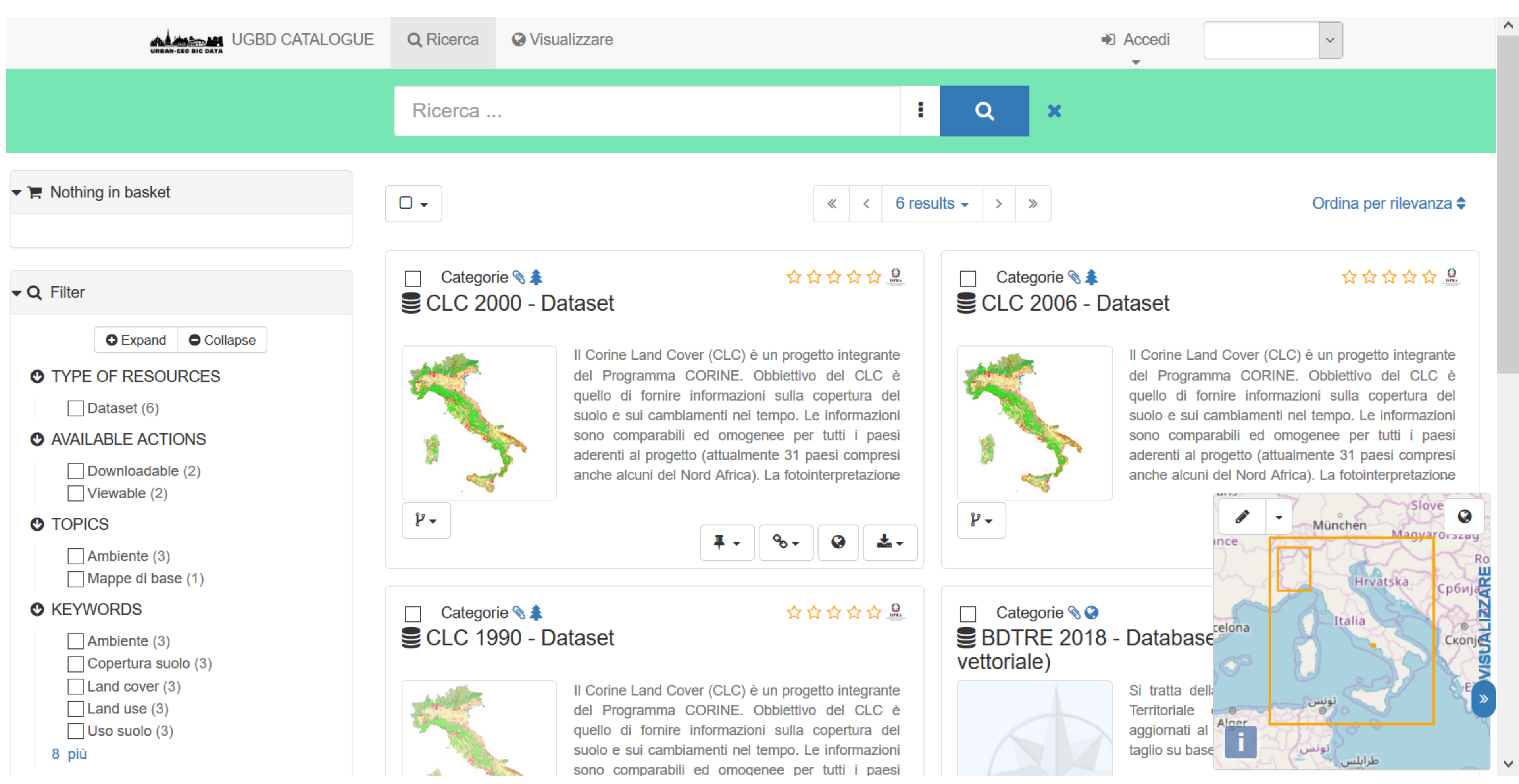

Figure 3. Screenshot of the discovery service of Urban Geo Big Data .

Acknowledgements

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