

***EuroSDR***  
**(European Spatial Data Research)**



**ROLLING RESEARCH PLAN**

**2011-2014**

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# Table of Contents

Executive Summary .....	2
1 Introduction.....	4
2 EuroSDR Vision .....	4
3 EuroSDR Mission .....	4
4 EuroSDR Research Perspective and Topics.....	5
4.1 EuroSDR Research Perspective.....	5
4.2 EuroSDR Research Topics.....	6
4.3 EuroSDR Research alliances: .....	7
5 EuroSDR Commissions.....	8
5.1 COMMISSION 1: SENSORS, PRIMARY DATA ACQUISITION AND GEOREFERENCING .....	9
5.2 COMMISSION 2: IMAGE ANALYSIS AND INFORMATION EXTRACTION .....	10
5.3 COMMISSION 3: PRODUCTION SYSTEMS AND PROCESSES .....	11
5.4 COMMISSION 4: DATA SPECIFICATIONS.....	12
5.5 COMMISSION 5: NETWORK SERVICES.....	14

## Executive Summary

This EuroSDR Rolling Research Plan defines the framework within which EuroSDR research, developments and teaching is performed. Its main purpose is to properly structure the work in the coming years, while leaving enough flexibility to be able to react to unforeseen developments.

The EuroSDR Steering Committee (SC) has discussed the outline of the plan 2011-2014 in several stages and has given approval during the 117<sup>th</sup> Meeting in Zagreb.

The vision of EuroSDR is to be the European research platform for National Mapping and Cadastre Agencies (NMCA's), Academic Institutes, the Private Sector, Industry and User Groups, on issues related to Research & Development and implementation of technology with respect to optimising the provision of spatial information in a Geoinformation Infrastructure (GI) context.

Implementing the vision includes the development and improvement of methods, systems and standards for the acquisition, processing, production, maintenance and dissemination of spatial information and to promote applications of all such data. Furthermore, EuroSDR would like to encourage interaction between research organisations and the public and private sectors to exchange ideas and disseminate knowledge about relevant research problems and to help transfer research results into geoinformation production, dissemination and use activities. These aims make EuroSDR unique in Europe: a network of NMCAs, leading universities and research institutes engaged on the common goal of exploring the future needs of geoinformation infrastructures at national and European levels and related technological developments. Cooperation between European NMCAs research institutions and the private sector is pursued to ensure appropriate applied research is carried out and results are transferred between research laboratories, industry and NMCA operations.

The key EuroSDR research topics, for the period 2011-2014, are:

1. Investigation and monitoring of new sensor systems and platforms, related calibration aspects, including digital aerial and satellite sensors, laser and hyper-spectral scanners, SAR sensors, unmanned aerial vehicles, and mobile mapping systems.
2. Geometric data collection and refinement issues (sensor orientation and geo-referencing, refined image matching, digital surface models, digital terrain models). As multiray photogrammetry meets LiDAR and airborne SAR it is interesting to see the geometric performance when comparing those data collection methods.
3. Radiometric data processing and refinement. Absolute and relative radiometric data calibration becomes an issue, especially when using advanced remote sensing classifiers and texture mapping.
4. Acquisition and update of static and moving objects (topographic vector data, DTMs and data from other objects) from images and collateral data in order to serve traditional and novel applications. Merging data of several resolution and accuracy will become an issue.
5. From 2D cartographic databases to 3D topographic information systems serving the needs of 3D landscape and 3D city models. Here, all aspects of the whole spatial data chain are to be renewed: spatial modelling, acquisition, management, analysis and visualisation. Add value to the basic 3D spatial database!
6. Process modelling and interfaces (product diversity/servicing/outsourcing). Cloud Computing (CC) will become an additional computing resource also for geospatial data. The three areas of CC are SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service).

7. Core geoinformation databases (data modelling, currency/maintenance, unique ID, metadata, changes only). How to profit from industrial and crowd-sourced strategies for data revision? What about privacy enabling aspects?
8. Standards and open software for data and metadata. What about spatial data archives? Spatial data history becomes an issue, especially for key applications of the 21<sup>st</sup> century: climate change, energy efficiency, and noise reduction.
9. Semantic interoperability: Ontologies, schema translation, and data integration. Model generalisation, multi-resolution and multi-representation data bases.
10. Implementation strategies of INSPIRE. How should INSPIRE 2.0 look like?
11. Cartographic generalisation in terms of up- and downscaling, for traditional and non-traditional displays. 3D generalisation becomes an issue, especially when using more and more mobile (handheld) computing devices (iPhone etc.).
12. Delivery and data publishing mechanisms and, in particular, Geospatial Data Infrastructure and associated topics in Ontologies and translation services. Web-based dissemination of spatial data.
13. Geoinformation data quality. Professionally maintained spatial data meets crowd-sourced data. What about integration?

Those key research topics are maintained and guided by the five commissions of EuroSDR: Sensors, Primary Data Acquisition and Georeferencing (Commission 1), Image Analysis and Information Extraction (Commission 2), Production Systems and Processes (Commission 3), Data Specifications (Commission 4), and Network Services (Commission 5). The commission presidents report briefly to the EuroSDR delegates at every EuroSDR Science Committee Meeting, just to keep all informed about the progress made.

This EuroSDR Rolling Research Plan is a living document and might be adapted at any time if necessary.

## **1 Introduction**

The EuroSDR Rolling Research Plan defines the framework within which EuroSDR research, developments and teaching is performed. Its main purpose is to properly structure the work in the coming years, while leaving enough flexibility to be able to react to unforeseen developments. In order to achieve this goal, the document first contains the EuroSDR vision and mission statements, followed by comments on the coming challenges in our field, relating these to the general EuroSDR research perspective and topics. The areas of interest of the five EuroSDR Commissions are then described, which together cover the whole technical field of Photogrammetry and Geoinformatics. Operational issues such as guidelines for planning and executing projects can be found in the appendix.

The EuroSDR Steering Committee (SC) discussed the outline of the plan 2011-2014 in several stages:

- In a number of EuroSDR Workshops prior to the 116<sup>th</sup> meeting in Frankfurt/Main, Germany, many delegates and representatives of EuroSDR members presented their priorities for future research and for an evolution of the organisation as a whole.
- Based on these observations the Management Team (MT) prepared a draft of the new EuroSDR Research Plan 2011-2014 and presented it to the delegates during the Frankfurt/Main meeting. The proposal has been discussed and approved by the SC during its 117<sup>th</sup> meeting in Zagreb, Croatia in Autumn 2010.

## **2 EuroSDR Vision**

To be the European research platform for National Mapping and Cadastre Agencies (NMCA's), Academic Institutes, the Private Sector, Industry and User Groups, on issues related to Research & Development and implementation of technology with respect to optimising the provision of spatial information in a Geoinformation Infrastructure (GI) context.

## **3 EuroSDR Mission**

The aim of EuroSDR is to

- Develop and improve methods, systems and standards for the acquisition, processing, production, maintenance and dissemination of spatial information and to promote applications of all such data. Special emphasis is placed on the further development of airborne and space borne methods for data acquisition, on methods for information extraction from such sources and on the integration of such information with information from other sources.
- Encourage interaction between research organisations and the public and private sectors to exchange ideas and disseminate knowledge about relevant research problems and to help transfer research results into geoinformation production, dissemination and use activities.

Our organisation is therefore unique in Europe: a network of NMCAs, leading universities and research institutes engaged on the common goal of exploring the future needs of geoinformation infrastructures at national and European levels and related technological developments. As such it acts as a sister organisation to EuroGeographics as for R&D and education matters.

## 4 EuroSDR Research Perspectives and Topics

Mainly driven by changing needs of society and developments in the area of information and communication technologies, developments in the geoinformatics sector in Europe over the last couple of years have been profound and continue at a very fast pace. Key questions to be answered today are

- what happens where and when?
- how will potential responses look?
- why do they look like this?

Answering these questions quickly and with high reliability in a pan-European context will require constant monitoring efforts, as well as integration and linking of distributed information sources, often in real-time.

In this transformation, while former tasks remain important, the emphasis of many European National Mapping and Cadastre Agencies (NMCAs) changes rapidly

- from a provider of paper and digital map data to an information service provider, which provides the core reference infrastructure by which other stakeholders' data can be integrated in a common framework
- concerned with maintaining, updating this core reference infrastructure, and disseminating modern reference geoinformation to support the development of advanced and integrated spatial data infrastructures and services
- from an agency using analogue technology and specialised hard- and software to one employing increasingly emerging technologies such as Cloud Computing, Parallel Computing, 3D Viewing, and Geospatial Entertainments
- from a national body with an exclusively national purpose to one of many players in close connection and cooperation in a larger national and pan-European context of Galileo, GMES, INSPIRE, and Crowd-Sourced Mapping
- from a national administrative body with a standalone in-house production to an agency which increasingly integrates data from various sources to create the core reference framework, and often coordinates and maintains the NSDI.

During these times of change knowledge about latest technology changes is recognised as a major advantage. Cooperation between European NMCAs research institutions and the private sector is pursued to ensure appropriate applied research is carried out and results are transferred between research laboratories, industry and NMCA operations.

It is against this background that the following research principles have been formulated.

### 4.1 EuroSDR Research Principles

- EuroSDR research serves the whole European Geoinformatics Community, deal with problems of more than local significance, and be carried out by means of international co-operation.
- While retaining a special emphasis on data acquisition EuroSDR research is concerned with the whole chain of reference information production, management, basic analysis, visualization and delivery. In particular developments such as Cloud Computing, Digital Data Repositories, Galileo, GMES, INSPIRE (and EuroSpec) should be closely integrated into the EuroSDR activities.
- Emphasis is placed to improvements in methodology and accuracy as well as to the improvement of performance and efficiency of production.

- EuroSDR profiles itself as a professional research exchange platform that is commercially neutral and which provides services to the European GI community.
- Recognising that geospatial data can be a facilitator for progressing public sector policy, EuroSDR will seek to engage with European strategists to identify where its research focus can add value to appropriate policy objectives.
- Private sector and industry are involved in EuroSDR research, in particular through funded and non-funded projects.
- EuroSDR research results should be timely, having short project phases of about 2-3 years with intermediate and final deliverables. Every project starts with a Kick-off presentation and discussion, having an intermediate Midterm Review after about one year, and will be closed with the Final Review.
- Pilot software, bought, developed and extended during a EuroSDR project are to be made available to every EuroSDR member. Here, OpenSource developments should play an important role to fulfil some standardization.

## 4.2 EuroSDR Research Topics

The key EuroSDR research topics, for the period 2011-2014, are as follows:

1. Investigation and monitoring of new sensor systems and platforms, related calibration aspects, including digital aerial and satellite sensors, laser and hyper-spectral scanners, SAR sensors, unmanned aerial vehicles, and mobile mapping systems.
2. Geometric data collection and refinement issues (sensor orientation and geo-referencing, refined image matching, digital surface models, digital terrain models). As multiray photogrammetry meets LiDAR and airborne SAR it is interesting to see the geometric performance when comparing those data collection methods.
3. Radiometric data processing and refinement. Absolute and relative radiometric data calibration becomes an issue, especially when using advanced remote sensing classifiers and texture mapping.
4. Acquisition and update of static and moving objects (topographic vector data, DTMs and data from other objects) from images and collateral data in order to serve traditional and novel applications. Merging data of several resolution and accuracy will become an issue.
5. From 2D cartographic databases to 3D topographic information systems serving the needs of 3D landscape and 3D city models. Here, all aspects of the whole spatial data chain are to be renewed: spatial modelling, acquisition, management, analysis and visualisation. Add value to the basic 3D spatial database!
6. Process modelling and interfaces (product diversity/servicing/outsourcing). Cloud Computing (CC) will become an additional computing resource also for geospatial data. The three areas of CC are SaaS (Software as a service), PaaS (Platform as a service) and IaaS (Infrastructure as a service).
7. Core geoinformation databases (data modelling, currency/maintenance, unique ID, metadata, changes only). How to profit from industrial and crowd-sourced strategies for data revision? What about privacy enabling aspects?
8. Standards and open software for data and metadata. What about spatial data archives? Spatial data history becomes an issue, especially for key applications of the 21<sup>st</sup> century: climate change, energy efficiency, and noise reduction.
9. Semantic interoperability: Ontologies, schema translation, and data integration. Model generalisation, multi-resolution and multi-representation data bases.
10. Implementation strategies of INSPIRE. How should INSPIRE 2.0 look like?

11. Cartographic generalisation in terms of up- and downscaling, for traditional and non-traditional displays. 3D generalisation becomes an issue, especially when using more and more mobile (handheld) computing devices (iPhone etc.).
12. Delivery and data publishing mechanisms and, in particular, Geospatial Data Infrastructure and associated topics in Ontologies and translation services. Web-based dissemination of spatial data.
13. Geoinformation data quality. Professionally maintained spatial data meets crowd-sourced data. What about integration?

Commissions	1	2	3	4	5
<b>Research Topics</b>					
<b>1: Sensor systems</b>	X	(x)	(x)		
<b>2: Geometric data collection issues</b>	X	(x)	(x)		
<b>3: Radiometric data processing</b>	X	X	(x)		
<b>4: Vector data revision, DTM update</b>	(x)	X	(x)		
<b>5: 3D topographic information systems</b>		X	(x)	X	(x)
<b>6: Process modelling and interfaces, CC</b>			x		
<b>7: Core spatial databases</b>		(x)	(x)	X	(x)
<b>8: Standards and open software, archives</b>			X	X	(x)
<b>9: Ontologies and data integration</b>		(x)		(X)	X
<b>10: Model generalisation, MRDB</b>				X	X
<b>11: Cartographic generalisation, 2D and 3D</b>			X	X	
<b>12: Geospatial data infrastructures, services</b>			X	(X)	X
<b>13: Geoinformation quality</b>	X	X	(x)	X	(x)

Table 1: Mapping of research targets to the Commission structure  
*x* means primary field of interest of the Commission,  
*(x)* means secondary field of interest of the Commission

### 4.3 EuroSDR Research alliances:

To ensure a global perspective and participation EuroSDR will actively seek to intensify cooperation and collaboration with sister organisations at the European level and beyond.

In particular:

- EuroSDR has signed a cooperation agreement with EuroGeographics and will therefore cooperate very closely with its sister institution, as the NMCAs provide the drivers for both organisations.
- Collaboration with organisations such as the Joint Research Centre and the European Commission is encouraged. The EU Framework programme in particular should be exploited for funding EuroSDR projects, and cooperation with AGILE will be further developed.
- EuroSDR is open for further collaboration with international bodies. As such we will cooperate with the International Society for Photogrammetry and Remote Sensing (ISPRS), the International Cartographic Association (ICA), the International Association of Geodesy (IAG), the Fédération Internationale des Géomètres (FIG), the Global Spatial Data Infrastructure Association (GSDI), the World Wide Web Consortium (W3C), the European Space Agency (ESA), other national and regional scientific societies, the International Standard Organisation (ISO), the Comité Européen de Normalisation (CEN), the Open GeoSpatial Consortium (OGC), and other standardisation bodies, and others.

## **5 EuroSDR Commissions**

All commissions of EuroSDR should

- Explore common areas of interest:
  - suggest specific topics,
  - conduct appropriate discussions with representatives from NMCAs,
- Initiate and direct new projects in these areas,
- Organise workshops and tutorials on specific topics,
- Seek to involve the private sector into the commission activities,
- Present relevant research results in scientific and technical meetings and journals,
- Engage in training and capacity building in their respective area.

A brief overview of the terms of references and activities of every commission is given on the following pages. The commission presidents report briefly to the EuroSDR delegates at every EuroSDR Science Committee Meeting, just to keep all informed about the progress made.

## 5.1 COMMISSION 1: SENSORS, PRIMARY DATA ACQUISITION AND GEOREFERENCING

### Scope:

To explore, demonstrate, and/or further develop sensors and platforms for geo-spatial data collection with emphasis on the accuracy, reliability and standardization of orientation, calibration and georeferencing procedures.

### Terms of Reference:

- Sensor orientation and calibration
- Accuracy and reliability of orientation, calibration and georeferencing
- Earth Observation platforms
- Standards for sensor orientation and calibration

### Commission Activities:

Continuing research priorities:

- Radiometric aspects of digital photogrammetric images
- European Digital Airborne Camera Certification EuroDAC<sup>2</sup>
- Biennial workshop EuroCOW (Calibration & Orientation Workshop)

New research project possibilities to be considered:

- The impact of Galileo on sensor orientation, calibration and on georeferencing
- Global Differential GNSSPS for airborne photogrammetry and remote sensing (including PPP, real time networks)
- Contribution of LiDAR and digital cameras to accurate and reliable navigation
- Best practices for (airborne / terrestrial) sensor orientation and calibration
- Applications of multispectral and hyperspectral sensing to the development of NMCAs core spatial databases
- Airborne / terrestrial LIDAR block adjustment
- Airborne InSAR block adjustment
- Multi-sensor data collection
- Rigorous combined calibration of airborne and/or terrestrial LIDAR and digital camera systems
- Combination of airborne and/or terrestrial photogrammetric and LiDAR surveys
- UAS / UAV sensor platforms, high altitude sensor platforms
- automated orientation of non-conventional image blocks
- Potential and applications of web sensors and sensor networks
- intelligent sensor clusters, crowd sourcing using airborne / terrestrial sensors
- Development of implementation standards for sensor orientation and calibration

## 5.2 COMMISSION 2: IMAGE ANALYSIS AND INFORMATION EXTRACTION

### Scope:

To explore, demonstrate, and further develop the applicability of image analysis methods for automatically extracting and updating geo-spatial data from images and additional information

### Terms of reference:

- Information content of multi-spectral, multi-sensor, multi-resolution, and multi-temporal imagery;
- Methods and algorithms for automated acquisition of geo-spatial data and the description of data quality;
- Methodology for the integrated acquisition and update of geo-spatial data from imagery and additional information.

### Commission Activities:

Continuing research priorities:

- Radiometric Calibration of ALS Intensity
- Road Environment Mapping using Multi-Sensor Vehicles
- Registration quality – towards integration of laser scanning and photogrammetric methods

New Research project possibilities to be considered:

- Benchmarking of Image Matching Approaches for DSM Computation
- Towards 3D landscape models\* (continuation of several previous projects, e.g. Building Extraction, Tree Extraction)
- Use of calibrated image and LiDAR features in automatic object classification (Proposed continuation of projects Radiometric Calibration of ALS Intensity, Radiometric Aspects of Digital Photogrammetric Images and Registration Quality)
- Benefits of multitemporal imaging and ranging for core geoinformation databases
- Integration of LiDAR data and aerial photogrammetric images (proposed continuation of Registration Quality)
- Merging data of several resolution for mapping and map updating\* (links to previous projects on change detection)
- Use of mobile (car-based) mapping as a tool to support core geoinformation databases (proposed continuation of project Road Environment Mapping using Vehicle-based Laser Scanning)

### 5.3 COMMISSION 3: PRODUCTION SYSTEMS AND PROCESSES

#### Scope:

To explore, evaluate, demonstrate and/or further develop production systems and processes for the generation and updating of geo-spatial information.

#### Terms of Reference:

- Semi-automatic and automatic feature extraction
- Evaluation of performance (time, costs, versatility) of current production processes
- Incorporation of multi-spectral image sources.
- Incorporation of multi-sensor data in production.
- Quality assurance in production processes
- Change Detection
- Transformation of 2D datasets in 3D datasets
- Data models for national data sets
- Incorporation of user generated content
- Incremental updating
- Data harmonisation processes
- Formulation of data archiving policies for geospatial data and meta-data

#### Commission Activities:

Continuing research priorities:

- Virtual Globes. Chances, challenges and opportunities. Evaluation of impact on geospatial industry.
- Semantic Enrichment of 3D City Models for Sustainable Urban Development (COST)
- Stimulating workshops on
  - Automated change detection for updating national databases
  - 3D Digital Landscape Models - From 2D cartographic to 3D topographic data
  - Crowd Sourcing for Updating National Databases

New Research project possibilities to be considered:

- Integration of terrestrial (including CAD and GIS datasets) and aerial methods for 3D city modelling.
- Mobile Mapping approaches in navigation industries. Potential and chances for cooperation on European level.
- Business process modelling in the context of increasing outsourcing/ subcontracting of NMCAs and public/private partnerships.
- Automated change detection for updating national databases
- 3D Digital Landscape Models
- Formulation of data archiving policies
- Retrieval of vegetation parameters

## 5.4 COMMISSION 4: DATA SPECIFICATIONS

The demands for interoperability between different data themes, different user needs, and different levels of detail imply several challenges in development of specifications for spatial data.

### Scope:

To investigate, evaluate and document the development of databases for storing and maintaining national core/framework geodata. This includes related data management research topics in extending the capability of such databases such as:

- Data/information structures (incorporating data models and classification mechanisms) supporting interoperability between and sharing of geodata from different sources
- Linking & integrating data in registers and geodata,
- Linking & integrating 3rd party data,
- Developing the height and temporal component of spatial data models and
- Deriving smaller scale datasets/products from the definitive database.

### Terms of Reference:

- Evaluate, and where applicable, test and document applications and best practice for Reference Information databases in terms of data models, data content (specification) and database technology capabilities, supporting interoperability.
- Best practice in geoinformation data quality in terms of accuracy, currency, completeness and consistency relative to requirements.
- Methods and mechanisms for database updating and maintenance, including methods for tracing the lineage of data.
- Methods and mechanisms for data integration with 3rd party data, either directly as part of the database update process or indirectly as in linking all kinds of associated data.
- Methods for development of efficient web services from existing geodata bases.
- Models and approaches in the development of 3D core geoinformation databases to support new applications such as virtual reality.
- Models and approaches in the development of spatio-temporal core geoinformation databases.
- Methods and approaches for establishment of multi-resolution databases in order to support the derivation or automated publication (in many forms) of lower resolution databases/data sets from the large-scale database or to support other kinds of specific needs.
- Methods for production partnership management

### Commission Activities:

Continuing research priorities:

- Develop an overview of geoinformation quality, to determine scope, best practice and knowledge sharing.
- Generalisation – To establish by a small set of controlled tests the state-of-the art in generalisation
- Collaborate with EuroGeographics and EC on the development of specifications for INSPIRE.
- Cooperate on operational technical developments related to the above

New research project possibilities to be considered:

- Methods for efficient re-structuring of fundamental GI databases in order to meet new needs
- Handling of INSPIRE data specifications within mapping agencies, including establishment of multi-map products
- Database versioning, updating and use of Style Layer Descriptions
- Database schema – classification, models and structures
- Data integration/interoperability (internal reference information and user/reference information, use of identifiers)
- Multi-resolution, multi-representation databases
- Managing height in the database
- Spatio-Temporal aspects
- Database archiving
- Towards 3D generalisation
- Efficient methods for development of web services, e.g. use of WFS 2.0

## 5.5 COMMISSION 5: NETWORK SERVICES

### Scope:

To investigate, evaluate and document developments in the technologies for data integration, service-level interoperability and delivery of all forms of geoinformation, data and services. Major themes are the impact of the Internet and Web service, and related technologies such as XML, the shift to service-based architectures and the use of object models for information.

### Terms of Reference:

- Methods and mechanisms for integrating core (framework) data with other geoinformation and business (or value-added) data, both by data linking and by interoperable data access. (Strong interaction with Commission 4)
- Harmonisation requirements on core data, including cross-jurisdiction issues.
- The adoption of new delivery mechanisms, including mobile communications and distributed spatial data infrastructures, and their effect on the business models and practices of NMCAs
- Methods and mechanisms for delivery of metadata with emphasis on discovery and registry services and data quality information
- Multi-purpose deployment of data, including schema translation services and semantic query
- Applications of visualisation technology to geoinformation data and added-value refinements

### Commission Activities:

Continuing research priorities:

- State-of-the-art in Generalisation (in support of EuroSDR Commission 4)

New research project possibilities to be considered

- Ontology's and translation services (with JRC, JRC taking the lead in near-term practical aspects and EuroSDR the lead in research)
- Access management techniques
- Validation of services
- Service provision in local, regional and global SDIs
- Delivery and use of 3D data including City Models (with Commissions 3 and 4)