

## **Report of ISPRS/GEO Workshop on High Resolution Global Land Cover (GLC) Mapping, held in Beijing China on 27-28 April 2013**

### **Summary**

With nearly 60 participants from more than 20 institutions and organizations, including ISPRS, GEO and other units, GEO/ISPRS international workshop on high resolution global land cover mapping was successfully held in Beijing during April 27-28, 2013.

The workshop discussed and exchanged the new progress in global land cover research, data services and verification system. In particular, introduced the outputs of 30m global land cover mapping project by the National Geomatics Center of China (NGCC), under the leadership of ISPRS President *Professor Chen Jun*. The prototype data for global land surface water at 30-meter resolution in the year of 2000 and 2010 was on display.

The participants discussed the evaluation and validation of global land cover datasets, dynamic GLC information services and cooperation issues with an agreement on a roadmap for international support in water product validation with the objective to broaden the GLC validation overall. This includes a call through GEO network to contribute validation datasets, to support validation of 30m water product (and other future GLC products) if possible etc.; develop and discuss a validation interface for GLC products and update/enhancement which is linked to existing tools and interfaces in the GEO GLC task.

The participants recommended that the next step is developing strategic planning for the GEO ministerial on presenting some demonstration on how the GLC tools could be used and clean up validation task sheets with an agreement among validation task leaders and other relevant contributors of GEO SB-02 task.

The workshop was organized by ISPRS ICWG IV/II/VIII-Global Land Cover Mapping and Services, jointly organized by GEO SB-02 (Global Land Cover Mapping) Task Team, National Geomatics Center of China (NGCC), Institute for Global Change Studies at Tsinghua University, and State Key Laboratory of Earth Surface Processes and Resource Ecology (ESPREE) in Beijing Normal University.



## **The workshop Sessions**

The two-day workshop consists of six sessions including progress updates on GLC mapping, new methods for GLC mapping and monitoring, GLC validation, and GLC information services and applications.

### ***Session 1: Progress Report I***

*Professor Chen Jun* introduced the objectives of the project and described its current status. The aim is for a GLC data service at 30 m resolution. Approximately 10,000 scenes from Landsat and other sources have been processed by manual and automatic methods to obtain worldwide coverage for each of the years 2000 and 2010. Due to the time taken to acquire the scenes, the data covers different seasons around the world and there are still some areas obscured by cloud. The plan is to launch the GLC data by the end of 2013.

*Professor Peng Gong (Tsing Hua University)* described the progress of automatic classification for the GLC mapping, which he is undertaking and is described as 'GLC lite'. Valuation of the data showed an overall accuracy of between 70% and 80%. There were some regional outliers. 90,000 test areas are available for the water extraction. Support Vector Machines (SVM) and Random Forest are examples of image processing methods that proved to give the best results.

*Professor Anping Liao (NGCC)* spoke of the hierarchical classification methods used for the GLC mapping. It is pixel and object based, followed by checking and editing. The best method was chosen from SVM, classification trees or Maximum likelihood and also eCognition. For water areas, the main channels were classified as water, the rest as wetlands. There are 4 steps used for quality control of the GLC.

*Xiaoping Song (University of Maryland)* spoke of the current results of forest monitoring using Landsat data.

### ***Session 2: Progress Report II***

*Bruce Mora (GOFC-GOLD land cover project and a panel of GTOS)* presented details of coordinating international efforts for a systematic program of space-based and in situ ground observations for forests and land cover. He advocated free access to data. Achievements include historical archives, global products with an emphasis on validation, based on the land cover classification system developed by FAO and UNEP. The first land cover product is for 2008. Reference data for GLC is available on a web portal, including a list of available datasets, upcoming data and future datasets. Many publications are available including fire risks maps, REDD source book, and training materials.

*Antonio Arozarena (IGN Spain)* spoke on the Spanish contribution to high resolution GLC. Spain is decentralised and hence the integrated land monitoring and production system is for 17 separate administration areas. Very high resolution products are obtained from aerial photos and lidar data. Object oriented data models are used instead of a hierarchical data model based on a bottom up approach. This is being discussed with FAO. Thematic accuracy is 80%. It is possible for collaboration with the GLC project.

*Paul Uhlir (NAS-USA)* spoke on progress of GEO data sharing principles. Data sharing principles include minimum time delay/cost, meta data free or at minimum charge. Guidelines include 'full and open exchange'. The data sharing action plan, adopted in 2010, includes the following actions: GEOSS core data to address all 9 GEO societal benefit areas; members' use of data; maintaining common infrastructure and integration into GEOSS activities; take leadership; overlapping flexible policy frameworks; maximise the number of datasets; and promote benefits and open access. Case studies are in the action plan. They are now working on legal aspects of data sharing, focusing on the 'public domain'. More participants are required worldwide to achieve semantic interoperability.

### ***Session 3: New Methods for GLC Mapping and Monitoring***

*Yifang Ban (KTH in Sweden)* spoke of the data gap for high-resolution GLC mapping when using optical data alone due to cloud cover and needs for integration of SAR and optical data. She presented a case study on fusion of SAR and optical data for GLC mapping and change detection. The results showed that fusion of SAR and optical data achieved better accuracy than SAR or optical data alone.

*Dengsheng Lu (Michigan State University)* spoke of GLC mapping using multi-scale remotely sensed data. Many countries have LC maps of their own. Critical issues in undertaking the mapping include the selection of suitable variables from the data. He fused MODIS and settlement index and concluded that coarse remotely sensed data can be beneficial when combined with higher resolution data.

*Xuehong Chen (Beijing Normal University)* described an automated approach for updating land cover maps based on integrated change detection and classification methods. He used

an iterative Markov random fields approach with post classification, vector analysis in posterior probability space.

*Miao Lu (NGCC)* described a spectral gradient difference-based change detection approach for land cover.

#### ***Session 4: GLC Data Validation***

*Lijun Chen (NGCC)* spoke on preliminary results and next steps on the validation of GLC surface water product. He has established cooperation with various locations in the world and will have more than 10,000 samples worldwide, based on self—evaluation. Global accuracy is about 96%. International evaluation is needed before launching the site. The future will include design and documentation, prototyping and testing, product validation.

*Linda See (IIASA Austria)* described validation and the Geo-Wiki development. She compared various GLC products and has developed a hybrid land cover map based on crowd sourcing and Google maps using Web Map services. Data includes disagreement layers and a rating of the GLC maps with Geo-Wiki used to assist in correcting. 250,000 pixels have been collected by crowd sourcing campaigns. Geo tagging of photos is available on Geo-Wiki Mobile/pictures. Validation can be done by adding details to Geo-Wiki, which will be live in the June/July period. She encouraged students and professional to access [www.geowiki.org](http://www.geowiki.org).

*Carlos Padovani (IMPA, Brazil)* has mapped and monitored water surfaces and land use in the Pantanal and other areas in Brazil.

*Alexander Jacob (KTH Sweden)* spoke on the GLC validation. He stated that his first impressions of the quality of the GLC are good, but closer scrutiny shows some minor problems. Due to missing features of the validation portal, efficient validation was difficult. Manual validation is not possible for small institutions. Good potential to use existing reliable maps for validation. There are good maps over Sweden, but uploading to them to the GLC portal may be a problem. The process needs standardisation for validation. A ‘wish list’ for validation includes: a web service - WMS; receiving quality assessments; definition of quality measures; display of problem areas; possible solutions.

Tobias Langanke (EEA) GEO supports GLC validation. He spoke of the concepts, roadmap, challenges and next steps. A land monitoring pan-Europe component has been undertaken using RapidEye images. They are waiting for Sentinel2 to further this work. Corine land cover is for 25 ha minimum areas and done commercially, then verified, enhanced, integrated and disseminated. The final product will be available by 2015. Validation requires reviewing and planning. There are many databases available, but procedures need to be refined. For Europe, JRC and EEA plan to validate the data by end 2013. This could then be integrated into GLC data, but not necessarily the Chinese data. Corine is validated for 2000 but not 2005.

#### ***Session 5: GLC Information Services and Applications***

*Eren Turak (GEO Biodiversity)* spoke on using ground observations by volunteers to produce time series of wetlands from GLC products. For global biodiversity monitoring there are essential biodiversity variables which should include with the ecosystem. Primary observations are derived from various sources including remote sensing, then modelling is undertaken, processing and inferences. The freshwater working group needs to improve monitoring, data sharing, modelling and forecasting. Key variables are required by 2015. They need global snapshots at 1-5 years intervals for wetlands as small as 0.4 ha, to detect significant gains and losses in major habitats for biodiversity, consistent over time and space, easily accessible, and at low cost. Crowd sourcing by volunteer networks and communities are used for in situ observations and by remote sensing. This requires volunteer protocols for ongoing monitoring using for example Geo-Wiki. In Australia, Freshwater Watch is done in collaboration with HSBC bank, which trains its employees as science leaders for monitoring national and local wetlands programs

*Xin Cao (Beijing Normal University)* spoke on the spatio-temporal analysis of global land surface water cover. Water areas vary significantly but globally they total about 3.6 million km<sup>2</sup>. There is a systematic difference between water areas detected from MODIS and Landsat TM. Southern hemisphere has <15% water surfaces, the Northern hemisphere has 86% water surfaces, which varies with longitude. Europe has average coverage of water areas, while Africa is 1% less than average and South America 1.5% less than average. North America has above average water areas while Oceania has 0.5% water areas.

*Hao Wu (NGCC)* showed preliminary results of dynamic land cover information service.

### ***Session 6: Cooperated GLC Information Service Platform***

*Songnian Li (Ryerson University)* described CanICE, serving historical sea ice overage which is available the web through a portal.

*Gang Han (NGCC)* described the necessary components for validation and publication of the GLC: project team members, system administration, design of SOA architecture, web service, functional service, data service etc.

*Songnian Li (Ryerson University)* also spoke on setting up the GLC portal with meta data catalogue which will not hold the data. It should provide capacity for a dynamic GLC service computing to facilitate access to the GLC data.

In the discussions, it was suggested that a call for expressions of interest could be made to contribute to validation datasets from other land cover projects, based on a validation interface. This could be similar to existing methods with a top down/bottom up approach using standardised methods.

*Chen Jun* concluded with a request for Songnian Li, Tobias Langanke and Linda See to contribute to the development of the portal. A proposal will be submitted shortly to ICSU within the framework of Future Earth. He is also seeking a person to assist with the further development if the water component. There is still room for improvement in the GLC due to

cloud cover, so extra data is required to fill the gaps. The group suggested that they should meet again in Toronto in August 2014.

Reported by Lijun Chen, John Trinder and Yifang Ban  
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