uncertainties are not provided at the spatial scale at which emissions are offered; they suffer from untransparent documentation (e.g EDGAR) or data are offered at inappropriate spatial scales to effectively navigate mitigation implementation (e.g. country level in FAOSTAT). Thus, unlike aggregated estimates, spatially explicit data favour targeted mitigation action and implementation by identifying where are the areas within a country that hold the largest emissions, and what are the key emission sources to address in these areas (e.g. deforestation, degradation, livestock, cropland soils, paddy rice). Spatially explicit sassessments ~~napshots~~ of ~~the location of~~ AFOLU emissions ~~hotspots (CO_2, CH_4, N_2O)~~ and their associated ~~data on their~~ uncertainties would assist national policy makers, investors and other decision-makers who seek to understand the mitigation potential of the AFOLU sector, and which areas to prioritize~~.~~ This potential is here defined as the maximum mitigation reduction that could be achieved without technical or economic considerations. Better understanding of the AFOLU mitigation potentials will also ~~be needed under~~be important under the Paris Agreement (PA) since ~~the success of the PA will be measured against~~ the fulfilment of the 2°C target ~~and it~~ is dependent on the mitigation ambition presented by individual countries in their Nationally Determined Contributions (NDCs). To safeguard this ambition ~~is the~~ a stock-take process has been defined, by which ~~where~~ countries are required to update their NDCs every five years, starting from 2020, and to enhanc~~ing~~e their mitigation commitments from previous submissions (Bodle et al., 2016). It is therefore imperative to improve our understanding of where and how much could countries enhance their AFOLU ambition from what ~~is~~ they have currently reported.

Mitigation action can be directed to reducing emissions by the sources, or to increasing the absorptions by the sinks, or to both. While gross and net emissions are equally important, they offer different information (Richter and Houghton, 2011; Houghton et al., 2012). Net land use emissions consider the emissions by the sources and the removals by the sinks ~~in a final emission balance where the removals are discounted from the emissions~~. Land use sinks refer to any process that stores GHGs (e.g. forest growth, forest regrowth after disturbances, organic matter stored in soils, etc) (see Richter and Houghton, 2011, for further details). Countries report their emissions and their reduction targets based on net AFOLU balances (IPCC, 2006; Iversen et al., 2014; Smith et al.,2014). Gross assessments can consider both the emissions produced by the sources (gross emissions) and the removals absorbed by the sinks (gross removals), but they are not offered in a final balance where the sinks are discounted from the emissions. They are offered separate fluxes, instead. Gross fluxes are -useful to navigate mitigation implementation since they offer direct information on the sources -and sinks that need to be acted upon through policies and measures to enhance and promote mitigation.- However, ILack of ground data makes the assessment of the sinks much more difficult than the assessment of the sources (Lewis et al., 2009; Houghton et al., 2012; Grace et al., 2014; Brienen et al., 2015) with a particular gap on disturbed standing forests (Poorter et al., 2016).

For these reasons, we present here an assessment of AFOLU gross emissions in the tropics and subtropics that focuses only on the emissions by the sources, excluding the sinks (e.g. no regrowth of cleared forests or burned areas, nor soil carbon storage are included for the 2000-2005 period). We offer spatially explicit (0.5°) multi-gas -(CO_2, CH_4, N_2O) CO_2e gross emission data that help identifying the of hotspots the of land use emissions hotspots in the tropics and subtropics, and associated uncertainties, for 2000-2005. Our method uses , using aa consistent approach to overcome problems of different definitions, methods, and input data present in other approaches (e.g. nationally reported data), allowing data comparability. It is a top-down approach based on published spatially explicitavailable published GHG datasets for the key sources of emissions in the AFOLU sector as identified inby the Fifth Assessment Report of the IPCC (AR5) (Smith et al. 2014): deforestation, fire, wood harvesting, crop soil emissions, paddy rice emission, enteric fermentation and manure management. We also provide information on the leading sources of emissions per cell. We address three questions at the landscape, tropical, and continental scales: 1. Where are the hotspots of tropical AFOLU emissions and how uncertain are they? 2. What are the main GHGs behind these hotspots?, 3. What are the emission sources behind these hotspots? 4. How do our gross AFOLU emissions relate to other AFOLU datasets such as FAOSTAT or EDGAR?

2. MATERIAL AND METHODS

FAOSTAT database: covers agriculture, forestry and other land uses and their associated emissions of CO_2, CH_4 and N_2O, following IPCC 2006 Guidelines at Tier 1 (Tubiello et al., 2014). Emissions are estimated for nearly 200 countries, for the reference period 1961–2012 (agriculture) and 1990–2012 (FOLU), based on activity data submitted to and collated by FAO (www1). FAOSTAT includes estimates of emissions from biomass fires, peatland drainage and fires, based on geo-spatial information, as well as on forest carbon stock changes (both emissions and absorptions) based on national-level FAO Forest Resources Assessment data (FRA, 2010). FOLU carbon balances in FAOSTAT are emissions from afforestation, reforestation, degradation, regrowth, and harvest activities. The FAOSTAT emission estimates are based on annual FAO emissions updates for AFOLU (Tubiello et al., 2014).

EDGAR database: The Emissions Database for Global Atmospheric Research (EDGAR) provides global GHG emissions from multiple gases (CO_2, CH_4, N_2O) at 0.1° and country levels. It covers all IPCC sectors (energy, industry, waste management, and AFOLU), mainly applying IPCC 2006 guidelines for emission estimations (EDGAR, 2012). We selected EDGAR's 4.2 Fast Track 2010 (FT 2010) data (www2). Emissions cover the period 2000-2010 in an annual basis, at the country level and are offered as Gg of gas. No uncertainties are provided. Transformation to CO_2e used AR4 100year-Global Warming Potential values to be consistent with other datasets. Metadata can be found at EDGAR (2012), although further transparency and more complete documentation are required for this database.

2.2 Methods

Hotspots dataset

Our AFOLU assessment is based on several assumptions: we focused on human-induced gross emissions only, excluding natural fluxes from unmanaged land (e.g. CH_4 or N_2O emissions from undisturbed unmanaged natural wetlands). We focused on direct gross emissions excluding indirect emissions whenever possible (e.g. indirect emissions from nitrate leaching and surface runoff from croplands). Delayed fluxes (legacies) are important (e.g. underestimations of up to 62% of the total emissions when recent legacy fluxes are excluded) (Houghton et al., 2012) but are frequently omitted in GHG analyses that derive from remote sensing, such as our deforestation emissions from Harris et al., (2012). Wood harvesting emissions also excluded legacy fluxes. Therefore, no forest regrowth of cleared, burned, or disturbed forests are included in our AFOLU 2000-2005 assessment. Other important components of the overall terrestrial and carbon balance such as changes in litter, coarse woody debris and soil carbon, are also not part of the emissions from deforestation and wood harvesting, since these pools were not considered in the original datasets (see Table S2, SOM). For the other land uses, fire, agricultural soils, and paddy rice, their emission models (e.g. CASA, DAYCENT and, DCDN) included temporal spin-ups to guarantee the stability of the emissions for their temporal scales under analysis. Certain legacies have, therefore, been -considered (please see references for further understanding of these models).-In the case of fires, since 90 percent of tropical fires are the result of human activity (Roman-Cuesta et al., 2003; Van der Werf et al., 2010), we assumed all emissions to be human-induced. This might have resulted in an overestimation of some fire emissions in drier unmanaged ecosystems (e.g. lightings over African woodlands) but since we have excluded deforestation fires (to avoid double counting with deforestation), and we have also excluded savanna and agricultural fires (under the assumption of carbon neutrality), we are quite certain that our gross fire emissions for 2000-2005 are rather conservative. We assumed instantaneous emissions of all carbon that is lost from the land after human action (Tier 1, IPCC 2006) (e.g. deforested and harvested wood), with no transboundary considerations (e.g. the emissions are assigned wherever the disturbance takes place, particularly important for the-Harvested Wood Products). Life-cycle substitution effects) are neither considered for harvested wood (Peters et al., 2012).

Figure 1 describes the steps followed to produce our spatially explicit layers of gross AFOLU emissions and uncertainties. We first assessed all possible emissions, and land uses and human activities under the framework of the IPCC 2006 AFOLU guidelines. We then selected the key AFOLU emissions sources as identified in the IPCC Fifth Assessment Report (AR5) (Smith et al., 2014). There were seven key emission sources, three within the forest sector: deforestation, fire, and wood harvesting (these last two were considered as forest degradation), and four within agriculture: cropland soils, paddy rice, enteric fermentation and manure management (aggregated