

UPDATE September 2016-September 2017 and PLANS for LandCover6k from October 2017: land-cover and land-use activities

LandCover6k coordinators: Marie-José Gaillard, Kathleen Morrison, Marco Madella and Nicki Whitehouse

Since September 2016, i.e. during the past year, you have got only sporadic news from your coordinators due to unexpected circumstances for three of us. We apologize for the lack of communication during this long period and hope that this **presentation of plans for the coming months (A)** and **update sept 2016- sept 2017 (B, p. 3)** will help you to understand our strategies, catch up on our progress over the last year, and understand the way we are working to achieve the challenging goal of LandCover6k, i.e. **provide descriptions of the global past (Holocene) vegetation cover that will be useful for climate -, dynamic vegetation -, and anthropogenic land-cover change modelling.**

A. PLANS FOR THE COMING MONTHS (September 2017 – March 2018)

Introduction

The LandCover6k community is now focusing on a number of “**products**”, i.e. good examples of achievements that meet the aims of PAGES LandCover6k and will contribute to the final goal of the working group. These aims are:

1. Archaeology/history-based land-use upscaling for the purpose of global scale land-use maps for selected time windows of the Holocene; **each land-use type will have quantifiable attributes useful for climate modelling**; those are e.g. **burning (use of landscape-scale fire), tillage-cropping intensity (m²/m²), grazing intensity (m²/m²), livestock, wood harvest (m²/m²), irrigation (m²/m²), presence of specific crops/domesticates.**
2. Pollen-based estimates of **plant cover (% or fraction of grid cell)** for the purpose of global scale gridded land-cover maps for selected time windows of the Holocene or/and continuous Holocene time series
3. Use of 1 and 2 above (i) to improve anthropogenic land-cover change (ALCC) scenarios (in particular the HYDE Database) and other land-use schemes for climate-modelling applications, (ii) as forcing in climate modelling experiments

Once the 3 aims are achieved for most land on Earth where human impact on vegetation has been significant, the final goal of LandCover6k will be accomplished. **Our focus areas are those where humans have had most impact on land cover within the five large regions Latin America (in particular the Amazon and Argentina), Central and Northern America, Europe, Africa (in particular eastern and western Africa), and Asia-Oceania (in particular Siberia, China, SE India).**

The LandCover6k **products** have a primary goal to demonstrate the usefulness of the PAGES LandCover6k working group approach and convince the PAGES SSC to endorse the working group for a second 3-year period, 2018-2020. A continued endorsement by PAGES is necessary to maintain the momentum that grew out of the first 3-year period of LandCover6k (2015-2017). LandCover6k will

focus on producing land-use and land-cover maps (gridded data with **quantifiable attributes** useful for climate modelling) in areas of the globe for which it is not currently available. **The application to PAGES** for an extension of the working group with a second 3-yr period is due **October 23rd 2018**. Moreover, we have been invited by PAGES to guest edit a **Special Issue of PAGES Magazine on Past Global Land Cover and Land Use** to appear in **May 2018**. This issue will allow us to present the first LandCover6k products in a broader context of articles providing an overview of what is known and debated on past land-use and land-cover changes.

From 2018, the plan is to proceed with the reconstructions needed to fulfill the final goal of LandCover6k following the same strategy as earlier, by i.e. (i) focusing on the regions with major past human influence, (ii) training contributors in land-use classification and pollen-based land-cover reconstructions, (iii) creating gridded databases (maps) of past land use and land cover, (iv) interacting with ALCC modelers and climate modelers to achieve products useful for climate modelling. Our hope is that the working group and its very large network of palaeoecologists, archaeologists and historians will continue its amazing collaborative work in the future in order to achieve the LandCover6k goals. A continued endorsement by PAGES would greatly facilitate this process.

Products

The **products** we are currently working on are:

- Land-use maps of Mid-America at 6k BP, AD 1490, and AD 1850, comparison with the ALCC scenarios of the HYDE Database, and possible consequences for land cover-climate interactions – does the LandCover6k product make a difference? Contact person: Kathy Morrison, kathy.morrison@sas.upenn.edu
- Land use classification and code book for same; GLOBE data integration (Erle Ellis, Emily Hammer) Contact person: Kathy Morrison, kathy.morrison@sas.upenn.edu
- *Land-cover maps for the Northern Hemisphere ($\geq 40^\circ\text{N}$) (N America, Canada, Alaska, Europe, Siberia, China). Contact person: Marie-José Gaillard; marie-jose.gaillard-lemdahl@lnu.se
- Comparison of the HYDE ALCC scenarios with the existing pollen-based land-cover maps for Europe and China for selected time windows of the Holocene, improvement of ALCC scenarios based on the pollen-based reconstructions, and possible implications for climate modelling. Contact person: Marie-José Gaillard; marie-jose.gaillard-lemdahl@lnu.se
- *Comparison of Holocene time series of model simulated plant cover (from a dynamic vegetation model) with time series of pollen-based estimates of plant cover in Europe, and possible implications for climate modelling. Contact person: Marie-José Gaillard; marie-jose.gaillard-lemdahl@lnu.se

*Products that will be presented at the first PMIP4 workshop in Stockholm, September 2017. PMIP: Palaeoclimate Model Intercomparison Program; is part of CMIP (Climate Model Intercomparison Program). PMIP4 is part of CMIP6.

Other longer-term planned products

- Land-cover maps for the monsoon regions of the globe (Africa, India, ...) Contact person: Marie-José Gaillard; marie-jose.gaillard-lemdahl@lnu.se

- Comparison of land-use maps with land-cover maps in western Africa, and implications for the HYDE ALCC scenarios and climate modelling. Contact person: Marie-José Gaillard; marie-jose.gaillard-lemdahl@lnu.se
- Implications of the LandCover6k land-cover reconstructions on carbon budgets in the past: Do LandCover6k reconstructions make more sense than the ALCC scenarios to date? Contact person: Beni Stocker, b.stocker@creaf.uab.cat

Published papers that are contributions to the goals of LandCover6k are also **products**. Please consult the **LandCover6k webpage on the PAGES website** where you will find those papers, <http://www.pastglobalchanges.org/ini/wg/landcover6k/intro>

Upcoming Workshops

Pondicherry, India, January 29th – February 4th 2018: INQUA REVEALS training and S/SE Asia land use; contact person: Krishnamurthy Anupama, anupama.k@ifpindia.org

Barcelona, Spain, Spring 2018: PAGES LandCover6k: Focus on Europe LandUse6k; contact person: Nicki Whitehouse, nicola.whitehouse@plymouth.ac.uk

Barcelona, Spain, time period not decided yet, 2018: INQUA HoLa workshop; focus on data handling for LandUse6k; contact person: Marco Madella, marco.madella@upf.edu

B. UPDATE September 2016 – 2017

Below we list the **workshops (1)** and **research activities (2, p. 2)** that occurred or are still currently ongoing in different parts of the world. **Funding** has been provided by **PAGES** for part of the workshops, otherwise financial support is from national (e.g. the LandCover6k members own research grants) or other international sources (**INQUA**).

1. Workshops

All workshops with published reports in **PAGES Magazine** have got support from **PAGES**.

Annual General Workshops

Please read the reports from the two General Workshops 2016 (Utrecht, the Netherlands) and 2017 (Zaragoza, Spain) in PAGES Magazine (also attached to this update):

Klein-Goldewijk, K. et al. 2016: Uncovering the past: multidisciplinary research on historic land cover and land use. <https://doi.org/10.22498/pages.24.2.81>

Gaillard, M.-J. et al. 2017: Towards global land-cover and land-use reconstructions over the Holocene. PAGES Magazine 25, 2, 121. <https://doi.org/10.22498/pages.25.2.121>

In case you require more detailed information on these workshops, their content, presentation, etc. please contact Marie-José Gaillard marie-jose.gaillard-lemdahl@lnu.se

Other international workshop with strong participation from LandCover6k

Giesecke et al. 2016: The European Pollen Database: Research tool and community. PAGES Magazine, 24, 1, 48; <https://doi.org/10.22498/pages.24.1.48>

Regional Workshops

France September 2016 – Training course in pollen-vegetation modelling to estimate plant cover in the past: international with strong participation from India. Organized by F. Mazier and L. Marquer. Teachers: S. Sugita, P. Kunes, L. Marquer.

Hungry/Central Europe 2016-2017

The **Central European historical land-use change group** lead by **Zsolt Pinke** organized 7 thematic Landcover6k international workshops at the Central European University on the interactions of (i) climate and landscape change, (ii) climate and land use change, (iii) land use, landscape, climate change and population density, (iv) landscape features and animal husbandry, (v) continental cattle transport from Central Europe, (vi) road network and population density.

The output of networking and these workshops are articles published in Quaternary International, Quaternary Research Review, Conservation Biology, and Hungarian journals, and manuscripts in review or under revision submitted to Scientific Reports, Ecosystem Services and Global Change Biology, and Quaternary International. For more information on these products contact Zsolt Pinke, pinkezsolt@gmail.com

China October 2016 – Workshop on land-use mapping in China and organization of the Chinese contribution to PAGES LandCover6k; organized and coordinated by Q. Xu, M.-J. Gaillard and K. Morrison

Brazil October 2016 – Latin America: pollen-based land-cover reconstructions: training course

Fontana, S. L. et al. 2017: Pollen-based reconstructions of past land-cover change in Latin America. PAGES Magazine 25, 2, 122; <https://doi.org/10.22498/pages.25.2.122>

China March 2017 – Workshop and training course in pollen-vegetation modelling to estimate plant cover in the past. Strong participation from China and India

Cao, X. et al. 2017: Past land-cover change for climate modeling: data from Eastern Asia. PAGES Magazine 25, 2, 123; <https://doi.org/10.22498/pages.25.2.123>

Sweden April 2017 – Workshop on land-use mapping in Africa.

LANDUSE6K-Africa, Royal Academy of Letters, History and Antiquities, Stockholm, Sweden, organized by Mats Widgren. One major focus was on discussing a synthesis on eastern Africa lead by Rob Marchant. For more details contact robert.marchant@york.ac.uk

The synthesis is now in review: Rob Marchant, Suzi Richer, Claudia Capitani, Colin Courtney-Mustaphi, Mary Prendergast, Daryl Stump, Stephanie Wynne-Jones, Oli Boles, David Wright, Cruz

Ferro Vazquez, Julius Lejju, Carol Lang, Paul Lane, Andrea Kay, Leanne Phelps, Dorian Fuller, Mats Widgren, Paramita Punwong, Nicole Boivin, Marie-Jose Gaillard-Lemdahl, Kathleen D. Morrison, Jed Kaplan, Jacqueline Benard, Alison Crowther, Aida Cuní-Sanchez, Gijs de Cort, Nicolas Deere, Jennifer Farmer, Lindsey Gillson, Esther Githumbi, Tabitha Kabora, Rebecca Kariuki, Rahab Kinyanjui, Elizabeth Kyazike, Hayley McParland, Veronica Muiruri, Cassian Mumbi, Rebecca Muthoni, Alfred Muzuka, Emmanuel Ndiema, Chantal Nzaba, Dan Olago, Isaya Onjala, Annemiek Pas Schrijver, Nik Petek, Stephen Rucina, Anna Shoemaker, Senna Thornton-Barnett, Geert van der Plas, Liz Watson, David Williamson, Drivers and trajectories of land cover change in East Africa: human and environmental interactions from 6000 years ago to present. *Earth Science Reviews*.

For more details on other subjects discussed at the workshop, contact Mats.Widgren@humangeo.su.se

Other workshop reports published in 2016 for which workshops were held in autumn 2015:

Kay, A. U. et al. 2016: Mapping Human Subsistence in West Africa (1000 BC - AD 1500). PAGES Magazine 24, 1, 38; <https://doi.org/10.22498/pages.24.1.38>

Marchant R. et al. 2016: Synthesizing East African land-cover change over the past 6000 years. PAGES Magazine 24, 1, 39; <https://doi.org/10.22498/pages.24.1.39>

Morrison, K. et al. 2016: Land-use classification. PAGES Magazine 24, 1, 40; <https://doi.org/10.22498/pages.24.1.40>

2. Research activities

We list below the research activities for both pollen-based land-cover reconstructions/mapping and archaeology/history-based land-use mapping. Please contact the main coordinators of the activities for more detailed information and if you wish to contribute.

GLOBAL

- Land-use classification (K. Morrison et al.)

Land use determinations are made using a single set of hierarchical categories, with provision made for multiple categorical assignments for a single time and place. A very early version of the classification, currently in Lucid Chart format, was made public on the LC6K website hosted by the University of Chicago, but with the move of K. Morrison to the University of Pennsylvania, we are currently without a web site. Look for an announcement when the new one is completed. The three-level classification scheme is by now quite detailed – each regional workshop has added and clarified categories – and the ‘code book’ is in preparation. Work on the **quantifiable categorical variables** (tillage, wood harvest, burning, livestock, pyrotechnologies, and cultigens) has also advanced. The urgent need now is to bring together all of this into a unified database format. This is our top priority for the rest of 2017. For more details contact Kathy Morrison, kathy.morrison@sas.upenn.edu

- Associated project:

The **Holocene Global Landuse** (<https://www.upf.edu/web/ho-la>) INQUA IFG is the first global initiative to assess anthropic activity on the environment via the archaeological record (e.g. geoarchaeology, bioarchaeology, material culture, etc.). A specific character of this INQUA IFG initiative will be a spatial and temporal downscaling approach to firmly frame the archaeological and palaeoclimate data. (PIs K Morrison, M Madella, MJ Gaillard). Funded by INQUA. Contact Marco Madella, marco.madella@upf.edu for more details.

- **Pollen-based land-cover reconstructions and mapping (M.-J. Gaillard et al.)**

We attempt at using the REVEALS model (Sugita 2007, The Holocene) following the same protocol over the globe. The protocol was first established for Europe (Mazier et al., 2012, Rev. Pal. Pal.; Trondman et al. 2015, Global Change Biology; Marquer et al., 2014, 2017, Quat. Sc. Rev.). The REVEALS model requires estimates of relative pollen productivity (PPEs or RPPs). Such estimates do not exist for all major taxa of the vegetation on Earth. Therefore, the LandCover6k initiative proceeds in steps of various duration including (i) estimation of PPEs based on field data (pollen samples and related vegetation surveys following a standard protocol), (ii) collection of appropriate pollen records and grouping of the records according to a common grid system (scale: 1°x1°), (iii) application of the REVEALS model to the groups of pollen records from (ii). In order to achieve these steps as fast as possible we have organized a large number of workshops and training courses on pollen-vegetation modelling. See below for the progress made in each of the five large LandCover6k regions. For more details on the protocols used for estimation of PPEs and REVEALS reconstructions of past plant cover, contact Marie-José Gaillard, marie-jose.gaillard-lemdahl@lnu.se

THE AMERICAS

- **Latin America land-use (U. Lombardo et al.)**

The **INQUA** workshop on **Mapping pre-Columbian land use in Amazonia** (2016) aimed at bringing together archaeologists, geographers and paleoecologists working in the Amazon basin in order to produce the first land use maps of pre-Columbian Amazonia. The reconstruction of pre-Columbian land-use patterns in Amazonia is a prerequisite in order to assess the possible influence that pre-contact deforestation and post-contact re-forestation had on global climate. (PI U Lombardo). Funded by INQUA. **Mapping pre-Columbian land use in Amazonia** (Part 2) (2017) (PI U Lombardo) also funded by INQUA will occur later. For more information, contact Umberto Lombardo, umberto.lombardo@upf.edu

- **Latin America/Middle America land-cover (S. Fontana, W. Gosling et al.)**

LAPD: Latin American Pollen Database (www.latinamericapollendb.com) now in the process to be included in the Neotoma Palaeoecology Database; there are now 158 pollen records from 142 sites. The LAPD is an inventory of 1379 paleoecological sites, see Flantua et al. (2015), Review of Palaeobotany & Palynology 223: 104-115. For more information, contact Will Gosling, W.D.Gosling@uva.nl

There are PPE studies in progress in southernmost Brazil, Argentina (Patagonia) and Bolivia. For more information contact Sonia Fontana, Sonia.Fontana@biologie.uni-goettingen.de

- **Central and Northern America land-use (A. Sluyter, T. Foster et al.)**

A land-use map was created for Central and part of northern America and three time windows of the Holocene, 6k, AD 1500 (1490) and AD 1850. It is based on archaeological data and follows the land-use categorization established for the LandCover6k initiative, see "Global" above. The aim is to compare with the Anthropogenic Land-Cover Change (ALCC) scenarios of HYDE 3.2 (Klein-Goldewijk, in press) and KK (Kaplan et al., 2009) and evaluate the difference and its implication in terms of impact on climate. For more information contact Kathy Morrison, kathy.morrison@sas.upenn.edu, Andrew Sluyter, asluyter@lsu.edu, and Thomas Foster, thomas-foster@utulsa.edu

- **Northern America, Canada, Alaska land-cover (A. Dawson, M. Chaput, E. Hopla al.)**

A first gridded pollen-based REVEALS reconstruction of plant cover was achieved using pollen productivity estimates (PPEs) from the literature (N America) and new PPE values from recent studies (Canada (M. Chaput); Alaska (E. Hopla)). It was produced so far for 6k (5.7-6.2), AD 1250-1600, and AD 1600-1850 for a total of 30 taxa and maps exist for three broad land-cover types i.e. openland, evergreen trees, and summer-green trees. This product is part of the Northern Hemisphere past land-cover project (gridded dataset and maps) including also Europe, Siberia, and China (see below). The Northern Hemisphere product was presented at the 1st PMIP4 workshop in Stockholm, 25-29 september 2017. It will hopefully be published in the beginning of next year. For more information on the N Hemisphere project contact Marie-Jose Gaillard, marie-jose.gaillard-lemdahl@lnu.se For more information on the work in Northern America, Canada and Alaska contact Andria Dawson, andria.dawson@gmail.com, Michelle Chaput, mchap036@uottawa.ca, and Mary Edwards, M.E.Edwards@soton.ac.uk, respectively.

EUROPE

- **Europe land-use (N. Whitehouse et al.)**

Nicki Whitehouse has put a great effort in networking during the past year and gathered together a large group of archaeologists with the expertise and research projects in progress that will contribute to the great challenge of mapping past land use in Europe. A workshop to be held in Barcelona, Spain, is planned for next spring. For more details and if you wish to get involved contact Nicki Whitehouse, nicola.whitehouse@plymouth.ac.uk

Zsolt Pinke is leading a land-use group for Central Europe, focused in particular on the great flood plains, also with the goal of comparing with other great flood plains in Europe and the world. For more details and if you wish to get involved contact pinkezsolt@gmail.com

- **Europe land-cover (M.-J. Gaillard, R. Fyfe, F. Mazier et al.)**

A first gridded pollen-based REVEALS reconstruction for a major part of Europe from 6k to present (5 time windows) was published by Trondman et al. (2015) in Global Change Biology. There are also transient reconstructions over the entire Holocene for 19 target sites along transects (Marquer et al., 2014 in Quaternary Science Reviews) and for groups of 1°x1° grids around each target site (Marquer et al., 2017 in QSR). These reconstructions were produced within a Swedish research project (LANDCLIM I). They do not cover the Mediterranean area and easternmost Europe. This reconstruction is part of the Northern Hemisphere reconstruction (see America, Canada, Alaska

above). Within a new Swedish project (LANDCLIM II) new gridded REVEALS reconstructions will be produced for continuous time windows through the Holocene and for entire Europe (including the Mediterranean and easternmost areas). These new gridded reconstructions will be available in February-March 2018. For more information contact Marie-Jose Gaillard, marie-jose.gaillard-lemdahl@lnu.se

AFRICA

- Africa land-use (A. Kay, R. Marchant, A. Ekblom, et al.)

Rob Marchant lead a review of land-use and land-cover changes through the Holocene in eastern Africa, see above under workshops in early 2017. This review will hopefully be published at the beginning of 2018. Andrea Kay has produced maps of past land-use based on archaeological data for western Africa (a paper was submitted recently). Lézine et al. 2013 (in C. R. Geoscience) published a comparison of pollen-based vegetation changes and archaeological data on human settlement in Cameroon that is of great relevance for Landcover6k. Anneli Ekblom is responsible of land-use reconstructions in southern Africa. A land-use map of Africa based on different methods than those applied in LandCOVer6k was produced earlier by Mats Widgren and collaborators. The latter is published in : Widgren Mats: Agriculture in sub-Saharan Africa by 1800: a map and a gazetteer. In Mercuri, A.M., D'Andrea, A.C., Fornaciari, R., Höhn, A. (eds.): Plants and People in the African Past - Progress in African Archaeobotany (in press), SPRINGER, with data (incl. shape files) at doi.org/10.17045/sthlmuni.5173477

For more information, please contact Anneli Ekblom (S Africa, anneli.ekblom@arkeologi.uu.se), Andrea Kay (W Africa, Andrea.Kay@unil.ch), Anne-Marie Lézine (W Africa, anne-marie.lezine@locean-ipsl.upmc.fr), Rob Marchant (E Africa, robert.marchant@york.ac.uk), and/or Mats Widgren (all Africa, Mats.Widgren@humangeo.su.se

- Africa land-cover (R. Marchant, M.-J. Gaillard et al.)

Within a French research project coordinated by Anne -Marie Lézine, estimation of pollen productivity (PPEs) was attempted using the ERV model. Tentative PPE values were used with the REVEALS and LOVE models to estimate the cover of major tree and herb taxa from a number of pollen records in Cameroon (Gaillard et al., unpublished). These reconstructions can be used for first comparisons with land-use reconstructions, but more work is needed to obtain robust PPEs and reliable REVEALS reconstructions. New PPEs and REVEALS estimates of plant cover will be available in the course of 2018. For more details contact Marie-Jose Gaillard, marie-jose.gaillard-lemdahl@lnu.se.

Rob Marchant and collaborators have synthesized the interpretation of pollen records in terms of land use in a review paper on eastern Africa (see land-use above).

ASIA-OCEANIA

- Siberia land cover (U. Herzschuh, X. Cao et al.)

X. Cao and collaborators have achieved a first pollen-based REVEALS reconstruction of plant taxa for Siberia. This reconstruction is part of the Northern Hemisphere reconstruction (see N America, Canada, Alaska and Europe above). For more details contact Xianyong Cao, Xianyong.Cao@awi.de

- **Central Asia and Middle East land use (E. Hammer, L. Popova)**

For information please contact Emilie Hammer, ehammer@uchicago.edu and Laura Popova, Laura.Popova@asu.edu

- **India land use (A. Bauer, M. Madella, K. Morrison et al.)**

Southern India is one of the focus areas of the land-use activity of LandCover6k for which there is now a well-established leadership. For more information contact Kathy Morrison, kathy.morrison@sas.upenn.edu and/or Marco Madella, marco.madella@upf.edu

- **India land cover (K. Anupama et al.)**

There is good progress in PPE studies in SE India and application of those values in REVEALS reconstructions of plant cover (PhD thesis of Navya Kumar, Pondicherry). These PPE values and REVEALS reconstructions will be published in the course of 2018. PPE studies and REVEALS reconstructions in northern India are planned for the coming years (2018-2019). For more information contact Krishnamurthy Anupama, anupama.k@ifpindia.org

- **China land use (X. Fang et al.)**

There is a great richness of historical and archaeological land-use data in China. Networking and workshops held in China in 2016 and 2017 resulted in a strong group of Chinese experts that will take the lead in synthesizing the land-use data for the three priority time windows of LandCover6k. For more information contact Kathy Morrison, kathy.morrison@sas.upenn.edu

- **China land cover (Q. Xu, M.-J. Gaillard, F. Li et al.)**

New PPE studies were performed during the years 2015-2017 in several regions of China and a synthesis of all PPE values is now submitted for publication (Li et al.). These PP values were used to achieve a first REVEALS reconstruction for temperate China over the entire Holocene (Li et al., soon to be submitted). Part of this dataset was used in the Northern Hemisphere reconstruction (see N America, Canada, Alaska above). For more details on the temperate China dataset contact Furong Li, furong.li@lnu.se

- **Japan land use and land cover (H. Takahara, S. Sugita et al.)**

There is good progress in the estimation of absolute pollen productivity for a number of major trees and herbs in Japan and their application in REVEALS reconstructions. For more information contact Hikaru Takahara, takahara@kpu.ac.jp and/or Shinya Sugita, sugita@tlu.ee

- **Oceania land use and land cover (Simon Heberle et al.)**

Little progress so far. A single PPE study exists for plant taxa of Tasmania (Mariani et al., 2016 in QSR). For information on progress in land-cover reconstructions in Australia, take contact with Simon Heberle, simon.heberle@anu.edu.au