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The main objectives of ESF for the years 2006 – 2010 as defined by its current Strategic Plan are to promote Science Strategy and Science Synergy, paving the way for initiatives across disciplinary and geographic boundaries in the European Research Area (ERA).

The Exploratory Workshops scheme is one of the key instruments of the Science Strategy "pillar". Each year, ESF supports approximately 50 Exploratory Workshops across all scientific domains. The focus of the scheme is on workshops aiming to explore an emerging and/or innovative field of research or research infrastructure, also of interdisciplinary character. Workshops are expected to open up new directions in research or new domains. It is expected that a workshop will conclude with plans for specific follow-up research activities and/or collaborative actions or other specific outputs either within the frame of ESF (e.g. prepare the ground to develop a proposal; publication of a Policy Briefing...) or for submission to the EU 7th Framework Programme or to other European or international funding organisations.

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ESF EXPLORATORY WORKSHOP

Laser Scanning Spatial Data Infrastructure (LASDI)

September 8 – 10, 2011

Convened by

Bernhard Höfle · University of Heidelberg · Institute of Geography · Chair of GIScience

Norbert Pfeifer · Vienna University of Technology · Institute of Photogrammetry and Remote Sensing

Alexander Zipf · University of Heidelberg · Institute of Geography · Chair of GIScience

Report publication and dissemination

The abstracts of the presentations and a scientific report on the outcome of the workshop will be released on the workshop website. Furthermore, a Special Issue on the workshop theme in an international scientific journal will be initiated.

Dear colleagues,

we would like to cordially welcome you in Heidelberg to the European Science Foundation (ESF) Exploratory Workshop "Laser Scanning Spatial Data Infrastructure (LASDI)".

This workshop aims at bringing together high-level, experienced and young researchers in the scientific fields of Geographical Information Science (GIScience) and Remote Sensing & Laser Scanning technology in order to explore new concepts of integrating laser scanning data in spatial data infrastructures. The Laser Scanning Spatial Data Infrastructure (LASDI) demands for novel interdisciplinary strategies, incorporating the rapid technological and scientific development of the two research communities. This meeting will identify the core themes and research areas and initialize the roadmap to a European collaborative research agenda.

The major objectives covered by the workshop are:

- *Identify the core themes and research areas required for integrating laser scanning point cloud data in a Spatial Data Infrastructure (SDI)*
- *Define strategies for collaborative research of the two scientific communities including potential cooperation with external organizations (e.g. OGC and EuroSDR) and data providers (e.g. public authorities)*
- *Initialize the roadmap to an European test bed including hardware and software requirements (e.g. Open Source Project) in order to bring together fragmented knowledge into a collaborative scientific development*

This workshop was approved by the Standing Committees for, Life Earth and Environmental Sciences (LESC) and Physical and Engineering Sciences (PESC). Further detailed information can be found on the website http://lasdi.uni-hd.de.

We are looking forward to compelling presentations and fruitful scientific discussions and would like to kindly thank you for your active participation.

Bernhard Höfle, Norbert Pfeifer, Alexander Zipf

Thursday, 8 September 2011

20:00	GUIDED NIGHT TOUR OLD TOWN OF HEIDELBERG *Meeting point: fountain in the marketplace* *(prior registration required: hoefle@uni-heidelberg.de)*

Friday, 9 September 2011

10:00-10:20	WELCOME AND MISSION STATEMENT BY CONVENORS *Bernhard Höfle (University of Heidelberg, DE),* *Norbert Pfeifer (Vienna University of Technology, AT) and* *Alexander Zipf (University of Heidelberg, DE)*
10:20-10:40	PRESENTATION OF THE EUROPEAN SCIENCE FOUNDATION (ESF) *Constantin Doukas (ESF Standing Committee for Life,* *Earth and Environmental Sciences – LESC)* *AND* *Ramiz Hamid (ESF Standing Committee for Physical* *and Engineering Sciences – PESC)*
10:40-12:10	**SESSION:** LIDAR DATA ACQUISITION AND MANAGEMENT *CHAIR: Chaitan Baru (UC San Diego, US)*
10:40-11:10	**KEYNOTE: Lidar Principles and Airborne Scanning Lidar** *Norbert Pfeifer (Vienna University of Technology, AT)*
11:10-11.30	**LIDAR Data Management from a trans-national perspective** *Gottfried Mandlburger (Vienna University of Technology, AT)*
11:30-11:50	**Efficient data storage and network transfer by means of a compressed multiresolution DTM model** *Maria Antonia Brovelli (Politecnico di Milano, IT)*
11:50-12:10	**DISCUSSION**
12:10-13:45	LUNCH
13:45-15:35	**SESSION:** SPATIAL DATA INFRASTRUCTURE (SDI) *CHAIR: Lars Bodum (Aalborg University, DK)*
13:45-14:15	**KEYNOTE: Towards the Next Generation Spatial Data Infrastructures: New Data, New Opportunities** *Max Craglia (Joint Research Centre, European Commission, IT)*
14:15-14:35	**GeoWebServices and standards in a SOA web-based SDI** *François Robida (BRGM and OGC Board of Directors, FR)*
14:35-14:55	**Providing Guidance on Metadata Capture to A Multi-National Team** *Claire Ellul (University College London, UK)*
14:55-15:15	**Efficient LIDAR Processing in Standardized SDIS for Web-based 3D City Models** *Sandra Lanig (University of Heidelberg, DE)*
15:15-15:35	**DISCUSSION**
15:35-16:05	COFFEE/TEA BREAK
16:05-17:45	**SESSION:** LIDAR DATA ANALYSIS AND VISUALIZATION *CHAIR: George Vosselman (University of Twente, NL)* *CO-CHAIR: Martin Rutzinger (University of Innsbruck, AT)*
16:05-16:25	**Segmentation of LIDAR data: Application on 3D point cloud and full-waveform data** *Frédéric Bretar* *(Public Works Regional Engineering Office (CETE), FR)*
16:25-16:45	**Derivation of biophysical vegetation parameters from airborne laser scanning** *Felix Morsdorf (University of Zurich, CH)*
16:45-17:05	**Applications and challenges in the context of natural hazards and engineering solutions** *Pauline Miller (Newcastle University, UK)*
17:05-17:25	**3D generalization** *Monika Sester (Leibnitz Universität Hannover, DE)*
17:25-17:45	**DISCUSSION**
17:45	**CONCLUDING REMARKS** *Convenors*
19:30	DINNER: RESTAURANT "WEISSER BOCK" (GROSSE MANTELGASSE 24)

Saturday, 10 September 2011

08:30-09:45	**SESSION:** REFERENCE PROJECTS *CHAIR: Marketa Potuckova (Charles University in Prague, CZ)*
08:30-09:00	**Case Study: OpenTopography.org** *Chaitan Baru (UC San Diego, US)*
09:00-09:30	**Case Study: A national 3D SDI: case of The Netherlands** *Jantien Stoter (TU Delft & Kadaster & Geonovum, NL)*
09:30-09:45	**DISCUSSION**
09:45-10:15	COFFEE/TEA BREAK
10:15-11:45	**BRAINSTORMING AND GROUP DISCUSSIONS:** DISCUSSION IN SMALL GROUPS – LaSDI REQUIREMENTS AND RESEARCH OBJECTIVES TO BE IDENTIFIED:
	Management *(SPEAKER: Gottfried Mandburger, AT)*
	Analysis *(SPEAKER: Frédéric Bretar, FR)*
	GeoWebServices *(SPEAKER: Alexander Zipf, DE)*
	Standards and Interoperability *(SPEAKER: Jantien Stoter, NL)*
	... further topics to be identified on Day 1
11:45-13:00	LUNCH
13:00-14:00	**REPORT OF RESULTS OF GROUP DISCUSSIONS** *SPEAKERS OF GROUPS*
14:00-14:30	COFFEE/TEA BREAK
14.30-16:30	**Roadmap and Collaborative Activities** *CHAIR: Convenors / ESF Representatives*
14:30-15:30	**MODERATED DISCUSSION:** DEFINITION OF JOINT RESEARCH AGENDA
15:30-16:30	**SPECIFIC PLANNING OF ACTIVITIES** (E.G. PROJECT PROPOSAL, SPECIAL ISSUE, WHITE PAPER)
16:30	END OF WORKSHOP AND DEPARTURE

EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE

Objectives of the ESF Standing Committee for Life, Earth and Environmental Sciences (LESC)

The main objectives of the ESF Standing Committee for Life, Earth and Environmental Sciences (LESC) are:

- to identify and promote emerging scientific topics and high quality science deserving special attention in Europe;
- to manage a wide ranging portfolio of activities of the European Science Foundation;
- to examine and report on issues of strategic scientific importance within its fields of competence.

This committee's sphere of activities comprises the broad field of life, earth and environmental sciences: Biology | Climate research | Biotechnology | Glaciology | Agriculture | Oceanography | Earth sciences | Environmental sciences, etc.

ESF Standing Committees support a limited number of Exploratory Workshops each year. These workshops allow leading European scientists to explore novel ideas at the European level with the challenging aim to "spear-head" new and preferably interdisciplinary areas of research. Further details are available on the internet at *www.esf.org/workshops*.

One desirable outcome of an ESF Exploratory Workshop may be that participants submit high quality proposals for further ESF activities (such as *www.esf.org/lesc/programmes* à la carte Programmes or a EUROCORES initiative), or research funding applications for submission to the EU 7th Framework Programme or to other European or international funding organisations.

In the case of ESF Programmes (*www.esf.org/lesc/programmes* or *www.esf.org/eurocores*), which are financed by, and coordinated through, the European Science Foundation, a draft proposal should be submitted to the LESC Secretariat for advice, to then subsequently undergo further external refereeing. If successful in obtaining LESC's scientific recommendation, the proposal will be submitted to ESF Member Organisations for funding on a voluntary basis. More details are available at *www.esf.org/research-areas/life-earth-and-environmental-sciences.html*.

Objectives of the ESF Standing Committee for Physical and Engineering Sciences (PESC)

The ESF Standing Committee for Physical and Engineering Sciences (*http://www.esf.org/research-areas/ physical-and-engineering-sciences.html* PESC) covers a broad number of fields from physics, chemistry, mathematics, informatics and computer sciences, to engineering, material and technical sciences. PESC has the following responsibilities and tasks: to develop scientific initiatives within the ESF operational framework;

- to make proposals for "a la carte" scientific initiatives;
- to undertake studies on large research facilities and assist in the evaluations and assessments and other special reviews requested by Member Organisations;
- to provide specialist advice and input on a wide range of ESF actions and contribute to the development of the ESF science policy agenda and take a strategic view of the scientific area for which it has responsibility; and
- where appropriate, to work with other Committees and groups in promoting multidisciplinary and interdisciplinary activities.

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► **SESSION:** LIDAR DATA ACQUISITION AND MANAGEMENT

LIDAR principles and airborne scanning LIDAR

The concept Light Detection And Ranging allows the direct observation of the range between a sensor and a target. This is exploited widely for the acquisition of topographic information from airborne platforms, requiring additionally a scannning mechanism and the observation of the sensor trajectory. Beyond the measurement of the coordinates of 3D points, also geophysical parameters of the reflecting surfaces can be recorded exploiting the LIDAR principle. Ongoing and possible developments will be presented, but also limitations of the technology. The physical foundations will be laid out first. This concerns especially the formation of the backscatter, i.e., the properties of the reflected signal. The properties depend on the characteristics of the surface and the emitted signal including its wavelength. The focus is, however, the impact onto the measured point cloud, containing more than purely geometry. The developments in sensor technology indicate the properties of "tomorrow's" point clouds, leading to higher point density and therefore enabling a wider range of applications. Also the properties of current commercial state-of-the-art sensors will be presented. Finally, the quality of the primary products of airborne scanning LIDAR will be discussed.

Norbert Pfeifer
(Vienna University of Technology, Institute of Photogrammetry and Remote Sensing)

LIDAR Data Management from a trans-national perspective

Within the last decade, the availability of countrywide Airborne Laser Scanning (ALS) datasets featuring high resolution (>1 pt/m²) and height accuracy (<15 cm) has steadily increased. In Europe, many countries are currently working on finishing their national ALS campaigns (e.g. AT, DE) whereas others are already updating their initial datasets with higher densities (e.g., NL). The point cloud as primary deliverable of ALS is the basis for many subsequent models (e.g., DTM/DSM) and applications (e.g., city modeling, forestry, infrastructure, hydrology, disaster management, ecology...) and, therefore, an efficient seamless management is of crucial importance. This contribution reviews the aptitude of different geo-database for the administration of trans-regional ALS point clouds and derivatives. Commercially available products (Oracle Spatial) are discussed as well as open source solutions (Postgres/PostGIS) and scientific approaches (TopDM). High performance spatial indexing methods (Kd-, R*-, Quad-, Oct-Trees) are a preconditions for an efficient data management but, beyond that, organizational matters (data hierarchies, metadata, spatial and temporal reference systems) are crucial. For a European Laser Data Spatial Data Infrastructure initiative, especially the smooth

and reproducible 3D-transformation from the European Reference System (ETRS 89/EVRS) to the respective national geodetic systems (and back again) is of high importance as current ALS data has to be combined with (historic) national geo-data. This requires compliance to approved standards (e.g. OGC Coordinate Transformation Service) and their application, but, however, the standards lag behind the practice as ALS data in sub-dm accuracy often require model oriented transformation approaches (NTv2 grid shifts, height systems...), especially in a trans-national context.

Gottfried Mandlburger
(Vienna University of Technology, Institute of Photogrammetry and Remote Sensing)

Efficient data storage and network transfer by means of a compressed multiresolution DTM model

The presentation deals with the problem of efficiently store and transfer through the Internet, without losing their original accuracy, the high resolution digital terrain models (DTMs) nowadays available. A significant example of such data are the DTMs obtained from LiDAR (Light Detection And Ranging), where up to several height measurements for each terrain square meter are obtained. An important limit in their usage is that many Geographical Information Systems (GIS) available are slow when the management and processing of a huge quantity of data is involved. The problem becomes more evident in cases of Web-GISs and virtual globes: when the systems are based on a frequent flow of height data, the network band-width and the size of the data to be transmitted are two fundamental factors in order to guarantee the really usability of these technologies. In the presentation we focus our attention on high resolution DTMs and we briefly analyse the problem related to the definition of the minimal information necessary to store and transmit DTMs, with a fixed tolerance, starting from a huge number of accurate observations. A multi-resolution spline approximation model is proposed. Our model is able to provide a metrical accuracy at least comparable with that of the most common interpolation algorithms and, at the same time, to significantly reduce the minimal information essential for storing, transmitting and rebuilding the DTM. First results on the accuracy and percentage of compression obtained on sample datasets are shown.

Maria Antonia Brovelli, Giorgio Zamboni
(Politecnico di Milano, DIIAR)

Towards the Next Generation Spatial Data Infrastructures: New Data, New Opportunities

Understanding and managing the complex interactions between society and the environment remains a formidable challenge, despite the progress of the last 20 years particularly in respect to data availability and data processing capacity. To make a step change in our understanding we need better theories, more integrated multi-disciplinary models from both environmental and social sciences, more real-time and quality-controlled data, and better data infrastructures to support the sharing of data and models, public participation and the development of collective understanding. We have made progress: The INSPIRE Directive is developing an infrastructure for spatial information in Europe based on those established and maintained by the member states. Implementation in taking place and we start seeing the first fruits of increased interoperability of metadata and services in Europe, with new data specifications and data models on their way. At the same time, new initiatives like data.gov increase access to public sector information, while the Shared Environmental Information System is also moving into implementation. In addition, we are starting to exploit new data collections from space, from sensor networks, and from citizens via social networks. Integrating these and new data sources such as LiDAR offers exciting new opportunities for real time, or almost to real time, data and feedback mechanisms able to provide new insights for both policy and science. More heterogeneous and dynamic data require however to address new scientific challenges in their own right including issues of data quality, data synthesis, spatio-temporal analysis and visualisation.

Max Craglia
(Joint Research Centre, European Commission)

GeoWebServices and standards in a SOA web-based SDI

The thematic or regional SDIs are built on Service Oriented Architectures. Therefore, a prerequisite to develop such SOA SDIs is a set of agreed standards, in order to develop services that could be used in cross-thematic and cross-boundaries contexts. Those standards are mainly developed through the Open Geospatial Consortium (OGC), an international industry consortium of 420 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. The development of new standards is

driven through the definition of specific requirements (i.e. in a new application domain), the development of new specifications and the testing and validation of those specifications by the consortium members, supported by a valuable expertise of standard engineering. OGC® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT. The standards empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. An example of the development of a thematic SDI in geosciences will be given, the OneGeology international initiative, supported by 116 countries. OneGeology aims at developing a geological spatial data infrastructure at the global scale, through the use of existing standards, and the support of development and use of new specific domain related standards. The presentation will highlight some of its important dimensions: organisational and technical (within the community/ with other communities).

François Robida
(BRGM, Member of the OGC Board of Directors)

Providing Guidance on Metadata Capture to A Multi-National Team

The recent INSPIRE conference in Edinburgh highlighted once again that metadata and metadata standards are very producer centric. During the many presentations there were very few that focused on or mentioned end-users of the metadata and in most cases the end users were involved directly in metadata creation. While this is perhaps a direct consequence of the INSPIRE deadlines, it is very important to consider the users of the metadata during the metadata creation process – in particular does the metadata contain sufficient information to allow them to evaluate the data, and make appropriate use of it? Do the metadata standards help to meet this requirement or hinder it? The presentation will focus on a series of guidelines created for metadata producers to assist them in providing appropriate metadata for end users – differentiating between minimal metadata, which is easy to produce but perhaps not useful for evaluation, and over-detailed metadata, where production is an onerous task but the results may be more useful.

Claire Ellul
(University College London, Civil, Environmental & Geomatic Engineering)

Efficient LiDAR Processing in Standardized SDIs for Web-based 3D City Models

Digital Terrain Models (DTMs) are the basis for the creation of 3D city and landscape models. In order to acquire terrain data quickly and over the entire surface, Airborne Laser Scanning (ALS) is the best way. However, ALS data result in large volumes data sets. Processing with classical GIS software or linking laser scanning processing to conventional, already existing Web Processing Services (WPS) in Spatial Data Infrastructures (SDIs) is not satisfactory. A lack of computing power appears. Especially for Web-based 3D city models, diverse Levels of Details (LoDs) and multiscale 3D terrain models must be generated in order to achieve acceptable performance. There is a need for sophisticated data management and processing techniques. For this purpose the use of Grid Computing is a good choice to accomplish high processing performance and storage capacity. Therefore a range of terrain pre-processing Web services based on a Grid-enabled WPS interface are realized for geo-tessellation, spatial partitioning and generalization. The integration into the Grid infrastructure is realized with the Globus Toolkit 4 (GT4) middleware. The research results have shown that efficient processing based on standardized open OGC services within a Grid-enabled SDI by conventional interfaces is possible. However, traditional SDI infrastructures have to be enriched with additional security mechanisms. Additionally, implemented WPS processes have to be parallelized for efficient data processing and geodata require to be split up and distributed to Grid resources.

Sandra Lanig
(University of Heidelberg, Institute of Geography, Chair of GIScience)

Segmentation of LiDAR data: application on 3D point clouds and Full waveform data

The analysis of raw LiDAR data states the problem of the automatic recognition of areas and specific objects. Based on recent research works, examples of segmentation methodologies and results will be presented from both 3D point clouds and Full Waveform LiDAR data on natural and urban landscapes. On the one hand, we will discuss the supervised segmentation approach Support Vector Machines on an urban area wherein attributes extracted from full waveform data have been rationally analysed. On the other hand, the "Mean Shift" unsupervised methodology will be briefly presented and results will be discussed regarding the segmentation of forest strata as well as single trees. Finally, links between LiDAR data infrastructure at the European level and issues from the data analysis will be sketched.

Frédéric Bretar
(Public Works Regional Engineering Office (CETE) – Public Works Regional Laboratory)

Derivation of biophysical vegetation parameters from airborne laser scanning

Airborne laser scanning is a relatively young and precise technology to directly measure surface elevations. With today's high scanning rates, dense 3-D pointclouds of coordinate triplets (xyz) can be provided, in which many structural aspects of the vegetation are contained. The challenge now is to transform this data, as far as possible automatically, into manageable information relevant to the user. We present two such methods: the first extracts automatically the geometry of individual trees, with a recognition rate of over 70% and a systematic underestimation of tree height of only 0.6 metres. The second method derives a pixel map of the canopy density metrics from the pointcloud, in which the spatial patterns of vegetation cover are represented. These patterns are relevant for habitat analysis and ecosystem studies. The values derived by this method correlate well with field measurements, giving a measure of certainty (R2) of 0.8. The greatest advantage of airborne laser scanning is that it provides spatially extensive, direct measurements of vegetation structure which show none of the extrapolation errors of spot measurements. A large challenge remains in integrating these new products into the user's processing chains and workflows, be it in the realm of forestry or in that of ecosystem research. Two major obstacles are identified here: a) the handling of huge data volumes and b) to maintain relevant meta data along the processing chain.

Felix Morsdorf
(University of Zurich, Department of Geography)

Applications and challenges in the context of natural hazards and engineering solutions

LiDAR has become an important resource for a range of natural hazard applications and the engineering management solutions which attempt to mitigate associated problems. Amongst others, this includes landslide hazard assessment and coastal change, examples of which will be presented and discussed here. Such applications generate a demand for high quality, high resolution outputs, which are often founded on DTMs, in order to support change detection, volumetric calculation, and landscape visualisation and characterisation. The recent trend towards uptake and development of full waveform LiDAR presents new possibilities for these applications, including enhanced DTM generation, and a potential wealth of additional information. However, effective manipulation and management of LiDAR data presents a host of challenges. LiDAR generally suffers from a lack of standardisation and a consistent data management structure. Often relatively little is known about the quality and pre-processing associated with the original survey. Such aspects are compounded by large data volumes and the associated difficulties in effective storage, management and processing. These issues must be addressed if LiDAR is to continue to develop and be exploited in full, allowing effective integration with other data sources.

Pauline Miller
(Newcastle University, School of Civil Engineering and Geosciences)

3D generalization

LiDAR offers the potential of a rapid acquisition of high resolution 3D point clouds. For an usage in a spatial data infrastructure, a major interest lies in the management and access to interpreted 2.5 or 3D objects. Such objects are needed in different levels of detail – depending on the applications. In the presentation, methods for the generalization of 2.5D and 3D-objects are presented, which mainly aim at an enhanced visualization as well as an efficient data transmission.

Monika Sester
(Leibnitz Universität Hannover, Institute of Cartography and Geoinformatics)

OpenTopography.org

The OpenTopography.org data portal democratizes access to high-resolution topographic data and tools by providing access to these resources to a broad user community. OpenTopography.org provides access to high-resolution LiDAR point cloud data as well as pre-computed digital elevation model data (DEMs). Users may download existing data products, or use the tools and services provided to derive their own DEMs or other data products. A rich user interface allows users to track jobs, and data providers to monitor usage of their contributed data. The OpenTopography effort originated initially as a sub-project in the Geosciences Network (GEON) project and referred to as the GEON LiDAR Workflow (GLW). Since then, OpenTopography.org has been launched as a standalone service that leverages the significant cyberinfrastructure resources at the San Diego Supercomputer Center. The site partners with a number of public domain data holders, including other groups, projects, and individual researchers – who are the ultimate data owners – to leverage OpenTopography infrastructure for data discovery, hosting and processing of their data by a larger user community. Data may also be stored with fixed-duration embargoes, if necessary, which allows exclusive access to only a few "privileged" users. While the current focus is on airborne LiDAR point cloud data, we are also working towards providing access to satellite-based data as well as terrestrial laser scan data. This talk will describe the available data, tools and services at OpenTopography; the technical infrastructure; and, some technical challenges along with a discussion of some future directions for LiDAR data storage and processing.

Chaitan Baru
(San Diego Supercomputer Center, UC San Diego)

A national 3D SDI: case of The Netherlands

The past ten years technologies for creating and managing 3D geo-information have matured while costs of 3D geo-information and 3D tools have significantly reduced. Yet many (governmental) organisations hesitate to introduce 3D into their everyday processes. Despite the slow progress of 3D in practice, it is clear that 3D applications are important and will become even more important in the near future. Therefore, the Dutch Kadaster, Geonovum, the Dutch Committee of Geodesy (NCG) and the Ministry of Infrastructure and Environment initiated a pilot to progress in the area of 3D in the Netherlands. In this pilot (run between March 2010 and June 2011), more than 65 private, public and scientific organisations collaborated on use cases and a testbed to push 3D developments in The Netherlands. After a year of collaborating with many stakeholders it can be concluded that the objective has been achieved. The 3D pilot has shown the added value of 3D and what it takes to exploit this value. Also the pilot has resulted in a 3D standard NL via a CityGML implementation profile for large scale topography in The Netherlands (CityGML-IMGeo). This standard makes 3D applications tangible in the Netherlands. In addition the pilot has shown the need for a nationwide reference 3D dataset. Promising results have been achieved in the pilot for generating 3D topography based on a combination of 2D topography and high density laserpoint data. Besides generating new knowledge and bringing together existing knowledge, the findings of the 3D pilot identified a number of issues for further research. Examples include automatic generation of 3D information compliant to the new standard, updating 3D data sets, and maintaining 3D information (i.e. support for 2.5D/3D topology and validation of 3D geometry). A follow up research is currently set up to study the open issues.

Jantien Stoter
(TU Delft & Kadaster & Geonovum)