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IS THERE A PROPER LAND USE AND LAND COVER DATASET TO ASSESS THE HUMAN IMPACT ON CO_2 FLUXES IN THE PAN-AMAZON?

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RESUMO: Na floresta Pan-Amazônica as principais emissões de CO_2 ocorrem por mudanças de uso e cobertura da terra (MUCT), principalmente do desmatamento e da degradação florestal. Para uma melhor compreensão do fluxo de CO_2 medido pelo projeto CARBAM, são necessários dados de MUCT multitemporais para a região Pan-Amazônica que reflitam o impacto humano. Comparamos brevemente as classes de MUCT de 2010 a 2018 do PRODES, TerraClass e MapBiomas Amazônia. As diferentes abordagens metodológicas do uso de uma máscara de desmatamento, tornam a classificação das classes MUCT diferentes. Apenas o MapBiomas Amazônia possui dados de MUCT para toda a Pan-Amazônia. Com base nas características de cada conjunto de dados de MUCT, oferecemos recomendações sobre como poderíamos juntá-los, incluindo outros estudos que consideram a vegetação secundária e a degradação para ter um conjunto de dados MUCT anual para a Pan-Amazônia.
Palavras-chave: Mudança no uso e cobertura da terra, Amazônia, emissões de CO_2

ABSTRACT: The main CO_2 emissions in the Pan-Amazon region come from land use and cover change (LUCC), mainly deforestation and degradation. To better understand the CO_2 fluxes along this region, it is necessary to assess if the CO_2 measurements, collected by the CARBAM project, have any relation with multitemporal LUCC data for the Pan-Amazon region that reflect the human impact. We briefly compared the LUCC data classes from 2010 to 2018 of the Deforestation Monitoring Program known as PRODES, TerraClass and MapBiomas Amazonia. The different methodological approach of using a mask of deforestation, make the LUCC classes classification different. Only MapBiomas Amazonia has LUCC for the whole Pan-Amazon. Based in each LUCC dataset characteristics we give recommendation on how we could join them including other studies which consider secondary vegetation and degradation to have an annual LUCC dataset for the Pan-Amazon.
Keywords: Land use and cover change, Amazon, CO_2 emissions

INTRODUCTION

In the Pan-Amazon region, the main CO_2 emissions come from land use and cover change (LUCC), especially from deforestation and degradation of natural forests (AGUIAR et al., 2016; TEJADA et al., 2016). The role of forests under climate change and deforestation needs to be understood in the current carbon balance at different scales. The lower-troposphere greenhouse gas (GHG) monitoring program “CARBAM project”, has been collecting bimonthly GHGs vertical profiles in four sites of the Amazon since 2010, filling a very important gap in regional GHGs measurements (GATTI et al., 2014). In order to study the potential relation between CO_2 data, collected by the CARBAM, and human induced deforestation and forest degradation, it is necessary to assess the feasibility of multitemporal LUCC data for the Pan-Amazon region that reflect the anthropogenic activities that influence the CO_2 emissions. Multitemporal LUCC datasets exist for Brazil and the Pan-Amazon region with different temporal scale and methodological approach. Here we briefly compare tree LUCC datasets classes to identify the potentialities or limitations in gathering the datasets for the Pan-Amazon countries. Also we give recommendations on how we could have an annual Pan-Amazon LUCC dataset to represent the CO_2 emissions.

MATERIALS AND METHODS

Our study area is the Amazon forest biome (Fig. 1). We briefly compared the LUCC classes from 2010 and 2018 of the Deforestation Monitoring Program known as PRODES (INPE, 2015) (even though this product is for deforestation), TerraClass (ALMEIDA et al., 2016) and MapBiomas Amazonia collection 2 (MAPBIOMAS, 2020). The spatial digital data of each dataset were cut with the CARBAM mask (Fig.1), to get the classes and calculate the area of each class within. To relate the classes, we used the comparison of MapBiomas Brazil and Terraclass made by NEVES et al., (2020) based on the FAO Land Cover Classification System (LCCS). The area and percentage of each LUCC class was calculated for the 2010-2018 period. We focus on the year 2014 (the last year of TerraClass) so we can compare all the datasets. As in the MapBiomas Amazonia many classes of the LCCS were missing, so we groped them in the Reclassify column of Table 1.

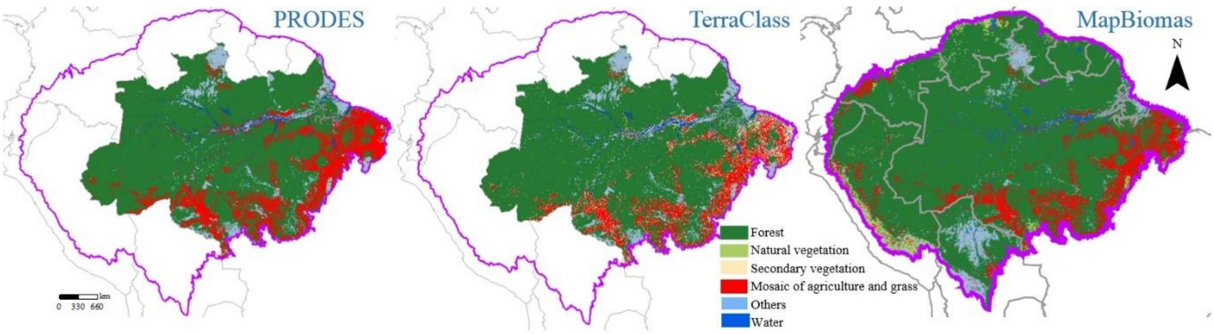

Figure 1–Land use and cover datasets of PRODES (INPE, 2015), TerraClass (ALMEIDA et al., 2016) and MapBiomas Amazonia (MAPBIOMAS, 2020) in 2014, the CARBAM mask our study area (in purple).

RESULTS AND DISCUSSION

LUCC classes comparison are shown in Table 1 and Figure 2. The temporal and spatial scale is the main limitation to build an annual LUCC dataset for the entire Pan-Amazon. PRODES that is an annual deforestation product (1988-2019) do not have the LUCC data of the deforested area. TerraClass classifies these areas, but only for the years 2004, 2008, 2010, 2012, and 2014. So we are missing the 2015-2018 period. TerraClass and PRODES are only for the Brazilian Amazon covering only 58% of the CARBAM mask, 42% is in the rest of the Pan-Amazon countries (see Figs. 1 and 2). MapBiomas Amazonia is an annual product from 1985-2018 covering the whole Pan-Amazon, but the "secondary vegetation" class is missing and the classification method does not use the deforestation mask. PRODES and TerraClass use the deforestation mask which means that a pixel that is deforested get out of the mask, not been classified as forest again. That is why the percentage of Forest is higher in MapBiomas 81% when compared with PRODES or TerraClass (both 74%) and deforestation is lower in MapBiomas Amazonia (Table 1). The classes of Non-forest natural vegetation and Others, also presented differences as shown in Fig. 2, as other studies found (e.g. NEVES et al., 2020) within the Brazilian Amazon.

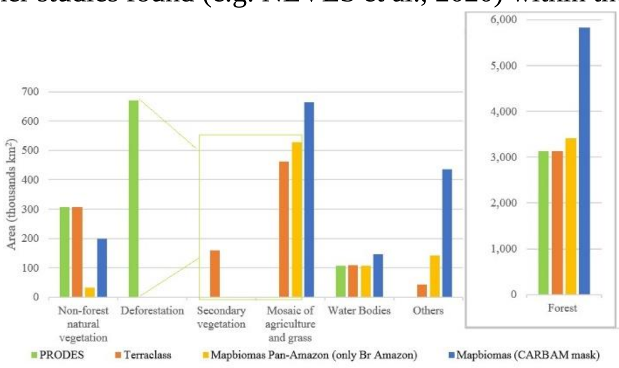

Figure 2 – Land use and cover change classes of PRODES (INPE, 2015), TerraClass (ALMEIDA et al., 2016) and MapBiomas Amazonia (MAPBIOMAS, 2020) for the Brazilian Amazon and only MapBiomas for the Pan-Amazon.

Table 1 – Land use and cover change classes of PRODES (INPE, 2015), TerraClass (ALMEIDA et al., 2016) and MapBiomas Amazonia collection 2 (MAPBIOMAS, 2020). The classes were grouped according to LCCS legend, but as in MapBiomas many classes were missing, we groped them in the Reclassify column. The percentage of each class is for 2014 (the last year of TerraClass) and only for the Brazilian Amazon.

LCCS	**PRODES (1988 to 2018) Brazilian Amazon**			**TerraClass (2004, 2008, 2010, 2012, 2014) Brazilian Amazon**			**MapBiomas Amazonia (1985 to 2018) Pan-Amazon**			**Reclassify**
Class name	**Class name**	**Code**	**%**	**Class name**	**Code**	**%**	**Class name**	**Code**	**%**	**Class name**
Forest	Forest	1	74	Forest	1	74	Forest	3	80.7	Forest
							Mangrove	5	0.1	
							Flooded forest	6	0.001	
Non-forest natural vegetation	Non-forest	3	7	Non-forest	14	7	Wetland	11	2	Non-forest natural vegetation
							Grassland	12	0.1	
							Savanna Formation	4	0.7	
Secondary vegetation	Deforestation	4	16	Secondary vegetation	2	4				Secondary vegetation
Planted forest				Silviculture	3	0.1				Planted forest
Agriculture				Perennial Crop	6	0.03	Mosaic of Agriculture and Grass	21	13	Mosaic of agriculture and grass
				Semi-perennial Crop	7	0.01				
				Temporary crop	8	0.9				
Pasture				Herbaceous pasture	5	7.8				
				Shrubby pasture	4	2.2				
Urban areas				Urban areas	10	0.11	Non vegetated area	22	0.1	Others
Mining				Mining	9	0.03				
Others	Non-forest	3	7.25	Others	11	1	Other non forest natural formation	13	3.3	
Non-Observed				Non-Observed	12	0.7				
Water Bodies	Hydrography	2	2.53	Hydrography	15	2.56	River, Lake and Ocean	33	2.5	Water bodies
							Glacier	34	0	

After this briefly comparison of LUCC classes we can make recommendations for joining the LUCC datasets to have an annual Pan-Amazon LUCC dataset. In the Brazilian Amazon, for Forest and Deforestation (larger than 6.25 ha), use the PRODES mask that has the best accuracy, almost 94% (MAURANO; ESCADA, 2019). For the LUCC of deforested areas, there is no TerraClass data after 2014, so we could use the annual MapBiomas data but including the data of secondary vegetation dynamics of SILVA JUNIOR et al. (2020) (based in MapBiomas Brazilian data). For the degradation that is inside the forest PRODES mask other studies as ASSIS et al. (2020) should be considered. For the rest of the Pan-Amazon countries, for Forest, Agriculture and grass, we could also use the MapBiomas Amazonia data, adding the Secondary vegetation using the same method of SILVA JUNIOR et al. (2020). For degradation we could use the data of BULLOCK et al. (2020).

CONCLUSIONS

The comparison of PRODES, Terraclass and MapBiomas LUCC classes show that they have different objectives, temporal and spatial scales. The different methodological approach of using a deforestation mask, make the LUCC classes classification different. Only MapBiomas Amazonia has LUCC for the whole Pan-Amazon, but does not consider the secondary vegetation and degradation dynamics. Based in each LUCC dataset characteristics we give recommendation on how we could join them including other studies which consider secondary vegetation and degradation to have an annual LUCC dataset for the Pan-Amazon.

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