Urban Atlas:

from EU funded project towards a land use map in supporto to local planning and monitoring

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GSE LAND – Urban Atlas

GSE Land Information Service

➢ Urban Atlas was born in the frame of GSE LAND (2006-2009) project as a continuation of other related services developed in past projects such as MOLAND and GSE Urban Services (GUS).

➢ GSE LAND project was funded by ESA (European Space Agency) with th aim to deliver geo-information services over large areas and for a wide spectrum of land applications, focusing on two of the GMES priorities "Land Cover Change in Europe", and "Environmental stress in Europe".

➢ Planetek Italia was involved in GSE LAND as provider of the land use product Urban Atlas, designed to support public authorities at various levels of resposability in their reporting obligations and and in the improved management of natural resources.

Urban Atlas definition

✓Along GSE Land, Urban Atlas has been growing and developing according to Users and experts inputs, which have finally shaped a service compliant with the most feasible User needs. Two main actors have taken part in the development of the Urban Atlas as users: Local (e.g. Veneto Region) and European users (DG Regio).

The focus was on finding a full harmonization of two complementary perspectives:

✓**European Level**: needs of homogeneity, comparability and feasibility

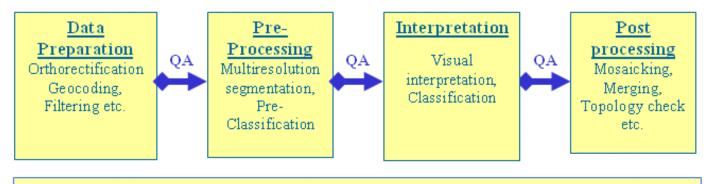✓**Local perspective**: more thematic detail, better scale

The solution was to deal together with these two perspectives, providing land cover products with a strong and common core and with a customized and deeper level of information detail in relation to the different User needs.

Urban Atlas implementation

Phase 1 – GSE LAND testing activities on several Veneto cities

➢ Testing with SPOT5 data funded by ESA with the aim to define a standard mapping protocol feasible to be applied over wide areas


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Data                QA   Pre-              QA   Interpretation    QA   Post
Preparation              Processing                                   processing
Orthorectification       Multiresolution        Visual                Mosaicking,
Geocoding,               segmentation,          interpretation,       Merging,
Filtering etc.           Pre-                   Classification        Topology check
                         Classification                               etc.
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+ Final Quality Assessment

➢ Prototype over test cities: VE, PD, RO

➢ *Quality assurance* and external validation by ETC-LUS

➢ Delivery to Veneto Region and technical review

Urban Atlas implementation

Phase 2 – Veneto Region adoption of Urban Atlas for operational use

- ➢ SPOT5 acquisition data 2006-2007 (11 scenes) funded by ESA

- ➢ Land cover mapping over the whole region up to 18.300 km2

- ➢ *Quality assurance* according to GSE LAND procedure

- ➢ Product delivery and User quality evaluation

URBAN ATLAS specifications

Technical specification	European level	Regional level
Input data	SPOT-5 data, GMES FTS sealing	SPOT-5 data, GMES FTS sealing
Ancillary data	TeleAtlas network	TeleAtlas network, **Ortofoto, Topographic map, Forest map, HR DEM**
Nomenclature	22 classes based on CORINE LC / MOLAND	**32 classes** based on CORINE LC / MOLAND
Thematic detail	Artificial classes I-IV Level; Non Artificial classes I Level	Artificial classes I-IV Level; **Non Artificial classes II Level**
Scale	1:10.000	1:10.000 (mapping scale on screen **1:5000**)
Minimum mapping unit	0,25 ha MMU 10 m MMD	0,25 ha MMU (**exception for road network**) 10 m MMD
Thematic accuracy	Artificial classes ≥ 80%, Non Artificial classes ≥ 80%	Artificial classes **≥ 85%,** Non Artificial classes ≥ 80%
Positional accuracy	+/- 5m	+/- 5m
Spatial accuracy	TBD	**Artificial Surfaces +/- 5m Natural Surfaces +/- 15m**
Delivery format	Topologically correct shapefile Metadata ISO 19115	Topologically correct shapefile Metadata ISO 19115

Input data: SPOT 5 images

Launch Date	May 3, 2002
Orbit	Sun-synchronous
Orbital altitude	822 km
Orbit time	101.4 minuti
Revisit time	2-3 days depending on latitude
Resolution	PAN 2,5m Green 10m Red 10m NIR 10m SWIR 20m
Image bands	Pan: 0,48 – 0,71 μm Green: 0.50 - 0.59μm Red: 0.61 - 0.68 μm NIR: 0.78 - 0.89μm SWIR: 1.58 - 1.75 μm
Swath width	60 km x 60 km
Digitization	8 bit per pixel

Venezia from satellite SPOTV Multispectral at 10m - RGB (Nir-Red-Green)

Input data: SPOT 5 images

Venezia from satellite SPOTV Pancromatic at 2.5m

Launch Date	May 3, 2002
Orbit	Sun-synchronous
Orbital altitude	822 km
Orbit time	101.4 minuti
Revisit time	2-3 days depending on latitude
Resolution	PAN 2,5m Green 10m Red 10m NIR 10m SWIR 20m
Image bands	Pan: 0,48 – 0,71 μm Green: 0.50 - 0.59μm Red: 0.61 - 0.68 μm NIR: 0.78 - 0.89μm SWIR: 1.58 - 1.75 μm
Swath width	60 km x 60 km
Digitization	8 bit per pixel

Input data: GMES FTS sealing

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GMES FTS project (2006-2007) has been developed under the framework of GMES program Fast Track Service on Land Monitoring
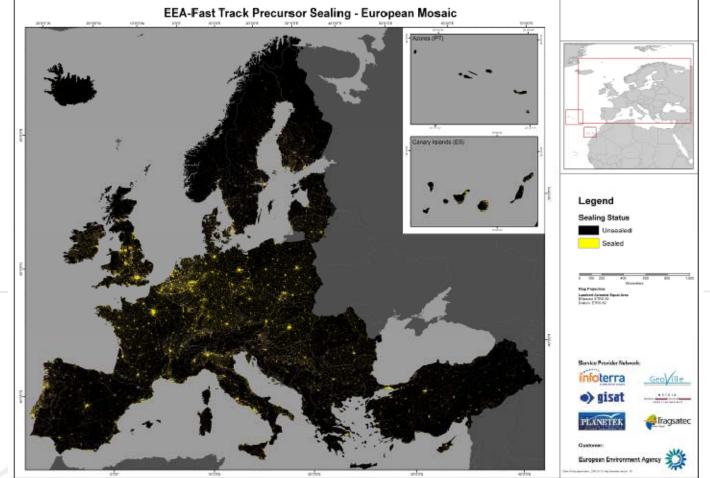
Objective: provide map of impervious area over all the European territory and classification of the level of imperviousness starting from EO data processing (SPOT/IRS)

2006 GMES Fast Track Service Precursor on Land Monitoring

High-resolution core land cover data built-up areas incl. degree of soil sealing

Customer: European Environmental Agency

Input data: GMES FTS sealing
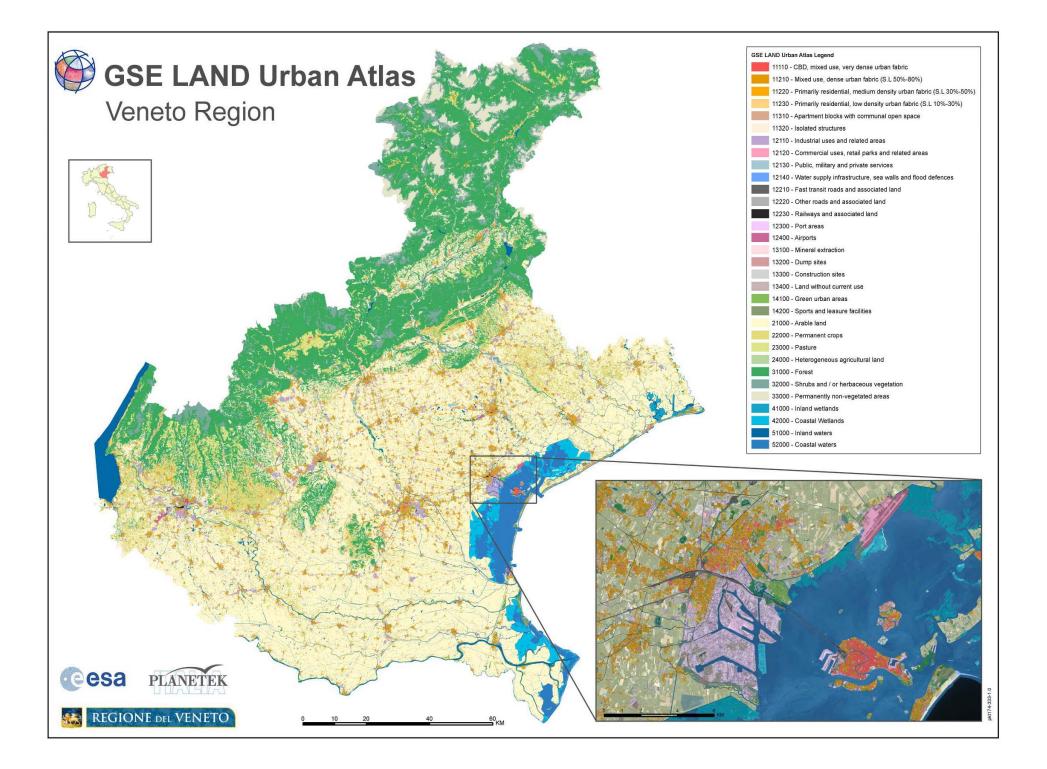

European Sealing map
showing areas with
imperviousness
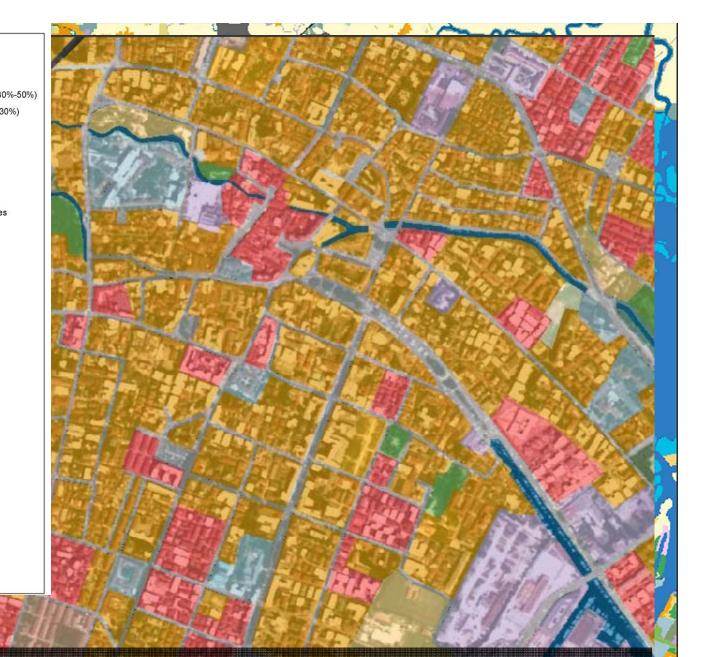degree ≥ 80%
(spatial resolution 1ha)

URBAN ATLAS nomenclature

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11110 - CBD, mixed use, very dense urban fabric	
11210 - Mixed use, dense urban fabric (S.L 50%-80%)	
11220 - Primarily residential, medium density urban fabric (S.L 30%-50%)	**Discontinuos urban fabric classified on the basis of the impervious area density**
11230 - Primarily residential, low density urban fabric (S.L 10%-30%)	
11310 - Apartment blocks with communal open space	
11320 - Isolated structures	**Sparse urban fabric**
12110 - Industrial uses and related areas	
12120 - Commercial uses, retail parks and related areas	
12130 - Public, military and private services	
12140 - Water supply infrastructure, sea walls and flood defences	
12210 - Fast transit roads and associated land	
12220 - Other roads and associated land	
12230 - Railways and associated land	
12300 - Port areas	
12400 - Airports	
13100 - Mineral extraction	
13200 - Dump sites	
13300 - Construction sites	
13400 - Land without current use	**Land wihout current use**
14100 - Green urban areas	
14200 - Sports and leisure facilities	
21000 - Arable land	
22000 - Permanent crops	
23000 - Pasture	
24000 - Heterogeneous agricultural land	
31000 - Forest	
32000 - Shrubs and / or herbaceous vegetation	
33000 - Permanently non-vegetated areas	
41000 - Inland wetlands	
42000 - Coastal Wetlands	
51000 - Inland waters	
52000 - Coastal waters	

GSE LAND Urban Atlas
Veneto Region

GSE LAND Urban Atlas Legend

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- 52000 - Coastal waters

esa PLANETEK ITALIA

REGIONE DEL VENETO

0 10 20 40 60 KM

0 2 4 6 KM

pkt174-333-1.0

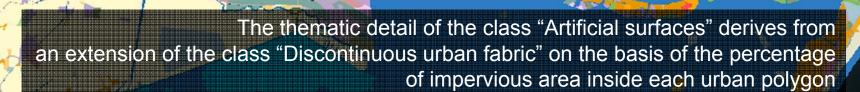Sample detail RGB moisaic of 2006 SPOT5 image over Venice area

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The thematic detail of the class "Artificial surfaces" derives from an extension of the class "Discontinuous urban fabric" on the basis of the percentage of impervious area inside each urban polygon

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Veneto Region
Operational use of Urban Atlas

✓ Basic support for planning activities

✓ New design approach of the tools used for planning (e.g. fusion of data multi-source multi-purpose)

✓ Updating of cartographic data infrastructure

✓ Supporting the activity of analysis and design of the Regional Territorial Coordination Plan (RTCP)

Benefits for Regional User

✓The benefits coming from GSE Land project concern the acquisition of a land use map accomplished on the whole region compliant to European quality standard.

✓Urban atlas map allows the use of an extremely detailed database aimed to monitor the land use (urban development, land use transformation and land use change), most of all for the applications and the studies based on detailed geographic data
(e.g. agricultural soils, ecological soils, Venice basin)

Urban Atlas update – Geoland2

➢ The results achieved during GSE LAND with the development of Urban Atlas product have found their natural prosecution in GEOLAND2 project, financed by EC within the FP7 Programme.

➢ The project lasts four years and is carried out by an international team made up of fifty partners coordinated by EADS Astrium.

➢ GEOLAND2, represents a step towards the full implementation of the GMES services for land monitoring (GMES-LMCS) and includes different service components at **global**, **continental** and **local** scale.

Urban Atlas High Resolution

✓Within the **local component**, Planetek Italia is involved into the service design and development activities related to Urban Atlas.

✓One of the main fields of research is focused on the potential of new **VHR EO** optical sensors in the processing chain in order to improve the geometric accuracy and the thematic detail of the final product.

✓As a first result, a new product named **Urban Atlas HR** (High Resolution) has been defined. The new mapping product has been implemented on the basis of WorldView2 images, collected on April 2010, over a portion of Veneto Region affected by a new important highway infrastructure (Passante di Mestre motorway bypass).

Urban Atlas High Resolution

✓WorldView-2, launched in October 2009, is the first high-resolution 8-band multispectral commercial satellite. Operating at an altitude of 770 kilometers, WorldView-2 provides 50cm panchromatic resolution and 2m multispectral resolution.

Urban Atlas High Resolution

✓Urban Atlas HR is a <u>multilevel mapping database</u> which includes the following cartographic polygon layers:

✓**Land cover map** with 36 classes based on Urban Atlas nomenclature and a MMU of 0,16 ha for artificial classes and 0,25ha for non artificial classes. The land cover map includes also information about impervious area density, building surface density and NDVI average;

✓**Road and transport network** with MMD of 5m and an attribute which gives indication of the new construction roads and railways;

✓**Buildings** layer with the delineation of the single buildings classified according to CTR nomenclature in combination with the following characterization with respect to the cartographic reference data (CTR): a) new building, b) existing building, c) modified building, d) no more existing building.

Urban Atlas High Resolution

Technical specification comparison

	Urban Atlas	Urban Atlas High Resolution
Input data	SPOT-5 2006/7 (2,5 – 10 m)	**Wordview-2 (0,5 – 2 m)**
Ancillary data	TeleAtlas network, ortofoto, Topographic map, forest map	**Topographic map, ortofoto**
Thematic detail	Artificial classes I - IV Level Non artificial classes II Level (**32** classes)	Artificial classes I - IV Level Non artificial classes II Level (**36** classes)
Scale	1:10.000	1:10.000
MMU **MMD**	0,25ha 10m	**0,16ha (artificial), 0,25ha (non artificial)** **5m**
Thematic accuracy	85% Artificial classes 80% Non Artificial classes	85% Artificial classes 80% Non Artificial classes
Geometric accuracy	±5m Artificial classes ±15m Non Artificial classes	**±3m Artificial classes** **±5m Non Artificial classes**
Delivery output format	Urban Atlas Layer Metadata ISO19115 Topogically correct shapefile	**Information layers:** **- Land cover map** **- Buildings layer** **- Road and railway network** **GeoDB multilayer and topolog. correct shp** Metadata ISO19115

Urban Atlas High Resolution

PLANETEK ITALIA

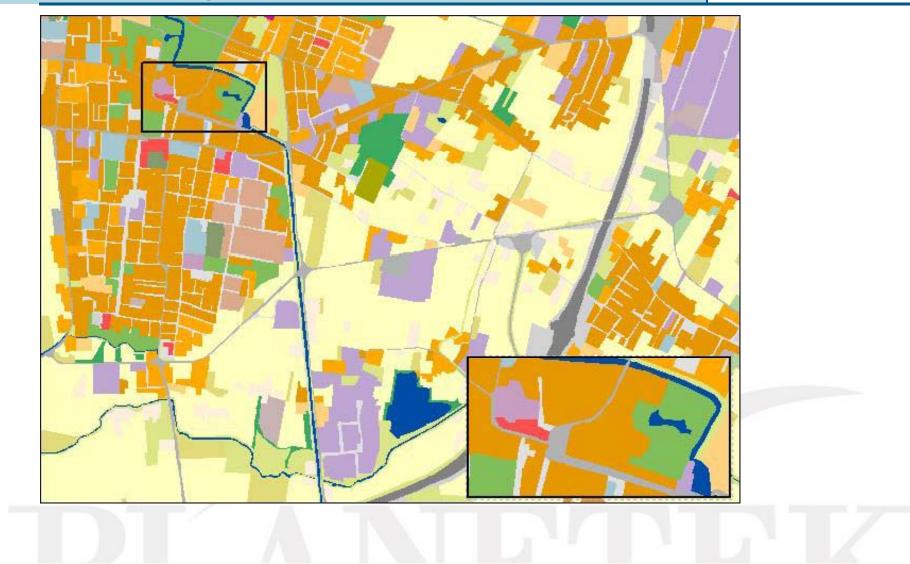## Methodology

Urban Atlas High Res

New thematic content

✓Urban Atlas HR represents an important step forward in the definition of a land cover map suitable at very high level of detail.

✓The land cover of Urban Atlas HR provides new thematic content (such us the new classes of churches, hospitals, local minor roads) taking advantage from a full integration of the cartographic existing data (e.g. topographic) with the VHR satellite technology.

Code	Description
11110	Centro città con uso misto, tessuto urbano continuo molto denso
11210	Tessuto urbano discontinuo denso con uso misto (S.L 50%-80%)
11220	Tessuto urbano discontinuo medio, principalmente residenziale (S.L 30%-50%)
11230	Tessuto urbano discontinuo rado, principalmente residenziale (S.L 10%-30%)
11310	Complessi residenziali comprensivi di area verde
11320	Strutture residenziali isolate
12110	Aree destinate ad attività industriali
12120	Aree destinate ad attività commerciali
12130	Aree destinate a servizi pubblici, militari e privati
12160	Luoghi di culto
12180	Ospedali
12140	Infrastrutture di supporto alle acque, barriere frangiflutti, dighe
12210	Rete stradale veloce con territori associati
12220	Rete stradale secondaria con territori associati
12221	Strade vicinali
12230	Rete ferroviaria
12300	Aree portuali
12400	Aeroporti
13100	Aree estrattive
13200	Discariche
13300	Aree in costruzione
13400	Aree in attesa di una destinazione d'uso
14100	Aree verdi urbane
14200	Aree destinate ad attività sportive e ricreative
14300	Cimiteri vegetati
21000	Seminativi
22000	Colture permanenti
23000	Prati stabili
24000	Aree agricole eterogenee
31000	Aree boscate
32000	Aree caratterizzate da vegetazione arbustiva e erbacea
33000	Aree aperte con vegetazione rada o assente
41000	Aree umide interne
42000	Aree umide costiere
51000	Acque interne
52000	Acque marittime

Urban Atlas High Resolution

Land cover layer

Urban Atlas High Resolution

Buildings layer

Urban Atlas High Resolution

Urban density classification improved

✓ One of the crucial aspects is also the possibility to enhance the classification of the urban density in the residential areas.

✓ Worldview2 data with 8 multispectral bands with 2m resolution, allows to improve the spatial accuracy of the impervious area map (soil sealing) which becomes more suitable for regional and local applications.

✓ The procedure designed to produce the sealing layer from Worldview2 multispectral bands gives as a result a homogeneous distribution of the information at 2m resolution over the whole area.

✓ This is used as input during the automatic classification of the urban density, avoiding any possible misinterpretation related to traditional photointerpretation.
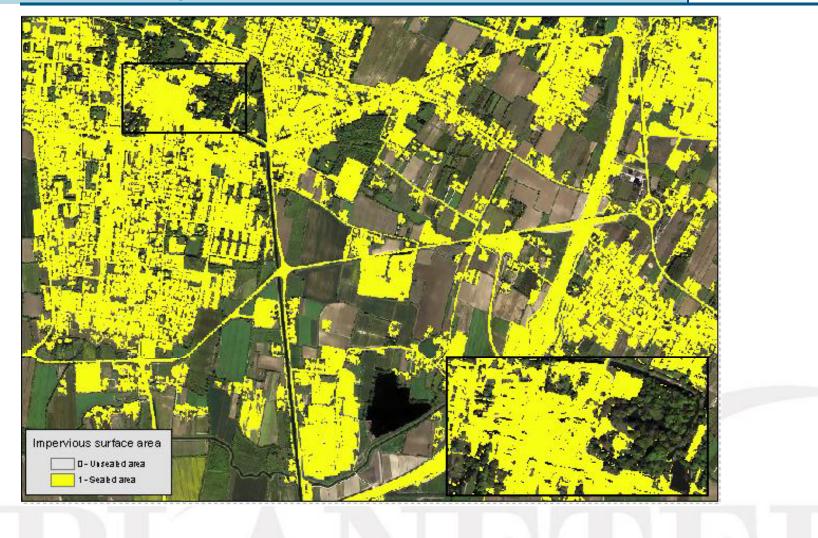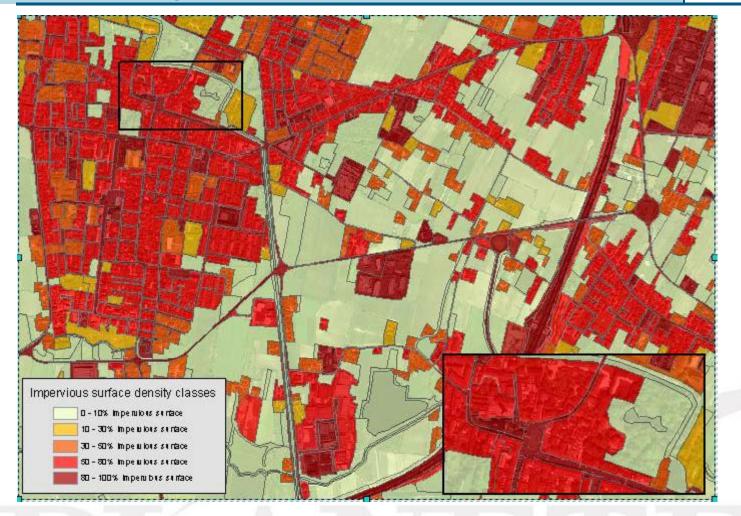
Urban Atlas High Resolution

Urban density classification improved

Urban Atlas High Resolution

Urban density classification improved

Impervious surface area
- 0 – Unsealed area
- 1 – Sealed area

Urban Atlas High Resolution

Urban density classification improved

Impervious surface density classes
- 0 – 10% Impervious surface
- 10 – 30% Impervious surface
- 30 – 50% Impervious surface
- 50 – 80% Impervious surface
- 80 – 100% Impervious surface

Conclusion 1/2

✓During GSE LAND and then under GEOLAND2 project, the exercise carried out on local scale with the involvement of Regione del Veneto as final User, has brought Urban Atlas to be interested by a progressive process of technical changes towards a more complex multilevel land cover map with increasing information content and spatial detail.

✓The direction of this change and the evolution of the design of Urban Atlas is driven by the need even more strong among the User community to have a even more complete and updated framework of the landscape dynamics in order to monitor the changes over time in the land use and urban expansion with a periodic frequency of 2-3 years.

Conclusion 2/2

✓In this context, GEOLAND2 will continue the research to develop an update mapping protocol of Urban Atlas by testing the integration of multiple data sources with different scale and resolution.

✓One of the main challenges of the project will be the improvement of the production lines of product mapping and updating, by increasing the semi-automatic processes thanks to new technical solutions, achieving high quality standards without increasing the production costs.

Thanks for your attention!

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