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Papers

Spatio-Temporal Dynamics of Land Use in Mato Grosso do Sul from 1988 to 2018 and Payments for Ecosystem Services

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Abstract
Human actions in nature are ancient relationships that allow, among some characteristics, changes in land use. One possibility for studying these changes is the classification of their uses and their transformations over the years to make it possible to understand the relationship between people and nature in a given location. In this context, this research addressed the State of Mato Grosso do Sul, with the objective of investigating the dynamics and temporal space of land use in its mesoregions, and the implementation of public and private actions of environmental policies developed in the municipalities, aiming at the scope of ecosystem services. For this, the Shift-Share model was used to identify changes in land use from 1988 to 2018, and the data were extracted from MapBiomas. Furthermore, based on the recommendations of the Forest Code for the conservation of rural property areas and the creation of Conservation Units, the Value of Conservation via Public Policies per municipality in the state was estimated. During the analysis period, it can be seen that, between 1988 and 2018, changes in land use occurred in all mesoregions of the state. Each mesoregion has unique characteristics for replacing land use; however, in general, it can be seen that natural vegetation has lost area for other uses, with the main destination being agricultural use. It was also observed how public environmental policies have helped conserve areas in Mato Grosso do Sul.

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INTRODUCTION

Human activities have transformed natural landscapes significantly (Dronava *et al.*, 2015; Yang *et al.*, 2013). Given this context, it can be observed that among the forms of environmental change that the planet Earth has suffered, the dynamics of land use is one of the most performed environmental studies (Hassan *et al.*, 2016). The attention of researchers to the topic can be understood if land use changes are considered one of the main factors that generate the degradation of natural resources (Wang *et al.*, 2015; Kindu *et al.*, 2018).

With technological advances, geotechnologies have contributed to land-use monitoring and are facilitators in identifying changes in localities (Gong, 2012). These geological resources enable the registration of a temporary series of information in the same area, often made available for free. Such geological features tend to contribute to the development of studies on environmental issues. Thus, this monitoring is essential for studies that address issues that are societal needs, such as environmental change, natural resource management, and urban planning, among other issues that may be related to global or local situations (Zell *et al.*, 2012; Chen *et al.*, 2015).

Demography is an important factor in land-use change. Population growth and migration tend to cause changes in these uses, especially in urban areas, due to population agglomerations that put pressure on the occupation of areas that are often not recommended for the desired use, such as civil construction. In rural areas, agricultural production must be increased. It is denoted that, in turn, the agricultural and livestock production and its increase, are carried out through the substitution of natural vegetation by food vegetation exotic to the natural biome. This planting is done because of the characteristics of the consumer market, which results in the prioritization of certain food crops over others, and in some situations, may be natural crops of the locality (Degife *et al.*, 2019).

When observing the use of soil for agricultural activities, regardless of climatic conditions, agricultural management practices should avoid soil impoverishment resulting from the removal of nutrients by crops, among other actions, such as compaction. Thus, planning activities related to land use should be selective concerning the characteristics of the region (Serra, 2005). This selectivity of use is also a prerogative for urban land use, where the determination of activities without concern for soil characteristics can lead to the compromise of other natural resources, such as groundwater (Embrapa, 2013).

Considering these characteristics, it can be observed that Brazil is a country in which its recent urbanization was carried out in an accelerated manner, arising from a process of rural exodus, and is still considered an agro-exporting country (Marques, 2006; Chaveiro, Dos Anjos, 2007; Ugeda Junior, 2014). Urbanization and agricultural production are two land uses that alter natural vegetation. Urban space is considered a location with greater dynamism in relation to changes in land use due to population agglomeration and needs (Brenner *et al.*, 2015). Agricultural production is considered the main cause of terrestrial biodiversity loss (Maxwell *et al.*, 2016). It is denoted that the process of land use change has culminated in the loss of biodiversity (Kline *et al.*, 2015, TEEB, 2015), and human needs can be considered a threat to the conservation of natural vegetation (Laurance *et al.*, 2014). In this context, this study makes a cut, referring to the state of Mato Grosso do Sul, which aims to investigate the dynamics and temporal space of land use in the mesoregions of that state and identify the implementation of public and private actions of environmental policies developed in municipalities, aiming at the scope of ecosystem services.

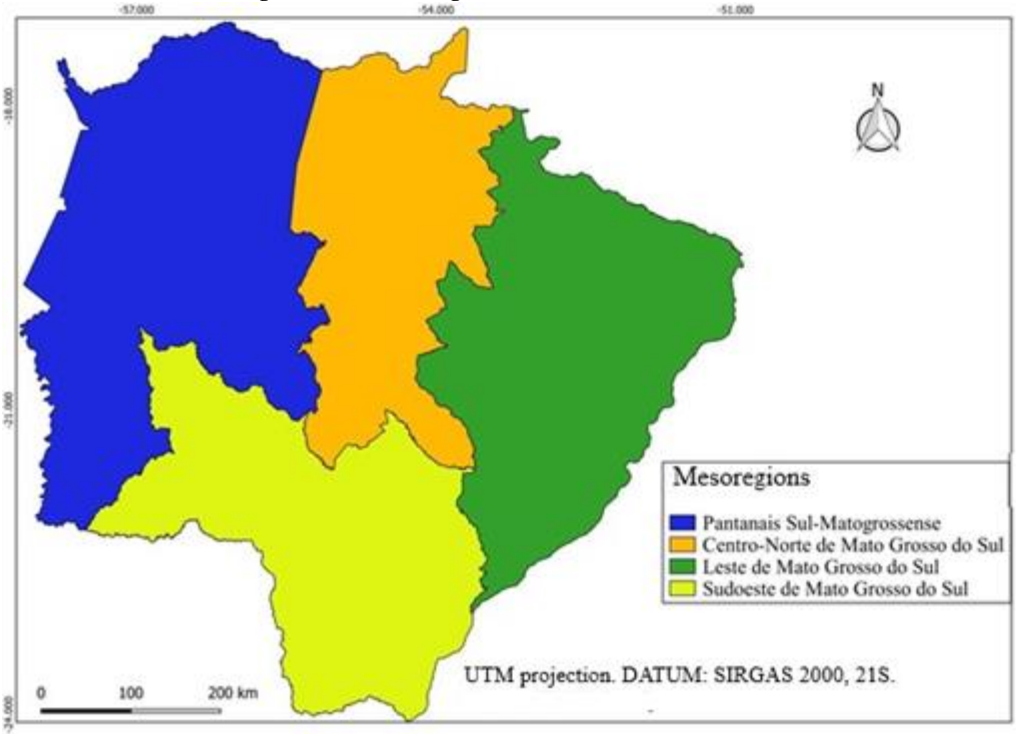
MATERIALS AND METHODS

Investigating the dynamics of the temporal space of a given location provides insight into the process that leads to the configuration of current land use. Furthermore, it helps to identify the reduction or conservation of areas of natural vegetation, that is, green areas consistent with the original biome of the location, which is the object of interest in this study, as a condition for analyzing public environmental policies. Therefore, to identify these characteristics, secondary data made available by MapBiomas (2020), collaborative network, formed by NGOs, universities and technology startups, the Instituto Brasileiro de Geografia e Estatística – IBGE (2017), which is the largest federal data and information provider in the country, the Ministério do Meio Ambiente (2020) and the Instituto de Meio Ambiente de Mato Grosso do Sul (2020), government agencies related to environmental issues. The data were used, referring to the municipalities of Mato Grosso do Sul, which are consistent with the period from 1988 to 2018.

Shift-Share Model

Shift-share is one of the oldest and most widely used techniques for analyzing the characteristics of regions (Rolim, 1999). This analysis is also known as variance component analysis, which decomposes the growth of a given variable into determinants at the regional level (Pospiesz *et al.*, 2011). In this case, land use change between 1988 and 2018 was investigated using this model. We used data from the MapBiomas (2020) platform grouped by the mesoregion of Mato Grosso do Sul (Figure 1).

Figure 1 - Mesoregions of Mato Grosso do Sul



Source: IBGE (2015). Elaborated by the authors (2020).

After the collection, using the shift-share model, considerations were made in relation to the Area Effect, and this effect was decomposed into Scale Effects (EE) and Substitution Effects (ES). In turn, the EE estimated the changes in size or scale per land-use class; thus, this effect shows whether there was an expansion or retraction in each land-use class. The second effect, ES, in turn, identified the areas that were replaced by the expansion of other land uses, which means that upon identification of change, which of the land use categories substituted the previous category (Fagundes; Borges, 2015; Garcia; Buainain, 2016; Carvalho *et al.*, 2017). The Shift-Share model is registered using the following analytical expression:

$$Ai2 - Ai1 = (\alpha Ai1 - Ai1) + (Ai2 - \propto Ai1) \quad (1)$$

where Ai2 – Ai1 is the area variation for land use between the time periods T1 and T2; (αAi1 – Ai1) = EE; (Ai2 – αAi1) = ES.

The EE is the result of multiplying the coefficient of variation (α) by the land use area of the initial analysis year (Ai1), subtracting the same initial area from this result. The ES is the result of subtracting the land use area of the final analysis year (Ai2) by multiplying the coefficient of variation by the land use area of the initial period. In both cases, the analyzed area was specific to each land use category. The coefficient of variation (α) is the result of the ratio between the total land use area of the final year and the initial year of the given timeframe (Fagundes; Borges, 2015; Carvalho *et al.*, 2017).

It is understood that positive and negative EE values indicate, in this order, tendencies of expansion or reduction of the land use analyzed. The EE values indicate the behavior of land use, if there was an increase or reduction in the area among the use categories (Santos *et al.*, 2008). In turn, ES, when positive, indicates the occupation of areas of other land uses by that use under analysis. A negative result indicates that the land use analyzed has had areas replaced by other uses. Furthermore, in ES, the result between the addition of the values of each land use category should be equal to zero, given that in this model, the replaced areas are occupied proportionally by the land uses that have expanded (Lourenzani; Caldas, 2014).

Land Use and its relation to Public Environmental Policies

From the first analysis, it was possible to identify changes in land use in the municipalities of Mato Grosso do Sul from 1988 to 2018. Thus, it was proposed to relate land use with the current performance of public environmental policies in the country. For this, it was necessary to identify the areas that corresponded to conservation units in the Ministry of Environment (2020) and the Instituto de Meio Ambiente de Mato Grosso do Sul (2020). Conservation Units have been created over the years based on environmental legislation linked to the subject, with Legislation nº 9.985 of the 2000s being considered the mainstay at present. In addition, the size of rural properties was identified in the 2017 Agricultural Census (IBGE, 2017).

This information was necessary to identify the size of the total area of rural properties conserved through the public environmental policy. Considering that the current environmental legislation refers to the 2012 The Código Florestal (Law nº. 12.651/2012), this legislation requires rural properties, through their owners, to maintain a percentage area with natural vegetation (determining the percentage of conserved area linked to the biome of the location), which is called a Reserva Legal (RL - area with native vegetation cover). The percentage of conservation via RL is 20% of the property area for the Pantanal, Atlantic Forest, and Cerrado biomes (Brasil, 2012).

Another mandatory way to conserve rural areas via the Código Florestal is through the Área de Preservação Permanente (APP - a protected area, covered or not by native vegetation, with the environmental function of preserving water resources, the landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations), which was not used in this study because of the impossibility of information for calculation at the time. In Mato Grosso do Sul, there are three biomes: Atlantic Forest, Pantanal, and Cerrado. Each predominates in the state region. The Database of environmental information made available by the IBGE (2020) was used to identify the predominant biome in each region. The predominant biome was identified for each municipality, as well as the total area of the RL related to rural properties and the area related to Conservation Units. From this information, the values of the ecosystem services of each biome were used to identify the economic value conserved from the environmental legislation in the two land uses that promoted some measure of conservation (Table 1).

Table 1 - Ecosystem Services Value by Biome

Atlantic Forest Biome			**Total Services Common to Biomes**	
Service	**$US\$.m^{-2}.year^{-1}$**	**Reference**	**Service**	**$US\$.m^{-2}.year^{-1}$**
Climate regulation	0.0223		Climate regulation	0.0223
Disturbance Regulation	0.0005		Water regulation	0.0006
Water regulation	0.0006		Erosion control	0.0245
Erosion control	0.0245		Soil formation	0.0010
Soil formation	0.0010	Costanza *et al.* (1997)	Nutrient recycling	0.0922
Nutrient recycling	0.0922		Tailings treatment	0.0087
Tailings treatment	0.0087		Biological control	0.0021
Recreation	0.0112		Recreation	0.0112
			TOTAL	**0.1626 - value/m^2/year**
Cultural	0.0002			
Water supply	0.1610	Oliveira. (2000)		
Biological control	0.0021			
Option value	0.0002	Santos *et al.* (2000)		
Existence value	0.0003			
TOTAL	**0.3248 value/m^2/year**			
Cerrado Biome			**Total Services Common to Biomes**	
Service	**$US\$.m^{-2}.year^{-1}$**	**Reference**	**Service**	**$US\$.m^{-2}.year^{-1}$**
Atmosphere regulation	0.0007		Climate regulation	0.000
Climate regulation	0.000		Water regulation	0.0003
Water regulation	0.0003		Erosion control	0.0029
Erosion control	0.0029	Costanza *et al.*, (1997)	Soil formation	0.0001
Soil formation	0.0001		Nutrient recycling	0.0130
Tailings treatment	0.0087		Tailings treatment	0.0087
Pollination	0.0025		Biological control	0.0023
Recreation	0.0002		Recreation	0.0002
Biological control	0.0023	Santos *et al.* (2000)	**TOTAL**	**0,0275- value/m^2/year**
Nutrient recycling	0.0130	Medeiros *et al.*, (1995)		
TOTAL	**0.0307**	**0.0307 - value/m^2/year**		
Pantanal Biome			**Total Services Common to Biomes**	
Ecosystem Service	**$US\$.m^{-2}.year^{-1}$**	**Reference**	**Service**	**$US\$.m^{-2}.year^{-1}$**
Atmosphere regulation	0.006795		Climate regulation	0.004476
Climate regulation	0.004476		Water regulation	0.037881
Disturbance Regulation	0.174719		Erosion control	0.006341
Water regulation	0.037881		Soil formation	0.002237
Water supply	0.197711		Nutrient recycling	0.018506
Erosion control	0.006341		Tailings treatment	0.050505
Soil formation	0.002237		Biological control	0.001129
Nutrient recycling	0.018506		Recreation	0.015737
Tailings treatment	0.050505	Seidi and Moraes (2000)	**TOTAL**	**0.136812 - value/m^2/year**
Pollination	0.001227			
Biological control	0.001129			
Habitat	0.010588			
Food production	0.005340			
Genetic Resource	0.000823			
Recreation	0.015737			
Cultural	0.042513			
Total	**0.576467**	**0.576467 - value/m^2/year**		

Source: IBAMA (2002); Seidi and Moraes (2000).

It was observed that the information on the estimation of the same ecosystem services was different for each biome; however, we chose to represent the values in two situations: the first in relation to the same ecosystem services available per biome, namely, biological control, erosion control, soil formation, nutrient recycling, recreation, water regulation, climate regulation, and waste treatment. The second situation includes all services with available information. It should be noted that the reference values were used by Farinha *et al.* (2023).

To identify the conservation value of ecosystem services in a municipality for Conservation Units (VConUN), it is necessary to multiply the total amount of conserved area by the total value of services for each biome. It should be noted that the same measurement units were used.

$$VConUn = AT\ x\ VLSE \quad (2)$$

In the case of properties, it is necessary to use the following equality to perform estimation (3).

$$VConPRO = (\%RL\ x\ AT)\ x\ VLSE \quad (3)$$

VConPRO - Conservation Value of rural property by municipality, %RL - % of RL by Biome, AT - Total area of the municipality related to rural properties, and VLSE - Total Value of Ecosystem Services by biome.

These two estimates are necessary to identify the total Conservation Value through Public Policies, which is the result of the sum of VConUN and VConPRO.

RESULTS AND DISCUSSION

Regarding the dynamics of land use during the period of analysis, percentage variations in land use can be observed in all mesoregions and categories of analysis (Table 2). In the Pantanal mesoregion of Mato Grosso do Sul, the greatest variation in the dynamics of use over the last 30 years occurred in the agricultural category (106.6%), which is related to food production of vegetal and animal origin. In the central-northern Mato Grosso do Sul and eastern Mato Grosso do Sul, the greatest variation was in the water bodies category (70.6% and 132.1% respectively), linked to water resources such as rivers. In the mesoregion Southwest of Mato Grosso do Sul, the non-vegetated area showed the greatest variation, indicating the expansion of urban areas of the municipalities present in this mesoregion. This mesoregion covers the largest number of municipalities in the state, and since the 1970s, most of them have been increasing their population, which mostly resides in urban spaces (IBGE, 2020).

Table 2 - Land use dynamics by Mato Grosso do Sul mesoregion - 1988/2018

Pantanal of Mato Grosso do Sul	**Variation (%)**	**Scale Effect(ha)**	**Substitution Effect (ha)**
Forest	-14,9	0,8	-766.319,7
Non-forest Natural Formation	-8,8	0,7	-396.665,3
Agriculture and Livestock	106,6	0,2	1.243.647,5
Non Vegetated Area	21,1	0,0	985,3
Water Body	-33,5	0,0	-81.647,7
North-Central Mato Grosso do Sul	**Variation (%)**	**Scale Effect (ha)**	**Substitution Effect (ha)**
Forest	-38,3	-0,000000085	-1.209.910,8
Non-forest Natural Formation	-12,5	-0,0000000066	-30.567,0
Agriculture and Livestock	34,4	-0,000000095	1.223.985,7
Non Vegetated Area	43,5	-0,00000000071	11.418,1
Water Body	70,6	-0,00000000019	5.074,0
Eastern Mato Grosso do Sul	**Variation (%)**	**Scale Effect (ha)**	**Substitution Effect (ha)**
Forest	-32,1	0,000021	-1.117.551,5
Non-forest Natural Formation	-20,7	0,0000017	-59.522,1
Agriculture and Livestock	18,5	0,000033	1.018.696,8
Non Vegetated Area	78,5	0,000000078	10.345,6
Water Body	132,1	0,00000067	148.031,2
Southwest Mato Grosso do Sul	**Variation (%)**	**Scale Effect (ha)**	**Substitution Effect (ha)**
Forest	-26,5	-1,2	-547.113,4
Non-forest Natural Formation	-22,8	-0,2	-63.272,8
Agriculture and Livestock	10,3	-3,5	599.564,1
Non Vegetated Area	42,5	0,0	8.732,2
Water Body	6,7	0,0	2.089,9

Source: Mapbiomas (2020). Elaborated by the authors (2022).

However, a Scale Effect can be observed in relation to land use dynamics. This effect reveals the distribution of expanded or reduced areas among the land-use categories according to their shares in the initial period of the analysis. Therefore, one can observe that positive results indicate expansion, and negative results indicate a reduction in areas of land use. The Substitution Effect shows variation in the participation of land use in each mesoregion, indicating when land use was substituted or replaced by another use. In the Pantanal mesoregion of Mato Grosso do Sul, forest land uses (-766,319.7 ha), non-forest natural formation (-396,665.3 ha) and water bodies (-81,647.7) gave way to other uses, with predominant absorption by agriculture and cattle ranching (1,243,647.5). Because it is a region whose predominant biome is the Pantanal, the reduction in areas of the listed categories can be a matter of concern, considering that one of the characteristics of this biome is that it consists of wet or flooded areas.

An indication of a possible reduction in water bodies is critical for biome maintenance (Mapbiomas, 2022). It is worth considering that Brazil (1988) guarantees the Pantanal biome as a national heritage. According to Mendes and Oliveira (2019), the biome stands out for its environmental connotation and development arising from the local culture and agricultural activity developed over more than 270 years in the region, with its own characteristics. However, it is worth highlighting that there are swampy regions, such as Nhecolândia, where environmental weaknesses can be identified and linked to climatic seasonality, periodic floods, poor soils, and high temperatures. Furthermore, there is little technical information about the possibility of sustainable use of forest species in the region (Soares *et al.*, 2017; De Mattos *et al.*, 2010), which is an obstacle or hindering factor in the development of sustainable activities.

The other mesoregions of the state of Mato Grosso do Sul exhibited similar behavior. The Substitution Effect was negative for the land use categories of forest and non-forested natural formations, indicating that they abandoned land for the other categories. Among the categories with positive results, those that received land for their respective uses, agriculture, and cattle ranching, in all mesoregions, had the highest values, indicating that the use of land for agriculture and cattle ranching has increased in the state. In fact, the contributions of agribusiness to the state economy from rural production are recognized (Domingues, 2011). However, it is also recognized that the lack of planning for the use and occupation of the state's lands and the lack of adequate management for animal and vegetable production have caused degradation in the soils of Mato Grosso do Sul (Chaves *et al.,* 2012; Santos; Comastri-Filho, 2012).

The dynamics of land use in the mesoregions of Mato Grosso do Sul indicate that during the period investigated, there were changes that reduced natural vegetation, which was mainly replaced by agricultural use. In this context, it is noteworthy that man, by transforming his environment, enables the formation of a second nature based on artificial elements (Santos, 2006). The problem in this formation process is that individuals are increasingly closer to the artificial environment and farther from the natural environment, which results in imbalances (Santos, 1988). When woody cover is substituted by agricultural areas, there are negative effects on climate. These effects are related to carbon reserves in the soil, either in water resources or in biodiversity (Sibanda *et al*., 2016). Negative effects occur because this change in land use influences the organization of the existing habitat at the site and the hydrological process, and also promotes the loss of biodiversity (Liu *et al*., 2008).

The Substitution Effect on land use in the state of Mato Grosso do Sul was represented by changes in 12% of its land during the analysis period. At first, this percentage can be considered low, however, it should be considered that it can be explained by the existence of 63% of the state's municipalities today already in the 1970s (IBGE, 2020). The creation of municipalities is conditioned by changes in land use, which suggests that transformations in land use had already taken place before the analyzed period. Unfortunately, no data were identified before the analysis period.

In addition to the dynamics of land use, this study proposes to investigate issues related to public environmental policies, which makes the need for this investigation even more evident when identifying the reduction in areas of natural vegetation in mesoregions. Figure 2 overlaps the mesoregions and predominant biomes in each mesoregion according to the municipal information. Among those comprising the highest percentages is the Pantanais Sul-Matogrossense mesoregion, in which the predominant biome, as shown in this figure, is the Pantanal biome. Similar to other mesoregions, in relation to the replacements carried out, they are mainly related to the reducing of areas of natural vegetation due to agricultural use. The Central-North regions of Mato Grosso do Sul and East of Mato Grosso do Sul are the other mesoregions that present behavior close to the first mesoregion exposed, regarding changes in land use (both in terms of percentages of participation in the changes identified, as well as the replacement of natural vegetation for agricultural use).

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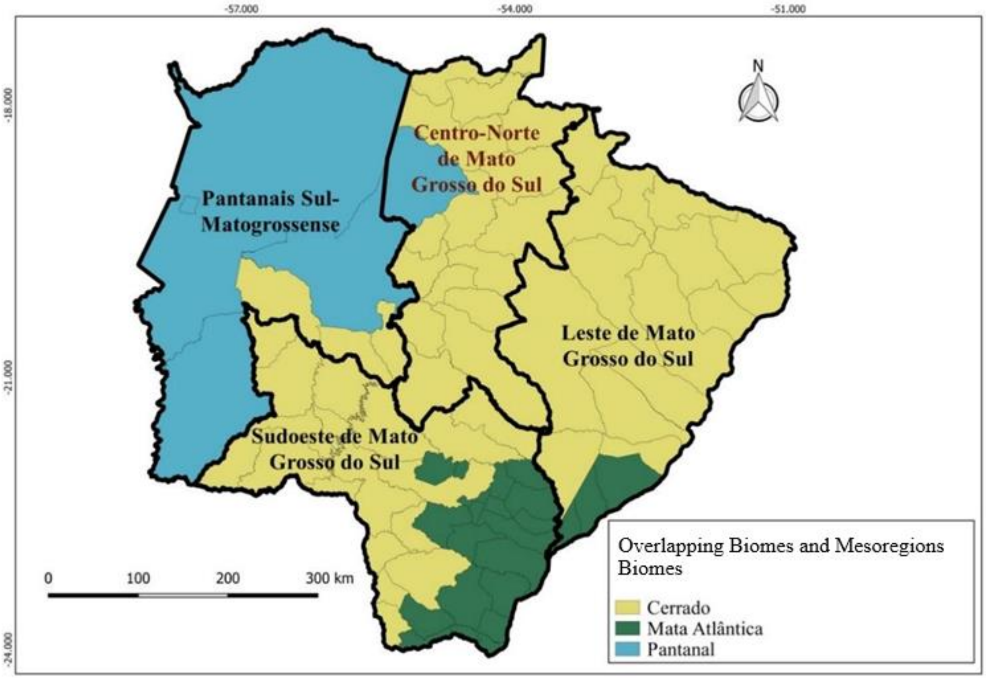
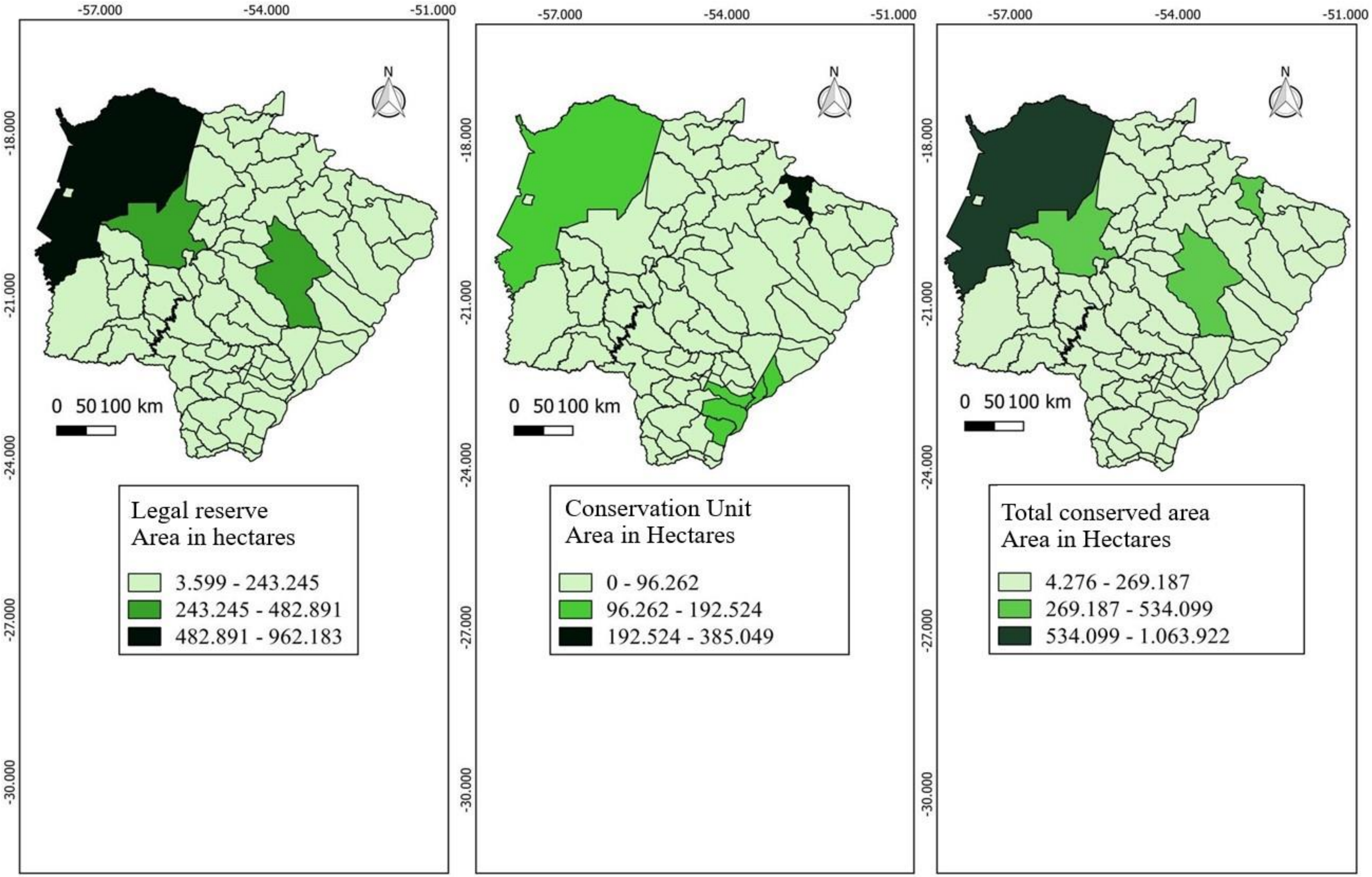
Figure 2 - Overlap of the Mesoregions of Mato Grosso do Sul and biomes - East of Mato Grosso do Sul



Source: IBGE (2015). Elaborated by the authors (2022).

Figure 3 shows the number of areas designated as RL. These areas ensure sustainable economic use of the natural resources of rural property. These areas help, therefore, with the conservation and rehabilitation of ecological processes and promote the conservation of biodiversity, as well as the shelter and protection of wild fauna and native flora (Brasil, 2012), as the RL areas valued by the 2012 Código Florestal- Law No. 12.651/2012, but already exists legally in Law 4.771/1965. Another important piece of information, referring to the environmental legal framework, is the quantity of areas destined for Conservation Units, created by public and private initiatives, from the use of Law Nº. 9.985/2000. By definition, a Conservation Unit is a territorial space and its environmental resources, including jurisdictional waters, with relevant natural characteristics legally established by the Public Power, with conservation objectives and limits defined (Brasil, 2000).

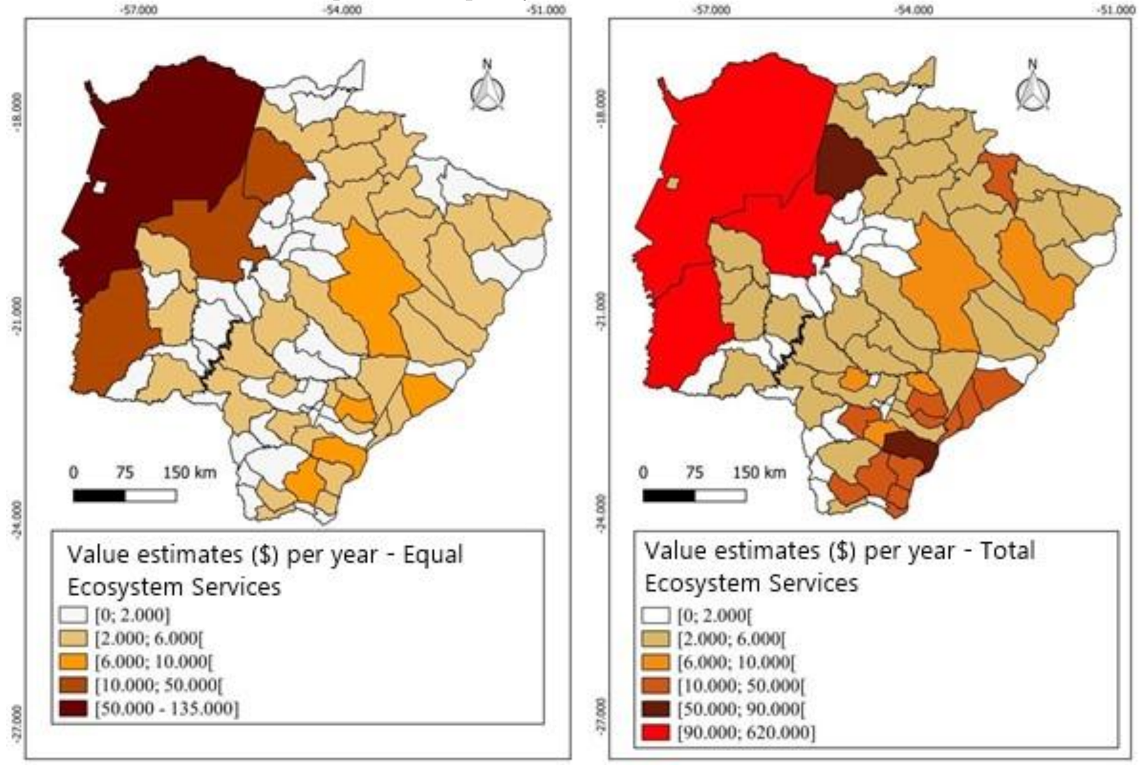
Figure 3 - Amount of Municipal Areas set aside for RL and Conservation Units, according to legislation



Source: IBGE (2017), MMA (2020) and IMASUL (2020). Elaborated by the authors (2022).

In addition to representing the number of areas resulting from public policy measures, the values corresponding to the provision of ecosystem services from these areas were also estimated (Figure 4). In the figure, two situations are represented regarding the estimation of ecosystem services: the first represents the values referring to the same ecosystem services performed by the biome; the second image represents the values corresponding to all the ecosystem services estimated for each biome. It can be observed that the region with the predominance of the Pantanal biome is the one with the highest values of ecosystem services in both situations illustrated. This finding can be justified by the number of hectares protected, considering that the same ecosystem services for the Pantanal biome (0.136812 US$. m^2.Year^1) had a lower value than the same services provided by the Atlantic Forest biome (0.1626 US$. m^2 Year^1).

Figure 4 - Values corresponding to the provision of ecosystem services in RL and Conservation Units per municipality in Mato Grosso do Sul



Source: The authors (2022).

It should be considered that among the three biomes that make up the state, the Pantanal biome has the highest value referring to the junction of ecosystem services provided. Among the set of services offered by nature and made available to people, the water supply in the context of the Pantanal biome is the one with the highest value (Seidi; Moraes, 2000).

Furthermore, it can be observed that, to some extent, municipalities can offer ecosystem services to people, especially because they are identified as conservation areas. However, the economic valorization of the provision of ecosystem services in Brazil is still incipient, with some initiatives being carried out in different regions of the country based on specific local characteristics and aimed at distributing fiscal resources from state governments to municipal governments. For example, the ICMS-Ecológico is carried out in states such as Mato Grosso do Sul and Paraná, to which part of the tax collection on the Circulation of Goods and Services is allocated to municipalities. For the municipality to receive values related to the ICMS-Ecológico, it is necessary to comply with a set of specific characteristics for each state (De Castro *et al.*, 2019).

However, globally, it has been observed that the main purpose of payment for ecosystem services is to encourage landowners to practice more environmentally friendly production activities through economic incentives (Jiangyi *et al.*, 2020). Such measures aim to protect the environment and its biodiversity (Farley; Costanza, 2010; Dehua *et al.*, 2019). It is observed that the legal determination in Brazil of the existence of areas in rural properties destined for the RL partially covers this objective, leaving aside the economic incentives aimed at rural producers to maintain these areas.

Moreover, the initiative of payment for ecosystem services has been adopted worldwide since 1980, and since its inception, it has expanded to different locations (Jiangyi *et al.*, 2020). Currently, there are more than 550 programs distributed around the world, with the objective of supporting actions that generate environmental conservation and can still reduce rural poverty (Moros *et al.*, 2020). In total, these programs represent $36 billion of annual transactions (Salzman *et al.*, 2018). However, when privately funded, these programs are more efficient than government programs because they impose conditionalities and are designed based on local characteristics (Wunder *et al.*, 2008). The two identified characteristics that promote greater efficiency are measures that can be incorporated into the development or improvement of government programs, enabling them to improve their results. There are also considerations that highlight the importance of public-private partnerships for the development of these programs as a measure of their success (Huang *et al.*, 2011).

FINAL CONSIDERATIONS

The state of Mato Grosso do Sul is a biodiverse region composed of three Brazilian biomes. In contrast, it has developed throughout its history, activities considered traditional for food production, and that consequently generate changes in land use. During the analysis period, it can be seen that between 1988 and 2018, changes in land use occurred in all mesoregions of the state. Each mesoregion has unique characteristics for land use replacement, but in general, it can be seen that natural vegetation has lost area to other uses, with the main destination being agricultural use. This question is aggravated when the loss of natural vegetation is related to the biome that predominates in the area. The Pantanal biome is a natural heritage site that has been modified over the years and is vulnerable to traditional agricultural production processes. The Cerrado and Atlantic Forest biomes are biodiversity hotspots that, due to changes in land use verified in the mesoregions, already have a low percentage of existing natural vegetation in the country and, as such, should be priorities for preservation.

It was also observed how public environmental policies have helped the conservation of these areas in Mato Grosso do Sul. In general, RL are represented by larger hectares than conservation units. Furthermore, conservation units have legal obstacles that make it difficult even, in some situations, for the sustainable use of the area, and this may be a characteristic that facilitates the reduction in land use change. Moreover, by establishing a relationship between the areas created from environmental public policies and the provision of ecosystem services, the importance of these areas is reinforced. The use of payments for ecosystem services as a measure to encourage the conservation of areas, or even the use of sustainable management, is a Brazilian need that would facilitate people's understanding of the need to conserve the environment. Previous experiences, registered in research on the subject, consider that the elaboration of public actions must include their structure and characteristics, such as regional conditions. This issue is relevant to Brazil considering the biodiversity of its five biomes. Thus, there is a need to consider the issues peculiar to each locality or region when formulating an action. Another feature that can be included in this context is the establishment of conditionalities to be met by people who enjoy the economic benefits generated by the payment of ecosystem services. An example is the on-site maintenance of environmental conservation.

In this context, rural producers must be encouraged to conserve and continue to use sustainable food production management. In this sense, economically rewarding producers for conserving RL and APP as well as additional areas, may reduce the discussion about the need for the existence of these areas in rural properties, a discussion still to be better held in the country. Moreover, the inclusion of sustainable management as a measure for the existence of economic rewards for producers may enable practices identified as efficient and new knowledge to be created. It is possible that production and conservation are related in rural spaces. In relation to urban space, a measure that may be interesting to the country is the determination of specific characteristics for each region through legislation, which enables the existence of conservation actions in urban areas, making it mandatory, as it is in rural space, the maintenance of urban green areas, both for public and private agents.

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