POTENTIAL TRADEOFFS BETWEEN ECOSYSTEM SERVICES RELATED TO FOOD PRODUCTION IN THE BRAZILIAN CHACO

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Abstract

The impacts of human interference in the use and management of land, arouses the need to assess them, in order to bring out the importance of ecosystem services provided by the environment to support life and human well-being. Thus, the general objective of this study was to analyze possible tradeoffs in services (ES) related to agricultural production in Porto Murtinho, MS, which is part of the Brazilian Chaco. The Brazilian Chaco is a cradle of fauna and flora biodiversity, being considered the second largest forest area on the American continent and the largest dry tropical forest in South America, hence the importance of conducting studies in this area. The methodology consisted of three stages, starting with the classification of the ES and collecting secondary data, followed by the systematization and processing of the data, reaching the third and final step in which the possible tradeoffs of the ES were analyzed. The ES studied were: *Maintaining populations and habitats in nurseries*, *Animals raised for nutritional purposes* and *Terrestrial plants cultivated for nutritional purposes* (CICES classification). Secondary data on forest from MapBiomas and stocking rate of cattle and agricultural productivity (PPM/PAM-IBGE) were used. This work aimed to alert decision makers to possible tradeoffs that are taking place in the Brazilian Chaco region, as the data point to a reduction in the area of natural forests and a significant increase in agricultural production indicators.

Keywords: agricultural production; environmental preservation; ecosystem; provisioning services

INTRODUCTION

Ecosystem services (ES) were defined by MEA (2005) as the benefits provided by ecosystems to human beings. Costanza et al (1997) bring the importance of ES as life support, awakening the need to assess human interference in the balance of the environment and in the provision of these services. MEA (2005) categorizes ESs into provision, regulation, support and cultural services, but there are other classifications used in the literature, such as the Common International Classification for Ecosystem Services (CICES). The dynamics of land use and land cover have destroyed and fragmented natural environments, interfering with the climate, altering biogeochemical cycles and, thus, restricting the capacity of ecosystems to provide ecosystem services to humanity. (Sala et al., 2000; Fu et al., 2015). Agricultural activities are related to the provision of various ES, either through livestock or agriculture, and Brazil is one of the largest food producers in the world (Embrapa, 2016).

On the other hand, agriculture must be highlighted as a major forcing of changes in land use and land cover. Occupation of land with pastures or other agricultural crops has increased deforestation, with serious negative impacts on ecosystem services (IPCC, 2018). Inadequate agricultural management has also led to degradation of extensive areas, siltation of rivers and water contamination, and destruction of pollinators, among other effects (FAO, 2019). Tradeoffs are described as conflicts between different ES that occur when the provision

of some ES compromises or reduces the provision of other ES, exerting negative impacts on the environment and society in general (Andrade and Romeiro, 2009; Power, 2010). In this study, we analyze potential tradeoffs in ecosystem services (ES) related to agricultural production in Porto Murtinho, MS, which is located in the Brazilian Chaco.

MATERIALS AND METHODS

Area of study: The Brazilian Chaco is located in Mato Grosso do Sul, in semi-flooded areas between the Pantanal biome and Paraguay. Despite the rich biodiversity of this region, the Chaco is not recognized as a biome in Brazil. Almost 90% of the municipality of Porto Murtinho/MS is located into the Brazilian Chaco. In 1998, the estimated area of the Brazilian Chaco was 12,400 km² and currently only 13% of its original vegetation remains. Its climate is transitional between tropical and temperate, with the occurrence of dry and semi-arid forests (Pennington et al. 2000; Silva et al. 2000).

Systematization and analysis of data:

Step 1: Classification of SE and secondary data collection - Initially, ES and their indicators were defined and classified between 1990 and 2019. The classification used was the CICES being the ES and indicators: *Animals raised for nutritional purposes* - indicator: stocking rate (heads of cattle/area), calculated from the Municipal Livestock Survey - PPM of the Brazilian Institute of Geography and Statistics - IBGE and Mapbiomas (grazing area); *Terrestrial plants cultivated for nutritional purposes* - indicator: agricultural productivity (production/area), calculated from Municipal Agricultural Research - PAM of the IBGE; *Maintaining populations and habitats in nurseries* - indicator: natural forest area, obtained from Mapbiomas.

Step 2: Data systematization and processing - The cattle stocking rate, agricultural productivity and natural forest area data were processed and systematized in Excel spreadsheets.

Step 3: Analysis of possible tradeoffs in the SE - In this step, the data related to the ES indicators were compared and analyzed in order to identify the potential tradeoffs.

RESULTS AND DISCUSSION

The ES in Porto Murtinho – Brazilian Chaco

Figure 1 (A) shows the historical values of the stocking rate (SR) in Porto Murtinho, this rate is expressed in terms of the maximum number of animals supported by the pasture without causing its degradation (IAGRO, 2010). An oscillation in SR over time from highest (1.7 AU/ha in 1992, 1993) to lowest (1.1 AU/ha in 1996, 1997, 1998, 1999) values is perceived. According to the Agência Estadual de Defesa Sanitária Animal e Vegetal (IAGRO, 2010) the maximum stocking limit for properties located in the Pantanal is 1.5 AU/ha, which means that the SR remains most of the time below the permitted. This is a consequence of several factors such as pasture fertility, precipitation, credit lines, management and producer profile. It is noteworthy that Porto Murtinho occupy the 4th place in the ranking of production of meat in the state of MS and the 15th in the country (provisioning service) (G1/IBGE, 2017).

Therefore, under this indicator, cattle production in the municipality is sustainable, not negatively affecting, for example, the ecosystem services of water regulation and erosion control. It should also be considered that these are flat areas, where the declivity factor does not contribute much to erosion processes. In Figure 1 (B) it is observed that cassava productivity varied during the 29 years analyzed, always remaining above 10 and below 25 (t/ha). Acre was the Brazilian state with the highest productivity of cassava in 2019 with 27.61 (t/ha) (DERAL, 2020), which shows an average productivity of cassava in the municipality of Porto Murtinho.

It is noteworthy that this is a culture closely associated with the presence of indigenous peoples in the region, being also related to cultural services, not evaluated in this study. The maximum value of sugarcane productivity was 57 t/ha. This is an average value when compared to the total productivity of the state of Mato Grosso do Sul, which was around 74.83 t/ha in 2017/18 (Conab, 2017). Corn productivity has grown

considerably since 2007 with 3 t/ha to 4.93 t/ha in 2019. However, this value is still very low compared to the average value of productivity in MS, which reached 9.2 t/ha in the 2017/18 harvests and 8.2 t/ha in 2018/19 (Conab, 2019). About soy productivity, the lowest value was in 1990 with 1.26 t/ha, reaching 3.12 t/ha in 2019, which is close to the value of 3.5 t/ha reached in 2020 for the total crop brazilian (Conab, 2021).

Therefore, it is clear that the agricultural productivity of the municipality has expanded significantly in the period analyzed (food provision). Figure 2 shows the area of natural forests and its decrease over the years in Porto Murtinho, and consequently, alerts to the change in land use and land cover in the municipality.

It can be seen that while agriculture has remained in expansion over the last 29 years in Porto Murtinho, the natural forest cover has been constantly decreasing, being drastically reduced. Despite not being the state with the highest deforestation rate, Mato Grosso do Sul was the only state with an increase in deforested area in 2019 and 2020 (Mapbiomas, 2021).

Figure 1: (A and B). Stocking rate and cassava, sugarcane, corn and soy productivity in the municipality of Porto Murtinho, Brazilian Chaco (1990-2019).

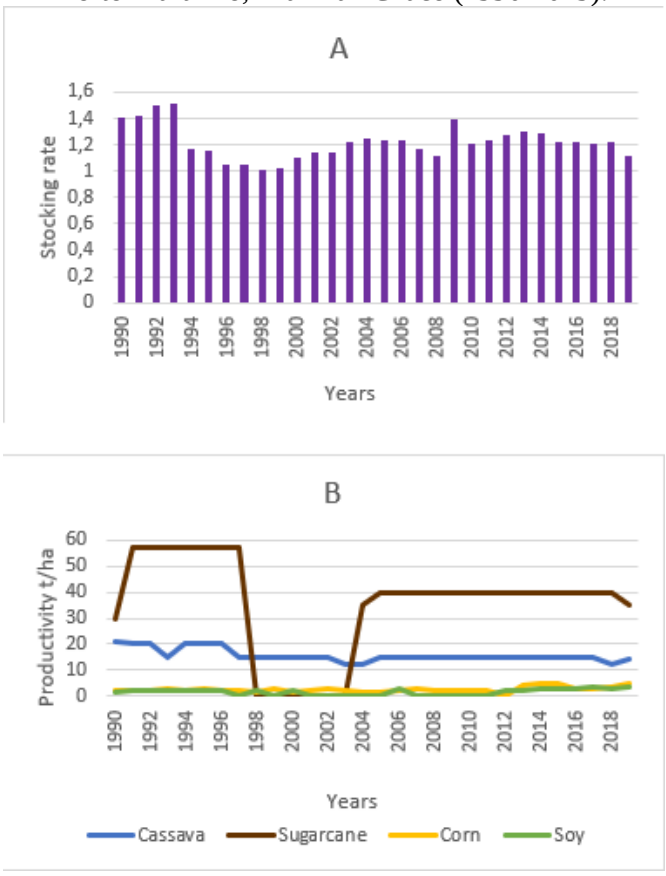
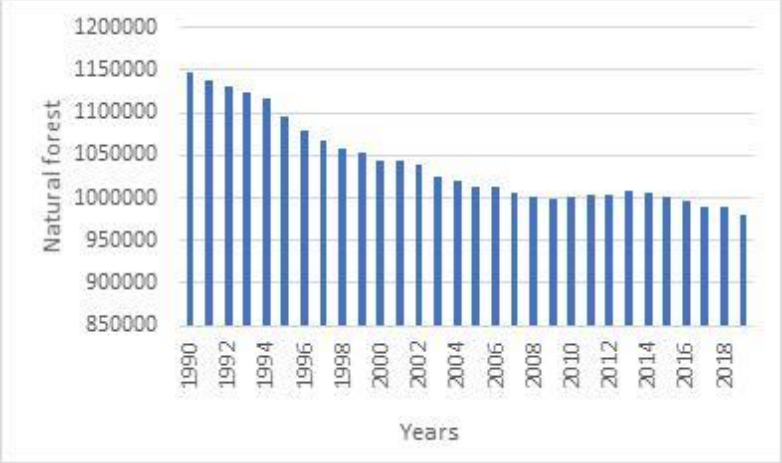


Figure 2: Area of natural forest in the municipality of Porto Murtinho, MS, from 1990 to 2019.



Potential tradeoffs in ES related to food production in Porto Murtinho – Brazilian Chaco (1990 to 2019)

Table 1 shows how deforestation of natural forests has come into conflict with agricultural production in the period studied. Over the years forest cover has decreased considerably, with rare exceptions (years 2010, 2011 and 2014), while agricultural productivity has doubled in the case of soy and corn. The reduction of forests not only compromises the ES of *Maintaining populations and habitats in nurseries*, but also compromises services of regulation and water supply, carbon sequestration, pollination, nutrient cycling, among others not analyzed in this study. In relation to the ES of *Animals raised for nutritional purposes*, gaps in production are observed for most of the period analyzed, as the SR remains below allowed threshold. This sugest this ES are suffering negative impacts from others, such as the ES *of terrestrial plants cultivated for nutritional purposes*.

Table 1: Comparison of ES indicators for analysis of potential tradeoffs related to food production and natural forest cover in Porto Murtinho – Brazilian Chaco

Years	Stocking rate (n° of head cattle)	P* Sugarcane (t/ha)	P* Cassava (t/ha)	P* Soybean (t/ha)	P*Corn (t/ha)	Total natural forest (ha)
1990	1,49	30	21	1,26	1,8	1.146.902,79
1991	1,55	57	20	1,8	1,8	1.137.215,20
1992	1,7	57	20	20	2,4	1.129.833,58
1993	1,73	57	15	2,2	2,5	1.124.692,57
1994	1,31	57	20	2,2	2,07	1.115.670,88
1995	1,28	57	20	2,2	2,52	1.094.591,81
1996	1,14	57	20	2,4	1,8	1.078.190,63
1997	1,14	57	15	SD	1,8	1.067.515,98
1998	1,11	SD	15	1,8	1,5	1.058.599,45
1999	1,15	SD	15	SD	3	1.052.641,18
2000	1,25	SD	15	1,8	1,2	1.044.754,99
2001	1,27	SD	15	SD	1,8	1.044.088,30
2002	1,27	SD	15	SD	2,5	1.038.998,98
2003	1,34	SD	12	SD	1,8	1.025.024,85
2004	1,35	35	12	SD	1,43	1.020.581,28
2005	1,32	40	15	SD	1,2	1.012.757,27
2006	1,32	40	15	2,7	1,8	1.013.540,84
2007	1,25	40	15	SD	3	1.005.721,68
2008	1,2	40	15	SD	2,4	1.002.012,42
2009	1,52	40	15	SD	2,4	997.936,09
2010	1,32	40	15	SD	2,4	1.002.339,80
2011	1,37	40	15	SD	2,4	1.003.903,95
2012	1,45	40	15	2,4	SD	1.003.448,03
2013	1,48	40	15	2,4	3,98	1.008.836,22
2014	1,46	40	15	3,06	4,61	1.005.026,14
2015	1,36	40	15	2,8	4,98	1.001.598,02
2016	1,37	40	15	2,9	3	995.540,00
2017	1,33	40	15	3,1	2,97	989.080,21
2018	1,37	40	12	2,92	3,66	988.548,70
2019	1,25	35	14	3,12	4,93	980.100,51

CONSIDERATIONS

The present study presented results of a preliminary analysis of ES related to agricultural production in the Brazilian Chaco aiming to identify *tradeoffs* between them. These results show a reduction in the area of natural forests and a significant increase in agricultural production indicators, alerting to the needs of public policies aimed at territorial planning and forest protection, in order to ensure a greater supply of ES. However, it should be noted that other factors can interfere with agricultural production, such as rainfall and economic issues, which will be investigated in the next stage of the study. The assessment of tradeoffs among other ES will also be included in the analysis.

Presentation: https://youtu.be/DPLYXa1dtB4

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