# ISPRS Commission VII Status update Report August 2011

11 November 2011

## *1. State of Science and Technology of Commission VII Topics*

ISPRS Technical Commission VII (TC VII) deals with the "Thematic processing, modelling and analysis of remotely sensed data". It covers the following thematic areas, represented by its working groups (WGs):

- WG VII/1 - Physical modelling and signatures in remote sensing
- WG VII/2 - SAR Interferometry
- WG VII/3 - Information extraction from hyperspectral data
- WG VII/4 - Methods for land cover classification
- WG VII/5 - Methods for change detection and process modelling
- WG VII/6 - Remote sensing data fusion
- WG VII/7 - Theory and experiments in radar and lidar
- ICWG III/VII - Pattern recognition for remote sensing

Recently, several general trends in earth observation have been identified that have their impact on the thematic topics covered by TC VII. These developments have been fed by the increasing need for high accuracy data for specific purposes and the ever increasing role of earth observation in endorsing national and international political agendas, e.g. with respect to climate change, natural disasters and food security. These common trends include:

- Rapid developments of specialised missions, e.g. for the water cycle (Aquarius, SMOS, SMAP, CryoSat-2, GOCE), ocean colour and mineralogy (EnMap and PRISMA imaging spectrometers).
- Rapid developments in SAR remote sensing data sources, such as such as the high resolution RADARSAT-2 from Canada, the COSMO-Skymed SAR satellite from Italy, the German TerraSAR-X and TanDEM-X, and ESA's upcoming Sentinel-1 and Sentinel-2 in support of GMES.
- The recognition that a fundamental conception and modelling of the physical processes is required to robustly retrieve thematic information from earth observation data.
- Observed Earth surfaces are no longer regarded individually but instead considered as part of a series of observations (multimission strategies, time series, multiple satellite constellations such as the Global Precipitation Mission(GPM) and TerraSAR-X/ TanDEM-X) or signatures (e.g. spectral and angular, radar in combination with optical observations)
- Last two components have led to an increase in multiple sensor approaches (e.g. image fusion, multiple sensor classifications) for improved characterisation of land and water surfaces, increased temporal resolution, and

extended time series in support of global change and climate studies.

The relevance of the above aspects is reflected by the developments within the thematic focus covered by the individual WGs.

## *2. Accomplishments of Commission during the current year*

A selection of papers related to the TC VII symposium held from 5-7 July in Vienna, Austria was published in a special issue of "Remote Sensing". The special issue, entitled "100 years ISPRS – Advancing Remote Sensing Science", currently contains 12 papers. For more information see:
ttp://www.mdpi.com/search/?s_journal=remotesensing&s_special_issue=909

## *3. Working Group Activities During the current year*

### WG VII/1 - Physical modelling and signatures in remote sensing

***State of Science and Technology of Working Group Topics:***

Focus topics of the WG remain and emerge increasingly in advanced methods of forward and inverse modeling. Forward approaches are discussing direct radiance assimilation of satellite measurements into process models, where inverse approaches are either mathematical inversion (Hadamard criteria), intermediate or hybrid inversions (eg Minnaert-k), or biophysical and/or biochemical parameter inversion with their associated ill-conditioned and ill-posed constraints. The use of spectral invariants (recollision probability theory) has found its way into generating products in remote sensing.

***Accomplishments of Working Group in 2011***

1. NA

***Upcoming Working Group participation***

1. NA

### WG VII/2 - SAR Interferometry

***State of Science and Technology of Working Group Topics:***

The current hot topics of SAR Interferometry are DEM generation from space borne high-resolution SAR data, for example, from TerraSAR-X/TanDEM-X or COSMO-Skymed imagery, and surface deformation monitoring with SAR Interferometry and Persistent Scatterer Interferometry based on time series differentials of satellite SAR data.

In June 2010 TanDEM-X was launched, the sister satellite of TerraSAR-X. Both satellites will perform systematic bi-static mapping of Earth for the period of three years. From this data a global DEM shall be derived by DLR, which will be commercialized by Infoterra Company, Germany. The final DEM will complement and most probably clearly outperform well known SRTM data: the grid size is planned to be about 10 m and the vertical point-to-point errors are expected to be below 2 m (90%). Compared to traditional repeat-pass Interferometry conducted by single satellites taking images separately at repeated cycles, single-pass image acquisition comes along with at least two advantages: no temporal decorrelation occurs and the phase terms caused by atmospheric phase delay cancel out.

The advent of high-resolution civil SAR satellite sensors gives the opportunity of urban area mapping with much finer level of detail than ERS type of devices could provide. A striking example for the capability of the new sensor generation is the dramatic rise of so-called persistent scatterers (PS) preferably found in settlement areas in stacks of TerraSAR or COSMO-Skymed imagery. There are several reasons for this rise, we give two here: Firstly, close-by PS, which would lie in the same resolution cell for ERS, are mapped into different cells now due to finer spatial grid. Secondly, also weaker PS may be detected since they compete with clutter signal of a far smaller area.

The dense grid of PS boosts advanced techniques that rely on time series of satellite SAR images, for example, multi-baseline SAR Interferometry, Persistent Scatterer Interferometry, SAR Tomography, and Differential SAR Tomography. Those approaches usually require quite demanding signal processing methods, for instance, sophisticated spectral estimation techniques or compressive sensing. Besides the required further development of such approaches still many efforts have to be conducted in the future to validate such techniques, for example, in terms of accuracy and reliability in order to be able to apply those new methods to operational monitoring tasks, be it driven by public authorities or the private sector.

***Accomplishments of Working Group in 2011***

1. Organization of a benchmark activity: Validation of DEM from high-resolution SAR images of modern satellite sensors. DLR provided more images, so we now have available about 100 TerraSAR-X images over Berlin, Barcelona, Hannover, Edmonton, Trento, and Istanbul. Currently, 13 international groups of scientists participate. The groups conduct various techniques for elevation extraction from SAR data: Radargrammetry (e.g., SAR stereo), conventional InSAR (two images), and multi-baseline InSAR using image stacks. First results already have been published, for example at the Hannover ISPRS workshop. DLR evaluated positively a proposal of us to extend the work also to data of the TanDEM-X mission.
2. The WG co-organized the ISPRS Workshop for High-Resolution Earth

Imaging for Geospatial Information. Hannover, June 14 - 17, 2011. http://www.ipi.uni-hannover.de/ipi-workshop.html The proceedings can be found online in the ISPRS archives.

***Upcoming Working Group participation***

1. A special issue of ISPRS journal is currently organized by the WG, the publication is scheduled for fall 2012..

## WG VII/3 - Information extraction from hyperspectral data

***State of Science and Technology of Working Group Topics:***

Hyperspectral remote sensing has become mature in the past few years. The added value compared to multispectral systems has been broadly recognized which is evidenced by the large number of approved satellite missions including DLR/GFZ's EnMap and ASI's Prisma missions. In Summer 2009, ESA's airborne benchmark instrument APEX made its first aquisitions. There is a lot of ongoing research and activities in the field of hyperspectral remote sensing where an establishment of operational algorithms can be observed. Other progress includes:

1. Establishing a ground based validation site for HSR: Makhtesh Ramon Israel, has suggested as a calibration/validation site and now is placed on the CEOS website: http://calval.cr.usgs.gov/sites_catalog_template.php?site=makh. In March 2009 it was visited by more than 80 scientists worldwide to be recognized by the HSR community.
2. Quality Layer indicator for hyperspectral remote sensing data has been established within the EUFAR program and will be available soon in the EUFAR homepage. This was done after sending questioners to many HSR users in Europe.
3. A new approach on how to better correct the atmosphere in a non stable HSR sensor utilization has been developed and published in Remote Sensing of Environment by Brook and Ben Dor).
4. A new approach to correct for smile effect in Hyperion data over desert environment has been developed (Dadon A., E. Ben Dor and A. Karnieli (2010), Use of derivative calculations and minimum noise fraction (MNF) transform for detecting and correcting the spectral curvature effect (smile) in Hyperion images, published in IEEE Transactions on Geoscience and Remote Sensing.
5. Errors in soil spectral measurements using ASD field spectrometer were studied and presented at the ASD IEEE Workshop. A paper on that topic have been published in Soil Science Society of America by Feinstein et al, 2011.
6. Soil Spectral Group was established and aimed to collect soil spectra libraries worldwide (http://groups.google.com/group/soil-spectroscopy). So far spectral from 43 counties were gathered. Leader of the group is Raphael Viscarra

Rossel.

7. Within the EUFAR TA program a comperhensive flight campaing composed of 5 sensors and two aircrafts was conducted to check the SVC methods. 7 international groups were involved in this initaive.
8. Within the EUFAR program, an expert working group on hyperspectral applications for soil was created (www.eufar.net), lead by Eyal Ben-Dor. So far the group has more than 200 members.

A new scientific journal "Journal of Imaging Spectroscopy" has been established and the first volume is to be issued. The journal aimed at gathering all potential IS users under one umbrella. Ben-Dor is appointed as an associated editor managing the terrestrial application section.

***Accomplishments of Working Group in 2011***

1. Organisation of the Workshop "A Demonstration and Practical Exercise for Modeling of Soil Spectral Information (DePeMossi)", as follow-up meeting of the EUFAR Expert Working Group on hyperspectral soil applications. The Workshop consisted in a summer school for field spectrometry measurements, standards and protocols, and for practical training in three software packages: Unscrambler, Paracuda, and Hysoma. The Workshop DePeMossi was held at the GFZ German Research Center for Geosciences in Potsdam, Germany, from 29 to 31 August 2011. Workshop content are available on www.eufar.net. This Workshop was leaded by Chabrillat and Ben Dor.
2. A special issue of Hyperspectral Remote Sensing volume in Remote Sensing Open Access is open http://www.mdpi.com/journal/remotesensing/special_issues/hyperspectral-remote-sens/ (edited by Ben Dor).
3. An Hyperspectral Soil Mapper (HYSOMA) software interface has been developed under the EUFAR and EnMap umbrella at the GFZ German Research Center for Geosciences. It focuses on easy access for non-expert hyperspectral users to soil hyperspectral products (e.g. soil moisture maps, organic carbon and soil minerals content map). The HYSOMA will be soon distributed for free through the web. It is integrated in DLR hyperspectral processing chain, and (in 2012) in EUFAR Toolbox. Preliminary software content has been published in 2011 Conference Proceedings (Earsel conference) and a peer-review publication is in preparation on the subject
4. A special issue in currently organised by the WG on Quantitative Soil Spectroscopy in the Journal of Applied and Environmental Soil Science. http://www.hindawi.com/journals/aess/si/qss/
5. A proposal to the new EUFAR program to open the TIR region for Hyperspectral remote sensing and combine LIDAR data with Hyperspectral data have been submitted and passed a first stage.
6. Serving as a member in the advising committee board of the new NASA

hyperspectral mission to orbit: HySPIRI

***Upcoming Working Group participation***

1. The HYSOMA software interface will be distributed for free through the internet and through the EUFAR Toolbox
2. Open a collaboration channel between the Global Soil Library Group Activities and the NASA HySPIRI project.
3. Two invited talks in the IGARSS (Munich July, 2012) and 34ICG (Brisbane August 2012) conferences in Hyperspectral activities in soil.

## WG VII/4 - Methods for land cover classification

***State of Science and Technology of Working Group Topics:***

Very high resolution (VHR, better than 1 m) optical, polarized radar, and high density lidar (denser than 1 m) data are increasingly available to remote sensing community for research and application. Existing classification techniques have faced tremendous challenges to effectively extract information from these new data sets. Therefore:

- The number of research papers on classification of VHR optical imagery and polarized radar imagery is rapidly increasing;
- Research on classification using LiDAR data or multi-polarization SAR data starts to increasingly appear in publications;
- There are also many papers on combination of optical, radar and/or LiDAR data for classification.

Within the area of classification of VHR optical imagery, research on object-based classification is most active. However, most research is based on how to use eCognition software to achieve desired classification results. Research papers on new algorithms or new methods independent of eCognition are not many.
In the area of classification of polarized radar data, most papers have been trying to adopt, improve or change existing algorithms or concepts of optical image classification for classifying polarized radar images.

Since the launch of WorldView-2 satellite in October 2009, research activities have been increased on whether high resolution 8-band mulispectral images (2m MS, and 0.5m pansharpened MS) can improve the classification accuracy. These research activities have been promoted by DigitalGlobe through providing researchers (upon applacations) with WorldView-2 images free of charge.

According to the abstract statistics of the 2012 ISPRS Congress, 1776 abstracts were submitted to 98 sessions of the Congress (including ISPRS working group sessions and other joint sessions). Among which:

- 62 abstracts were submitted to WG VII/4, the second largest submissions

among all the sessions;

- 69 were submitted to WG III/4: Complex Scene Analysis and 3D Reconstruction, the largest session; and
- on average, 18 abstracts were submitted to each session.

This means that land cover classification still remains to be one of the most active research areas within ISPRS community.

***Accomplishments of Working Group in 2011***

1. Participating in the committee of The 2011 Joint Urban Remote Sensing Event (Urban 2011 & URS 2011), Munich, Germany, April 11-13, 2011, sponsored by IEEE GRSS and ISPRS.
2. Participating in the committee of The Third International Conference on Earth Observation for Global Changes (EOGC2011), Munich, Germany, 13-15 April 2011, sponsored by ISPRS, etc.
3. Technical chair of AfricaGE0 2011 in Cape Town, 31 May - 02 June 2011. This was a conference of the Southern African Geomatics community and was attended by some 700 delegates and exhibitors. Although not specifically aimed at WGVII/4 there was a significant component related to image classification. In fact two, well attended, conference technical sessions were dedicated to this and provided very interesting work. Keynote speakers at the conference included the ISPRS President Prof. Orhan Altan. The conference proceedings and details can be found at www.africageo.org
4. Scientific committee member of the International Symposium on Image & Data Fusion (ISIDF 2011) and giving a tutorial at the ISIDF 2011 conference.
5. Participated in the International Workshop on Global Land Cover Mapping, Beijing, January 12 – 14, 2011, on behalf of ISPRS WG VII/4.
6. Updated the ISPRS common datasets for land cover classification, providing a variety of remote sensing data free of charge to research communities to promote:
   - the development of land cover classification techniques;
   - the collaboration between remote sensing researchers; and
   - the exchange of research experience and comparison of research results based on the same datasets.

The data sets include medium resolution, high resolution and very high resolution satellite images, airborne digital images, and LiDAR data.

***Upcoming Working Group participation***

1. Assisting and attending *The XXII ISPRS Congress*, Aug 24 - Sep 3, 2012, Melbourne, Australia

# WG VII/5 - Methods for change detection and process modelling

***State of Science and Technology of Working Group Topics:***

Processing of multi-temporal images and change detection has been an active research and application field in remote sensing for decades. Although plenty successful applications have been reported on the monitoring and detecting of environmental change, there are enormous challenges in applying multi-temporal imagery to derive timely information on the Earth's environment and human activities. In recent years, great progress has been observed to overcome technological obstacles by the development of new platforms and sensors. The wider availability of large archives of historical images also makes it possible for long-term change detection and modelling. Such a development stimulates further investigations to develop more advanced image processing methods and new approaches to handling image data in the time dimension.

The mission of the working group VII/5 is to further enhance international collaboration in the field of remote sensing change detection. The focus also extends to the study of geo-process modelling using long-term remotely sensed data. It is endeavoured to promote and encourage collaborated efforts for the development of new technology for processing multi-temporal imagery, detecting changing environment and objects, and modelling long-term geo-processes.

***Accomplishments of Working Group in 2011***

1. Publication of the Workshop Proceedings: Lenz-Wiedemann, V.I.S. and Bareth, G. (eds.) (2011): Proceedings of the Workshop on Remote Sensing Methods for Change Detection and Process Modelling, 18-19 November 2010, University of Cologne, Germany. Kölner Geographische Arbeiten 92 (in press).
2. Co-organization of the 2011 International Symposium on Image Data and Fusion, 9-11 August, 2011, Tengchong, Yunnan, China.
3. Co-organization of ISPRS working group workshop on 'Dynamic and Multi-dimensional GIS (DMGIS'11), 17-18 October 2011, Shanghai, China.
4. Organization of ISPRS working group workshop on "Remote Sensing Change Detection and Spatio-temporal Modelling", 15-16 December 2011, Hong Kong. The conference details can be found at http://www.lmars.whu.edu.cn/cdsm2011/

***Upcoming Working Group participation***

NA

# WG VII/6 - Remote sensing data fusion

***State of Science and Technology of Working Group Topics:***

Image and data fusion aims at the integration of multi-sensor, multi-temporal, multi-resolution and multi-platform image data, together with geospatial data, GIS, in-situ, and other statistical data sets for improved information extraction, as well as to increase the reliability of the information. Image and data fusion techniques are important for combining the many sources of satellite, airborne and ground based imaging systems, and integrating these with other related data sets for enhanced information extraction and decision making. Through scientific workshops and a dedicated journal, WG VII/6 coordinates and sponsors state-of-the-art discussions and developments on the theory, methodology and applications of image and data fusion including a) automatic registration of images with different sensor, different resolution, and different acquisition mode, b) concept study and methodology development of data fusion at different processing levels, especially at feature and decision level, c) multi-source/multi-sensor data fusion and integration methodologies, such as fusing laser scanning data with images, fusing high resolution satellite optical imagery with high resolution SAR imagery, d) applications of data fusion to feature extraction, object recognition, classification, mapping, disaster monitoring, change detection, and e) information mining from multi-platform, multi-source, multi-scale, spatial-temporal data, e.g., geometric information, topological information, statistical information, etc.

***Accomplishments of Working Group in 2011***

1. Participation in the scientific committee of the International Symposium on LiDAR and Radar Mapping- Technologies & Applications, Nanjing, China, May 26-29, 2011( http://www.lidar2011.org), sponsored by ISPRS, IAG and FIG.
2. The main event organized by WG VII/6 in 2011 is the 2011 International Symposium of Image and data Fusion (ISIDF 2011), held in Tengchong, Yunnan, China, on August 9-11, 2011 (http://isidf2011.casm.ac.cn/). Sponsored by ISPRS, IEEE Geoscience and Remote Sensing Society, National Administration of Surveying, Mapping and Geoinformation of China, and Taylor & Francis Group. All papers resulting from the symposium have been published via IEEE Xplore and indexed by EI. Selected papers will appear in the International Journal of Image and Data Fusion published by Taylor & Francis.
3. WG VII/6 co-organized the ISPRS Workshop for Change Detection and Process Modeling (sponsored by ISPRS, etc), to be held in Hong Kong, December 15-16, 2011,

***Upcoming Working Group participation***

NA

## WG VII/7 - Theory and experiments in radar and lidar

***State of Science and Technology of Working Group Topics:***

Radar is an active remote sensing system transmitting and receiving microwaves for the retrieval of biophysical properties. Several applications using radar imagery have been explored in the last decades, such as the retrieval of vegetation density, soil moisture, the mapping of areas of flooded surfaces, river heights, etc., for as well global scale as small scale applications. Several physically-based radiative transfer models have been developed and tested for their use in parameter retrieval. The success of these models however is generally hampered by the lack of knowledge of additional biophysical parameters needed in the inverse problem (e.g. soil roughness). To overcome these problems, change detection techniques are being proposed that allow for relative information (e.g. change in soil moisture).

Airborne laser scanning (ALS) is an active remote sensing system for surface topography and object characterization. It is based on lidar range measurements between an aircraft and the target, and produces a point cloud (x,y,z), and the intensity (I). ALS has found a large number of applications in remote sensing, e.g., forestry, agriculture, cultural heritage, and built environment. The radiometric calibration and usage of the intensity data have been intensively studied recently as the first calibration methods have been published. This will enhance the usage and interpretation of point cloud data for, e.g., automatic target recognition and classification of objects. Integrating ALS with photogrammetry has also been widely studied in the laser remote sensing community.

Terrestrial laser scanning (TLS) methods have also become widely used in remote sensing, and the applications are constantly increasing in, e.g., forestry, hydrology, glaciology, archaeology, geomorphology, etc. The TLS applications are also related to vehicle-based laser scanning (also called mobile mapping), which has become a topic of increasing interest because of its efficiency in producing large amounts of data and high future potential for applications. The most recent mobile applications of TLS are commercial, low-weight TLS+GPS+IMU implemented in an unmanned airborne vehicle (UAV) platform.

***Accomplishments of Working Group in 2011***

1. Co-organiser Laser Scanning 2011 in Calgary. Fusion of lidar & radar data appears in the list of topics
2. Supporting Silvilaser 2011 in Hobarth, Tasmania, Australia: http://www.cdesign.com.au/silvilaser2011/

***Upcoming Working Group participation***

1. There is a new research article coming up about SAR and airborne scanning LiDAR 3D metrics in forest biomass determination. (This article is by Markus Holopainen, University of Helsinki, with contributions from S. Kaasalainen (WG VII/7) and Juha Hyyppä (TC vice president).
2. FGI and TU Vienna are planning a UAV based radar waveform tomography instrument
3. I would also like to report a radiometric calibration effort for ALS intensity in an EuroSDR project, for which the results will be presented in 2012.

## *4. Other Relevant Information (TCP)*

no other relevant information

## *5. Commission Officer Address Updates (TCP)*

no updates