

# Progress and status of the development of the core geospatial information infrastructure in Greece

Panos Lolonis

Surveying Engineer-Geographer, Ph.D.  
Head of the Geospatial Information Department

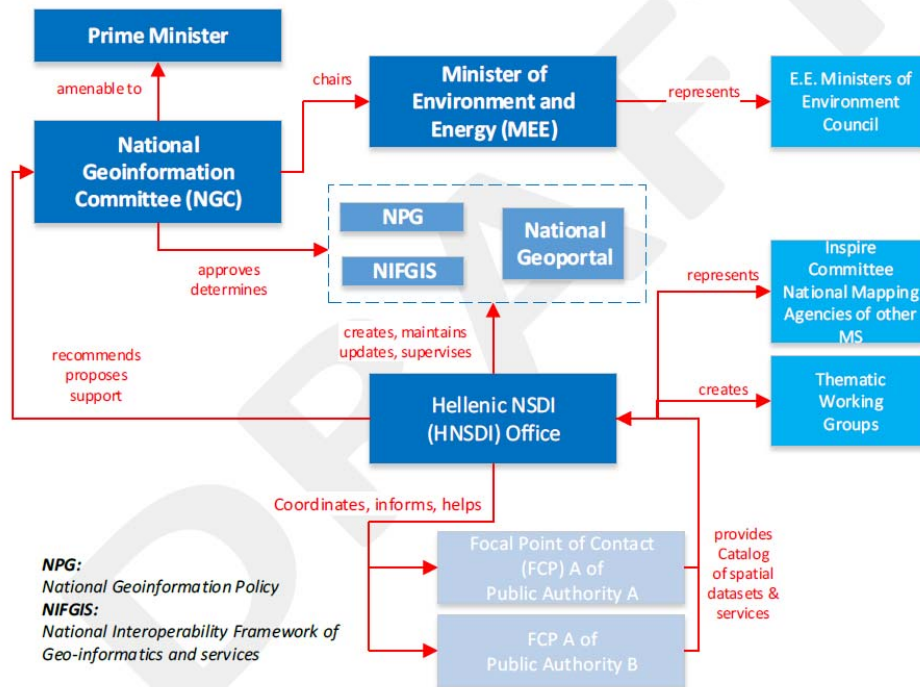
**HELLENIC CADASTRE**

**288 Mesogion Ave.  
155 62 Cholargos – Athens  
Tel. +30 (210) 6505-636**

# Background

## Major events

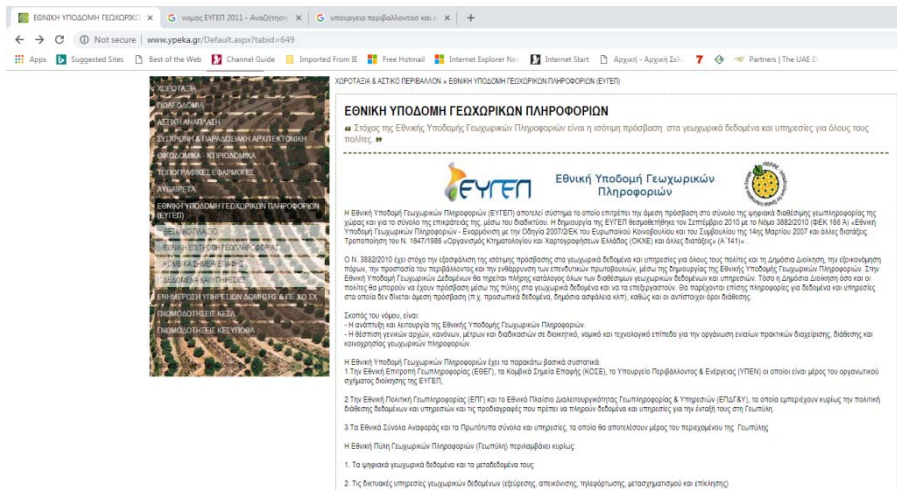
- Hellenic Mapping and Cadastral Organization, Technical Chamber of Greece (early 2000's)
- Passing of Law 3882/2010 (NSDI/INPIRE)
- Abolition of the Hellenic Mapping and Cadastral Organization (2013)
- Approval of the Organizational Chart of the Ministry of Environment and Energy (Presidential Decree 132/2017)
- Abolition of the National Cadastral and Mapping Agency SA and establishment of the “Hellenic Cadastre” Agency (2018)
- Compilation of a comprehensive study led by the Min. of Environment and Energy about the development of the Hellenic NSDI (Carried out by World Bank experts and financed by EU). It involved:
  - Identification of “best practices” from other countries
  - Compilation of interoperability specifications
  - Compilation quality assurance specifications



Proposed Hellenic NSDI framework (adopted from WB final report)



# Current Status



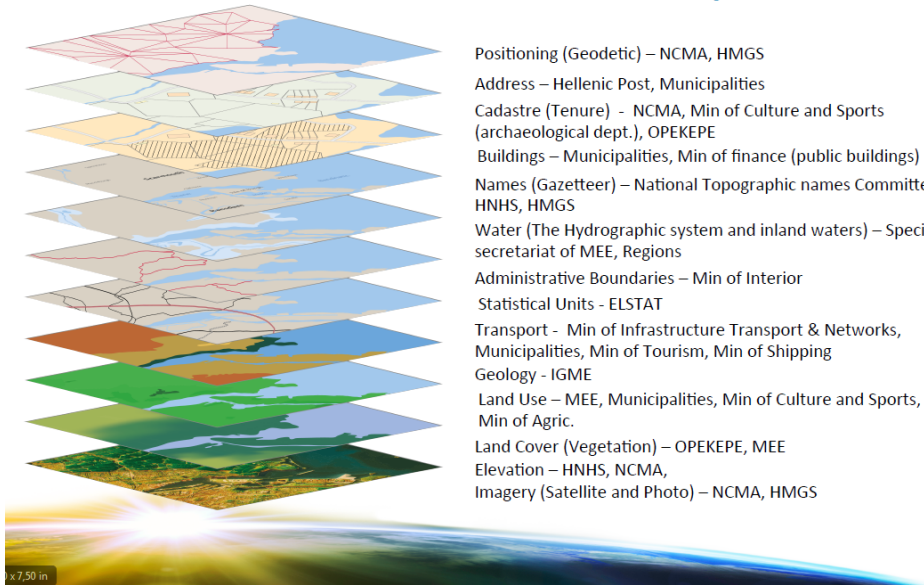
Main web-page of the Hellenic NSDI  
 (<http://www.ypeka.gr/Default.aspx?tabid=649>)

- The Ministry of Environment and Energy is the competent governmental authority for the development Hellenic NSDI
- Goal: *“To provide equal access opportunities to geospatial data to all citizens”* (<http://www.ypeka.gr/Default.aspx?tabid=649>)
- The Hellenic Cadastre is responsible for the development and maintenance of the basic geodetic, cartographic and geo-information infrastructure (or “core geo-information”, for the purposes of this presentation)



# Approach adopted by the Hellenic Cadastre towards development of the “core” Hellenic NSDI

## Proposed decision on the Foundation data for Greece – 14 layers



- Positioning (Geodetic) – NCMA, HMGS
- Address – Hellenic Post, Municipalities
- Cadastre (Tenure) - NCMA, Min of Culture and Sports (archaeological dept.), OPEKEPE
- Buildings – Municipalities, Min of finance (public buildings)
- Names (Gazetteer) – National Topographic names Committee, HNHS, HMGS
- Water (The Hydrographic system and inland waters) – Special secretariat of MEE, Regions
- Administrative Boundaries – Min of Interior
- Statistical Units - ELSTAT
- Transport - Min of Infrastructure Transport & Networks, Municipalities, Min of Tourism, Min of Shipping
- Geology - IGME
- Land Use – MEE, Municipalities, Min of Culture and Sports, Min of Agric.
- Land Cover (Vegetation) – OPEKEPE, MEE
- Elevation – HNHS, NCMA,
- Imagery (Satellite and Photo) – NCMA, HMGS

Adopted from the Hellenic NSDI World Bank led working group

- Adoption of the proposals of the World Bank study that have had a general consensus among the members of the working group
- Focus on implementing the law requirements and the WB study proposals in the domains that are under the competency of the Hellenic Cadastre
- Domains of focus:
  - Core geodetic data  
(Reference frames, coordinates)
  - Core cartographic data  
(Vector, imagery, DTM/DSM/DEM)
  - Core geo-spatial data  
(Cadastral parcels etc.)

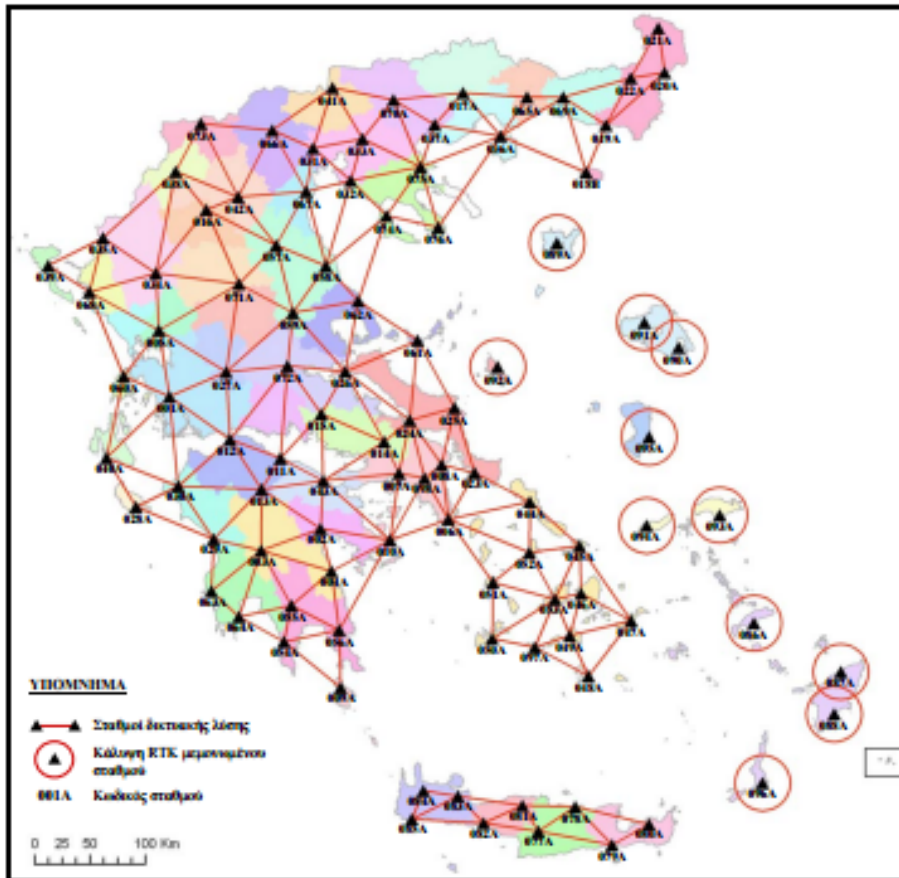




# Core Geodetic Data

## Operation of the Hellenic Positioning System (HEPOS)

HEPOS: Network of the permanent stations



Co-financed by EU   

- **Purpose:** Support the cadastral surveying process and the operation of the cadastre. Coverage of the geodetic needs of the country.
- **System:** One Processing Center and 98 permanent stations receiving GPS signals.
- **Coverage:** Entire country
- **System:** HTRS07, HGRS '87
- **Scale:** Few centimeters (RTK)  
Few millimeters (post-processing)
- **Date of operation:** 2008 – (onwards)
- **Frequency / Policy of updating:** Continuous
- **Format:** PINEX, Compact RINEX
- **Compliance:** 100%
- **Metadata:** Ad hoc
- **Provision of data / services:**
  - Subscription (payment by time used)
  - Payment by order
- **Web:** <http://www.hepos.gr/?Lang=GR>



# Core cartographic data

## Orthophotomaps (Large Scale Orthophotomaps –LSO)

Indicative sample of LSO orthophotomap



Co-financed by EU:



- **Purpose:** Support of:
  - Cadastral surveying
  - Operation of the cadastre
  - Other mapping needs of the country
- **Coverage:** Entire country
- **System:** HGRS '87
- **Scale:** ~1:5.000 (GSD: 50 cm)
- **Accuracy:** RMSE<sub>xy</sub><1,41m (achieved<0,71m)
- **Date of creation:** 2007-2009
- **Frequency / Policy of updating:** Once
- **Format:** Jpeg2000
- **Compliance:** ~100%
- **Metadata:** Available in XML
- **Provision of data / services:**
  - Free for the Public Sector
  - Free through Web applications
- **Web:** <http://gis.ktimanet.gr/wms/ktbasemap/default.aspx>





# Core cartographic data

## Orthophotomaps (Very Large Scale Orthophotomaps –VLSO)

Indicative sample of VLSO orthophotomap



Co-financed by EU:



- **Purpose:** Support of:
  - Cadastral surveying
  - Operation of the cadastre
  - Other mapping needs of the country
- **Coverage:** 58 Urban centers (Athens, Thessaloniki, prefecture capitals, ...)
- **System:** HGRS '87
- **Scale:** ~1:1.000 (GSD: 20 cm)
- **Accuracy:** RMSE<sub>xy</sub><0,28m (achieved: 0,17m)
- **Date of creation:** 2007-2009
- **Frequency / Policy of updating:** Once
- **Format:** Jpeg2000
- **Compliance:** ~100%
- **Metadata :** Available in XML
- **Provision of data / services:**
  - Free for the Public Sector
  - Free through Web applications
- **Web:** <http://gis.ktimanet.gr/wms/ktbasemap/default.aspx>



# Core cartographic data

## Orthophotomaps (Very Large Scale Orthophotomaps –VLSO)

Περιοχές κάλυψης VLSO



Co-financed by EU:



- **Purpose:** Support of:
  - Cadastral surveying
  - Operation of the cadastre
  - Other mapping needs of the country
- **Coverage:** 58 Urban centers (Athens, Thessaloniki, prefecture capitals, ...)
- **System:** HGRS '87
- **Scale:** ~1:1.000 (GSD: 20 cm)
- **Accuracy:** RMSE<sub>xy</sub><0,28m (achieved: 0,17m)
- **Date of creation:** 2007-2009
- **Frequency / Policy of updating:** Once
- **Format:** Jpeg2000
- **Compliance:** ~100%
- **Metadata :** Available in XML
- **Provision of data / services:**
  - Free for the Public Sector
  - Free through Web applications
- **Web:** <http://gis.ktimanet.gr/wms/ktbasemap/default.aspx>

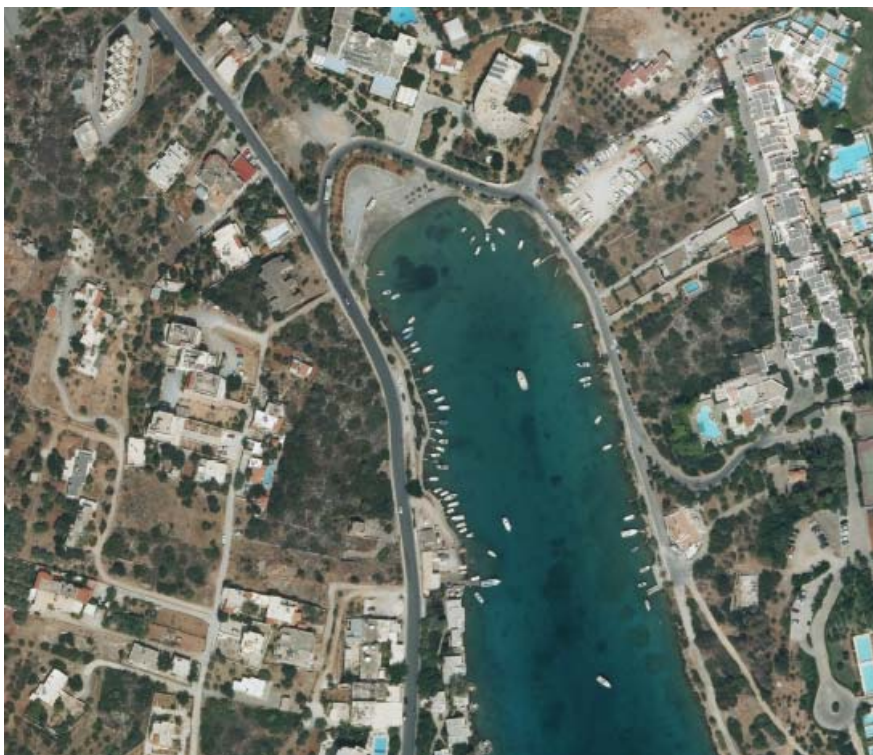




# Core cartographic data

## Orthophotomaps (Large Scale Orthophotomaps 25 –LSO25)

Indicative sample of orthophotomap LSO25



Co-financed by EU:



Co-financed by Greece and the European Union

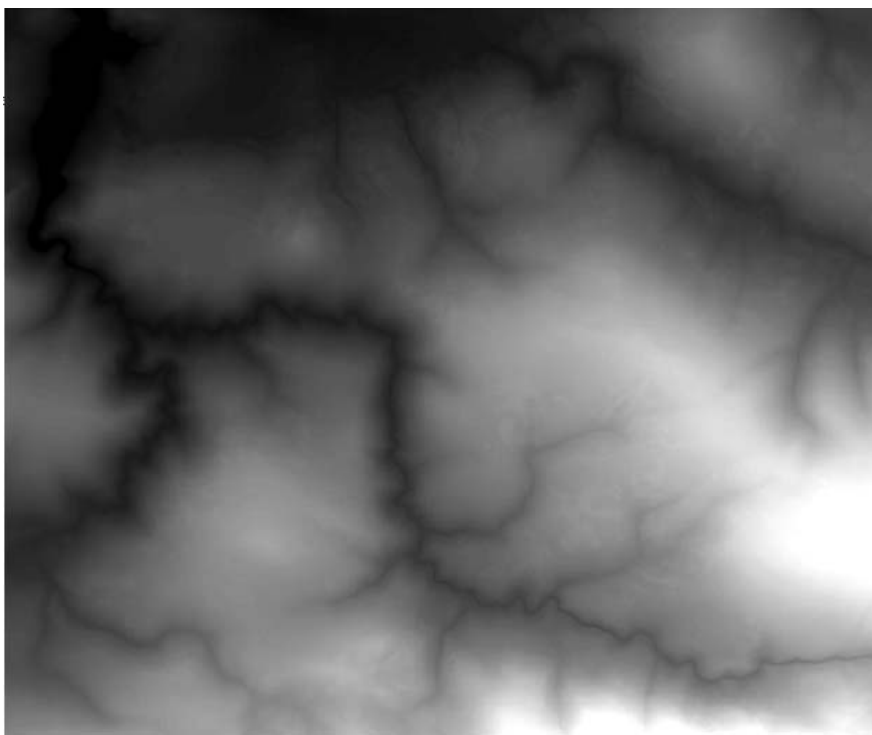
- **Purpose:** Support of:
  - Cadastral surveying
  - Operation of the cadastre
  - Other mapping needs of the country
- **Coverage:** Entire country
- **System:** HGRS '87
- **Scale:** ~1:1.250 (GSD: 25cm)
- **Precision:** RMSE<sub>xy</sub> <0,35 m (achieved 0,18m)
- **Date of creation:** 2014-2016
- **Frequency / Policy of updating:** Once
- **Format:** Jpeg2000
- **Compliance:** ~100%
- **Metadata:** Available in XML
- **Provision of data / services:**
  - Available to agencies, individuals, and firms subject to national security regulations



# Core cartographic data

## Elevation (Digital Elevation Model–LSO)

Indicative sample of Digital Elevation Model (DEM) (LSO)



Co-financed by EU:



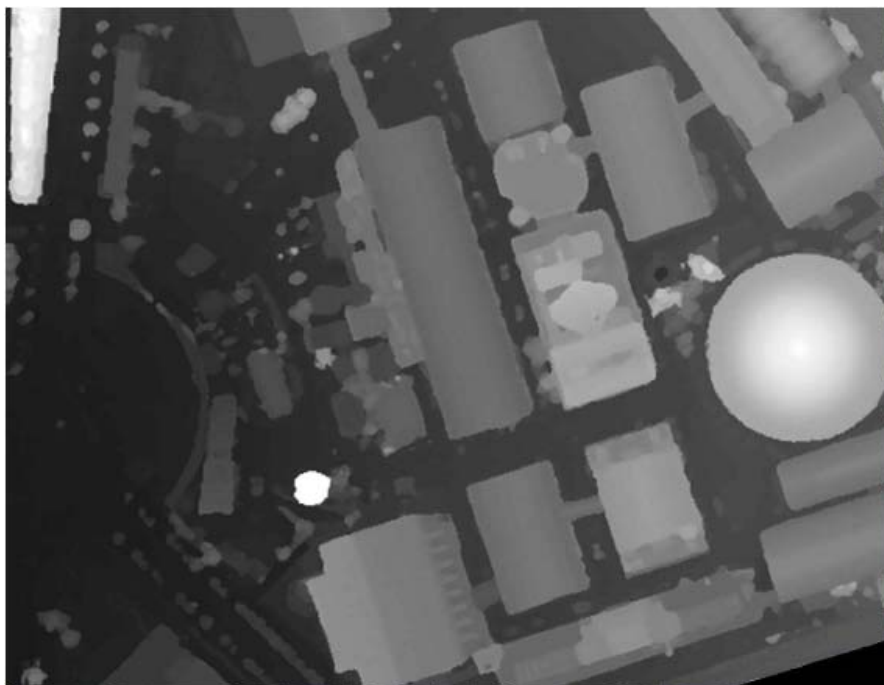
- **Purpose** : Creation of orthophotomaps for the development and operation of the Hellenic Cadastre (byproduct). Coverage of the other cartographic needs of the country.
- **Coverage**: Entire country
- **System**: HGRS '87
- **Scale**: ~1:5.000  
(Grid size: 5 m)
- **Date of creation**: 2007-2009
- **Frequency / Policy of updating**: Once
- **Format**: ESRI Floating Point Grid
- **Compliance**: ~100%
- **Metadata**: Available in XML
- **Provision of data / services**:
  - Provided only for cases and circumstances allowed by national security rules and regulations



# Core cartographic data

## Elevation (Digital Surface Model–VLSO)

Indicative sample of Digital Surface Model (DSM) (VLSO)



Co-financed by EU:



- **Purpose:** Creation of orthophotomaps for the development and operation of the Hellenic Cadastre in the urban centers (byproduct). Coverage of the other cartographic needs of the country
- **Coverage:** Urban centers (Athens, Thessaloniki, prefecture capitals, ...)
- **System:** HGRS '87
- **Scale:** ~1:1.000  
(Grid size: 0,8 m)
- **Date of creation:** 2007-2009
- **Frequency / Policy of updating:** Once
- **Format:** ESRI Floating Point Grid
- **Compliance:** ~100%
- **Metadata:** Available in XML
- **Provision of data / services:**
  - Provided only for cases and circumstances allowed by national security rules and regulations



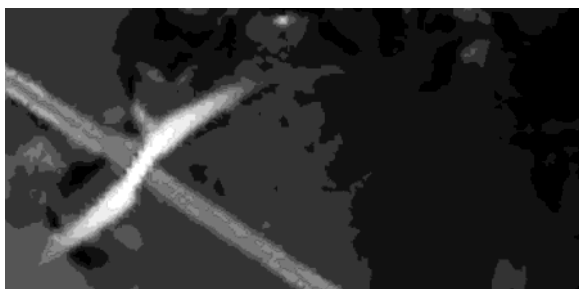
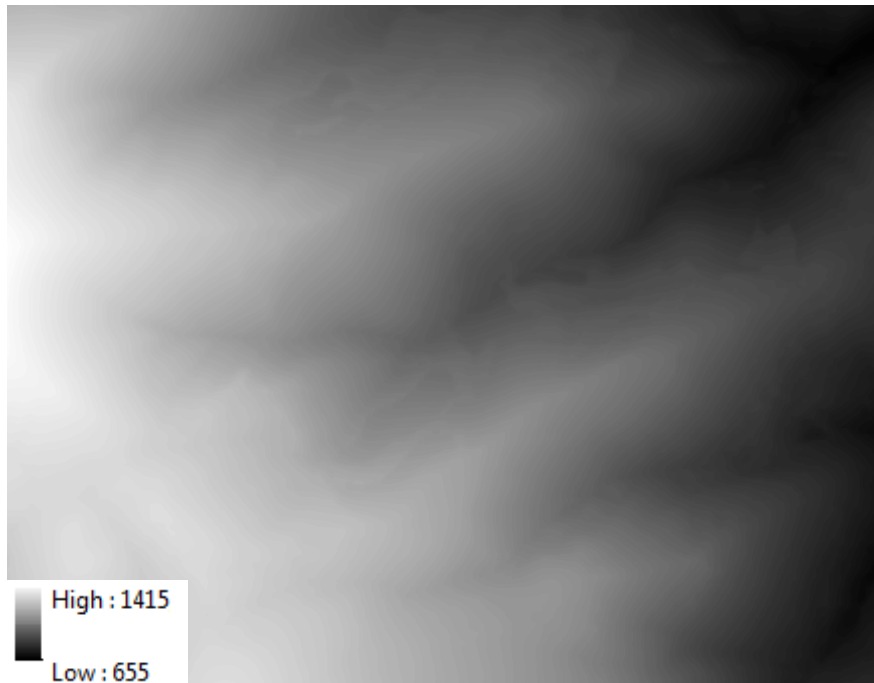


# Core cartographic data

## Elevation (Digital Elevation Model–LSO25)

Indicative sample of Digital Elevation Model (DEM) (LSO25)

A) Indicative rural area



B Indicative urban-suburban area)  
(road-bridge-fields)

- **Purpose:** Creation of orthophotomaps for the development and operation of the Hellenic Cadastre (byproduct). Coverage of the other cartographic needs of the country.
- **Coverage:** Entire country
- **System:** HGRS '87
- **Scale:** ~1:1.250  
(Grid size: 2 m)
- **Date of creation:** 2014-2016
- **Frequency / Policy of updating:** Once
- **Format:** ESRI Floating Point Grid
- **Compliance:** ~100%
- **Metadata:** Available in XML
- **Provision of data / services:**
  - Provided only for cases and circumstances allowed by national security rules and regulations



Co-financed by EU:



Co-financed by Greece and the European Union



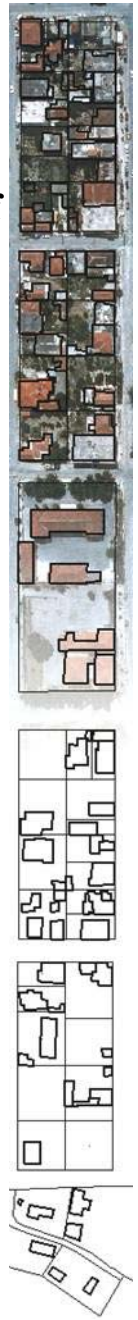
# Core geo-spatial data

## Cadastral maps

Indicative sample of a cadastral map for an urban area



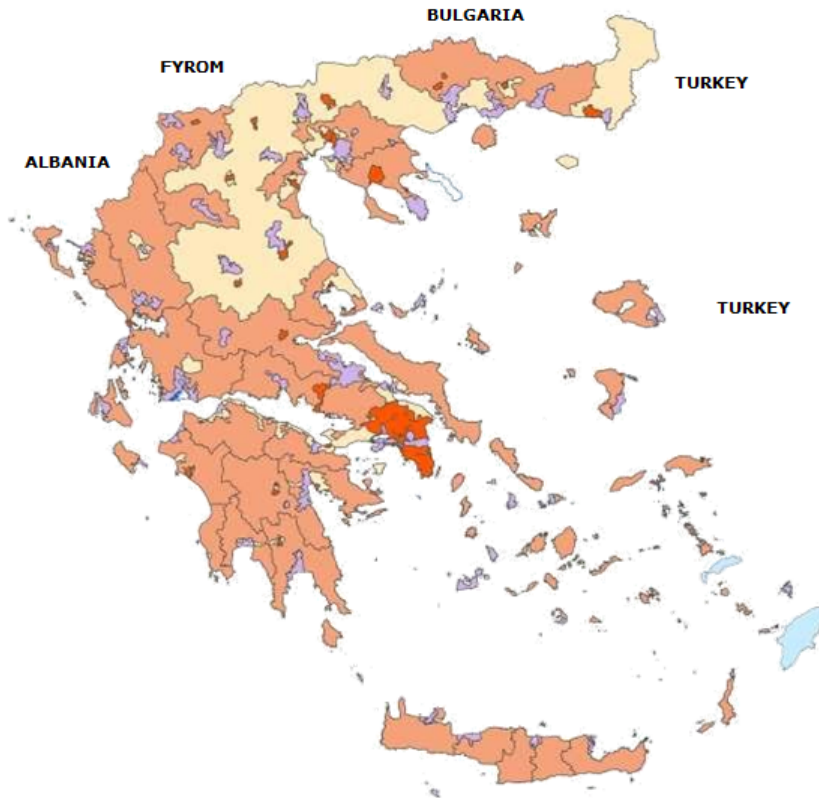
- **Purpose:** Registration and maintenance of real property rights in the country. Fulfillment of the INSPIRE requirements.
- **Coverage:**
  - Present: Areas of the 1<sup>st</sup> and 2<sup>nd</sup> Generation of Cadastral Surv. Projects
  - Future: Entire country
- **System:** HGRS '87
- **Scale:**
  - 1:1.000 & ~1:1.250 (Urban-built areas)  
RMSE<sub>xy</sub> <0,56 m (achieved 0,20 m)
  - 1:5.000 (Rural & Other areas)  
RMSE<sub>xy</sub> <1,41 m (achieved 1,10 m)
- **Date of creation:** 1999-present
- **Frequency / Policy of updating:** Continuous
- **Format:** Shape files
- **Compliance:** ~100%
- **Metadata:** Available in XML
- **Provision of data / services:** To everybody



# Core geo-spatial data

## Cadastral maps

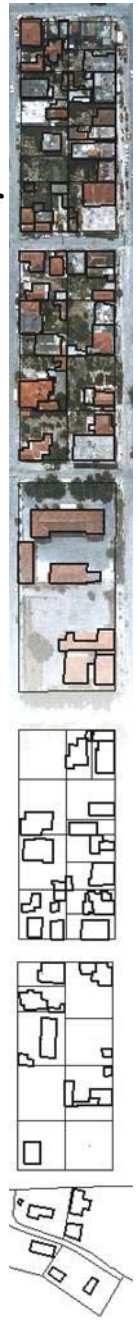
### Areas of Cadastral Surveying Programmes



#### LEGEND

- 1st Generation of Cadastral Surveying Projects (Pilot A, Pilot B, 1st Main Programs)
- 2nd Generation of Cadastral Surveying Projects (Urban centers and Parnitha Mountain)
- 3rd Generation of Cadastral Surveying Projects (Urban sprawl areas and land consolidation areas)
- 4th Generation of Cadastral Surveying Projects ("Rest of the country")
- Special Cases (Dodecanese Cadastre, Cadastre of Kallithea & Palaio Faliro)

- **Purpose:** Registration and maintenance of real property rights in the country. Fulfillment of the INSPIRE requirements.
- **Coverage:**
  - Present: Areas of the 1<sup>st</sup> and 2<sup>nd</sup> Generation of Cadastral Surveying Programmes
  - Future: Entire country
- **System:** HGRS '87
- **Scale:**
  - 1:1.000 & ~1:1.250 (Urban-built areas)  
RMSE<sub>xy</sub> <0,56 m (achieved 0,20 m)
  - 1:5.000 (Rural & Other areas)  
RMSE<sub>xy</sub> <1,41 m (achieved 1,10 m)
- **Date of creation:** 1999-present
- **Frequency / Policy of updating:** Continuous
- **Format:** Shape files
- **Compliance:** ~100%
- **Metadata:** Available in XML
- **Provision of data / services:** To everybody





# Other geo-spatial data developed by Hellenic Cadastre

## 1945/1960 orthophotomaps

Indicative sample of the 1945/60 orthophotomap



Co-financed by EU:

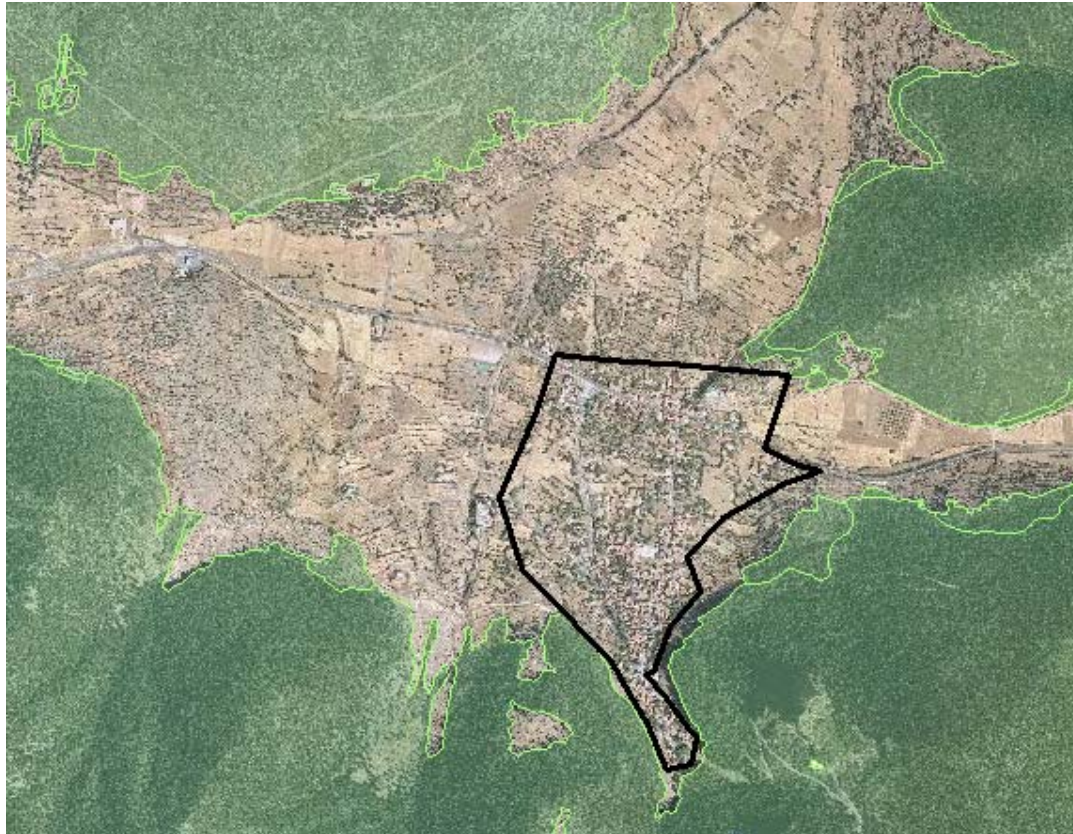


- **Compilation of the 1945/60 orthophotomap**
- **Purpose:** Creation of the basemap for the compilation of the “forest map” of the country (necessary for the development of the Hellenic National Cadastre).
- **Coverage:** Entire country
- **System:** HGRS '87
- **Scale:** ~1:5.000 (GSD: 1 m)
- **Accuracy:** <10 m. (Achieved:~6 m)
- **Date of creation:** 2008-2009  
(Original photos taken in 1945)
- **Frequency / Policy of updating:** Once
- **Format:** TIFF
- **Compliance:** ~100%
- **Metadata:** Available in XML
- **Provision of data / services:**
  - Through Hellenic Military Geographic Service
- **Web:** <http://gis.ktimanet.gr/wms/forestsuspension/default.aspx>



# Other geo-spatial data developed by Hellenic Cadastre

## “Forest” maps of the country

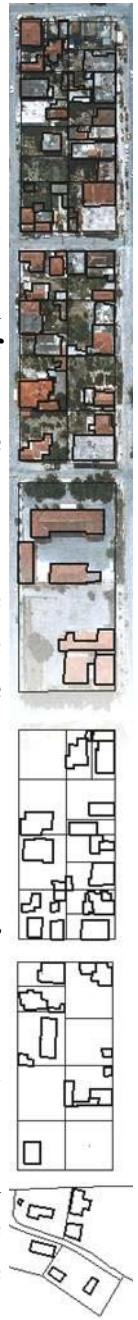


An excerpt of a “forest” map: Depiction of the current status and of the changes that have happened since 1945.

### Legend

- The area bounded by the black line is a settlement (zoned area).
- The areas in dark green are areas that have been always “forests”.
- The areas in light green are areas that have changed use since 1945.

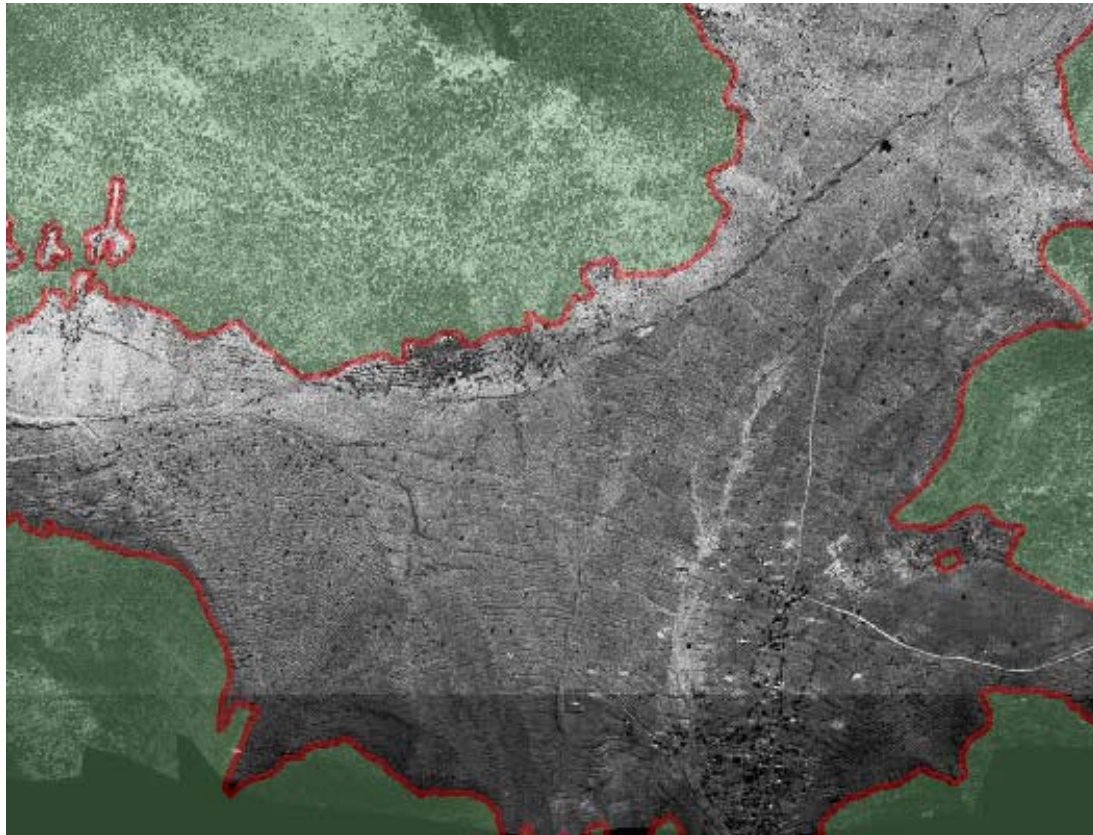
- Delineation of “forests” and “forest-like” areas is considered to be an essential element for the development of the cadastre in Greece because, by default, those areas are considered to be State land.
- Maps depicting those areas (called “forest maps”) are important because they enable the State services to declare forest land (mainly State land).
- Compilation of “forest maps” is made using standard photointerpretation methods on GSD 0,25-0,50 cm color orthophotomaps and on GSD 1m, B&W orthophotomaps depicting the situation in 1945/1960.
- Both the situation now, as well as, the situation that used to be in the past (1945 or 1960) are depicted on those maps.





# Other geo-spatial data developed by Hellenic Cadastre

## “Forest” maps of the country



An excerpt of a “forest” map depicting the situation as in 1945.

### Legend

- The area bounded by the black line is a settlement (zoned area).
- The areas in dark green are areas that used to be “forests”.
- The areas without shading indicate other uses (urban, agricultural).

- The “1945 forest maps” are important because they depict areas that used to be “forests” in the past and, thus, are, by default, State land. Potential owners in such areas must provide extensive documentation of their title to secure land ownership.
- Areas that used to be agricultural in the past and have been converted to forests now may be claimed (and accepted) as private land but their use (forest) cannot change
- Progress made so far (2017):
  - Areas having maps compiled: 72.000 (Km<sup>2</sup>) (~55%) (Ratified: ~1%).
  - Remaining: 50.000 (Km<sup>2</sup>) (45%).
  - Time horizon for completion: 2020.





# Other geo-spatial data developed by Hellenic Cadastre

## “Shore” maps of the country

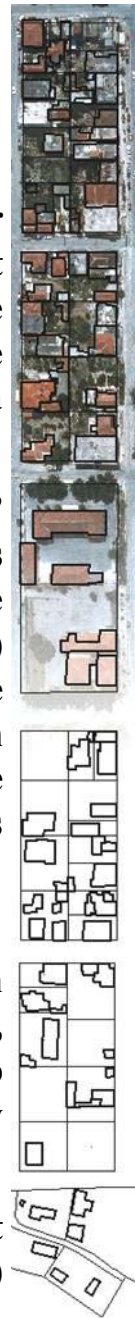


Base-map for delineating the “shore” (Co-financed by EU) 

### Legend

- The red line indicates the border line of the “shore”, as it was defined using standard procedures (field surveying and ground validation.
- The yellow line indicates the “*Preliminary borderline of the shore*”.

- The “shore” comprises another category of public land that must be registered in the cadastre. It constitutes the border zone land on the sea side.
- Delineation of the “shore” using standard procedures (ground surveying, on-site validation by committees) would require excessive amounts of time (for more than 70 years only 10% of the shore was covered) and money (tens of millions of Euros).
- **Alternative strategy:** Use of photointerpretation methods on GSD 25 cm, Color+NIR orthophotomaps to delineate the “Preliminary borderline of the shore”.
- The project was carried-out within two years (2008-2009) and cost 2,6 million Euros.



# Other geo-spatial data developed by Hellenic Cadastre

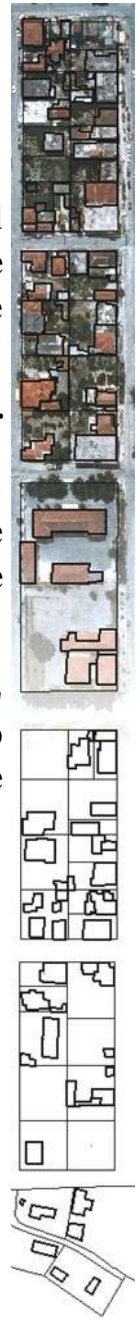
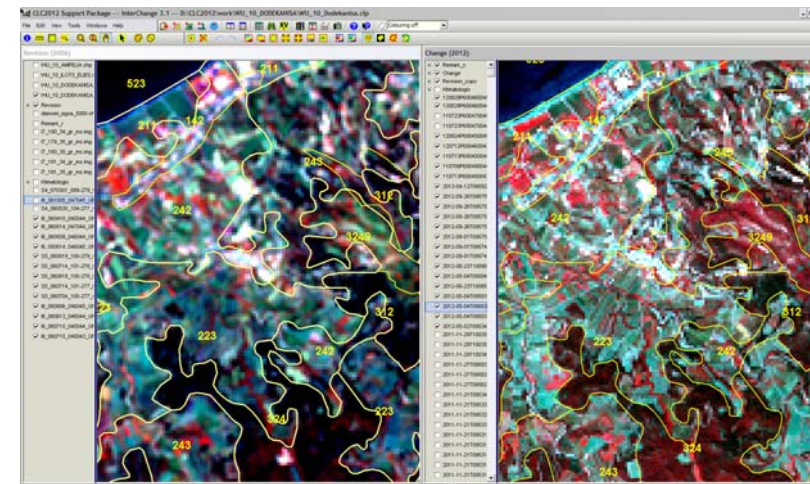
## Compilation of the CORINE Land Cover datasets

### A) CORINE Land Cover 2012 - Greece



### B) Specialized photo-interpretation software used to create the CORINE Land Cover data sets

- Photointerpretation methods (visual and semi-automatic) have been used to compile the CORINE Land Cover datasets for Greece for 2000 (correction), 2006 and 2012.
- Satellite images have been used as input for photointerpretation.
- There has been an on-going project for the compilation of the next version of the CORINE Land Cover dataset (2017-2021).
- Within the cadastral context, the CORINE Land Cover datasets have been used to estimate major project components (e.g. the number of rights to be registered).



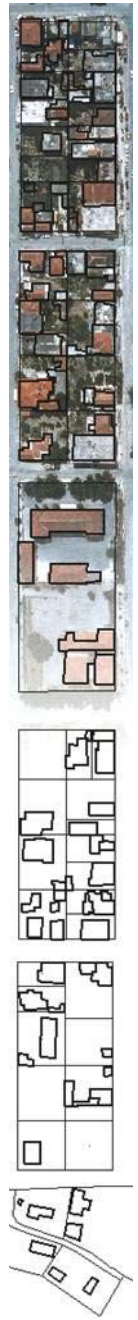


# On-going “core” NSDI initiatives and prospects at the Hellenic Cadastre

Preliminary cadastral map of a rural area in Greece, 2018



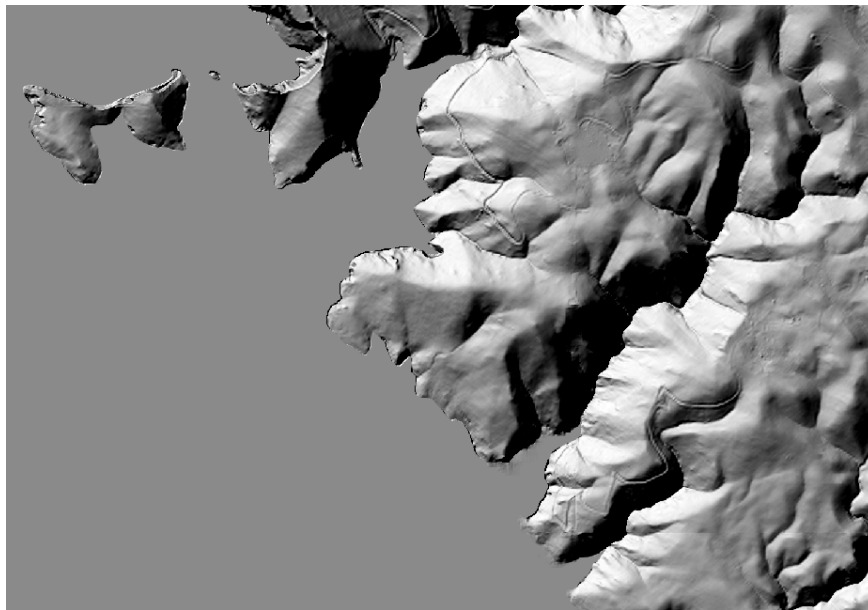
- Developing the administrative and software infrastructure for providing public access to core geospatial datasets according to the INSPIRE rules and specifications
  - Geodetic data
  - Orthophotomaps
  - Digital Terrain Models
  - Cadastral parcels
- The development of the software applications that would be used to transform the Hellenic Cadastre “core” datasets into INSPIRE compliant format would be outsourced to specialized private section firms
- The first set of geospatial data that would be available to the public in INSPIRE compliant format is the set of LSO25 at a GSD analysis of 50 cm.
- Expected time of availability: early part of the 2<sup>nd</sup> quarter of 2018.



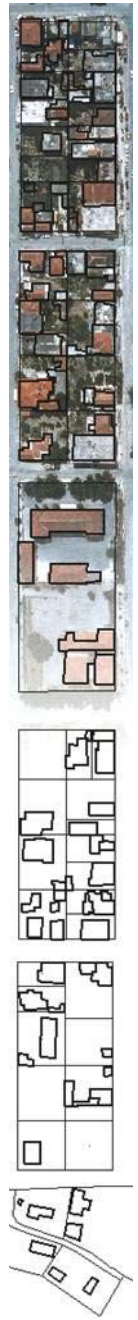


# Major issues in implementing the “core” NSDI infrastructure in the Hellenic Cadastre

Sample dataset from the LSO-25 digital terrain model (DTM)



- **Restrictions in the data provision due to national security regulations**
- **Lack of clear political and administrative will to free-up the data. Frequent changes in the directions and guidelines at the political level**
- **Lack of clear vision and will to establish the rules for providing the data**
- **Segmentation and overlap of responsibilities among involved governmental agencies**
- **Intra-agency and inter-agency rivalries**
- **Heavy bureaucracy and ambiguities in the rules about data provision**
- **Under-staffing of agencies and lack of incentives to the competent personnel to undertake initiatives for promoting NSDI**
- **Limitations in capabilities of existing IT infrastructures**
- **Strict restrictions in available financial resources**



# Overview and conclusions

Sample from the LSO-25 data set in coastal Greece



- **The Hellenic Cadastre plays a central role in the development of the NSDI in Greece**
- **Thanks to the development of a cadastral system in the country, the cadastral agency has been able to develop a valuable set of “core” geospatial data that could be used to “populate” the NSDI in the country**
- **The Hellenic Cadastre is undertaking proactive initiatives to promote the NSDI in the country. Also, it undertakes initiatives to help in the resolution of existing issues.**
- **It is envisaged that this contribution would lead to the development of a modern, trustworthy and useful for the country NSDI.**

