



PRISMA applications for territorial and urban planning

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Presentation title

PRISMA applications for territorial and urban planning

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Abstract

The Italian Tuscany Region, as part of its competences related to the knowledges of land use discipline, has been using, promoting, and maintaining functional territorial information since the 1970s. Nowadays, this activity is carried out not only for the needs of public administration technicians related to territory planning and management, but also for freelancers and citizens free information.

However, while for some types of services in administrative procedures, territorial information from an aerial platform is still preferred, attention in recent years has also shifted to the possible use of optical satellite data. For this reason, the Tuscany Region in 2018 started an agreement with ASI and begun a pilot project in collaboration with UniSI and CNR. The project, still in progress, has as its first objective the mapping of the main materials that make up the city roofs (brick, cement conglomerates, bituminous conglomerates, metal, plastic, silicon, etc.) with the goal of implementing the attributes of their Land Use/Land Cover databases that are stably issued, every 3 years, since 2007. The first results clearly express the fundamental contribution of the hyperspectral data but, at the same time, highlight some intrinsic limits to the PRISMA mission, easily to be overcome and, we hope, interesting proposals for future hyperspectral missions.

The Italian Tuscany Region, since the 1970's, has been using, promoting, and maintaining functional territorial information (as cartographic data first, and now, as territorial information systems), as a part of its competencies related to the land use discipline as established in the DPR n. 616/1977. The available information is primarily used for activities related to the territory planning and management.

Currently, this data is also used by public administration officials (Region officials, Municipalities, Provinces, Universities and Research Centres, Police Departments, Schools, etc.), geologists, agronomists, and engineers as well as private citizens and environmental or cultural protection agencies.

This condition makes essential for the Tuscany Region to recognize the type of information needed by its users to offer them the more appropriate services and products. As an oversimplification, it could be said that for the private citizen/agencies the territorial information is needed to recognize and know its own territorial and landscape heritage; on the other hand, for geologists, agronomists, engineers and other freelancers this data is important to recognize and evaluate the state of the territory, while for the PA officials the updated information is useful to support the institutional activities concerning the territory management. Thus, in continuity with the past, the basic data that the Tuscany Region needs to keep producing are: (i) high resolution images of the territory (for the summer 2021 a photogrammetric flight, with a ground spatial resolution of 15 cm, is scheduled for the whole Tuscany Region); (ii) periodical updates of the Regional Technical Maps and Topographic database (at the scales of 1:2.000 and 1:10.000); and (iii) the land use/land cover database.

For the first two types of information the platform preferred to acquire territorial information is the one aerial, the land cover/land use classification can be better carried out using multi-hyperspectral data made available especially by satellite data. To this aim, in 2018, the Tuscany Region started a series of collaborations with members of the public administration (urbanistic, agricultural, and soil defence departments, Regional Environmental Protection Agency - ARPAT, Regional Economic Planning Institute (IRPET), Regional Agency for Payments in Agriculture - ARTEA, etc.) as well as with external advisors (Italian Space Agency - ASI, University of Siena - UniSI, University of Firenze - UniFI, University of Pisa - UniPI, National Research Council - CNR),

National Association of Italian Municipalities - ANCI, etc.). From these collaborations, in some cases, specific pilot projects have started.

Among these, one, is related to the ASI satellite PRISMA mission and it concerns the stress-test of the PRISMA website for images request and download (December 2019), the calibration/validation of an image related to the Grosseto area (21 June 2020) with the support of the CNR-IBE, and, finally, together with UniSI, the application of another hyperspectral PRISMA dataset to the urban area of Prato.

The first objective of the last project, which is still in progress, is mapping the materials that make up the city covers (ex. buildings, streets, squares), with particular interest to surfaces made of brick, cement conglomerates, bituminous conglomerates, metal, plastic, and silicon. The second phase of this project will have an additional objective of analysing the degree of degradation of these materials. Both types of information will be included as attributes in the land use/land cover database, which is released by the Region every three years, continuously since 2007.

We expect to apply the results in, at least, three types of regional digital services: (i) the realization in the GIS (Geographic Information System) as support to territorial planning (and, in the case of the material degradation, also as a support for the infrastructure maintenance); (ii) the qualitative monitoring of land and its degree of erosion; and (iii) the addition of attributes for some classes of the topographic geodatabase.

The first phase of the project was developed applying the pansharpening technique among the HS and PAN images of a PRISMA scene (L2 level of processing) acquired in June 2020. With the aim of acquiring the spectral characteristics associated to each band, some samples of every land cover class were selected from an image subset related to Prato urban area. This operation highlighted the importance of having available *ground truths* represented by ancillary data referred to the area to be classified and from on-site direct observations or other reliable sources. Moreover, it is important to highlight that the selection of a land cover class must be very specific to take full advantage from the HS data; thus, some classes can be further divided in subclasses more suitable for image recognition.

During the preliminary classification phase, several supervised classification techniques have been evaluated, making possible to rank the algorithms efficiency on the base of categorization accuracy. Among these, it was also tested the usage, still by supervised classification techniques, of data from Principal Components Analysis and Independent Components Analysis passing by the compression of the bands number.

The first obtained results, currently on the accuracy assessment phase, testify the important contribution of the hyperspectral data especially for the classification of brick, cement conglomerates and metallic surfaces, which were successfully identified. The identification of bituminous conglomerates must be improved, while extreme attention still needs to be given when classifying materials like silicon and plastic.

These results while promising and indicative of a high potential of hyperspectral data to map materials, also reflect the need to remove some limitation to transform the experimental phase to stable regional services to be offered to the users. For instance, we hope that future missions can increase the spatial resolution, although the already available 5 m for the panchromatic is very promising. This is particularly true if we consider that in high density textures, like urban settlements, there are strong limitations in the land cover classification using only the spectral info.

In the short period we also believe it would be useful:

- to increase the number of image acquisitions in other pilot sites, if not for the whole Tuscany region, at least for areas more "*sensitive*" to specific phenomena.
- to schedule stable periodic acquisitions to guarantee the supply of services for different users.
- to look for more robust classification techniques, at the moment only of spectral type, using Artificial Intelligence techniques to reduce the errors of classification of pixels with similar spectral characteristics (i.e., some types of bare soils and brick);
- to support the establishment of a network of the different stakeholders involved in producing/using hyperspectral data and its related services.
- to arrange a service for the collection and cataloguing of field hyperspectral measurements constructing a sort of spectral signatures library. There are few and specific measurements only for some Italian Region. The Tuscany Region is currently undertaking efforts to schedule an acquisition fieldwork which, by the a priori identification of a shared methodology, could also lead to an open access service of data querying.