EuroSDR

European Spatial Data Research

Annual Report
2016

About EuroSDR

EuroSDR is a pan-European organisation established by International Treaty, as OEEPE, in 1953 in Paris in accordance with a recommendation passed by the Council of the Organisation for European Economic Co-operation. The spatial data research interests of European Countries are represented through the membership in EuroSDR of national organisations from their production and research sectors.

The result is a network of delegates, from European Geographic Information organisations and research institutes, effectively and practically addressing Europe's spatial data research requirements.

Collaborative research projects address the acquisition, management and delivery of spatial data and services while international workshops and courses, in collaboration with related organisations, address key issues in a timely and focused manner.

Vision

EuroSDR is the recognised provider of research-based knowledge to a Europe where citizens can readily benefit from geographic information. Our mission is to develop and improve methods, systems and standards for the acquisition, processing, production, maintenance, management, visualization, and dissemination of geographic reference data in support of applications and service delivery.

Our Member States and their Prime Delegates (2016)

Austria	Michael Franzen	Bundesamt für Eich- und Vermessungswesen (BEV)
Belgium	Eric Bayers	Nationaal Geografisch Instituut
Croatia	Danko Markovinović	Državna geodetska uprava
Cyprus	Andreas Sokratous	Department of Lands and Surveys
Denmark	Thorben Hansen	Geodatastyrelsen
Finland	Juha Hyyppä	Geodeettinen Laitos
France	Bénédicte Bucher	Institut Géographique National
Germany	Hansjörg Kutterer	Bundesamt für Kartographie und Geodäsie
Ireland	Andy McGill	Ordnance Survey Ireland
Norway	Jon Arne Trollvik	Statens Kartverk
Poland	Piotr Woźniak	Glowny Geodeta Kraju
Slovenia	Dalibor Radovan	Geodetski Institut Slovenije
Spain	Antonio Arozarena	Instituto Geografico Nacional
Sweden	Mikael Lilje	Lantmäteriet
Switzerland	François Golay	Ecole polytechnique fédérale de Lausanne (EPFL)
The Netherlands	Jantien Stoter	Technical University of Delft and NL Kadaster
United Kingdom	Malcolm Havercroft	Ordnance Survey of Great Britain

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Message from the President
Eric Bayers

'Times They Are A-changin' (Bob Dylan, Nobel Prize in Literature 2016).
The global technical context we live in is constantly in progress. The gradual integration of tools and methods typically devoted to spatial information into more global data management solutions (sensor integration, big data, cloud computing, web services, apps, …) is a real challenge for EuroSDR. In the economic environment of the last few years, where most of our countries have cut down on resources available for public activities, we are compelled to find ever more (cost-)efficient solutions. Besides, the increasing number of public and private stakeholders in the spatial information sector requires a big effort in terms of organization and coordination. Almost everywhere in Europe, NMCA's needed to evolve from their specific role as spatial data producer towards more diverse roles as producer, integrator, distributor or even broker of spatial data and services. As a consequence, we keep looking for new solutions for the integration of data and services coming from multiple sources, their validation, quality control, certification and authentication. In the meantime, these data and services are subjected to ever more complex distribution and access policies. The concrete and gradual implementation of European spatial policies (INSPIRE, Copernicus) is also a real opportunity for our organization.

In this context, within EuroSDR, the recent adaptation of our strategy and commission structure (set up by our former President Martin Salzmann) is a real asset. More than ever, it is necessary to strengthen the network between NMCA's and universities by welcoming new members and by ensuring a well-balanced representation between NMCA's and universities within our association. However, the involvement of the industry must be promoted too. In many regards, the industry is a major actor in our field of activity and it has not been represented sufficiently within EuroSDR until now, whereas it is often not very convenient to develop a project without the industry's involvement. This will be a key issue for 2017.

The industry's involvement is indispensable, but the involvement of young researchers and professionals is equally important. EuroSDR has been very active in 2016 on this matter. Just look at the growing success of the EduServ programme.

All these challenges can only be met by further developing properly targeted research projects. Of course, these projects require financing. In that respect, the current co-funding experience of the project about the economic value of 3D-data (started in 2015) is very interesting. We will need to draw the necessary conclusions and see in the future how this experience can be repeated.

In 2016, EuroSDR delegates had the opportunity to participate in two very interesting and very informative Board of Delegates meetings (BOD) organized in France (Paris) and in Spain (Madrid). We would like to extend our warmest thanks to Bénédicte Bucher (Paris, France) and Antonio Arozarena (Madrid, Spain) and their team for all the work they have done to welcome us to these BOD meetings.

Research (and publications) and training activities, information and knowledge exchange via BOD meetings, workshops (organized by EuroSDR or in collaboration with other associations such as EuroGeographics, OGC, NMCA's, …) and projects: the meaning of all this, largely depends on EuroSDR being a well-known and recognized actor in the field of spatial information. Therefore, it is highly important to extend our visibility. Speaking of this, I wish to warmly congratulate all the persons who got actively involved in the organization and progress of EuroSDR activities during the 2016 ISPRS congress in Prague. These activities have been greatly appreciated by ISPRS officials. The new president of ISPRS Christian Heipke has already invited us to the next ISPRS congress in Nice in 2020.

The proper functioning of an association depends greatly on the work carried out by its members and delegates.

In 2016, we welcomed Greece as a new member, which is very good news. We also welcomed Javier Barrado (Spain), Claire Ellul (UK), Paul Kane (Ireland), Audrey Martin (Ireland) and Vassilios Vescoukis (Greece) as our new delegates as well as Tambet Tiits (Estonia) who joined the meetings as observer and potential new delegate. We would like to thank Klement Aringer (Germany) and Manual Borobio Sanchíz (Spain) for all their valuable contributions to our network association.

We are also fortunate to be able to count on the commitment of an excellent Executive Management Team: André Streilein (Vice-President), our Commission Chairs (Fabio Remondino, Jantien Stoter, Jon Arne Trollvik (replacing Norbert Pfeifer), Bénédicte Bucher (replacing Jon Arne Trollvik), Joep Crompvoets and Markéta Potůčková) and of an efficient secretariat (Joep Crompvoets (Secretary General) and Anneke Heylen, who has recently been replaced by Tatjana Van Huyck. A big thank you to all of you and especially to Norbert and Anneke for all the work done and all the hours devoted to the good functioning of EuroSDR during the last years. Finally, let me thank Martin Salzmann again for the extraordinary job he has done as President of EuroSDR from 2014 to 2016.

EuroSDR is a small association that does a lot of great things. We can all be proud of it!

Message from the Vice-President
André Streilein

This year was an intense and prosperous year for EuroSDR. The organisation became noticeable through many practical achievements in an increasing heterogeneous and complex research environment. The Rolling Research Plan 2015-2018 defines the framework within which EuroSDR research, development and education is executed. Its main purpose is to properly structure the work for the coming years, while leaving enough flexibility to be able to react to unforeseen developments.

The improvements initiated by EuroSDR are achieved by common tests, workshops, cooperation with partner organisations, and the exchange of experiences with other organisations. The main research activities of EuroSDR in this year dealt with are:

- rapid technical development (ict, sensors, processes, vgi, rpas, mobile devices, etc.),
- growing demand for up-to-date spatio-temporal, 3D, multi-scale data and services,
- increasing focus on data integration and quality issues, and
- historical data and processes.

Many projects have been finalized and new projects have been launched, often based on the open tackled questions from workshops or the Board of Delegates Meeting. Since autumn 2013, National Mapping Agencies are working together on 3D issues in the EuroSDR 3D Special Interest Group (3D SIG). This group defines and coordinates the long-term 3D research agenda of EuroSDR based on experiences and developments of both research institutes and NMAs in the area of 3D, carries out research projects on topics of common interest and organizes a workshop series on relevant topics. Currently the EuroSDR 3D SIG works on the definition of a common vocabulary for 3D mapping of large areas (regions or countries) aligned to INSPIRE and CityGML. And, it is currently running a crowd-funded project on the "Economic value of 3D geodata". There is also a joint EuroSDR/GSDI project which focuses on research about how coastal marine communities and NMCAs can work together more effectively where land meets the sea. The project "Crowdsourcing and National Mapping" is already running in its second phase. The use of crowdsourced geographic information by NMCA and the Geomatics Industry is a very current, challenging and topical subject. Today we see very rich potential for collaboration and integration of NMCAs, the Geomatics Industry and citizen-based crowdsourcing (such as OpenStreetMap, Ushahidi, Geonames, Galaxy Zoo, GeoWiki, Flickr, GeoWiki, etc). However, we have seen limited examples of where collaboration and integration has happened. Finally, the project "Exploring Sustainable Open Data Business Models for NMCAs" aims to answer the following research question: Is it possible to have sustainable funding and high quality open data in the context of NMCAs?

Many of the activities, exchange of ideas and opinions, generation of new ideas and projects are performed in workshops. It is typical for EuroSDR workshops that these take place as joint events together with other relevant scientific organizations. To mention just a few: "Nationwide generation of height data from Airborne laser scanning and other sources" on January 12th and 13th 2016 in Tønsberg, Norway. The aim was to share experiences and knowledge gained with nationwide generation of height data as well as to identify common challenges, to discuss possible solutions, and to identify fields of possible cooperation. The biennial workshop "EuroCOW 2016" (10 - 12 February 2016, Lausanne, Switzerland) which brings together the world experts, both from public and private sectors, presents and discusses the recent findings and developments on navigation/optical sensor calibration and orientation. With the recent development of autonomous platforms, this traditional field of photogrammetry and geodesy integrates with robotics, computer vision and system control. The workshop "Geodata on the Web" (10 - 11 February 2016, Amersfoort, The Netherlands), which

dealt with web location framework, unsolved issues and contributions from new technologies. The 2nd Workshop "Preparation for the Sentinel-2 in Europe" (11 - 12 October 2016 at the Norwegian Space Centre, Oslo).) strengthened the collaboration among European mapping agencies, institutes and companies involved in work to support national users of data from the fleet of Sentinel satellites, with special focus on Sentinel-2. And finally, the "Linked Data Seminar – Culture, Base Registries & Visualizations" on December 2nd 2016, Amsterdam, The Netherlands.

In terms of publications, there have been many scientific and state-of-the-art papers produced during the year. Amongst these, the two official publications of EuroSDR are notable: publication no. 65 "How should NMCAs adapt to alternative sources for NMCA data?" by Joep Crompvoets et al. and publication no. 66 "EuroSDR contributions to ISPRS Congress XXIII", 12 - 19 July 2016, Special Session 12 - EuroSDR, Prague, Czech Republic.

In terms of knowledge transfer, EuroSDR is continuously active in documenting the outcome of their research results and workshop results in their publication series. In addition, this knowledge is disseminated via the Educational Service EduServ. The 14th series of the Educational Service was running this year and consists of the following courses: "RPAS in land survey – theory and practice" by Görres Grenzdörffer (University of Rostock) and Michael Cramer (University of Stuttgart); "International standards for geographic information" by Wolfgang Kresse (University of Applied Sciences, Neubrandenburg); "3D City Modelling" by Jantien Stoter, Ravi Peters and Hugo Ledoux (Delft University of Technology); "Synthetic Aperture Radar for Mapping Applications" by Olaf Hellwich, (Technical University Berlin). The two-day pre-course seminar was hosted at the University of Warsaw, Faculty of Geography and Regional Studies on 7th and 8th March 2016. The seminar was attended by 24 participants. The e-learning courses were actively followed by 46 participants, which was one of the highest participation in the EduServ history.
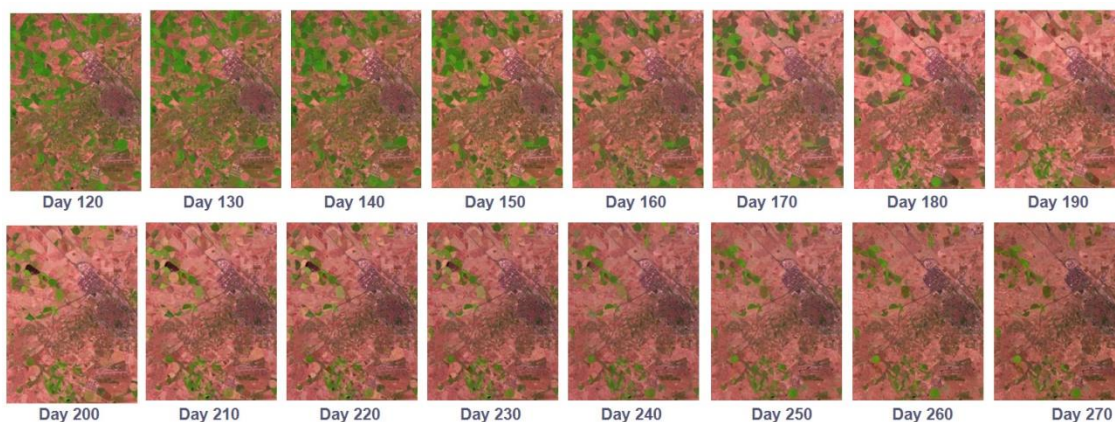
Interesting examples of real life practices at NMCAs based on results of existing applied research.

1. Spectro-Temporal Integration of remote sensing image time series (IGN, Spain)

More and more remote sensing satellites are being launched every year, carrying sensors with increasing spatial, temporal and spectral resolution. They are producing huge archives of data, but all this data is plagued by clouds, snow, and other effects, which makes it quite difficult to transform potential applications into operational programs. The objective of this work is to obtain multitemporal data from Landsat 8 and Sentinel 2 satellites, integrate all this data and generate cloud-free mosaics at any given date of interest and at a given spatial resolution by spectral and temporal interpolation. For this task, IGN Spain developed an integrated workflow that involves several processing techniques: multitemporal cloud screening, sensor inter-calibration, spectro-temporal interpolation, spatial downscaling/upscaling, etc.

This integration allows the development of higher-level products from cloud-free mosaics for different applications/services, such as change detection, land cover dynamics, and vegetation monitoring in agricultural areas.

Also, more and more demanding applications, some of them 'real time', such as precision agriculture support, will demand almost daily medium and high-resolution information about land surface. For these reasons, we will probably still need to combine different resolution sensors (SENTINEL-2, SENTINEL-3, Landsat 8, etc.).
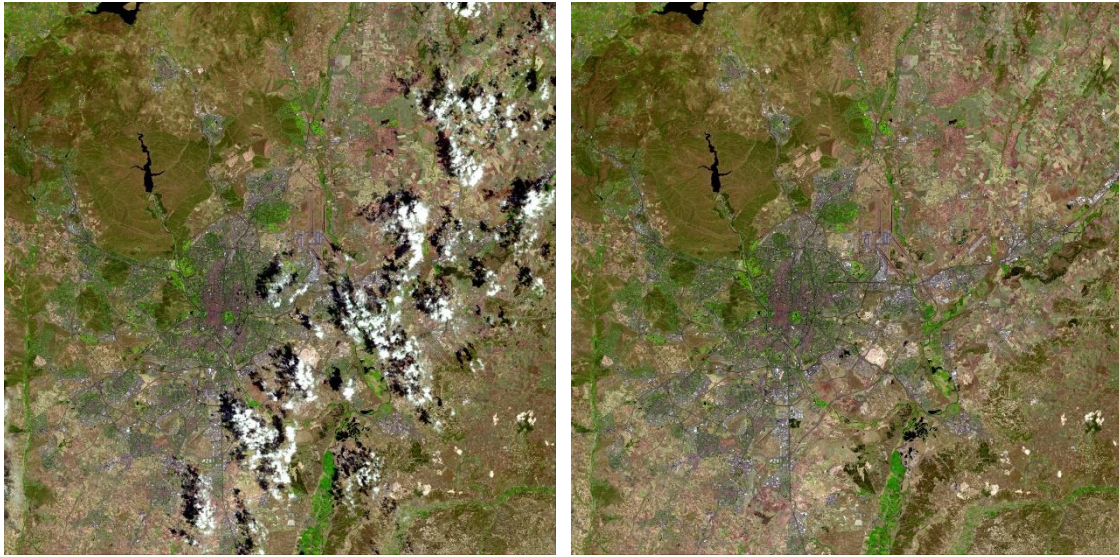

Fig.: Example of an image time series

Spectro-temporal integration could ease the development of algorithms and techniques capable to deal with this data, both for historical studies (with archived images of different satellites) and for present and future sensors, such as SENTINEL 2 and 3. The framework will foster real-time applications, and facilitate the integration of Copernicus data into the service chain of progressively added value.

Direct exploitation of the multi-resolution spectro-temporal information should allow a quick and easier development of applications with a good cost-benefit ratio, hence stimulating socio-economic activities about Copernicus data, with potentially high societal value.

We should also take into account that for important historical studies, such as climate change or deforestation monitoring, a large archive of images from different sensors is available. However, they are not directly comparable and, more importantly, many of them have never been used due to their

high percentage of cloudiness. With the proposed approach, the benefits obtained from all this information could be extended, by making it usable.

Fig. Example of a cloud-free mosaic generated by spectro-temporal integration from an image time series

2. From applied research in user centred methodologies, to operational activity
(Ordnance Survey, GB - Jenny Harding, Lucy Diamond)

Introduction
Research at Ordnance Survey (GB) spans an ever evolving technological environment with a principal aim to develop new opportunities for geospatial data and services, or improved efficiencies in the near to long term. Working at different stages of technology readiness, the research can range from theoretical concepts to early prototypes, with discussion and transfer of knowledge to operational parts of the business a core objective throughout. This article focuses on the development and application of user-centred research and approaches within Ordnance Survey, a vital area of capability to inform data content design and development.

Motivations for user research
Dedicated attention to what value user-centred design and usability approaches could deliver to data-focused research and development began within the OS Research group around 12 years ago. It was recognized that in order to inform research on future content development and enhancement (e.g. for 3D and spatio-temporal modelling), good understanding of user needs and the factors which influence data usability in diverse user contexts is essential. Existing sources of user knowledge, including market research and the internal knowledge of customer facing staff was valuable but tended to be market focused and to not capture sufficient depth of information concerning specific use. A different approach was needed that could develop the real-world knowledge base required to inform data research and development from the perspective of user needs and usability considerations.

From applied research in user centred methodologies to knowledge transfer
Relatively little existing research elsewhere focused on the design and usability of information products, in contrast to physical products and computer interfaces. However, drawing on user-centred design methodologies, an approach based on semi-structured interviews with people working on geographical problems on a day-to-day basis (e.g. in responding to emergencies; developing new urban design proposals) was developed. The interview structure was designed to capture, in a one hour session, the level of detail required for modelling and generating usable and desirable data items together with contextual information about the user's task and environment. From over 50 interviews a reference base of qualitative data on user needs for information about real world objects with respect to context of use was built and has served to inform the business about usability enhancements (Harding 2013), content specific queries as well as 3D modelling research.

Recognising the interdisciplinary nature of this applied research field, a series of workshops were initiated in 2009 with UK university contacts to develop links and share research practices between human factors, GISciences, computer science (e.g. Brown et al. 2013a). External collaboration through a Knowledge Transfer Partnership with the Human Factors Group, University of Nottingham, focused on adaptation of further user-centric methods for application in geospatial product design and the transfer of principles to product development areas (Brown et al. 2013b). Cognitive Walkthrough and Expert Review Methods were productively applied by researchers working with product management in evaluation of the, then new, OS VectorMap District product for example.

In another instance, working with the Office for National Statistics, an adapted Context of Use interview technique was used by researchers working with data users and product developers to inform a new approach to producing built-up areas data (Harding et al. 2013).

Fig. Extract of automatically generated built area extents

Attention to data usability and applied user-focused methods have also been built into some of the PhDs that OS supports. Two recently completed PhDs, one concerning usability of products in analytical contexts and the other concerned with ethnographic insight into user activities and information use, were followed by a period of time spent within Ordnance Survey specifically to transfer findings to parts of the business where they can be actionable.

User centred approaches in operational activity

Transitioning research into the more operational business environment requires conditions to be right (not least process, strategy, mindsets) for adopting new practices. New senior appointments to Ordnance Survey saw the establishment by 2016 of a user experience (UX) team who were instrumental in raising awareness throughout the business of the benefits of taking a user-centric approach in, for example, mobile application development. Product development teams were also keen to ensure that product design embraced these approaches in order to make data offerings more relevant and commercially viable. To this end, a team was mobilised to update and enhance the research approach based on semi-structured interviews developed years earlier, and to establish User Centred Design as the default method of product design in the organisation. A Discovery capability has been built, backed up by a Rapid Prototyping capability enabling user needs to be defined and the technical feasibility of potential solutions to be tested before committing resources to take an opportunity through the existing propositions, design, development and build processes.

Brown, M, Sharples, S, Harding, J, Parker, C, Bearman, N, Maguire, M, Forrest, D, Haklay, M, Jackson, M, (2013a) Usability of Geographic Information; Current Challenges and Future Directions. *Applied Ergonomics*, 44(6), pp 855-865.

Brown, M., Sharples, S. and Harding, J., (2013b). Introducing PEGI: a usability process for the practical evaluation of geographic information. *International Journal of Human-Computer Studies*. 71(6), 668-678

Harding, J. (2013). Usability of geographic information – factors identified from qualitative analysis of task-focused user interviews. *Applied Ergonomics*, 44(6), pp. 940-947

Harding, J., South, B., Freeman, M., Zhou, S., Babbington, A. (2013) Identifying Built-up Areas for 2011 Census Outputs. In *Proceedings of the 26th International Cartographic Conference*, Dresden.

3. Land cover classification from Copernicus data at the BKG
(Federal Agency for Carthography and Geodesy (BKG), Germany - Dr. Gopika Suresh, Dr. Michael Hovenbitzer)

Data regarding land cover and land use is vital for physical planning, updating land statistics and for quantifying information regarding vegetation foliage and biomass. While field surveys are time consuming and expensive, remote sensing techniques offer an efficient and fast alternative. Sentinel-1a, launched in 2014, was the first satellite launched within the Copernicus program, while its pair Sentinel-1b was launched in 2015. Together, these two satellites provide a complete coverage of Germany within a period of 5-6 days. Each satellite has a repeat cycle of 12 days. Equipped with a C-band (5.6 cm) Synthetic Aperture Radar (SAR), these two satellites provide weather independent images of the earth, taken both during the day and at night, which can be used for extracting land cover information. SAR backscatter from the land surface depends on factors like soil and vegetation characteristics like vegetation type, vegetation height/growth, soil moisture content and tree heights as well as sensor properties such as the wavelength used, polarization of the signal, incidence angles and orbit of acquisition. SAR images can thus be used for classifying land cover types of the imaged area. Since SAR backscatter also contains information regarding both amplitude and phase of the return signal, this can be exploited to extract further information regarding the scattering properties from objects within the target scene.

Within this framework, the Federal Agency for Cartography and Geodesy (BKG) located in Frankfurt, Germany, has a project that aims to conduct automatic land cover classification from Sentinel-1 images (Wiatr et al., 2015). The main aim of this project is to support the updating of the LBM-DE (Landbedeckungsmodell-Deutschland) when optical images are not available. A preliminary classification scheme (SAR-LC) was tested in Suresh et al. (2016) which was able to successfully classify 4 land cover classes (urban, forest, open land and water) from Sentinel-1 images with a classification accuracy of 70%. The classification results of the SAR-LC were compared to the LBM-DE from the year 2012 to estimate its efficiency. More recently, the SAR-LC was further updated to extract six land cover classes from SAR images, mainly urban, agricultural land, green fields, forest, mixed vegetation and water. A time series analysis of Sentinel-1 images and the resulting land cover classification results for the year 2016 was conducted to see the variation in the land cover over the year, and maximum variation was seen in agricultural land. Land cover classification using a fusion between Sentinel-1 and Sentinel-2 images was also conducted which resulted in an increased classification accuracy of 85%. The possibility of land cover classification from a multi-temporal stack of polarimetric SAR decompositions using PolSAR techniques was also tested.
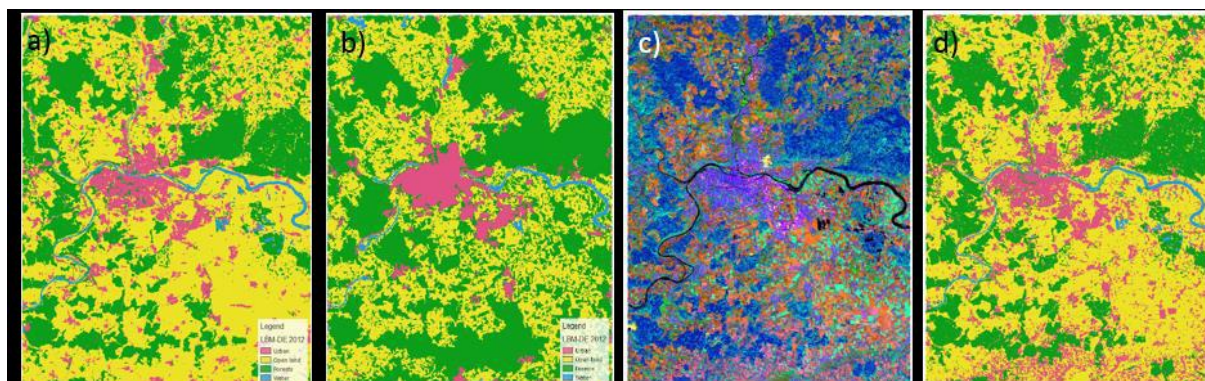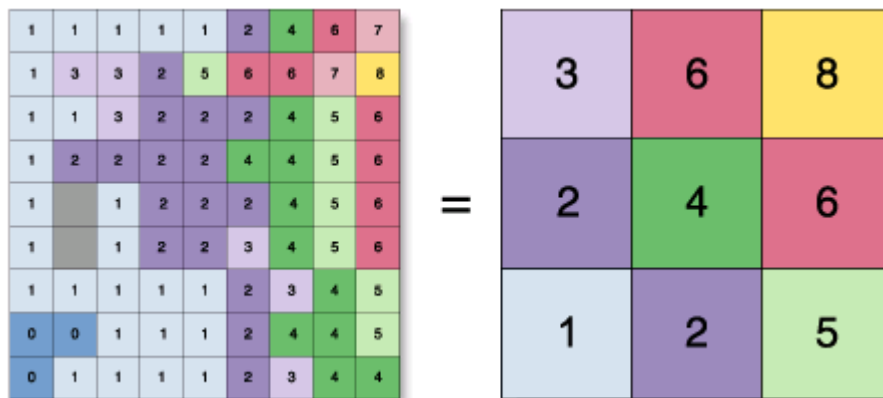

Fig. 1 a) LBM-DE2012 b) Land cover classification from Sentinel-1a images c) Fusion image between Sentinel-1 and Sentinel-2 and d) Land cover classification from the fusion image

Suresh, G., Gehrke, R., Wiatr, T., Hovenbitzer, M., 2016. Synthetic Aperture Radar (SAR) based classifiers for land applications in Germany, in: Proceedings of ISPRS'16. Prague.
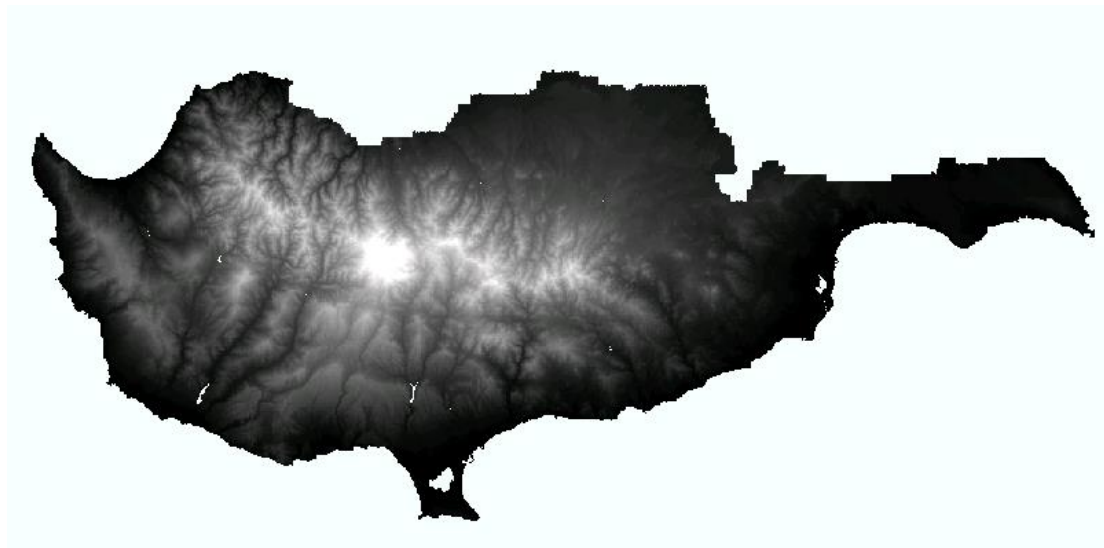
Wiatr, T., Suresh, G., Gehrke, R., Hovenbitzer, M., 2016. Copernicus- practice of daily life in a national mapping agency?, in: ISPRS Congress Archives. Prague.

4. Parcel mean slope and orientation calculation using high resolution elevation data (Geoset Ltd Company, Cyprus)

1. DLS procured a very high resolution DTM of 1X1 meters grouped in map tiles.

2. The mean slope, and the direction of the maximum slope of the surface within a parcel of SDB and DCDB parcel databases have been calculated using a generalized 5X5 meters surface model (**CY5X5.tif**) which has been developed from the **raster1X1tif.**

3. The generalized CY5X5.tif has been created with the following steps:

    a. Loop to aggregate each 1X1dtm tile to 5X5 cell. The result 5X5 meters cell is the **median** of the heights of the aggregated 1X1 input cells

    b. Mosaic the 5X5 meter tiles to a unique CY5X5.tif DTM

4. Create 4 meter interval contours (contours5X5_4m.gdb) from the CY5X5.tif in order to facilitate Quality Check of the final results.

5. Produce the hillshade **hillshade_gcy5X5.tif** from **CY5X5.tif** to facilitate Quality Control of the results.

6. Create a TIN model for each tile of 5X5 pixel DTM (RasterTin). An **overlap of 6 meters** around each tile has been applied in order to avoid gaps between neighbor tiles.

Each Tin model is a generalized approximation of the 5X5 cell size DTM tile. This generalization implied by allowing **the maximum tolerance of the elevation difference between a Tin point and the respect pixel to be less or equal 5 meters**.

Overlap detail:

7. Each Tin converted to polygon feature class (tintriangle) with percent for slope, and clipped to the boundaries of the tile index polygon.

8. The individual Tin FCs appended to **FC tinFCall** in the **FGDP aspectsandslopes.gdb.**

9. The FCs of SDB and DCDB parcel polygons intersected with the **FC tinFCall** and produced, **FGDP aspectsandslopes.gdb**:

   a. The FC sdb_tinFCall for the SDB parcels

   b. The FC dcdb_tinFCall for the DCDB parcels

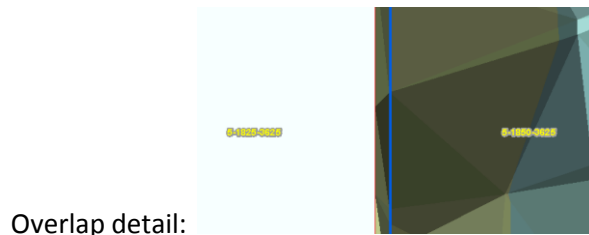10. The attributes items **wslope** (double) and **waspect**(double) to each table, in order to calculate the weight mean for each parcel:

   a. **Wslope** contains the product: slope (percent) of each triangle part contained in the parcel X the area of the triangle

   b. **Waspect** contains the the product: aspect (percent) of each triangle part contained in the parcel X the area of the triangle

11. The summary (group by) tables produced, in the **FGDP aspectsandslopes.gdb,** from the above intersections:

a. The table **sum_dcdb_tinFCall** for DCDB parcels and

b. The table **sum_sdb_tinFCall** for SDB parcels

For both tables, the PARCELOID item used as group by item and calculated the values Maximum, Minimum, Average, Sum, StdDev and Variance for the wslope, waspect and shape_area respectively.

12. The Parcel_Slope and Parcel_Slope_Direction fields of SDB and DCDB parcels, using PARCELOID as join item, are calculated as below:

a. **Parcel_Slope = sum_wslope / sum_shape_area**

b. **Parcel_Slope_Direction = sum_waspect / sum_shape_area**

5. The ongoing development and constant updating of the high resolution DTM and DSM based on ALS technology (GUGIK, Poland)

The Polish National Mapping and Cadastral Authority (GUGiK) carries out many activities with the aim of building a reference database for the entire country, basing on the experiences of other EuroSDR members and on results of the projects and studies carried out by the Association. One of the main tasks, carried out continuously, is the ongoing development and constant updating of the high resolution DTM (1m GRID) and DSM (1m GRID outside the cities, 0.5m GRID in the cities) based on ALS technology. This product is based on ALS point cloud of 12 points per square meter density in cities and 4 points per square meter outside the cities. At present, these products are prepared for an area of 289 000 square kilometers, and completing the entire country coverage (area of 312 000 square kilometers) is planned by the end of 2017. At the same time GUGiK conducts an update of the ALS data and resulting DTM and DSM, for urban areas (14 500 square kilometers) with the highest dynamics of changes. These data is the most frequently used product of the National Geodetic and Cartographic Resource, and its use is growing rapidly from year to year. It is a source dataset required in development of wide range of other products of the Resource like f.e.: orthoimagery as well a key material for the development of strategic products for the security of the country, including the process of developing flood hazard maps and flood risk maps.

Fig. 1 Scrap of flood hazard maps (source: www.isok.gov.pl)

Following the needs of users and trends in the development of spatial databases observed in Europe, GUGiK has undertaken steps allowing the production of 3D building models for the whole country. Participation in SIG3D is in this context crucial for the exchange of good practice and learning from the experience of other European countries, especially in elaboration of 3D buildings models, in order to secure high utilization, timeliness and usability of this product in Poland. Basing on the experiences gathered by other European countries, GUGiK decided to develop 3D buildings models based on the central topographic database and ALS data. Moreover, in order to maintain timeliness of developed data, GUGiK is taking steps to prepare the process of updating the data at the central

level using IT tools. In order to ensure the effective use of these data sets by stakeholders, it is planned to introduce a set of automatic update mechanisms guaranteeing high quality and timeliness of data. In accordance to the current schedule, these works will be completed by the end of 2018.

Substantive support of professionals from other Member States, the possibility of close cooperation with the national experts from EU countries and world class scientists, the opportunity to participate in research projects, access to expertise, EuroSDR studies and strategic documents prepared in the framework of the Association allow GUGiK to build a high quality reference database designed to serve the needs and requirements of its users.

6. The National Elevation Model of Norway (Norwegian Mapping Authority, Norway)

The Norwegian Mapping Authority (NMA) started in 2016 a mapping program which aim is to generate a new detailed elevation model based on LiDAR and image matching. The Ministry of Local Government and Modernization together with 7 other national government bodies sponsor the project. The goal is to have a complete new set of national elevation and surface models at various detail levels by 2020. All elevation datasets, both raw point clouds and derived grid products collected in the program, are open data and are freely available to everyone to use and republish.

Terratec AS in Oslo was awarded the LiDAR acquisition in the project after a two stage tendering process. Terratec AS commenced the work on the project during the summer months of 2016 and will utilize Blom Geomatics AS and COWI AS as subcontractors on both data acquisition and processing. A total of 229 000 km^2 are to be covered by minimum 2p/m^2 LiDAR, and so far 48 363 km^2 has been scanned, processed and delivered by Terratec. The 2016 delivery consists of 57 blocks, and 6 sensors has been utilized in the project: Two Leica ALS70, two Leica ALS80, one Optech Titan and one Riegl Q-1560. The Riegl Q-1560 has proven to be the most efficient sensor for the 2p/m^2 requirements.

Fig. Status data acquisition 2016

In areas with high mountain plateaus, the elevation model will be generated using photogrammetric image matching using existing large coverage aerial surveys. The total area is approximately 39 000km^2 and will be tendered separately from the LiDAR contract during 2017.

Terratec deliver to NMA for quality control in a two-stage process: QC1 is carried out on an auto classified dataset and is designed to identify operational issues such as sensor calibration, strip adjustment, point density and coverage. After the dataset passes QC1 the contractor will carry out further work on the classification, resulting in a final delivery of the point cloud. 1m elevation contours are also generated and delivered to the NMA.

In order to distribute the elevation datasets, NMA published in 2015 a request for tender to build a new data management system for elevation data. The project was awarded to Geodata AS who has built the system using an ESRI based platform. The aim of this data management system is to hold all raw and derived elevation data and to distribute this via download, webpage and web map services.

The system consists of a data management module and a data access module. In the data management module, the contractor himself uploads the point cloud and metadata and the system then carries out a set of logical tests before the dataset is flagged for external QC. Once passed the external QC the system generates high resolution DTM and DOM grids and publishes these as web map services. These grids are then generalized to 1, 10 and 50m before being added to the seamless national models. In the data access module, the datasets can be visualized using a variety of web map services such as height, hillshade, multihillshade, inclination, local height, skyview, point density ground and point density all points. These layers can also be viewed in via the portal https://hoydedata.no. In addition, a 3D viewer makes it possible to look at and manipulate the point cloud for each project. All export of both raw point cloud and grid models are handled by in the portal.

Fig. Screen capture from the web portal showing Digital Surface Model of 2p/m2 data (Skjervøy, Troms)

The data management module has successfully been used during the 2016 survey campaign and Terratec and partners have all delivered directly to the system. The data access module is in its final stage of development. It has been running as a public beta since mid-summer 2016 and has served 3041 file exports per February 2017. Older LiDAR projects are also handled and distributed by the data management system and the total number of accessible projects is 466 and counting.

A new ultra-light and high resolution digital camera for photogrammetry
   (Université Paris Est, LASTIG-LOEMI, IGN, France - Jean-Philippe Souchon (jean-
   philippe.souchon@ign.fr), Christophe Meynard (christophe.meynard@ign.fr))

Five years ago, IGN France launched a research program aiming at designing a relatively low cost ultra-light high resolution photogrammetric camera. This was motivated firstly by the limitations of off the shelf digital cameras for high resolution survey, due to closed systems and some automatic features like auto-focus or variable aperture which can be disengaged on expensive systems only. Secondly, this was motivated by the expertness already acquired by IGN France in this domain since back in the 90ies IGN France had designed in its laboratory LOEMI the first civil photogrammetric airborn digital cameras at a time where no such camera existed for civil applications. These cameras are still used for IGN production lines and present some unique features for photogrammetric acquisition by night.

Experimental surveys using several off-the-shelf digital cameras led LOEMI researchers to list following requirements: a sensor with a large number of pixels available in a black and white version, a continuous frame rate of about five images per second, a global shutter, a low weight of about 300 grams for the camera and its interchangeable lens, a completely autonomous camera regarding the data storage and optionally regarding the energy, an interface with sensors to measure the angular attitude and the position of the camera for each acquired image, an interface with a computing and image processing power upstream of data storage. Last, a synchronization interface of high precision is required so that the camera can be an elementary part of larger systems. Based on these requirements, the LOEMI laboratory of IGN France selected the optimal sensor (CMOSIS CMV20000 CMOS sensor of 20 megapixels) and central processing unit (ZYNQ-7030). The cost of the whole components for a research prototype (cf figure 1), such as manufactured in a very small number at LOEMI, is approximately 5000€.

Fig 1a. The prototype   Fig 1b. Generation of a composite image out of 10 images

In 2014, the prototype camera was operational. The sensor can acquire up to 30img/sec with a millimetric ground sample distance at a flight altitude 30m on a UAV. Since 2015, a first prototype is currently industrialized with a French UAVs manufacturer, Delair-Tech, which is developing a specific fork dedicated to their needs.

Besides, research is going on ; *LOEMI Ultralightcam* project is now designed as an open platform that presents APIs at different levels. This makes it possible for several PhD students, funded by different thematic research projects, to work on the system. This also makes it possible for researchers from adjacent domain –image processing and photogrammetry- to interconnect with the platform. Current research target for instance : the generation of composite images with radiometric information of several images with short exposure times and therefore no motion blur (cf figure 1b) in order to store the most informative data out of all the sensor data, the improvement of the camera and of the embedded image processing to reach near real time smart camera functionalities, the combination with GNSS devices for metrological survey requirements, the metrological survey of complex indoor environments where GNSS is not available. The LOEMI is now seeking for scientific partners to collaborate thanks to this open research platform.

8. iTowns : an open source project connected to a research platform for continuous innovation (Université Paris Est, LASTIG-MATIS, IGN, France - Alexandre Devaux (alexandre.devaux@ign.fr))

Back in 2008, IGN-France started research on an immersive visualisation framework to address the requirements of high resolution 3D urban database production based on new sensors and usage. Existing solutions like Google Earth ® neither did offer to IGN enough level of interaction with the data as required for production (access to any 3D information and metadata) nor could support precise measuring within the images. Besides, they did not offer enough interfaces to add new functionalities in the code.

Fig. Visualisation of different categories of data in iTowns framework

Originally created for the visualisation of panoramic imagery and classification results, the iTowns software produced by an initial project funded by the French national research agency (ANR) later evolved toward a generic geographic visualisation and interaction tool. It can also render data taken on personal devices or from other databases. An important effort has been given to create an application that handles many different scales: from 10 points/cm2 street level lidar data density to world scale digital terrain model. Another important feature is the dynamic aspect of the application that gives the possibility to manipulate time and compare data not only spatially but on a time basis too.

In 2014, the decision was made to release some of the resulting software as open source and a specific organisation was settled to facilitate the open source project life cycle, the on-going research and the fast integration of research result into the open source project. This was made possible thanks to a collaboration between IGN and an industrial partner, Oslandia, who participate in the development of the software. http://www.itowns-project.org/

Report by Secretary-General
Joep Crompvoets

2016, the year that Tatjana van Huyck took over the numerous secretarial tasks of Anneke Heylen. This report reviews the annual Board of Delegates meetings happening in the framework of EuroSDR in 2016, the activities related to our partner associations, and some logistics.

Meetings

The 128th EuroSDR Board of Delegates meetings took place in Paris (France) from 25 until 27 May 2016. These meetings were hosted by the National Geographic Institute France – the French National Mapping Authority (with Bénédicte Bucher as the key host person) and were participated by 40 persons from 19 countries joined the events. These meetings started with an overview of excellent examples of GI research, education and professional activities in France. The highlights of the meeting were the two keynote presentations: 1) "The latest standardization developments at OGC" by Bart De Lathouwer (OGC – Open Geospatial Consortium) and 2) "EuroGeographic INSPIRE Knowledge Exchange Network (KEN) and beyond" by Dominique Laurent. The keynote of Bart De Lathouwer was about the latest standardization development at the Open Geospatial Consortium (OGC). In his keynote Bart De Lathouwer tried to answer the main question: 'What is 'hot' at the OGC at the moment'? The 'hot' topics referred to Linked Data, API's, and (missing) Geo-BIM link. The keynote presentation of Dominique Laurent was about the organization, activities, and key research questions of the INSPIRE EuroGeographics KEN as well as the potential links with EuroSDR. An important decision was the appointment of Bénédicte Bucher as the new chair of Commission 4 'Information Usage'. At the end of the BoD 128 meeting, the handover of the presidency took place. On behalf of The Netherlands, Martin Salzmann (Kadaster) served as president of EuroSDR from BoD 125 (Leuven) until the end of BoD 128. Eric Bayers (National Geographic Institute) took over the presidency on behalf of Belgium. EuroSDR is very grateful to Martin Salzmann for all that he has done for the EuroSDR network. All his constructive contributions were enormously appreciated. EuroSDR wishes Eric Bayers all the best for his 2-year presidency term. The French host organised an interesting guided tour in the historical heart of Paris. The excursion was informative – full of content about the rich history of Paris. What a beautiful city!

Fig. Group photo at the 128th Board of Delegates meeting, Paris, France (26 May 2016)

Fig. Impression of the 128 Board of Delegates meeting in Paris, France

Fig. Presentation of the French host Bénédicte Bucher

Fig. Presidency handover shake

The 129th EuroSDR Board of Delegates meetings took place at the headquarters of the National Geographic Institute of Spain and the Royal Observatory from 19 until 21 October 2016. Both venues are located in the wonderful city Madrid (Spain). The key topic of these EuroSDR meetings was 'Geospatial Reference Data as the first step for efficient geospatial information management'. These meetings were hosted by the National Geographic Institute of Spain (with Antonio Arozarena as the key host person). The meetings were attended by 41 persons from 21 countries. The meetings started with an overview of relevant innovations in the domain of Geographical Information achieved by the National Geographic Institute Spain, academia, and industry in Spain with emphasis on Copernicus in-situ data. The highlights of the meeting were the keynote presentation 'Copernicus Reference Data' given by Nuria Valcárel (National Geographic Institute Spain) and the presentation of one of the two winners of EuroSDR Award 2016 (Borja Rodríguez Cuenca, University of Alcalá, Spain) entitled: 'Detection, classification and post-classification of urban features from multispectral images and mobile lidar point clouds'. The topic of the breakout session was 'data archiving'. Other highlights were the presentations from two potential members: Greece (Vassilios Vescoukis, National Cadastre and Mapping Agency) and Estonia (Tambet Tiits, Estonian Land Board). At the end of the meetings,

the third and last term of Nobert Pfeifer (Vienna University of Technology) as chair of Commission 3 finished. Jon Arne Trollvik (Statens Kartverket) will take over this commission chair. As decided during the 128th Board of Delegates meeting, Bénédicte Bucher (National Geographic Institute France) will replace Jon Arne Trollvik as chair of Commission 4. EuroSDR would like to thank Norbert for his numerous contributions to EuroSDR. It was also the last meeting for Klement Aringer (Bavarian Agency for Digitizing, Broadband and Surveying) as the representative of the German mapping agencies at state level. His contributions were also enormously appreciated. Last but not least, this was also the last Board of Delegates meeting for Anneke Heylen as assistant of the Secretary-General. She brought colour to our network organisation. EuroSDR is very grateful to Anneke for all that she has done for the association. The host organised several exciting social events: a delicious cocktail at National Geographic Institute Spain, a guided tour at the Royal Observatory, and a tour and gorgeous dinner at the Cybele Palacio (Palacio Cibeles). In addition, delicious lunches were served. EuroSDR is grateful to National Geographic Institute for organising this special meeting.

Fig. Group photo at the 129th Board of Delegates meeting in Madrid, Spain

Fig. Some impressions

In preparation for these two Board of Delegates meetings, the Executive Team met at the University of Warsaw (7-8 March 2016, Warsaw, Poland) and Ordnance Survey Ireland (29-30 August 2016, Dublin, Ireland).

Partnerships

In 2016, EuroSDR continued collaborating with its key partner associations (e.g. Open Geospatial Consortium (OGC), International Society for Photogrammetry and Remote Sensing (ISPRS), EuroGeographics, CLGE, EuroGI and UN-GGIM.

Some examples indicating our successful collaborations with our partner associations are the following:

- Keynote of Bart De Lathouwer (OGC) about the latest OGC-standardization developments at the 128 Board of Delegates meetings in Paris.
- Organisation of two sessions at the ISPRS Conference (Prague, July 2016): Innovative technologies and methodologies for NMCAs (13 July 2016) , and UN-GGIM NMCA Forum highlighting the (research) activities happening at NMCAs (14-15 July 2016).
- Co-organisation of EuroSDR/JRC/EuroGeographics INSPIRE KEN workshop on INSPIRE validation workshop in Marne-la-Vallée, France (2-3 June 2016).
- Presentation 'Addressing Europe's spatial data research requirements' given by André Streilein as Vice-President Research at the General Assembly of EuroGeographics in Budapest (Hungary, 4 October 2016).
- Co-organisation of a CLGE/FIG Marine Cadastre seminar (Tirana, Albania, 17 March 2016).
- Presentation of a keynote at the Common Vision Conference with the title 'Migration to a Smart World'. This joint CLGE, ELRA, EuroGeographics, EULIS, PCC Conference took place in Amsterdam (The Netherlands) from 5 until 7 June 2016.
- Attendance to EuroGI-Workshop on policy position papers (Brussels, 29 January 2016)
- Attendance to the third meeting of United Nation initiative on Global Geospatial Information Management Europe (UN-GGIM Europe) in Budapest, Hungary (5 October 2016).

Logistics

Regarding the associated logistics, the Secretariat was among others strongly involved in preparing the meetings, processing the meetings' minutes, decisions and actions, registering for EuroSDR events (e.g. workshops, EduServ), editing the annual report, financial accounting, auditing, sending e-newsletters, managing websites, etc.

On behalf of the Secretariat, I would like to express that we really look forward to continue cooperating with our members, Commission Chairs, President, Vice-President, representatives of our partner associations and those that are simply interested in the activities of EuroSDR in the (near) future.

Commission II: Modelling and Processing
Jantien Stoter

In recent years, our living environment is increasingly modelled in 3D to be able to better understand our environment and to better predict the impact of interventions. Therefore National Mapping Agencies (NMAs) are seriously considering how to meet this demand of 3D modelling and processing.

Since autumn 2013 the NMAs of EuroSDR are participating in the EuroSDR 3D Special Interest Group (3D SIG) to collaborate on this topic. The aim of this group is to define and coordinate the long-term 3D research agenda of EuroSDR based on experiences and developments of research institutes and NMAs in the domain of 3D, to carry out research projects on topics of common interest and to organise a workshop series on relevant topics.

Since the start, the EuroSDR 3D SIG members meet 2 or 3 times a year and over these years we have observed significant 3D developments within the NMAs. While some NMAs are still in the initial (experimental) phase of 3D mapping, others have already built solid databases to maintain 2.5D and 3D topographic data covering their whole country.

In 2016 the EuroSDR 3D SIG published a paper on the state-of-the-art of 3D national mapping in 2016[1], which updates a similar paper of 2014.

In 2016, also the OGC CityGML Quality Interoperability Experiment finished, of which EuroSDR 3D SIG was one of the initiators. CityGML is the OGC standard for modelling 3D cities and landscapes. The aim of the experiment was to define data quality requirements for a general CityGML data specification, to create recommended implementation guidance for CityGML data, and to provide a suite of tools to carry out quality assurance on CityGML data. In 2016, the OGC has published the results of this experiment as a public Engineering Report[2].

Another activity of the EuroSDR 3D SIG in 2016, is the project to identify the economic value of 3D data for NMAs. The project (carried out in collaboration with Commission 5) has a new funding approach: it was funded through co-funding by 11 NMAs and EuroSDR as 12th partner. A more detailed project report can be found below.

The project appeared to be very successful: it explores a new way of EuroSDR research (via joint-funding) with valuable contributions of the participating NMAs. Therefore, other projects are being considered by the EuroSDR 3D SIG to be carried out with a similar approach.

Commission 2 is not only active in the domain of 3D, but also in the domain of automated generalisation. In 2016, the commission published a paper on the state-of-the-art of automated generalisation within NMAs in 2016[3], which is a summary of the outcomes of the EuroSDR workshop organised in December 2015 on this topic. The workshop was attended by more than 60 people from 18 NMAs.

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[1] Jantien Stoter, Bruno Vallet, Thomas Lithen, Maria Pla, Piotr Wozniak, Tobias Kellenberger, Andre Streilein, Risto Ilves, and Hugo Ledoux, State-of-the-art of 3D national mapping in 2016 , Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLI-B4, 653-660, 2016.

[2] https://portal.opengeospatial.org/files/?artifact_id=68821

[3] Automated generalisation within NMAs in 2016. Jantien Stoter , Vincent van Altena , Marc Post , Dirk Burghardt , and Cecile Duchêne. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLI-B4, 647-652, 2016*, Prague, 2016.

Project: Assessing the Economic Value of 3D geo-information
Andrew Coote (ConsultingWhere), Joep Crompvoets (Commission Chair 5), Jantien Stoter (Commission Chair2)

The aim of this project, undertaken as a collaboration between Commission 2 and 5, is to give the participating NMAs understanding in the business case of 3D data: "In what applications does a 3D approach give added value?"; "What are the required 3D data for these applications?"; and, "What are the costs and benefits to collect and maintain these 3D data nationwide?"

The project is timely as transforming their data to be 3D geo-information represents a good opportunity for National Mapping Agencies (NMAs) to re-position their products and services to advantage during a period of rapid and radical change in the expectations of the public and private sector user base. Furthermore, the economic focus of the study will inform the resultant changes required to their business models.

Approach
The funds raised were used to commission an international consultancy organisation specialising in geo-economics, ConsultingWhere, to work with the NMAs to deliver the project's objectives. The project has been undertaken in three stages.

Stage 1: Select Use Cases
The scope of the assignment (everything more than 2D) is potentially very wide. It was therefore agreed to select six user cases for initial assessment. A long list of use cases was discussed at a workshop of stakeholders in Brussels (March 2016) and the following selected:
- Forestry management
- Flood Management
- 3D Cadastre and Valuation
- Resilience (civil contingency)
- Asset management
- Urban Planning

Stage 2: Value chain mapping
The use of geo-information is now so widespread and disseminated through so many intermediaries, that the adding of value is no longer restricted to a relatively few suppliers and business partners. Value-chain analysis is a well-established technique for tracing and visualizing this complex process. Value-chain workshops hosted by NMAs, with public and commercial sector representatives, were held at six different locations across Europe during June and July 2016.

Stage 3: Cost-benefit Analysis
From analysis of the results of the stage 2 workshops, two use cases, flood management and urban planning, were selected for further study using cost-benefit analysis. Cost-benefit analysis is a technique for expressing quantitatively the benefits of a particular investment, in this case, high resolution Digital Terrain Models (DTMs) and where appropriate 3D City Models. In essence, it facilitates estimation of Return on Investment (RoI) which can be expressed as "for each €1 invested, the return is €x".
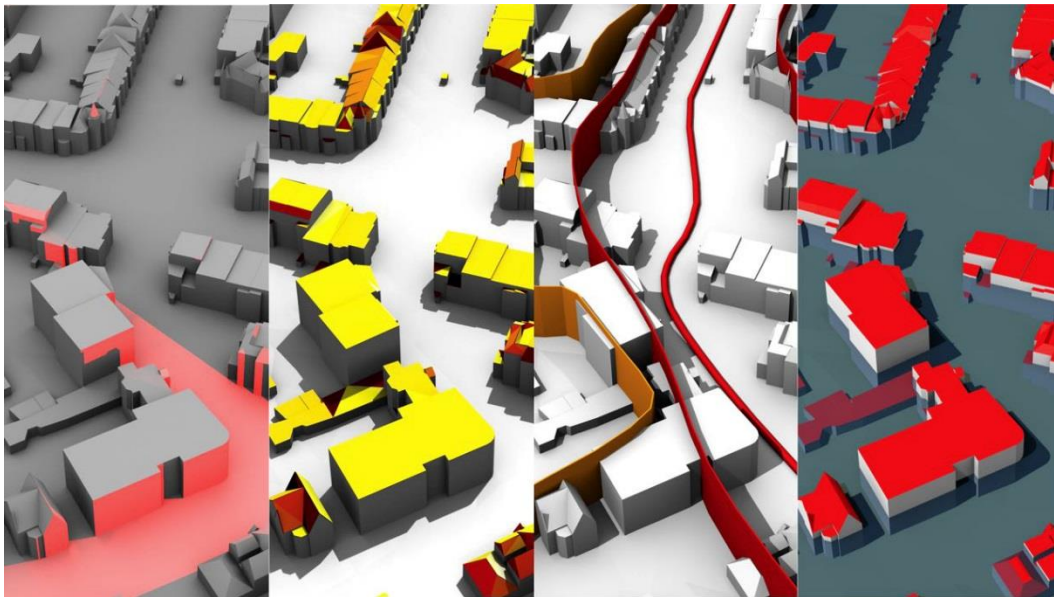
Cost-benefit analysis (CBA) attempts to collate the costs and the quantifiable benefits, adjusted for the time value of money, i.e. returns achieved at some future date are discounted to take into account the opportunity cost of having made an alternative investment. Qualitative benefits identified in the value chain analysis, that may be politically or socially significant, are also reported.

Initial results and conclusions

The provisional results of the project were reported to a workshop of the sponsors in February 2017. These indicate that there is a significant positive return on Investment from 3D geo-information even when considering only the two use cases in isolation. In reality the geo-information will add value to a number of use cases and whilst the costs of satisfying other use cases are will increase incrementally, the benefits of such re-use are additive, meaning that the case for investment becomes stronger as each additional application is implemented.

Next steps

On the basis of the feedback and discussion the results are being refined and subjected to peer review by an external economist with considerable expertise in this field. The final part of the project will be knowledge transfer which will be achieved through a workshop held over two days in Barcelona from 30 to 31 March. Subsequently a written report will be published by EuroSDR.

Fig. 3D image

Fig. Project group

Commission III: Updating and Integration
Jon Arne Trollvik

"We must move from Mapping to Monitoring!" This was a statement in the workshop on Sentinel-2 data last November. The trends within maintenance and updating of geospatial information are that we move to several ways for updating. LiDAR, crowd-sourcing, drones, satellite imagery and terrestrial systems are used to monitor and detect changes. That is one focus of Commission 3, in addition to data integration, archiving and historical data.

Two workshops, "Updating of national databases from LiDAR data" and "2nd workshop on Preparations for Sentinel-2 data in Europe" (both carried out in 2016) represent the activity level of Commission 3.

Workshop "Nationwide generation of height data from Airborne laser scanning and other sources"
EuroSDR and the Norwegian Mapping Authority organized a workshop on the Nationwide generation of height data from LiDAR data in January 2016 in Tønsberg, Norway. The objective of the workshop was to discuss aspects about laser data and other sources used for generation of detailed height data at a national level. 41 participants from 14 countries were present.

Fig. Piotr Wozniak, GUGIK, presents the Polish project "High resolution elevation data in Poland"

The first part focused on a number of presentations about four different themes: *concepts*, *quality*, *updating* and *applications.* On day two, there were discussions in smaller groups. The program and all presentations are available at the EuroSDR homepage[4].

Nationwide generation of height data is an ongoing task within most of the European National Mapping Agencies. The status and requirements are quite different for each agency, and therefore it is sometimes difficult to find suitable fields for cooperation. However, France and Poland declared to cooperate more closely in future as similar 3D LOD2 nationwide projects are on the way in their countries. The main goal of the workshop - to share experiences and gained knowledge - were met.

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[4]   http://www.eurosdr.net/workshops/eurosdr-workshop-nationwide-generation-height-data-airborne-laser-scanning-and-other

Recommendations:
1. To have a common area to place tenders/technical specifications from different organisations, and make them available for NMA's.
2. It is important to maintain expert knowledge within the public authorities. This is vital for a functional tender process, with well-written technical specifications and relevant quality control – a key to well-spent public resources.
3. Close international cooperation at early stage of planning project/nationwide initiatives will lead to closer cooperation in future.
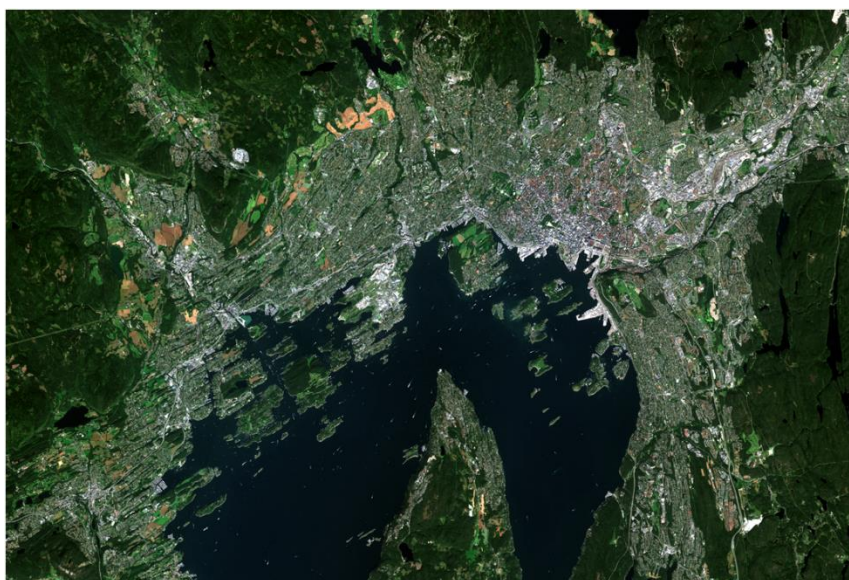
2nd workshop on Preparations for Sentinel-2 data in Europe
Following the need for a forum where the European countries can meet to discuss common challenges within the field of Copernicus, EuroSDR, the Norwegian Mapping Authority and Norwegian Space centre organized the "2nd Workshop on preparation for Sentinel-2 in Europe" in November 2016. Minutes and all presentations are available at the EuroSDR homepage[5].

The main objective for the workshop was to initiate contact and collaboration among European mapping agencies, institutes and companies who provide national users with data from the fleet of Sentinel satellites, with special focus on Sentinel-2.

The Copernicus program is still in its infancy. In the following years, more satellites will be in service, new applications will be developed, and we will have gained more experience both with the Collaborative Ground Segments and the use of Sentinel data.

The target group for the workshop was national agencies who provide the users with data from the Copernicus program. Specialists on key topics were invited as keynote speakers. 62 participants from 14 nations took part in the workshop, represented by universities, research institutes, governmental and private industries. They all gathered to discuss challenges and opportunities.

Fig. Copernicus – Sentinel-2 data from 2015, Oslo area

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[5] http://www.Eurosdr.net (URL to Workhop page TBD)

Conclusions
- The participants agreed that organizing a new workshop within two years would be useful and interesting (autumn 2018). Within this period more satellites will be in service and national services will be established and in use. New studies based on the new data are completed and new products are developed. Topics could be:
  - Functionalities of national services;
  - Access and processing of data including how to use toolboxes;
  - Use cases, new products and opportunities regards to high and low level users.
- It is recommended to organize conferences or workshops at a national level to include the end user needs (Potential of Copernicus data, possible products for end users, use cases, etc.)
- Regarding DTM's: SRTM stops at 60 deg. N. Provide appropriate data for ESA (Nordic level cooperation). Is the Pan Arctic DEM good enough? ESA must provide Sentinel-2 data with the best possible DEM for all countries in Europe. For Nordic countries, the national DEMs must be used. This should be a topic for the Nordic NMA cooperation.

Applied research

Concerning applied research, the availability of Sentinel-2 image time series raises important methodological issues that could be explored as well as solutions for well-known remote sensing problems. Some ideas for further research:
- integration of Sentinel-2 images in existing methods;
- the need to develop new algorithms for temporal analysis;
- the exploration of different strategies to combine them with Sentinel-1 images;
- the consideration of big data handling issues;
- from a NMA perspective: How can Sentinel-2 data be utilized within the NMA's?

Fig. Workshop participants at the second day (photo: Arnt Kristian Gjertsen)

Commission IV: Information Usage
Bénédicte Bucher

At the end of 2016, Commission 4 changed chair from Jon-Arne Trollvik to Bénédicte Bucher. Both the former and new chairs agreed that activities related to the usage of Sentinel data will now be reported under Commission 3, now chaired by Jon Arne Trollvik. Activities reported below are limited to the two following projects: historical and spatio-temporal data, and web location framework.

Historical and spatio-temporal data
The project on historical and spatio-temporal data aims at enhancing the usage of historical geographical data, typically NMCAs archives, as well as of spatio-temporal data in general, because data gets replaced by newer data. In 2016, the activities related to this project were limited to:
- Publication of the October 2014 workshop presentations and summary.
- Preparation of a workshop by IGN France and EPFL Lausanne to address two stakes identified after the first workshop and a short survey: to encourage collaboration around software development in this domain, to reach out users. This workshop will take place in 2017.
- Preparation of a survey to identify how NMCAs develop new usages of aerial pictures archives. This is carried out by Commission 3 and 4.

Web location framework (designing challenges for scientist based on NMAs use cases)
The web location framework project aims at improving communication and mutual understanding between specialists of web technologies applied to location, especially scientists and NMAs. It followed the linked data initiative and started with the spatial data on the Web workshop organized in February 2016 in Amsterdam, with a specific working session dedicated to gaining a common ground between participants from various backgrounds. This report was reused by the OGC-W3C spatial data group, of which some members participated to the EuroSDR working session in February. This seminar was reported in last annual report. The following generic issues were identified:

- Issue 1 : to produce, publish and maintain metadata about currency, meaning and provenance of geodata with an adapted metadata scope, that can be understood by users outside the NMA, and in a feasible process considering NMCAs resources.
- Issue 2 : to have access to a user oriented catalogues of geographical 'information resources' where data and service providers get some feed-back from users.
- Issue 3 : to handle multiple representations.
- Issue 4 : to improve visualisation on the web.
- Issue 5 : a technology decision support model for assisting NMCA in discovering, comparing and selecting technologies - URI policies, triple stores, vocabularies, etc. - with a concern for: making the tradeoff visible, considering important context elements like the background of people who will have to use this technology.
- Issue 6 : to handle cross border data.
- Issue 7 : to use existing data/capacities from the web to enhance some NMCA tasks, like schema alignment.
- Issue 8 : schema integration and comparison.

These generic issues have been a basis to try and design concrete use cases more specific and for which we have enough data and communities to organise challenges. This was done by soliciting delegates before the Board of Delegates meeting in October 2016. A representant from the ELF project helped assess what connection could be made to ELF.

Commission V: Business Models and Operation
Joep Crompvoets

As chair of the new Commission 5 'Business Models and Operation', it is my pleasure to contribute to the EuroSDR annual reports series. This new commission was established at the 126th Board of Delegates meeting in Tønsberg (Norway, May 2015). In the second year of the existence of the Commission, it already organised several workshops and launched some projects.

The objective of the new Commission is to contribute to the development and implementation of business models in terms of describing the rationale of how mapping and cadastre agencies can create, deliver, and capture value, in economic, legal, social, governance contexts.

Workshops

Commission 5 co-organised a pre-workshop meeting of the workshop 'Data to Decisions: Valuing the Societal Benefit of Geospatial Information'. The organization of the main workshop was mainly in the hands of the GEOValue community in collaboration with OECD, NASA, and USGS (OECD, Paris, 10-11 March 2016). The pre-workshop was

entitled 'Tutorial on Cost Benefit Analysis' and took place one day before the workshop (March 2016) at l'Ecole des Mines. The objective was to introduce, explain and discuss appropriate methods for valuing geographic information. It was attended by 45 participants around the world – EuroSDR was represented by National Land Survey, Danish Geospatial Agency, Kadaster, and Statens Kartverket.

Fig. Impressions of the Tutorial on Cost Benefit Analysis (9 March 2016, l'Ecole des Mines, Paris)

EuroSDR was asked by INSPIRE KEN of EuroGeographics to co-organise an INSPIRE validation workshop in Marne-la-Vallée, France (2-3 June 2016). Commission 5 accepted this request. The purpose of this workshop was to share experiences, to make a state-of-play of existing validation solutions and to identify remaining issues. The EU Joint Research Centre (JRC) also decided to join the organisation of this event. The program included many contributions from NMCAs as well as industry. The main workshop conclusions were that many validation activities are taking place resulting into several test suites with different levels of implementation. Around 50 persons will attend this event.

Fig. Group photo of participants of the INSPIRE validation workshop (2-3 June 2016, Marne-la-Vallée, France)

Projects

Commission 5 launched and contributed to several research projects.

In 2007, a workshop was organised in Dublin about the Marine Spatial Data Infrastructure (SDI). It appears that this topic is still a very relevant topic for NMCAs across Europe. Therefore, the Commission Chair contacted Jade Georis-Creuseveau (University of Bordeaux) and Roger Longhorn (Global Spatial Data Infrastructure (GSDI)) to set up a joint EuroSDR/GSDI project proposal which was approved at the 129th Board of Delegates meeting in Madrid. The objective of this project is to do research about how coastal marine communities and NMCAs can work together more effectively where land meets the sea and to organise several coastal/marine SDI workshops. The workshops are mainly about the identification and promotion of coastal and marine information management 'good practices' and exploration of challenges remaining among stakeholders in implementing Coastal/marine SDIs in relation to their legally mandated requirements under the INSPIRE Directive and implementing regulations for INSPIRE data themes of relevance to the coastal and marine communities.

At the 123th Board of Delegates meeting (Gävle, Sweden, October 2013), the second phase of the project 'Crowdsourcing and National Mapping' was launched by Peter Mooney as the first phase appeared to be very successful. Since then, not much happened. As this is a relevant and important topic for the future of NMCAs, it was proposed to relaunch this initiative with Peter Mooney of Manooth University (Ireland) as the project leader. The use of crowdsourced geographic information by NMCA and the Geomatics Industry is a very current, challenging and topical subject. Today we see very rich potential for collaboration and integration of NMCAs, the Geomatics Industry and citizen-based crowdsourcing (such as OpenStreetMap, Ushahidi, Geonames, Galaxy Zoo, GeoWiki, Flickr, GeoWiki, etc). We have seen some limited examples of where collaboration and integration has happened. However, for a myriad of reasons realising this potential for collaboration is not very easy.

In this context, a workshop will be organized on 3-4 April 2017 in Leuven (as a follow-up of the Nottingham workshop (2012)). The goal of this workshop is to engage with stakeholders from NMCAs, the Geomatics Industry, academic research, software developers, citizens involved in geographic crowdsourcing and to discuss the most prominent and pressing questions related to crowdsourcing and national mapping in Europe today.

Commission 5 also launched the project 'Exploring Sustainable Open Data Business Models for NMCAs' with Bastiaan van Loenen (Delft University of technology) as the project leader. This project aims to answer the following research question: Is it possible to have sustainable funding and high quality open data in the context of NMCAs? This objective will be achieved by setting up a simple survey to NMCAs, followed by a workshop in which the survey results are presented and discussed in order to arrive at a sustainable funding model for open NMCA data. This workshop is scheduled for April – June 2017. After the workshop, the survey as well as the workshop results are processed resulting to an Official EuroSDR publication.

Finally, Commission 5 also co-organised the project on the 'Economic Value of 3D' (see report of Commission 2).

Commission VI: Knowledge Transfer
Markéta Potůčková

The main activity of Commission VI focused on organizing the EuroSDR Educational Service (EduServ). In 2016, it continued with its 14th series offering four two-week e-learning courses:

- RPAS in Land Survey – Theory and Practice

  Tutors: Görres Grenzdörffer, University of Rostock, Michael Cramer, University of Stuttgart

- International Standards for Geographic Information

  Tutor: Wolfgang Kresse, University of Applied Sciences, Neubrandenburg

- 3D City Modelling

  Tutors: Jantien Stoter, Ravi Peters, Hugo Ledoux, Delft University of Technology

- Synthetic Aperture Radar for Mapping Applications

  Tutor: Olaf Hellwich, Technical University Berlin

The two-day pre-course seminar was hosted by Bogdan Zagajewski at the University of Warsaw, Faculty of Geography and Regional Studies on 7th and 8th March 2016. The seminar was attended by 24 participants. The e-learning courses were actively followed by 46 participants, which was one of the highest participation numbers in the EduServ history. The EduServ Advisory Board evaluated 11 applications for EduServ scholarships; four applicants (from Czechia, Moldavia, Poland and Romania) received grants covering the course fee and the travel expenses to the pre-course seminar (up to 500 EUR each). New topics of e-learning courses for 2017 on oblique aerial camera systems for mapping purposes and terrestrial point cloud for forest modelling were approved during the 128th BoD meeting in Paris. Registration opened in October 2016.

Fig. Opening of the EduServ 14 pre-course seminar, University of Warsaw, 7th March 2016

In order to involve young scientists in its research and to further strengthen its collaboration with academia, EuroSDR has established an Award to reward recent PhD theses that have significantly contributed to the development of Geoinformation Science in the context of national mapping and cadastral agencies. The first announcement of the EuroSDR Award 2016 for the best PhD thesis was issued in February 2016. The established six-member committee selected two out of twelve submitted theses: "Detection, classification and post classification of urban features from multispectral images and mobile LIDAR point clouds" by Borja Rodríguez-Cuenca from the University of Alcalá, Spain, and "Service-oriented Geoprocessing in Spatial Data Infrastructures" by Matthias Müller from the Technical University Dresden, Germany. The Awards were handed over during the 129th BoD meeting in Madrid.

The current and future Commission activities were presented at the ISPRS congress on 13th July 2016 as part of a special EuroSDR session (Streilein et al.: EuroSDR – the pan-european network for mapping agencies, Potuckova et al.: EuroSDR Educational Services for Continuing Professional Development).

Annual Report 2016 of the WG on Standards
Wolfgang Kresse

1. Standardization support for EuroSDR

The WG on standards has been requested by EuroSDR-members to provide guidance regarding the development of standards and to assemble activities towards new standardization projects. In the past, such a service followed once an INSPIRE-workshop in Copenhagen which focussed on deficits of ISO-standards for European geographic information data. The outcome of the workshop was compacted and forwarded to the ISO/TC 211.

In order to intensify the talks, France proposed a round table on standards. In 2016 those talks have started with standardization experts of IGN France. Two areas of interest were identified: BIM in cooperation with ISO/TC 211 and city models in cooperation with the OGC. In addition, a better visibility of EuroSDR in standardization organizations was proposed.

2. ISO/TC 211 in 2016

The two 2016 plenary meetings of the ISO/TC 211 took place in June in Tromsø, Norway, and in November/December in Redlands, California, USA.

ISO/TC 211 drives its activities towards building information models. This is documented by the new liaison-membership of the ISO/TC 59/SC (subcommittee) 13 "Buildings and civil engineering works – Organization of information about construction works" and by the new standardization project ISO 19166 "BIM to GIS conceptual mapping (B2GM)".

Recently three new national standardization bodies joined the ISO/TC 211 as P-Members (participating members): Mexico, Poland and Turkey. Thus, ISO/TC 211 presently has 38 P-members and 29 O-members (observing members).

The Belgian organisation "Small Business Standards" (SBS) has become a new liaison-member of the ISO/TC 211. SBS is a non-profit international association co-financed on the one hand by its members, and on the other by the EU and by EFTA member states. SBS is a response to the desire of the EU to make the standardisation system as inclusive, transparent and open as possible, enhancing participation of "weak" stakeholders, such as Small and Medium-sized Enterprises.

The International Cartographic Association will establish and host a wiki for geographic information standards (ISO/TC 211, OGC and IHO). Details will be published.

3. Important standardization projects

ISO/TC 211 and the Open Geospatial Consortium (OGC) cooperate closely since 1998. The cooperation has been intensified recently. ISO brings metadata, including specialized metadata such as imagery sensors models while the OGC often addresses encodings. This year the OGC has brought in many OGC specifications as future ISO standards. Examples are the Joint Project ISO 19123-2 "Schema for coverage geometry and functions – Part 2: Coverage Implementation Specification" (presently still OGC CIS 1.1), and the updated versions of the "Web Feature Service" (ISO 19142) and "Filter encoding" (ISO 19143).

The working draft of the ISO 19165 "Preservation of digital data and metadata" has successfully passed the balloted for Committee Draft (CD) and shall be forwarded for completion (Draft International Standard, International Standard). In its final shape the document builds upon the metadata standard ISO 19115-1 and integrates the requirements of the space data community documented by the ISO 14721 "Space data and information transfer systems – Open archival information system (OAIS) – Reference model". The demands of the European NMCAs were considered by the article "GI+100:

Long term preservation of digital Geographic Information – 16 fundamental principles" as well other documentation and talks e.g. with Switzerland, Sweden and Germany. The project is co-chaired by Joan Masó of the OGC. Thus, the ISO 19165 is also a cooperative project with the Open Geospatial Consortium.

4. Change of chair of ISO/TC 211
Olaf Østensen of Standard Norge (Oslo, Norway) has chaired the ISO/TC 211 "Geographic information / Geomatics" since its beginning in 1994. Now in his 22nd year, Olaf is "allowed" to resign after a successor has been found. In the future, the ISO/TC 211 will be chaired by Christina Wasström of Lantmäteriet (Swedish national mapping agency) in Gävle, Sweden. Two competitors took also an interest in chairing ISO/TC 211: China and Turkey.

5. EduServ
Standardization was one of the four topics of EduServ in 2015 and in 2016.

Workshops

- Linked Data seminar 'Culture, base registries and visualisations' (Amsterdam, the Netherlands, 2 December 2016)
- 2nd workshop 'Preparation for the Sentinel-2 in Europe' (Oslo, Norway, 11 – 12 October 2016)
- EuroSDR Special Session at ISPRS Conference 'Innovative technologies and methodologies for NMCAs' (Prague, July 2016)
- UN-GGIM NMCA Forum at ISPRS Conference highlighting the (research) activities happening at NMCAs (Prague, July 2016)
- 'Quality assessment of geospatial data: does it fit your needs?' AGILE 2016 pre-conference workshop (Helsinki University, Finland, 14 June 2016)
- 'Validation of INSPIRE data, metadata and services' (Marne-la-Vallée, France, 2 – 3 June 2016)
- EuroSDR/NASA/OECD GeoValue Tutorial 'Cost Benefit Analysis in the context of Geospatial Information' (Paris, 9 March 2016)
- EuroCOW 2016 (Lausanne, Switzerland, 10 – 12 February 2016)
- 'Geodata on the Web' seminar (RCE, Amersfoort, the Netherlands, 10 – 11 February 2016)
- Workshop 'Infrastructure for Geo-IT' at the GIM-International Summit (Amsterdam, 10 February 2016)
- 'Nationwide generation of height data – from Airborne laser scanning and other sources' (Tønsberg, 12 – 13 January 2016)

Publications

66 EuroSDR contributions to the ISPRS Congress XXIII, Special Session 12 – EuroSDR, 12 – 19 July 2016, Prague, Czech Republic. 2017, 129 pages.

65 Crompvoets, J.; Streilein, A.; Masser, I.: How should NMCAs adapt to alternative sources for NMCA data? 2016, 9 pages.

64 Domenech, E.; Malle, C.: Change Detection in High-Resolution Land Use/Land Cover Geodatabases (at Object Level). Walter, V.: A survey on state of the art of 3D Geographical Information Systems. Haala, N.: Dense Image Matching Final Report. Mooney, P.; Morley, J.: Crowdsourcing in National Mapping. 2014, 172 pages.

63 Fritsch, D.; Pfeifer, N.; Franzen, M. (eds.): 2nd High Density Image Matching for DSM Computation Workshop. 2013, CD.

62 Honkavaara, E.; Markelin, L.; Arbiol, R.; Martínez, L.: Radiometric Aspects of Digital Photogrammetric Images. Kaartinen, H.; Hyyppä, J.; Kukko, A.; Lehtomäki, M.; Jaakkola, A.; Vosselman, G.; Oude Elberink, S.; Rutzinger, M.; Pu, S.; Vaaja, M.: Mobile Mapping - Road Environment Mapping using Mobile Laser Scanning. 2013, 95 pages.

61 Fritsch, D.; Pfeifer, N.; Franzen, M. (eds.): High Density Image Matching for DSM Computation Workshop. 2012, CD.

60 Höhle, J.; Potuckova M.: Assessment of the Quality of Digital Terrain Models. 2011, 85 pages.

All publications can be downloaded on the EuroSDR website (www.eurosdr.net).