Are the forests where are supposed to be?

Land Use Cover Databases

Land use cover changes (LUCC) are one of the main drivers of biodiversity loss and it contributes with almost a quarter of the GHG emissions (IPCC, 2019). These changes are mainly caused by agricultural and livestock expansion, which in turn are determined by the demand of commodities. The identification of agricultural areas is important because it allows us to analyse the possible effects of climate change on crop productivity and the subsequent impacts on ecosystems. There are several global studies that have produced spatially explicit information on the different land uses and covers, either to assess past impacts as well as future trajectories under the assumptions of scenarios with multiple uses as biodiversity impact assessment or contribution to climate change from LUCC. One of the most important exercises is the Land-Use Harmonization (LUH2) project which focuses on develop a harmonized set of LUCC historical reconstructions and future scenarios that smoothly connects the historical reconstructions based in turn on the History of the Global Environment database of land- (HYDE) (from 850 BE) and with alternative scenarios of the future (2015-2300) from Integrated Assessment Model (IAM). They produced annually spatial estimates of LUCC at 0.25 x 0.25 resolution. The outputs of this harmonization feed some Integrated Assessment Models which have been use as part of the World Climate Research Program Coupled Model Intercomparison Project (CMIP6).

The LUH2 project estimates the fractional land-use patterns, underlying land-use transitions, among the eight categories (primary forest, non-forested primary land, potentially secondary land, potentially secondary non-forested land, managed pasture, rangeland, urban land, and cropland, and the subsequent possible transitions. These outputs overcome some issues from the CMIP5 like more detail on multiple crops, pasture types, and associated management, based on Landsat remote sensing data, updated algorithms, and new assessments. The main aim of LUH2 project is to enable new and improved estimates of the combined effects of land-use on the global carbon-climate system. However, although the outputs and information are important for global assessments, especially to link the impacts of LUCC on CC, it is unknown the capability of this database to express the real world observations at regional or local level regarding the forest, cropland, and grassland distribution. Consequently, this database needs to be tested to estimate

its true uncertainty. This information is necessary to provide adequate conclusions in the estimation of GHG emissions due to LUCC and biodiversity loss.

Therefore, the aim of this research is to assess the main global sets of land use and cover in comparison to national or subnational the spatial data sets for different countries; especially those which extremely biodiversity areas. This work will identify the best and worst areas of agreement between global and national and quantitatively assess the uncertainty of GHG emissions from LUCC when using different data sets.

Method

The analysis will consist in the recompilation and harmonization of different global datasets, the reclassification in diverse classes which allows the comparison among data. The validation of classes trough supervised rectification between the global data sets, selected national available and google earth based on satellite imagery. The estimation of the accuracy level by class and the identification of the best sources for regional levels (Fig. 1).

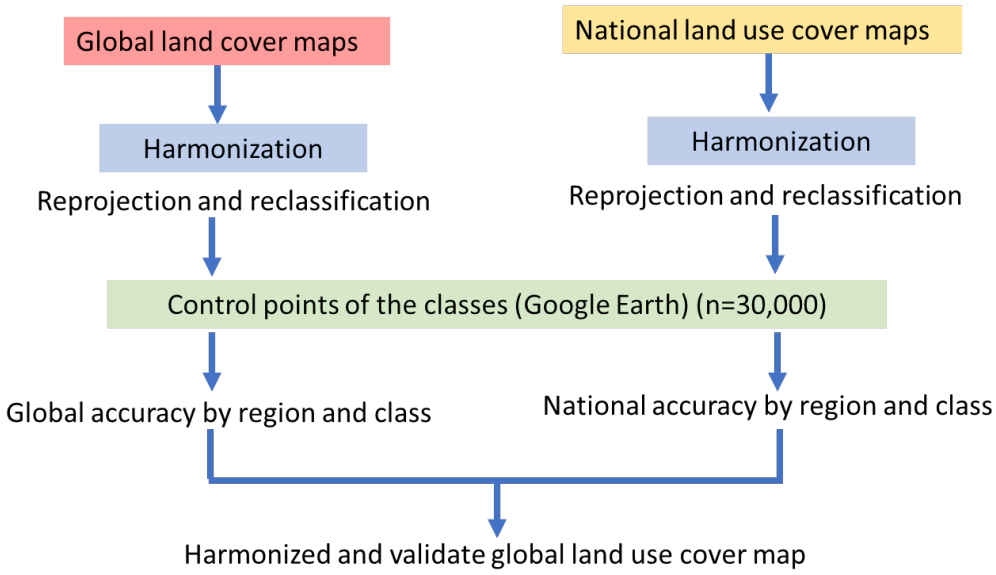

Fig. 1 Workflow to develop the global land use cover map.

Results

The outputs of the project will be consistent and harmonized global land use cover maps with the better regional possible accuracy based on the validation of control points. These maps will be the basis to develop land use cover change models.

The global data sets to be evaluated.

	GLC 2000*	Moderate Resolution Imaging Spectroradiometer Modis 2005	GlobCover/ESA*	Global Land Cover Facility	Global consensus*	LUH2*	globeland30	Global Land Cover-SHARE*
Sensor & Sattelite	Vegetation SPOT	MODIS Aqua-Terra	MERIS (MERIS FR & RR, SPOT VEGETATION, PROBA-V & ASAR) ENVISAT	Landsat IKONOS, Aqua, Terra, QuickBird-2 SRTM OrbView GOES	-	-	Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+)	MERIS MODIS
Class technique	Flexible classif	Supervised (decisión tree)	Per-pixel and unsupervised		Consensus of datasets (based on the previous 4 columns)	Base d on other datasets*	Maximum likelihood, J4.8 decision tree, support vector machine, and Random Forest	
Classes	22	17	22	2	12	12	10	11
Time framework	2000	2005	2005,2009	1990, 2000, 2005	-	850-2300	2000, 2010 & 2020	2014
Overall accuracy	68.8%	75.0%	73.1%			-	71.5%	
Resolution	1 km	500m	300 m	30 m	1 km		30m	30 arc-second
Source	(Mayaux *et al.*, 2006)	(Friedl *et al.*, 2010)	(Bicheron *et al.*, 2008)		(Tuanmu and Jetz, 2014)		(Gong *et al.*, 2013)	

* Based on HYDE 3.1 (Historical Database of the Global Environment)(Ramankutty and Foley, 1999; Klein Goldewijk *et al.*, 2007; Ramankutty *et al.*, 2008; Klein Goldewijk *et al.*, 2010) for cropland, grasslands and human settlements.

National datasets

Country	Source	time	Scale, resolution	Satelite /sensor	classes	Reference
Canada	Agriculture and Agri-Foods Canada	1990, 2000, 2010 2015	30m	-	15	https://open.canada.ca/data/en/dataset/18e3ef1a-497c-40c6-8326-aac1a34a0dec
	CCA	2015		Modis, Landsat and Rapid eye, & Sentinel 2	31	http://www.cec.org/north-american-land-change-monitoring-system/
Mexico	MADMEX - CCA	2015-2018	30m, 250m	Modis, Landsat and Rapid eye, & Sentinel 2	31	(Gebhardt *et al.*, 2014) http://www.cec.org/north-american-land-change-monitoring-system/
	INEGI	1985, 1993, 2002, 2007, 2011, 2015	1:250,000	Landsat ETM, TM and SPOT	170-375	(INEGI, 2001, 2005, 2011, 2015)
US	U.S. Geological Survey	2001,2004, 2006, 2008 2011, 2013, 2016	30m	LANDSAT	16	www.mrlc.gov
	CCA	2015		Modis, Landsat and Rapid eye, & Sentinel 2	31	http://www.cec.org/north-american-land-change-monitoring-system/
Guatemala	SEGEPLAN	2005,2012				
Colombia	Instituto de Hidrología,	2000-2002 2005-2009	1:100,000	Landsat, Spot, Cbers & Aster		http://www.ideam.gov.co/capas-geo

	Meteorología y Estudios Ambientales (IDEAM)	2010-2012				
Argentina			1:50,000	Landsat & Terra		https://inta.gob.ar/documentos/mapa-online-cobertura-del-suelo-de-la-republica-argentina
Brazil			1:250,000	Landsat		http://amazonia.mapbiomas.org
China	30*30m	Accuracy >90%		1980-2015	AVHRR, MODIS and Landsat	(Xu *et al.*, 2020)
India				1985,1995,2005	Landsat 4 and 5 Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+), and Multispectral (MSS) data, India Remote Sensing satellites (IRS) Resourcesat Linear Imaging Self-Scanning Sensor-1 or III (LISS-I, LISS-III) data,	(Roy *et al.*, 2016)
Australia	Geoscience Australia	22 classes	250m x 250m		https://www.ga.gov.au/scientific-topics/earth-obs/accessing-satellite-imagery/landcover	(Lymburner *et al.*, 2015)

Moambique	300m	2005		46 classes		http://www.fao.org/geonetwork/srv/en/metadata.show?currTab=simple&id=37198
Lesotho		2000/2014				http://geoportal.rcmrd.org/layers/servir%3Alesotho_landcover_2000_scheme_ii
Zambia						https://www.servirglobal.net/ServiceCatalogue/details/5bd052d451ebdcae79683375

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