Environmental-Economic Accounts

Ecosystem Accounts

Land Use in the Brazilian Biomes
2000 - 2018




Introduction

Natural capital accounting uses an accounting framework to systematically assess the stocks and flows of natural resources and assets, as well as account for the ecosystem assets and services they provide. Through this accounting structure, it is possible to measure and compare, over time, the contribution of natural resources and ecosystems to social and economic aspects of a given territory. Accounts provide dynamic and standardized statistics for the decision-making and planning process (NATURAL..., 2019).

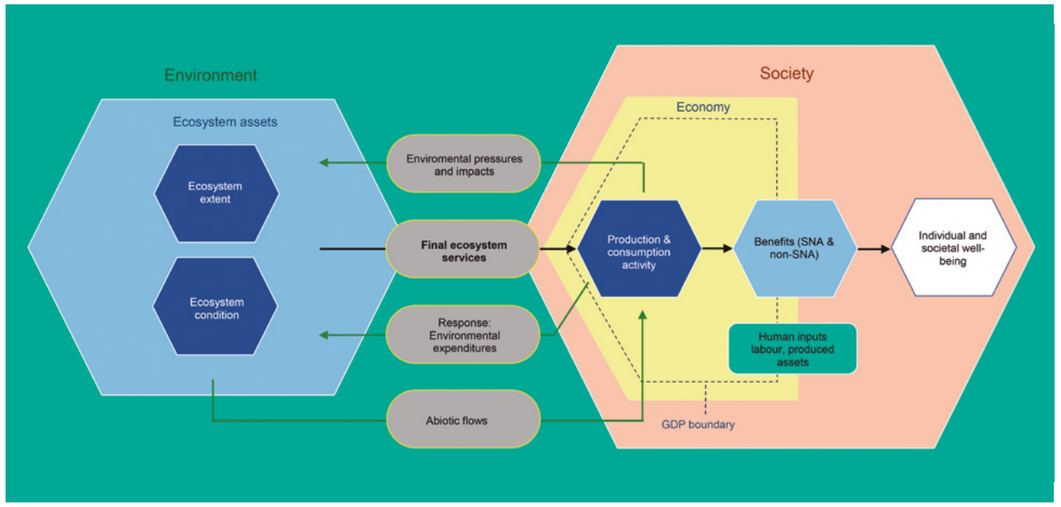
From the methodological perspective of Ecosystem Accounting, it is important to emphasize that, according to the System of National Accounts - SNA, not all environmental resources are considered as economic assets; only those that are owned and provide economic benefits are recorded in the national balance sheet (UNITED NATIONS et al., 2009). Thus, part of the benefits generated by nature, which are called ecosystem services, are not captured by the SNA since they do not constitute an economic production process. This is the case, for instance, in climate regulation provided by forest areas.

As such, it is necessary to first understand the spatial dimension of the ecosystems. The first issue of the Brazilian Ecosystem Accounts presents an analysis of the natural ecosystem areas in the National Territory and an approximation of their state of preservation based on the changes in their extent from 2000 to 2018. In order to do so, this publication has adopted the official environmental profile compatible with the ecological concept addressed in the spatial units as defined in the SEEA Experimental Ecosystem Accounting Methodology (UNITED NATIONS, 2014): Brazilian terrestrial biomes (BIOMAS...,2019).

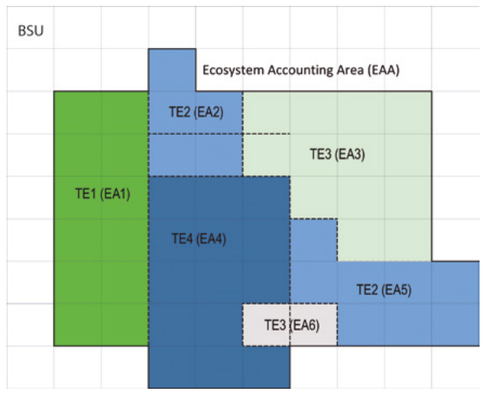
The Methodology of Experimental Ecosystem Accounts

A major step towards natural capital accounting was taken with the adoption of the System of Environmental Economic Accounting (SEEA) Central Framework by the United Nations Statistical Commission (UNSC) in 2012. After its adoption, the countries represented in the UNSC pointed to the importance of also accounting for ecosystems and the services they provide to economic activities and human needs.

The first step to consider such natural assets within environmental economic accounting is to define their spatial and functional dimensions, the latter based on the measurement and evaluation of their service flows. That way, these natural areas are treated as physical assets (stocks), and the range of ecosystem services (flows) they provide as an integral part of the natural processes in their spatial area. These steps are identified in the Ecosystem Environmental-Economic Accounts as Extent Accounts (spatial dimension) and Condition Accounts (functional dimension).



Key: **General Structure of Ecosystem Account.** Source: UNITED NATIONS. Statistics Division. *Technical Recommendations in support of the System of Environmental-Economic Accounting 2012*: Experimental Ecosystem Accounting. New York, 2019. p. 20. (Studies in methods. Series M, No. 97). Available at: https://seea.un.org/sites/seea.un.org/files/documents/EEA/seriesm_97e.pdf. Accessed: August 2020. Adapted.



This new methodology is in the experimental phase and being tested in several countries, with countries piloting different accounts and services depending on their own priorities and circumstances. The framework is recognized as SEEA-EEA (System of Environmental-Economic Accounting - Experimental Ecosystem Accounting).

The Extent Accounts record the changes in composition within an Ecosystem Accounting Area (EAA) with information on the different types of Ecosystem Assets (EA), usually grouped in terms of different Ecosystem Types (ET).

The current report has developed an experimental methodology which describes the change in the extent of natural ecosystems within Brazilian biomes based on an analysis of land use changes.

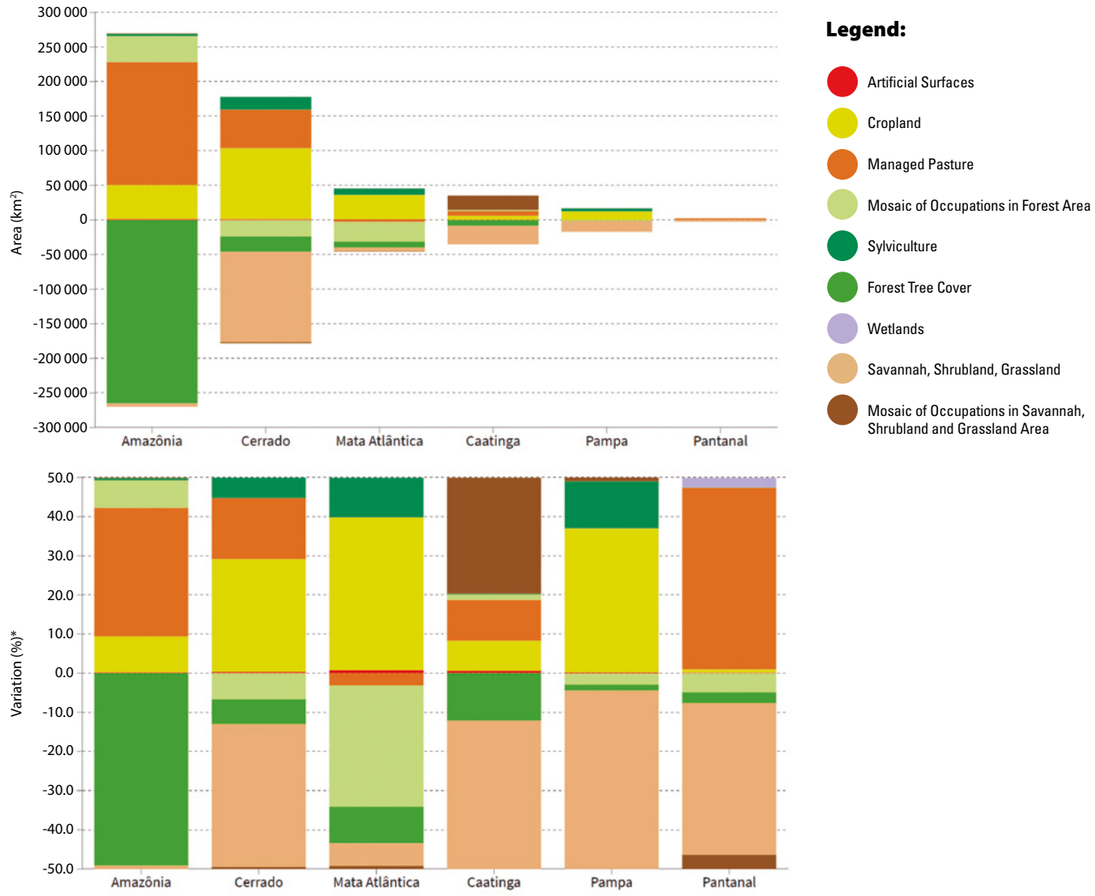
Key: **Relationship between the spatial areas in ecosystem accounting.** Source: UNITED NATIONS. Statistics Division. *SEEA Experimental Ecosystem* Accounting: *Technical Recommendations: Consultation Draft.* New York, 2015. Prepared under the auspices of the United Nations, United Nations Environment Programme - UNEP, Convention on Biological Diversity - CBD and the Norwegian Ministry of Foreign Affairs. Available at: https://unstats.un.org/unsd/envaccounting/ceea/meetings/eleventh_meeting/BK-11-3b-2.pdf. Accessed: August 2020. Adapted.

The Extent Accounts provide a common base to guide the discussions on the drivers of change in the ecosystems and their causal relations. The spatial information captured in an Extent Account provides the basis for understanding where the different types of ecosystems are located in a given ecosystem accounting area, and how they are changing over time (for instance, in terms of fragmentation of the landscape or changes compared to a historical baseline).

An initial analysis of the map immediately shows a clear concentration of continuous natural forest areas currently in the Amazônia (Amazon) Biome. Secondly, it is also important to note that the Mata Atlântica (Atlantic Forest) Biome contains only a few vegetational remnants, which are highly fragmented and currently concentrated in tiny regions along the coast. Thirdly, forest areas can be currently observed in the southwest Caatinga Biome, mainly in the valleys.

Regarding the savannah, shrubland and grassland natural areas, the Cerrado Biome is subject to a high degree of anthropogenic interference, especially in its southern part; the Pantanal Biome, on the other hand, is currently the most preserved region, with only a slight degree of anthropogenic influence along its eastern border. The Caatinga Biome currently features the highest degree of anthropogenic interference, mainly in its eastern sector, and the Pampa Biome has a pattern of strong human occupation in the uplands.

Chart 1 – Dynamic of net variation of land cover and land use in the Brazilian biomes, in absolute and relative terms – 200/2018



Source: IBGE, Diretoria de Geociências, Monitoramento da Cobertura e Uso da Terra do Brasil.
*Percentage in relation to absolute area of change in each biome.

It can be noted that, in relative terms, the main changes in natural areas in the Brazilian ecosystems took place in the Amazônia and Caatinga Biomes, which experienced losses of forest tree cover and savannah, shrubland and grassland vegetation. However, as the Caatinga spatial extent is almost five times smaller than that of the Amazônia, the greatest losses in absolute terms for these land use categories actually occurred in the Amazônia and Cerrado Biomes.

The Caatinga Biome also stands out for having presented a hegemonic conversion to anthropogenic use classes, as in managed pasture and croplands, or as in mosaics of occupations in forest and savannah, shrubland and grassland areas, while in the Cerrado and Amazônia Biomes, there is a predominance of a more intense process of anthropogenic influence, portrayed by the greater gain, both in absolute and relative terms, of croplands and managed pastures.

It is also worth mentioning that Mata Atlântica is the only Brazilian terrestrial biome which showed a loss of areas with broad anthropogenic uses in the studied period - the mosaics of occupations in forest areas, evidencing category gains of greater degree of anthropogenic influence, where several crops are developed. Accompanying this trend, the Cerrado biome also shows an increase in the croplands and sylviculture areas.

On the other hand, the Caatinga biome presented the highest absolute and relative increases of mosaics of occupations in savannah, shrubland and grassland areas, according to the regional phytoecological scenario, which shows the concentration of diversified anthropogenic uses in this part of Brazil, in small rural areas, according to its traditional use.

Regarding the increase of mosaics of occupations in forest areas, it is important to emphasize its predominance in portions of the fragmented amazon landscape, since in this region, the increase of that type of land use has been observed in absolute and relative terms, since it constitutes its complex environmental territorial dynamic.

Table 1 - Ecosystem Extent Accounts in the Brazilian Biomes - 2000/2018

Variables (km²)	Biome												Total	
	Amazônia		Cerrado		Mata Atlântica		Caatinga		Pantanal		Pampa			
	Natural Areas	Anthropized Areas	Natural Areas	Anthropized Areas	Natural Areas	Anthropized Areas	Natural Areas	Anthropized Areas	Natural Areas	Anthropized Areas	Natural Areas	Anthropized Areas	Natural Areas	Anthropized Areas
Opening Extent (2000)	**3.684.512**	**450.865**	**1.185.192**	**790.693**	**195.614**	**896.686**	**581.581**	**274.213**	**134.205**	**15.358**	**96.194**	**82.491**	**5.877.298**	**2.510.306**
Additions	1.282	248.427	509	135.983	257	43.490	519	21.477	378	1.707	10	9.446	2.955	460.530
Reductions	193.539	56.170	96.274	40.218	8.793	34.954	17.165	4.831	1.649	436	8.646	810	326.066	137.419
Extent (2010)	3.492.255	643.122	1.089.427	886.458	187.078	905.222	564.935	290.859	132.934	16.629	87.558	91.127	5.554.187	2.833.417
Additions	385	39.064	284	37.357	248	13.515	293	15.285	290	134	9	2.432	1.509	107.787
Reductions	27.376	12.073	23.068	14.573	3.083	10.680	13.375	2.203	189	235	2.225	216	69.316	39.980
Extent (2012)	3.465.264	670.113	1.066.643	909.242	184.243	908.057	551.853	303.941	133.035	16.528	85.342	93.343	5.486.380	2.901.224
Additions	2.043	39.654	320	35.913	44	7.362	1.000	6.895	101	243	84	3.548	3.592	93.615
Reductions	21.123	20.574	18.392	17.841	735	6.671	5.327	2.568	216	128	3.237	395	49.030	48.177
Extent (2014)	3.446.184	689.193	1.048.571	927.314	183.552	908.748	547.526	308.268	132.920	16.643	82.189	96.496	5.440.942	2.946.662
Additions	644	36.413	314	16.599	213	4.428	648	2.264	278	74	21	937	2.118	60.715
Reductions	23.541	13.516	8.417	8.496	1.509	3.132	1.801	1.111	326	26	841	117	36.435	26.398
Extent (2016)	3.423.287	712.090	1.040.468	935.417	182.256	910.044	546.373	309.421	132.872	16.691	81.369	97.316	5.406.625	2.980.979
Additions	8.185	38.566	2.706	25.583	102	4.513	1.545	2.376	123	1.026	233	2.232	12.894	74.296
Reductions	16.761	30.057	10.688	17.671	577	4.039	1.604	2.328	899	254	1.569	896	32.098	55.245
Closing Extent (2018)	**3.414.711**	**720.599**	**1.032.486**	**943.329**	**181.781**	**910.518**	**546.314**	**309.469**	**132.096**	**17.463**	**80.033**	**98.652**	**5.387.421**	**3.000.030**
Net change - Absolute (Km²)	-269.801	269.734	-152.706	152.636	-13.833	13.832	-35.267	35.256	-2.109	2.105	-16.161	16.161	-489.877	489.724
Net change - Percentage (%)	-7,32	59,83	-12,88	19,30	-7,07	1,54	-6,06	12,86	-1,57	13,71	-16,80	19,59	-8,34	19,51
Movement (Km²)	294.879	534.514	160.972	350.234	15.561	132.784	43.277	61.338	4.449	4.263	16.875	21.029	536.013	1.104.162
Movement (%)	8,00	118,55	13,58	44,29	7,95	14,81	7,44	22,37	3,32	27,76	17,54	25,49	9,12	43,99

Source: IBGE, Diretoria de Geociências, Coordenação de Recursos Naturais e Estudos Ambientais.
Note: Developed from the Ecosystem Extension Accounts and Monitoring of Coverage and Use of Land in Brazil.

It can be noted that natural areas show a decline in extent across all the Brazilian terrestrial biomes during the period from 2000 to 2018. Therefore, this accounts for a loss of these coverages in several points throughout the country, with a total reduction of approximately 500,000 km² of natural ecosystems. When analyzing the historical time series, it can be noted that despite the overall negative balance, the rate of the reduction of natural areas has been decreasing over the years.

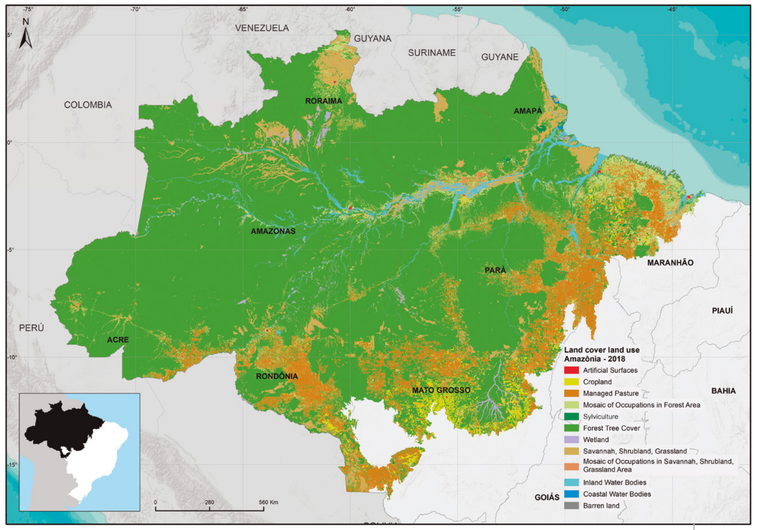
The greatest absolute reductions in natural areas were concentrated in the Amazônia and Cerrado Biomes, respectively 269,801 km² and 152,706 km². The greatest percentage loss took place in the Pampa Biome, where 16.8% of its natural area as of 2000 was converted into anthropogenic uses.

On the other hand, Pantanal was the biome with the smallest decreases in natural areas, both in absolute (2,109 km²) and in relative terms (1.6%), showing a lower dynamic of conversions of use in that region of the country.

The Mata Atlântica and Caatinga Biomes feature low conversion rates in natural and anthropized areas (13.6% and 12.2%, respectively). They were also the biomes that witnessed the greatest decreases in the conversion rate of natural areas, from 8,793 km² in the initial period (2000-2010) to 577 km² in the current period (2016-2018) for the Mata Atlântica, and from 17,165 km² to 1,604 km², in the case of Caatinga, in the same periods.

The conversions of land cover and land use: 2000-2018

Amazônia

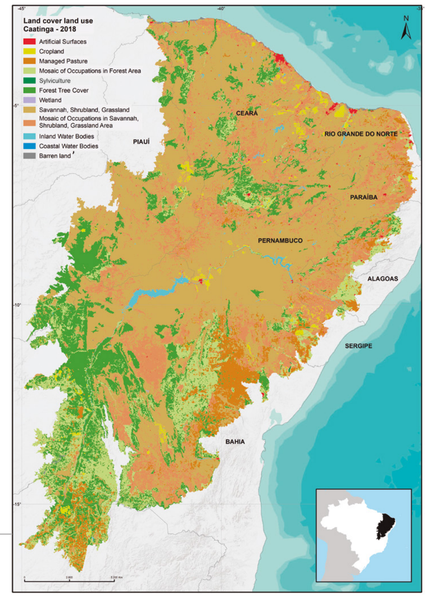


Amazônia was the biome with the greatest percentage of changes in land use observed between 2000 and 2018, with emphasis on the reduction of its forest coverage, which, in the last year considered, represented 75.7% of its total area.

In this period, it presented an increase of 71.4% in the managed pasture area, and of 288.6% in the cropland area, evidence of a transition dynamic typical of its occupation and exploitation process, which also includes a 31.0% conversion to mosaics, indicating a landscape fragmentation process.

These changes indicate a pattern of use referred to as the "consolidated settlement arc", initially observed on the borders of the Amazônia Biome, in areas of contact with the Cerrado Biome, and now presenting a considerable shift inward, following the construction of roads, river banks and adjacencies of infrastructure works.

Caatinga

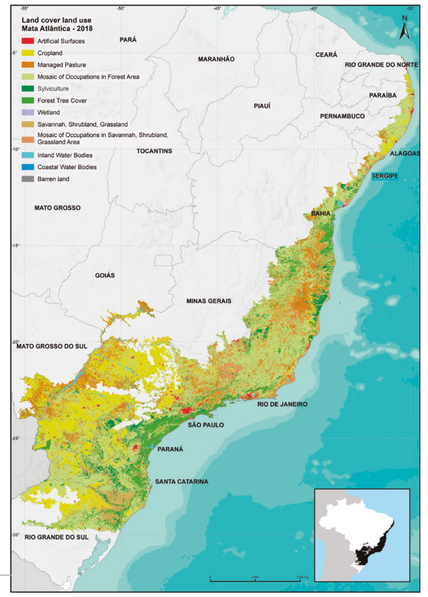


In the Caatinga Biome in 2018, there was a predominance of savannah, shrubland and grassland over 46.8% of its territory, with only 5.6% of strict anthropogenic uses under the form of managed pasture. However, the biome's natural cover is constantly decreasing.

In the studied period, 47.3% of the land use conversions were related to the shift from savannah, shrubland and grassland areas to mosaic of occupations. This represents the territory's occupation, with a high number of small rural companies, characterized by subsistence harvesting, small pastures or agroforestry systems.

Although representing only 1.5% of the area of the biome, the cropland category showed a noteworthy change, growing from an area of 7,213 km² in 2000 to 12,621 km² in 2018, corresponding to a 74.9% increase.

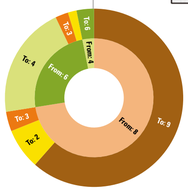
Mata Atlântica



Mata Atlântica is the only Brazilian terrestrial biome whose predominant land use category is not of natural coverage. Forest tree cover, whose physiognomies were originally predominant in its ecosystems, currently represents only 12.6% of its territory, having represented 13.3% in 2000.

The cropland and sylviculture areas were the highlights in category conversion, with a most expressive growth in the latter at 33.9%, followed by the former, at 19.6%. An outright expansion in the cropland areas can be observed, which especially advance in areas formerly used for pasture, accompanying the dynamic of the Cerrado Biome in the Center-South of the country.

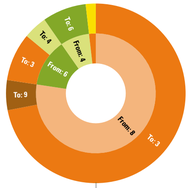
It is the biome with the greatest demographic density in the country, housing 49.3% of the urban areas in the National Territory in 2018. These characteristics are mainly due to its history of occupation and urbanization, from coastal areas inland.

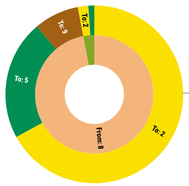


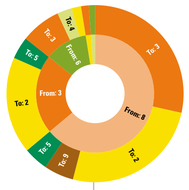
Legend:

- 2 Cropland
- 3 Managed Pasture
- 4 Mosaic of Occupations in Forest Area
- 5 Sylviculture
- 6 Forest Tree Cover
- 8 Savannah, Shrubland, Grassland
- 9 Mosaic of Occupations in Savannah, Shrubland, Grassland Area

The inner circle is related to 2000, while the outer is related to 2018.





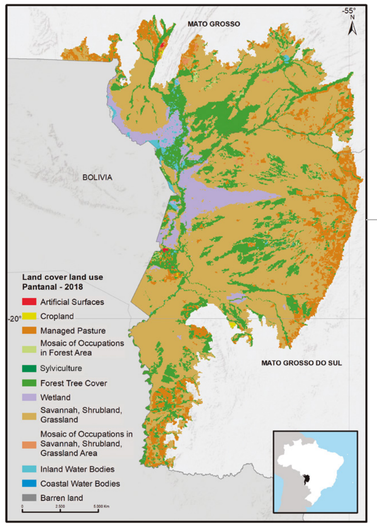


Pantanal

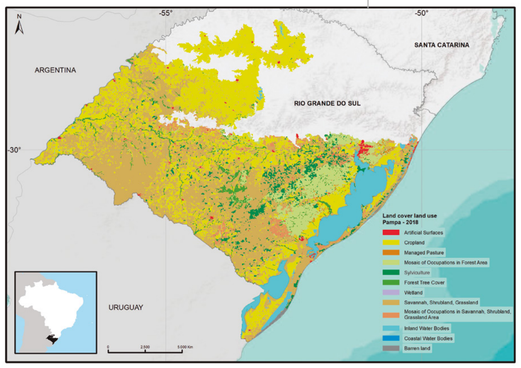
The Pantanal Biome is predominantly savannah, shrubland and grassland, measuring 91,711 km² in 2018, and it is also interesting to note the great relevance of other categories of natural coverage, with emphasis on the wetland area, which makes it a unique biome.

The wetland category has remained stable over time, but it is important to note that it occupies grassland and forest areas at times and is occupied by natural pasture, meaning that although its area is preserved, its transformations are dynamic.

It is important to emphasize that the majority (61.8%) of the changes observed correspond to conversions to managed pasture. In general, that conversion takes place over the savannah, shrubland and grassland areas, observing a reduction of 2,090 km² of that vegetation, and demonstrates the application of new cattle farming techniques over the traditional ones in the region.



Pampa

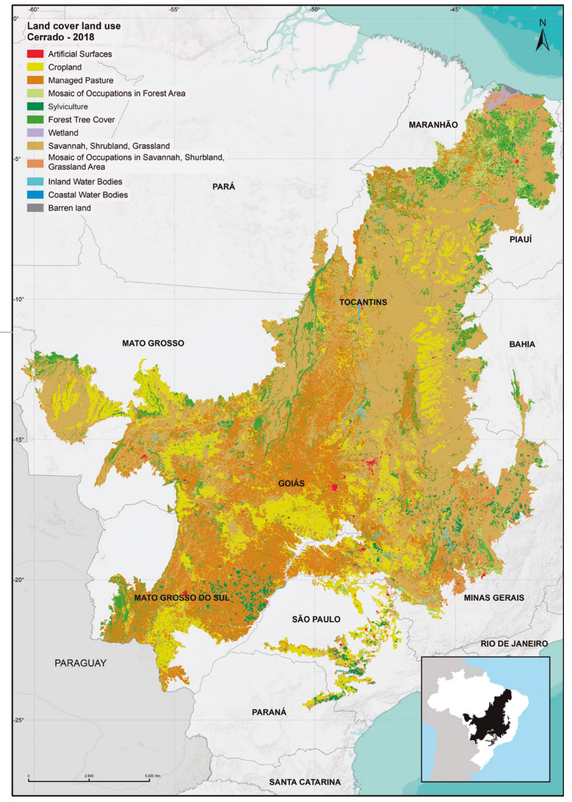


In 2018, the Pampa Biome was predominantly savannah, shrubland and grassland (37.4%), followed by the cropland category (36.3%), as well as 19.3% of the natural barren land in Brazil, which includes dunes and sandy areas.

However, its territory underwent intense changes in the past decades, registering a reduction of 15,607 km² in its natural savannah, shrubland and grassland vegetation from 2000 to 2018: 58.0% to cropland and 18.8% to sylviculture, due to expansions in the region of the greatest concentrations of investments by credit cooperatives.

The remarkable expansion of sylviculture, growing from an area of 2,700 km² to 6,838 km² is associated with the paper and pulp industry, with considerable participation in the value of the national production for said industry.

Cerrado



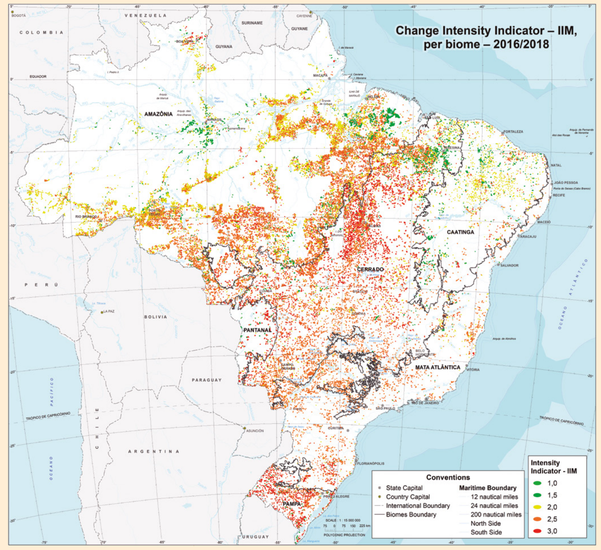
It is important to note that the savannah, shrubland and grassland areas and the forest tree cover areas experienced progressive reductions in extent, becoming replaced by managed pasture and cropland areas. This dynamic is influenced by the farming aptitude of the soil, especially in the chapadas and uplands sustained by basaltic spills, potentially favoring the use of agricultural technologies.

Managed pasture is the second most representative category of land use in this biome, and its relevance is due to the historical occupation characteristics, with cattle farming being a traditional and significant activity in the economic formation of the regions constituted here.

The most remarkable characteristic of the land use transformations in the Cerrado Biome is the continuous and accelerated expansion of croplands, with expansion to an area of 102, 603 km² between 2000 and 2018. These areas presented 52.9% growth, predominantly due to monoculture of grains and cereals for export, in addition to having recorded a 104.3% increase in sylviculture areas.

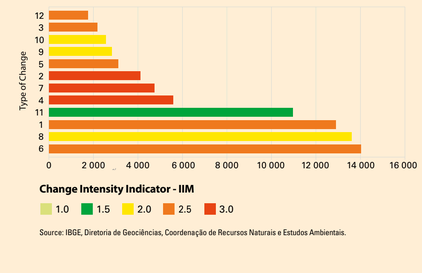
The Intensity of Changes 2016-2018

The Change Intensity Indicator (*Indicador de Intensidade de Mudanças* - IIM) is a parameter to evaluate the dynamic of changes in land cover and land use in Brazil. Its main focus is analyzing the transformations of the territory in terms of land use and conversions in natural coverage. From there, it is possible to point out areas where the land use changes were more prominent, that, in many cases, deserve special attention in the territory planning actions and in the management of the National Environmental Policy.



The map shows an overall trend of the land use dynamic in Brazil in relation to the current expansion of agricultural activities in the territory. This allows a great concentration of points of change to be observed between the Amazônia and Cerrado Biomes, many of them with high IIMs (2.5 and 3.0), which indicates intense changes in the landscape of those regions. The Pampa Biome was also highlighted with a relatively elevated number of high-intensity points of change (3.0) in its reduced area, pointing to an intense transformation of that spatial unit in the considered period.

Chart 2 – Intensity of the main types of changes in land cover and land use in Brazil (Area in km² - 2016-2018)



Type of Change

1 - **From** Mosaic of Occupations in Forest Area **To** Managed Pasture
2 - **From** Forest Tree Cover **To** Managed Pasture
3 - **From** Cropland **To** Managed Pasture
4 - **From** Savannah, Shrubland, Grassland **To** Managed Pasture
5 - **From** Mosaic of Occupations in Forest Area **To** Cropland
6 - **From** Managed Pasture **To** Cropland
7 - **From** Savannah, Shrubland, Grassland **To** Cropland
8 - **From** Forest Tree Cover **To** Mosaic of Occupations in Forest Area
9 - **From** Managed Pasture **To** Mosaic of Occupations in Forest Area
10 - **From** Savannah, Shrubland, Grassland **To** Mosaic of Occupations in Savannah, Shrubland, Grassland Area
11 - **From** Mosaic of Occupations in Forest Area **To** Forest Tree Cover
12 - **From** Managed Pasture **To** Sylviculture

Source: IBGE, Diretoria de Geociências, Coordenação de Recursos Naturais e Estudos Ambientais.

In a quantitative analysis, it was detected that between 2016 and 2018, there were 87,242 km² of changes in land use and land cover in Brazil, which corresponds to approximately 1% of the National Territory.

During this period, most of the changes have an IIM of 2.5 (approximately 40% of the total) and the greatest emphasis lies in the 14,039 km² of managed pasture that became cropland. In 2,172 km² of the country, the opposite occurred –cropland gave way to managed pasture.

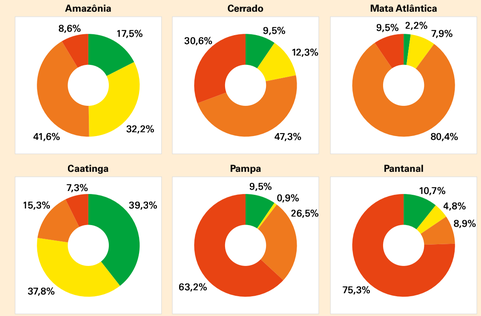
Other transitions indicated by the IIM of 2.5 were the areas of mosaic of occupations in forest or savannah, shrubland and grassland areas, which were converted into managed pasture or cropland areas, characterizing an increase in anthropogenic use of 18 376 km² of the territory.

Regarding the areas with an IIM of 2.0, there is indication of degradation or fragmentation of the landscape, referring to natural forest or savannah, shrubland and grassland that became their corresponding mosaics of occupations, for a total of 16,149 km², or approximately 20% of all changes.

Among the most intense changes, with an IIM of 3.0, it is important to emphasize the one that represents natural vegetation, whether savannah, shrubland and grassland or forest tree cover, which became a category of strict anthropogenic use (18.1% of the total), indicating an advancement of agricultural activity over 15,852 km² of natural areas in the country.

An IIM of 1.5 represents a change in broad or strict uses for natural cover, which can be interpreted as regeneration, as long as its permanence in the historical series is evaluated. A predominance of the category of mosaic of occupations that became forest tree cover or savannah, shrubland and grassland can be observed, with an area of 12,337 km².

Change Intensity Indicator (IIM), by biome – 2016-2018



Note: The IIM values = 1.0 are less than 0.4% and are not visible in the charts.
Source: IBGE, Diretoria de Geociências, Coordenação de Recursos Naturais e Estudos Ambientais.

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