**"Capacity Building for High-Resolution Land Cover Intercomparison and Validation"**

"Capacity Building for High-Resolution Land Cover Intercomparison and Validation" project (hereafter, the project) was focused on responding on current needs in field of intercomparison and validation of high-resolution Land Cover (LC) maps. The production of LC cover maps is expanding quickly due to the two complementary circumstances: advancement in the Earth observation technology and broader demands for the information they provide. Higher number of LC maps implicates higher effort for its validation to estimate their accuracy, which is essential parameter to determine suitability of LC map for certain objective.

The project was oriented towards creation of the computer aided teaching and learning material (hereafter educational material) that facilitates and enhances implementation of validation and intercomparison. Prior to creation of educational material, analysis of the state-of-the art were conducted to understand the needs in this field. The outputs were presented and advertised in several workshops and conferences. The participants in the project were: Maria Antonia Brovelli, Hao Wu, Marco Minghini, Xinyan Zheng, Msilikale Msilanga, Mark Iliffe, Maria Grazia D'urso, Sisi Zlatanova, Phoebe Oduor and George Sithole.

In the intial phase of the project, Maria Antonia Brovelli and Monia Elisa Molinari had a meeting with Wu Hao, Peng Shu, Xinyan Zheng, Chen Jun in Beijing, China. This research visit lasted between 11. May and 19. May 2018., during which the participants started planning how to develop educational material.

Another research visit was arranged between 08. July and 15. July 2018. In this occasion Xinyan Zheng went to Italy [1] to take part in a workshop and several meetings with Maria Antonia Brovelli, Marco Minghini, Monia Elisa Molinari, Candan Eylül Kilsedar and Gorica Bratic. The workshop called "International Workshop on Validation and Intercomparison of Global High resolution Land Cover" was focused on development of educational material and it was held in Como campus of Politecnico di Milano on 10. July 2018 [2]. Also, a number of meetings was organized in Como and Milan in the period between 11. July and 15. July 2018 for collaborative work on finalization of 3 deliverables of the project. First deliverable was the paper submitted to the International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, titled "Open source software and open educational material on Land Cover maps intercomparison and validation" [3]. Moreover, two reports, on the state of the art in Capacity Building for high-resolution land cover intercomparison and validation, and on the needs and requirements for training in this field (specifically focusing on developing countries) were concluded.

The two reports were fundamental to decide what to include in the training material and in which form (documents, slides, code snippets, etc.). In the period between May and August 2018, extensive case-based educational material in form of slides, text documents, exercises, code scripts and example datasets were prepared by participants in the project. The material was based on the of Freeware or Free and Open Source Software (FOSS). It is now available in official institutional repository under the Creative Commons Attribution 3.0 License (CC BY 3.0). It is a set of practical guides for three procedures: desktop validation/inter-comparison in QGIS using raster or vector points dataset as a reference [4], online validation platform [5], and collection of reference LC data [6]. The work on educational material creation was divided between: Maria Antonia Brovelli, Marco Minghini, Monia Molinari, Gorica Bratic,Candan Eylul Kilsedar,Chen Jun, Wu Hao,Xinyan Zheng,Peng Shu and Hongwei Zhang.

Dissemination of the educational material started with FOSS4G 2018 Conference in Dar es Salam, Tanzania (29–31 August 2018) [7]. In this conference "Capacity building for high-resolution land cover intercomparison and validation: what is available and what is needed" paper was presented [8]. This paper shows the analysis of existing software packages and their usefulness to for validation and inter-

comparison. Existing software with functionality of validation/inter-comparison were identified and described. However, the instructions for use were found to be mainly focused on the whole software and not on a specific functionality like validation. As a conclusion, an ad-hoc educational material, that is focused only on validation would facilitate validation/inter-comparison, and intensify its use. It was published in International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences (Volume XLII-4/W8) [9].

Furthermore, two hands-on workshops were given: the first on September 1, 2018 at the World Bank in Dar es Salaam, Tanzania (in conjunction with the FOSS4G 2018 conference) [10]; the second on September 3, 2018 at the Regional Centre for Mapping of Resources for Development (RCMRD) in Nairobi, Kenya [11]. The workshops were attended by a total of 60 people with a background in GIS and Remote Sensing, distributed among students, GIS analysts and developers, professionals and public employees.
The last workshop [12] was given during the ISPRS TC IV Symposium 2018, held in Delft (The Netherlands) in October 1-5, 2018 [13]. In this workshop there was around 60-80 attendees.
The program of the workshops was based on the previously created educational material. Participants were first given an introduction on LC maps and their importance for the assessment of SDGs [14]; this was followed by a presentation of GlobeLand30 (GL30), the first global LC map at 30m resolution, and its online platform for the visualization, analysis and validation of the LC data [5]. The Land Cover Collector application, which allows to collect and classify LC data, was then presented to the participants [6]; finally, a hand-on session was provided, showing a procedure for LC map validation based on QGIS and PyQGIS [4]. The workshops were conducted thanks to the effort of Chen Jun, Maria Antonia Brovelli, Peng Shu, Marco Minghini, Gorica Bratic, Msilikale Msilanga, Devotha Laurent, Phoebe Oduor and Kenneth Kasera

Moreover, during the ISPRS TC IV Symposium 2018 [12], paper "Open source software and open educational material on Land Cover maps intercomparison and validation" was presented [3]. This paper encompasses all the steps taken to finalize educational material, from analysis of the state of the art and requirements that new educational material should include, to the educational material development and illustration of its use.
One more paper was prepared for 5th Open Source Geospatial Research And Education Symposium (OGRS) [14] held on 9-11 October 2018 in Lugano, Switzerland. It was published in the PeerJ Preprints [15] with title "Open educational resources for validation of global high-resolution land cover maps". The paper presents work on educational material creation by participants from Politecnico di Milano. It describes desktop procedure for validation by means of QGIS/PyQGIS and collection LC reference data using smartphone application Land Cover Collector.

Lastly, in occasion of the first United Nations World Geospatial Information Congress (UNWGIC) held in Deqing, Zhejiang Province, China from 19 to 21 November 2018. [16] under the umbrella of ISPRS, the session "Global Land Cover and Intelligent Analysis of Remotely Sensed Images" was organised and held on Wednesday, 21 November 2018 [17]. The session was prepared in collaboration with Maria Antonia Brovelli, Wen-Zhong John Shi, Peng Shu, Olha Danylo, Qingquan Li and Serena Coetzee.

The session started with the current state-of-the-art in remote sensing for the generation and update of geospatial information and presented the mechanisms and applications of AI for Earth Observation. Then the existent High-Resolution Global Land Cover products, focusing on GlobeLand30 as considerable example, were shortly presented. Problems related to the creation of these datasets and their assessment were subject of the discussion. Besides the traditional assessment procedures made by the producers, collaborative validation, involving the activity of different countries in the world was presented as a best practice. Free and open education material (book, hands-on training material) "Capacity Building for High-Resolution Land Cover Intercomparison and Validation" was part of the session program, when it is shown

how it can be downloaded and used, and that it is able to improve the capacity in all countries, especially the developing ones. Summarizing, the session presented the Global High Resolution Land Cover Maps as a whole, from the scientific challenges to the involvement of citizens, using GlobeLand30 as a relevant example [18].

Since ISPRS TC V Mid-term Symposium in Dehradun, India on November 20-23, 2018 was in the same period as UNWGIC it was not possible to attend both. The latter one was chosen as it was seen as an opportunity to give more visibility to the project outside the ISPRS community.

In the following there are pictures taken during the workshops in Africa and during UNWGIC.



Participants of the Workshop in Dar Es Salaam (Tanzania), 1 September 2018

Participants of the Workshop in Nairobi (Kenya), 3 September 2018



Attendees and the speakers with Prof. Chen Jun, leader of the project GlobeLand30 (UNWGIC, Session: "Global Land Cover and Intelligent Analysis of Remotely Sensed Images")

# Documentation:

[1]  *Zheng Xinyan_invitation_letter.pdf.*

[2]  *Como Workshop Announcement.pdf.*

[3]  *Brovelli_et_al. Oct.2018.pdf.*

[4]  *http://www.gisgeolab.polimi.it/docs/training/ISPRS2018/Validation_QGIS.zip.*

[5]  *http://www.gisgeolab.polimi.it/docs/presentations/Validation_with_GlobeLand30_Geoportal.pdf.*

[6]  *http://www.gisgeolab.polimi.it/docs/training/ISPRS2018/Land_Cover_Collector.zip.*

[7]  *https://2018.foss4g.org/.*

[8]  *FOSS4G2018.pdf.*

[9]  *Brovelli_et_al. Aug.2018.pdf.*

[10] *Dar Es Salaam Workshop Announcement.pdf.*

[11] *Nairobi Workshop Announcement.pdf.*

[12] *http://www.isprs.org/tc4-symposium2018/workshops.html.*

[13] *http://www.isprs.org/tc4-symposium2018/.*

[14] *http://www.gisgeolab.polimi.it/docs/presentations/Supporting_SDGs_with_land_cover_information.pdf.*

[15] *https://peerj.com/preprints/27214/.*

[16] *http://ggim.un.org/unwgic/.*

[17] *http://ggim.un.org/unwgic/nov21-parallel-Global-Land-Cover-and-Intelligent-Analysis-of-Remotely-Sensed-Images/.*

[18] *Global Land Cover and Intelligent Analysis of Remote_Brovelli.pdf.*

[19] *http://2018.ogrs-community.org/.*

| FINANCIAL REPORT – ISPR PROJECT | | | |
|---|---|---|---|
| DATE | AMOUNT | DETAILS OF THE EXPENDITURE | EVIDENCE OF EXPENDITURE (*) |
| 01/03/2018 | € 204.21 | Department taxation on research funds from external sources in compliance with Politecnico di Milano regulations | The relevant regulations of Politecnico di Milano concerning this point can be provided upon request (only available in Italian) |
| 06/04/2018 | € 3,500.00 | Partial contribution to the 12-month research grant of Ms. Candan Eylul Kilsedar | Employment contract + Renewal of Host Agreement |
| 20/06/2018 | € 500.00 | 12-month health insurance for Ms. Candan Eylul Kilsedar (*pursuant to Italian law, health insurance must be provided to foreign researchers and paid for by the employer) | Ord. no. 66 - Health insurance receipt |
| 10/07/2018 | € 94.00 | Reimburse to Prof. Maria Brovelli for meal expenses during the stay of the guest Prof. Xinyang Zheng (research collaboration + attendance of "International workshop of validation and intercomparison of global high resolution land cover" in Como - 10-13.07.2018) | Ord. no. 37284 - Copy of receipts + invitation letter + workshop leaflet |
| 20/07/2018 | € 544.84 | Catering costs for international meeting in Nairobi-Kenya (Capacity building for high resolution land cover intercomparison and validation) - 03.09.2018 (*invoice is provided in dollars; payment was made in Euro according to daily conversion rate) | Ord. No. 33950 - Catering invoice + payment receipt + workshop leaflet |
| 02/08/2018 | € 511.60 | Catering costs for international meeting in Daar-al-Salaam-Tanzania (Capacity building for high resolution land cover intercomparison and validation) - 01.09.2018 (*invoice is provided in dollars; payment was made in Euro according to daily conversion rate) | Ord. No. 31418 - Catering invoice + payment receipt + workshop leaflet |
| 30/09/2018-03/10/2018 | € 475.92 | Business trip of Prof. Antonia Brovelli to Delft - participation to ISPRS Technical Symposium (Workshop ISPRS project) | Ord. No. 46017 - Trip documents |
| 30/09/2018-03/10/2018 | € 500.00 | Fee for the participation of Prof. Brovelli to the Geo Delft Conference 2018 | Ord. No. 46017 – Conference fee invoice |
| 11/10/2018 | € 42.42 | Business trip of Dr. Gorica Bratic to Lugano - participation to the 5th Open Source Geospatial Research and Education Symposium 2018 | Ord. No. 49110 - Trip documents |
| 11/10/2018 | € 104.99 equal to | Fee for the participation of Dr. Gorica Bratic to OGRS 2018 – Open Source geospatial research and education symposium, Lugano-Canobbio (Switzerland) | Ord. No. 49110 – Conference fee details |

| | 120 CHF (**) | | |
|---|---|---|---|
| 18/01/2019 | € 275.82 | External hard disk USB Samsung 1Tb | Ord. No. n. 7651 – Purchase documents (invoice, payment documents) |
| 31/01/2019 | € 49.99 | SanDisk Ultra Fit USB 3.0 Flash Drive (64 GB) | Ord. No. 49 – Purchase documents |

(*) Evidences of the expenditure (invoices, receipts, contracts, etc.) will be provided in Pdf format.

(**) Conversion rate applied on Nov. 15, 2018 upon reimbursement of trip/conference fee costs