

## EARSeL Workshop Reports

### 4<sup>th</sup> Workshop on Land Use/Land Cover

Following successful Workshops in Dubrovnik (2004), and Bonn (2006, 2009) the 4th Workshop of the Special Interest Group on Landuse/Landcover was hosted by the Technical University of Prague on 1-3 June 2011, attached to the annual EARSeL Symposium. The Workshop was attended by about 90 participants originating from over 20 countries. In contrast to the previous events, the 2011 Workshop was organized in five sessions along predefined themes, where invited keynote speakers gave oral talks followed by short oral introductions to the posters presented in each session. All keynote speakers presented current state-of-the-art research and pointed to future directions. They also highlighted still existing limitations and gave provocative thoughts to stimulate discussions afterwards. Participants presented their work in four posters and very intense discussions occurred in front of the posters.

Wrap-up discussions at the end of each half-day sessions were guided by the keynote speakers and fostered intensive exchange of experience, open questions, but also addressed major issues of concern, as well as unsolved problems. Participants very actively engaged in the discussions with quite different views. In particular the representation from science, operational service provider, and administration stimulated the open exchange. The Workshop was closed by a hands-on tutorial on support vector regression and classification. With this Workshop concept, the organizers intended to avoid the always unsatisfying task to select contributions for oral or posters. All submissions were handled equally and the posters receive already in previous events very much attention and often led to more feedback than talks. It was also the intension of the organizers to leave more room for discussion. By adopting such a clear Workshop character a distinguished event was achieved in comparison to other conference style meetings.



The National Technical Library in Prague, venue of the workshop.

In the opening session, two keynote presentations were given by Hans Dufourmont from the European Environmental Agency (EEA). His talks were titled "*Contributions to LULC mapping from the GMES Land Monitoring Service*" and "*Requirements in LULC monitoring in Europe*". They provided a focused elaboration on the GMES Initial Operations (GIO) program from a GMES programmatic point of view and on the requirements, the usage and role that the European Environmental Agency (EEA) takes up for the GIO land activities. The first keynote addressed the overall GMES program, how the user consultations led to the proposed portfolio for the land services, and how the programmatic framework has been elaborated by the GMES bureau, and finally some key examples of expected services. The second keynote addressed the requirements of the EEA in terms of land use and land cover data and information. The requirements have been illustrated by the evolution of usage of land cover data in the EEA, keeping the pace of policy requirements and the technological evolution. Furthermore the overall planning for the technical coordination of the upcoming GIO land services has been highlighted.

The following discussion was very active and controversial. Major issues raised among others were e.g. *Why an EU-wide urban atlas is generated while most cities have much more detailed data at hand?* Hans Dufourmont (H.D.) responded that a homogeneous database is required. Efforts to get and compile it from different European and administrative sources as well as data formats are a main obstacle. In order to have something put forward he pronounced that it is sometimes easier to do a

new product. Martin Herold (Wageningen Univ.) was concerned that the science community is supposed to be a major stakeholder in GMES and how this is handled in practice. H.D. mentioned that access via EU projects, as well as new FP7 projects in e.g. the space call, addressed to this community will enable this. Giles Foody rose the points (a) how much of the GMES budget is actually dedicated to quality check, and (b) if the increased quality demands for the high resolution layers are still in line with the costs. He was responded that it is expected to be a few percent of the budget (e.g. as for the soil sealing layer), and that quality/price issue will be a subject of the tendering process. Pavel Milenov asked if national orthophotos that are anyway acquired would not be a better alternative than space imagery. They are already successfully used. The difficulty for pan-European products are the different acquisitions dates for production, while on the other hand they are very valuable for QA. Another topic addressed the Corine Land Cover (CLC) compatibility with FAO Land Cover Classification System (LCCS). H.D. responded that EEA is directly involved in the discussions with FAO, and with UNSD on the SEEA methodology. A recent meeting between these stakeholders has yielded an agreement on how to best link the various approaches on LC/LU, and it will be possible to make a CLC derivative that fits the future commonly agreed approach.



Finally, H.D. asked the auditorium if there are other methods and techniques out in the science community that might be used for production and potentially reduce costs. There was not a clear response, however, it was highlighted that there exist many techniques. Most science labs do not focus on production over different physiographic regions and large areas. It is also a matter of access to the data used in operational production, e.g. image2006, image2009. The available methods cannot be easily tested or adapted for operational use. This fact strongly limits development and potential cost reduction. A comprehensive inter-comparison exercise for methods on different data sets and rigorous independent accuracy assessment should be targeted.



In a dedicated session on classification and change detection the first keynote was given by Lorenzo Bruzzone (Trento Univ.) on the topic of *“Current and future trends in automatic classification of remote sensing images”*. He focused on modern classification techniques and how they can advance the field in land cover. Various classification algorithms and active learning strategies were presented with example case studies for their applications. In a second talk given by Gunter Menz (Bonn University) *techniques and challenges in change detection* were reviewed. He first outlined how change detection research has developed since the launch of the first earth observation platforms from space by a comprehensive literature review. In subsequent part of the presentation, he provided case studies on various change detection approaches, and pinpointed where still difficulties and unsolved problems exist.

Questions addressed in the subsequent discussions covered e.g. the main limitations of current classifiers available in commercial software. The response by Prof. Bruzzone demonstrated that many methods do not take into account the data properties, e.g. when using high resolution or very high resolution data, multi-level object oriented approaches that properly model the semantics of the class would be appropriate. Many techniques have been developed in the research field but transformation into commercial software and hence application is lacking. In general, a large gap between the community that develops techniques and algorithms, and the application community was identified by the Workshop participants.

Other topics of concern were that a very clear legend and goals have to be predefined prior the classification, since often land cover and land use classes are merged. In this discussion also the issue of access to data came up again. Some contributions were in favour of constellations in order to ensure access to data, while others saw a main problem for research in accessibility of existing resources (e.g. Image2006, Image2009). From the responses it seemed to be more important to push for funds in the field of transfer of methodologies, rather than for new missions, in particular with the Sentinels in view. For change detection it was highlighted by J. Hill (Trier Univ.) that meanwhile time series are available to detect changes and that such approaches can provide more robust results also with slighter changes. The community is still very much focused on bi-temporal approaches, and should explore the available archives much more. One participant suggested that a web forum related to the EARSel interest group should be established. It emerged that the community has some needs to exchange on these topics. Such a platform could certainly be extended to other topics that came up during other discussions of the Workshop.



The morning session on Thursday covered European and global land cover monitoring as well as pre-processing, accuracy and quality issues. In the morning Steffen Kuntz from Astrium Services / Infoterra GmbH gave a first keynote on *European and global land cover monitoring: operational approaches and research demands*. He was followed by Martin Herold (Wageningen Univ.) with his talk on *Global land cover monitoring: where are we now and what is the way ahead?* Following both presentations a lively discussion was initiated. A general feeling among the attending scientists was that while the GMES activities for European land monitoring are making progress on developing and implementing services in cooperation with the EC, Member States and the EEA, GMES seems to be an encapsulated process, not necessarily driven by research and innovation, and science user involvement. As a consequence various issues of concern were addressed in the discussion, which can be summarized in the following:

- Many attendees of the Workshop showed the impression that GMES is still a distant, more political process with a strong engagement by some value adding industry. It seems to be difficult for many scientists to follow the process. Involvement of the science community, and drawing full advantage of European scientific capacities, seemed not to be fully developed. Much more consultation and interaction between production, users, and the available scientific expertise is necessary. Several complaints from the audience expressed that an early stage science involvement in the process was lacking, and now it seems to be showing up in some of the requests for alternative or improved methodologies.
- Some members of the audience also saw that the needs of the scientific community as key user of GMES seem to be not properly considered nor assessed. They also pointed out the need for a well-funded, independent scientific assessment of GMES Land service products.

Geoland2, as FP7 project, advancing methodologies for a GMES land service has some feedback mechanisms for users, but they also see that GMES was not designed for the scientific community. EARSeL is currently carrying out scientific soundness reviews for some of the approaches used in geoland2, but this does not include any aspects of scientific use of the products nor the testing of alternative approaches. For this, the products and databases would have to be made accessible to the broader scientific community and additional funding would have to be brought up. For instance, today access to Image2000, Image2006, Image2009 and the thematic products is either limited or complex or restricted to FP7 projects only, and thus limits even voluntary participation of scientific partners.

- Another issue covered in the discussion was that Calibration/ Validation (Cal/Val) activities are currently still largely understood as ad-hoc add-ons to products and service development; not as an integral part of an operational monitoring system. The lack of substantial investments into Cal/Val becomes the largest stumbling block to large area land cover Earth Observation progress beyond state of the art.
- In a similar way some aspects of the Sentinel missions were considered critically. They are defined as operational missions, but address important scientific challenges as well. Many science partners and user needs are not involved in GMES activities at this point, and hence have difficulties entering into the system. Thus, the sole focus of specific user/service needs, and service cost constraints creates a steadily growing innovation gap and limits European leadership and innovation in the field, as well as more research-driven approaches.
- In regard to global land monitoring, research needs are in a consistent global and large area time series processing and analysis (for Sentinels), and investigations into synergies between multiple Sentinel satellite observations with consideration of the Land Data Continuity Mission (LDCM). Robust Cal/Val networks need to be established as an integral part of an observing system. Additionally, the historical data archives are still lacking full exploitation, and are expected to contain very valuable information from a global perspective.

Overall, the discussion strongly reflected the statements and discussion outcome from the previous day. There seemed to be an evolving mismatch between the need of industry and administration for scientific involvement and contributions, while at the same time very limited investments are being made into related R&D. Joint efforts should be undertaken to close this discrepancy. The discussion also revealed that more benchmarking of algorithms and products is needed, however, with clear, predefined definitions of products and procedures for evaluation. In this regard, proposals to ESA/EU should be considered or addressed in scientific networks proposals to EC.



In the Thursday afternoon session, focus was laid on data pre-processing and accuracy assessment. Michael Schaepman (Zürich Univ.) opened the session with a talk on *“Advances in quantitative, physically based processing of optical data”*. He was followed by Giles Foody (Nottingham Univ.) focusing in his talk on *“Accuracy assessment for LULC products”*. He pointed out that remote sensing scientists are perhaps sometimes overcritical with the quality of their products in comparison to other approaches. Also maps are subject to generalization and have errors.

As expected, a very intense discussion developed around the quality issues as almost any project has to struggle with this. The question was posed, if there is any remedy to overcome ground data imperfections. Giles Foody pointed towards his talk, where he outlined possibilities to include (estimated)

errors of the ground truth data in the accuracy assessment as there is always a bias in ground truth data. He also recommended to focus on better higher quality data, than many. Michael Schaeppman pointed out to start a different view on ground truth as there are cases, where ground truth data are more wrong than the earth observation data. Lorenzo Bruzzone added that different classification algorithms have different sensitivities to ground truth errors and hence the selection of an appropriate method for approach needs to go in hand with the selection of Cal/Val data. It was also mentioned that the product users should be more explicit on their purpose for the product in advance as it might influence the chosen approach. In a similar way, the minimum mapping unit of the product needs to be considered in advance by equivalent areas. When using object-oriented approaches that are strongly associated with spatial patterns, those also need to be reflected by the validation data.

Based on this, Martin Herold asked how we do actually best generate reference data. This is becoming a very important topic for large-scale and global studies. Answers were that no ideal way may exist, but that systematic acquisition might be best, as errors can then be easiest removed. Moreover, standardization was suggested for ground truth data in order to be more comparable in the community. This was considered a very important point although very difficult to achieve. Micheal Schaeppman pointed out that very often it is not the measurement itself, but the protocol used for acquisition, as well as the documentation. He suggested to look at e.g. the INSPIRE initiative that has gone through this issue very extensively. It was concluded that it is better to have a poorer product, but a better and thoroughly validated one, rather than potentially excellent data validated in a poor process. Hence, it was advised that 1/3 of the budget should be spent on validation, and 2/3 on data acquisition and processing.

The last session of the Workshop on Friday June 3rd targeted a broader perspective from the so far very remote sensing concentrated view. The session was titled "*Beyond mapping: socio-economic dimensions and drivers for LUCC*" and was kicked-off by a very stimulating keynote by Patrick Hostert (Humboldt University Berlin) on "*LUCC - mapping, causes, drivers, implications*". He nicely showed the link between our remote sensing observations and the various components leading to land use and land cover change. With various examples from Eastern Europe, Africa, and South America he clearly demonstrated that observing the patterns of change is one thing, but explaining them and making full use of their content requires much more efforts. It also encouraged participants not to stop with their research at the pure remote sensing analysis and product, but interdisciplinary work with other science groups.



In the lively discussion in this session, one of the major issues raised was how are we going to differentiate between modification and transition, how much can classification contribute here, and how many other approaches do we need. Replies by e.g. Stefan Arnold, from the German Federal Agency for Cartography and Geodesy, mentioned that precise and detailed information is required in first order, from which subsequent other products may be derived. Novel, object-oriented data models can provide a better base for this. Matthias Braun (Univ. Alaska Fairbanks) mentioned that, in his view, continuous products based on physical correct algorithms, such as e.g. vegetation continuous fields or albedo products, will play a stronger role in the future. He also suggested that then more documentation on (pre-)processing is required. Such products might facilitate a better discrimination of subtle changes. Michael Förstner added that a global standardization might be difficult, but solutions tuned to the problem are required. Similar discussions were happening in ecology in the 1990's.

Other contributions added that the problem might be tackled at different scales and that more metadata need to be provided with the land cover classifications. The FAO Land Cover Classification System was also mentioned in this context having the potential to guide such meta information needs to a standardized product.

At the end of the Workshop a “Tutorial on Support Vector Regression for Satellite Imagery using imageSVM in the EnMAP-Box” was given by Sebastian van der Linden and colleagues from the Geomatics Lab of Humboldt University Berlin. He introduced the audience to their implementation of various classification and regression tools, and in particular to support vector regression. The toolbox is designed in the software framework of the upcoming German hyperspectral satellite EnMAP. It is a plugin for the commercial ITT ENVI distribution or can also be used with the freely available ITT ENVI virtual machine. Sebastian van der Linden explained the methodological background of the techniques, and demonstrated how to effectively make use of the software and how products can be generated with the software.

At the closing session, the overall feedback from the audience, as well as based on the intense discussions, the chairmen's impression was that the new Workshop concept with invited talks only and contributed posters by the participant was positively received. They will ensure that for the upcoming SIG events posters can be displayed for the entire Workshop time to provide even more attention to them. Tobias Kümmerle (Department of Earth System Analysis of the Potsdam Institute for Climate Impact Research), and Sebastian van der Linden (Geomatics Department of Humboldt University in Berlin) kindly offered to host the next Workshop in Berlin. It is currently scheduled to take place in 2013; details will be announced with sufficient time in advance.



geoland:2



The SIG chairmen would like to thank the local organizers, Lena Halounova and her team for their very active support. We will certainly remember the hearty welcoming smile of our hosts, and the wonderful icebreaker and dinner, which settle down in every ones memory.

The Workshop was financially supported by the EU FP7 geoland2 project. Both for the geoland2 project and the EARSel Community the Workshop was an excellent opportunity for live interaction and feedback on contemporary developments and trends. The high quality contributions by the Workshop participants, as well as the stimulating keynotes lead to very intense and vivid discussions.

Engaged participants and high quality level discussions form the backbone of our SIG, and guarantee the success of the SIGs role within the scientific and European community.

On behalf of the organizing team and the participants,  
Matthias Braun & Ioannis Manakos, with contributions by the keynote speakers.

The SIG Land Use / Land Cover on the internet: <http://www.earsel.org/SIG/LULC/>

## 1<sup>st</sup> Workshop on Forestry

### Operational remote sensing in forest management

The first European Association of Remote Sensing Laboratories workshop of the Special Interest group on Forestry was held in framework of the EARSel symposium 2011, 2 – 3 June 2011 in Prague, Czech Republic. It was jointly organized by the Czech Forest Management Institute and the Forestry