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Article

Insights for policy-based conservation strategies for the Rio de la Plata Grasslands through the IPBES framework

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Abstract: The Río de la Plata Grasslands (RPG) are one of the most modified biomes in the world. Changes in land use and cover affect the RPG's rich biodiversity. In particular, the expansion of crops, overgrazing, afforestation, and the introduction of exotic species pose a major threat to the conservation of biodiversity and ecosystem services (BES). In this study, we applied the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) conceptual framework as a new lens to approach biodiversity conservation enactments in the RPG. First, we systematically reviewed published scientific literature to identify direct and indirect drivers that affect the RPG's BES. Further, we conducted an extensive analysis of management policies affecting the BES directly in the region, at a national and international level. We conclude by offering recommendations for policy and praxis under the umbrella of the IPBES framework.
Keywords: *Land Use Change; Biodiversity; Ecosystem Services; Drivers, Nature's Contributions to People.*

Insights para estratégias de conservação baseadas em políticas para as pradarias do Rio da Prata através da estrutura do IPBES

Resumo: As pradarias do Rio da Prata são um dos biomas mais modificados no mundo. Alterações nos usos do solo afetam a rica biodiversidade deste ecossistema. A expansão da agricultura, sobrepastoreio, arborização e a introdução de espécies exóticas, principalmente, representam uma grande ameaça para a conservação da biodiversidade e dos serviços ecossistêmicos (BES). Neste estudo, aplicamos a estrutura conceptual da Plataforma Intergovernamental sobre Biodiversidade e Serviços Ecossistêmicos (IPBES) como uma nova forma de abordar as políticas de conservação da biodiversidade neste bioma. Primeiro, revisamos sistematicamente artigos científicos publicados de forma a identificar fatores diretos e indiretos que afetam os BES nas pradarias do Rio da Prata. Adicionalmente, realizamos uma extensa análise das políticas de gestão que afetam diretamente os BES na região, quer a nível nacional, quer internacional. Concluímos com propostas e recomendações de políticas e práticas sob a égide do quadro do IPBES.
Palavras-chave: *Alterações de Uso do Solo; Biodiversidade; Serviços Ecossistêmicos; Contribuições da Natureza para as Pessoas.*

Introduction

Obtaining natural resources for fulfilling human needs has been made at the expense of environmental degradation (Foley et al. 2005, MEA 2005, Zhang et al. 2019a). Based on the current trends in land use and land cover (LULC) changes worldwide, humans can obtain goods and services to improve their quality of life only by diminishing the capacity of global ecosystems to sustain the provision of such benefits (Foley et al. 2005, MEA 2005). Hence, contemporary societies face the challenge of developing regional land-use strategies that recognize short and long-term needs while reducing the negative environmental impacts and maintaining social and economic benefits (Foley et al. 2005, MEA 2005).

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an international body that works to strengthen the science-policy interface for biodiversity and ecosystem services. IPBES aims to assess the state of biodiversity and ecosystem services (BES) incorporating different disciplines and types of knowledge (Díaz et al. 2015). Nature's contribution to people (NCP) is a concept promoted by IPBES that refers to all the positive and negative contributions of nature to the quality of life of people, which can be recognized and valued in a range of existing worldviews. This approach underlines the central and pervasive role that culture plays in defining all links between people and nature (Díaz et al. 2018). According to Pascual et al. (2017), a multiple value perspective should be encouraged in decision making, focusing on three types of values: intrinsic, relational, and instrumental. In order to achieve sustainable development, it is important to consider long-term human well-being, the drivers, and the consequences of land-use changes (Crossman et al. 2013, Nagendra et al. 2013, Ellis et al. 2019). Therefore, the link between drivers, valuations, and NCPs might serve as holistic guidance for policy formulation.

Grasslands are one of the most modified biomes of the world (Hannah et al. 1995, Paruelo et al. 2007, Baldi & Paruelo 2008), which cover over 50 million km^2, accounting for 37% of the earth's terrestrial surface (O'Mara 2012). Native grasslands have been replaced or degraded by intensively managed agricultural lands (Hannah et al. 1995, Vega et al. 2009, O'Mara 2012, Gang et al. 2014), representing 70% of the agricultural areas worldwide (Schlesinger & Andrews 2000, Ramesh et al. 2019). Thus, grasslands play a unique role in food security by providing agricultural products (O'Mara 2012).

In the Neotropics, the Río de la Plata Grasslands (RPG) are the most extensive grassland ecosystem, covering an extent of 750,000 km^2 (Soriano et al. 1991, Carbutt et al. 2011). The RPGs are shared by eastern Argentina, southern Brazil, and Uruguay, encompassing two main sub-regions, Pampas and Campos (Soriano et al. 1991) (Figure 1). The mean annual temperature of the region is 10 to 20ºC, and the mean annual rainfall is between 400 and 1,600 mm (Soriano et al. 1991).

After the European colonization, the native grasslands of the RPG have become one of the most essential regions of grain and beef production in the world (Bilenca & Miñarro 2004, Paruelo et al. 2005, Baldi et al. 2006). Until the 20th century, cattle ranching was the most common and important land use, but then, cropping became the most important one (Vervoorst 1967, Soriano et al. 1991, Viglizzo et al. 2001, Baldi et al. 2006). For example, between 2000 and 2010, the cultivation of genetically modified soybean generated an intensification and expansion of monocultures of this crop in the region (Aizen et al. 2009, Redo et al. 2012, Modernel et al. 2016). Although there was a predominance of soybean, other crops also increased, such as sunflower, maize, rice, wheat, pine, and eucalyptus (Baldi & Paruelo 2008, Cubbage et al. 2012). In the last decade, the cropping systems became less diverse raising concerns about the sustainability and environmental risks associated with crop production in a region which is relevant for the world grain and oil market (FAO 2014). As such, the RPG have represented one of the most rapidly expanding agricultural frontiers not only in Latin America but in the world (Baeza & Paruelo 2020). Currently, most of the area is represented by sown pastures, annual crops, overgrazed areas, and tree plantations, and only a small portion of semi-natural native grasslands remain (Modernel et al. 2016, Paruelo et al. 2005).

All aforementioned LULC changes have affected the ecosystem functioning, the provision of ecosystem services (ES), and the state of biodiversity in RPG (Paruelo et al. 2005, Modernel et al. 2016). This region represents a biodiversity-rich area encompassing more than 550 different species of grass, 450-500 birds, with some endemic species, and a hundred species of terrestrial mammals (Bilenca & Miñarro 2004; Di Giacomo & Parera 2008, Azpiroz et al. 2012, Andrade et al. 2018). However, these species are being threatened by LULC changes in the area (Di Giacomo & Krapovickas 2005, Codesido et al. 2013, Dotta et al. 2015). Based on these and the fact that the RPG are the least protected sub-region in South America (Henwood 2004, Michelson 2009, Baeza & Paruelo 2020), it highlights the importance of protecting this area in order to conserve and maintain its BES (Baldi & Paruelo 2008, Modernel et al. 2016, Oyarzabal et al. 2019).

Most of the land is private in the region, belonging to families and corporations, often international (Modernel et al. 2016). LULC transformation is also driven, in turn, by global economic issues (the increase in the prices of commodities) and the availability of new technologies (no-tillage cropping, genetically modified organisms, afforestation know-how, etc.) (Satorre 2005, Trigo 2005, Céspedes-Payret et al. 2009). Therefore, land-use policies play a fundamental role in determining LULC dynamics (Lambin et al. 2003, van Meijl et al. 2006, Brannstrom et al. 2008). These policies can promote or restrain particular crops or types of land management using taxes and regulations (Redo et al. 2012). Internal policies established within a given country are the primary underlying drivers of LULC changes (Geist & Lambin 2002). Furthermore, political boundaries and biophysical heterogeneity of RPG also influence these trends (Vega et al. 2009).

New strategies should be considered to allow the coexistence of agricultural activities with grassland biodiversity conservation in the RPG. In this study, we applied the IPBES framework (Díaz et al. 2015) as a new lens to approach biodiversity conservation enactments in the RPG. Specifically, we sought to 1) identify the main drivers (direct and indirect) that are affecting the BES in the RPG and link them with the different values and categories defined by IPBES, 2) identify national and international policies related to RPG that affect the drivers underlying the BES, 3) build a conceptual framework for the RPG using the IPBES framework, based on the drivers, values, and policies identified in the previous objectives; 4) and finally, propose policies that could help the co-management of grasslands in this region and halt the rapid loss of BES.

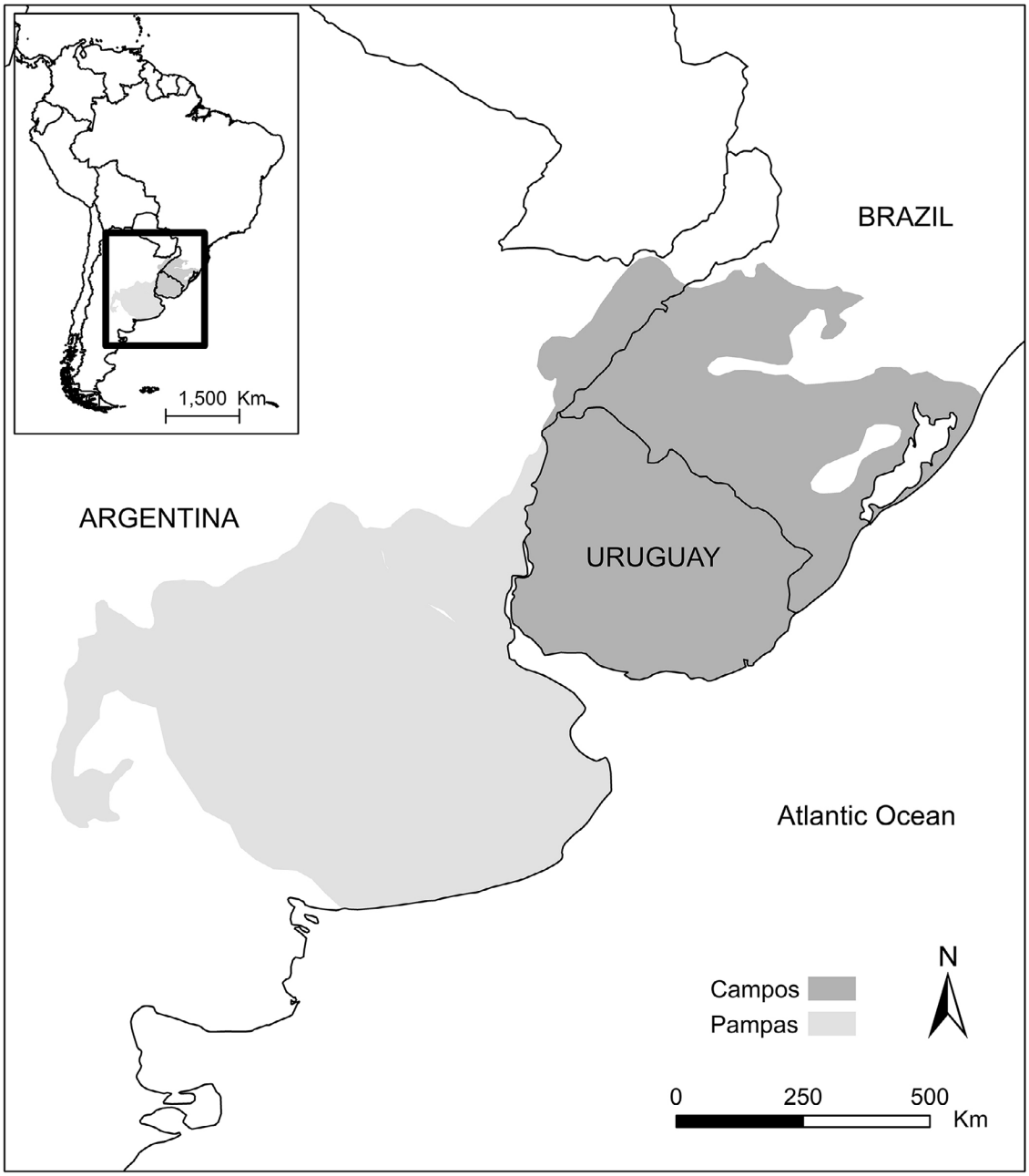

Figure 1. Location of the Río de la Plata Grasslands (RPG) and sub-regions, Pampas and Campos, in Southeastern South America (sensu Soriano et al. 1991).

Material and Methods

We engaged in a qualitative systematic review approach (Finfgeld-Connett & Johnson 2013) to centralize and consolidate pre-existing knowledge on LULC changes and BES in the RPG.

1. *Scientific literature review: Linking BES with IPBES in the RPG*

A literature search was conducted in two steps. First, we performed a Boolean search in Web of Science platform (July 22nd, 2019), using the following string of keywords: ("Río de la Plata grasslands" OR "Pampas grasslands" OR "Campos Grasslands") AND ("land use" OR "agriculture" OR "afforestation" OR "pasture" OR "grazing") AND ("ecosystem services" OR "biodiversity"). To add several papers that did not appear in the first search but were relevant for this study, we performed an ad hoc search using various resources, e.g., other database searches, such as Google Scholar, checked cited literature, etc. Following this procedure, we included different reviews and other articles relevant to the study area. From the selected papers, we chose the ones that were published between 2015 and 2019, because most of the papers before this period were included in the other reviews (e.g. Bilenca & Miñarro 2004; Modernel et al. 2016). From each one of the selected papers, we extracted the main ES mentioned in the study and the drivers of the loss of the BES (direct and/or indirect). We then organized the information following the 18 categories of the NCP and placed them into the types of contribution (regulating, material, and non-material) (Díaz et al. 2018).

2. *Review of current policy-based conservation in the RPG*

Current policies for RPG management were reviewed by conducting a systematic search of policies, regulations, and legislation available on official websites for each one of the countries. For our analysis, we identified and selected policies that are exclusively related to issues of BES conservation in RPG. We took into account historical national and regional legislation. Relevant information was extracted, in order to contrast to what extent these policies are addressing the drivers depicted in the scientific literature. We listed applicable laws or initiatives that promoted the LULC changes in RPG and represented the conservation situation within each country. Finally, we described the conservation efforts at an international and national level.

3. *An approach to IPBES conceptual framework*

Based on the key findings of these searches, we developed a conceptual model for the RPG using the IPBES framework (Díaz et al. 2018).

Results

1. *Scientific papers review: Linking BES with IPBES in RPG*

Based on our literature search, we found that most studies in the region focused on regulating contributions, highlighting material ones, while a few studies considered non-material contributions (Table 1).

Several papers focused on the ecological functions of RPG's biodiversity and the effect that agricultural activities have on them, highlighting and emphasizing nature's intrinsic value. In particular, these studies identify the importance of the RPG as habitat for pollinators (Sabatino et al. 2016, Marrero et al. 2017), and areas of high plant and animal diversity (Modernel et al. 2016). All the studies agree that biodiversity loss is associated with the transformation, homogenization, and perturbation of the habitat. Modernel et al. (2016) described other drivers of biodiversity loss, such as the invasion of exotic species, expansion of crops and implanted pastures, urbanization, and overgrazing. Illegal hunting and zoonotic diseases introduced by exotic species also threaten native species (Bilenca & Miñarro 2004).

Instrumental values were identified in several publications studying the benefits people can obtain from grasslands and associated biodiversity (Table 1). Goijman et al. (2015) stated that the agricultural intensification is detrimental to birds and their ecological functions, potentially causing a decrease in ES provided by them. For instance, insectivore birds play a role as pest controllers, a valuable ES in agricultural landscapes. Native grasslands provide regulation of water quality and availability, climate regulation, water provision, nutrient cycling, and erosion control (Modernel et al. 2016, Eguren et al. 2018, Villarino et al. 2019). All these benefits are affected by LULC changes, crop type and management, and climate change. Most of these papers reiterate the adverse consequences of climate change and LULC changes in the provision of agricultural products, which highlights the importance of sound and sustainable practices for the economy in the RPG.

Finally, we found that studies on both relational values and non-material contributions are scarce for the RPG (Table 1). Auer et al. (2017) identified agricultural activities that provided cultural benefits based on traditional activities in particular geographical areas. Furthermore, different aspects of the natural landscape sustained cultural values, giving local people a sense of place and cultural heritage. The authors also stated that although this study is from a small local area, the trends in agriculturalization processes follow a general pattern in the region, and based on socio-ecological similarities along the Pampas, this effect could be found in the entire sub-region (Auer et al. 2017).

Although we made a classification, it is recognized that the NCPs are perceived by people in different ways and each contribution can fit more than one category (Pascual et al. 2017, Díaz et al. 2018).

2. *Review of current policy-based conservation in the RPG*

2.1. *National laws and initiatives that promote the degradation of grasslands*

In Argentina, during the first half of the 20th century, there were cattle ranching and agriculture development under extensive or semi-intensive conditions, which consolidated the crop rotation model with annual pasture and forage (Viglizzo & Jobbágy 2010). By the 1970s and 1980s, increases in production were correlated to the expansion of cultivated areas over native grasslands and other types of environments (Carreño & Viglizzo 2007). In fact, between 1960 and 1990, the rate of grain production was six times higher than that of cattle ranching (Sturzenegger 2006). By the 1990s, intensive use of agricultural inputs and technology was prevalently escalating the LULC changes in the region (Viglizzo et al. 2001), while biotechnological innovations allowed an increase in yield per hectare. Technological advances were simultaneous to economic policy reforms that favoured Argentina's agriculture, such as export tax elimination; the reductions in tariff and non-tariff protection on fertilizers, agrochemicals, machinery and irrigation equipment; the deregulation of private economic activities, mainly commercial and financial, which allowed the reductions of agricultural financial marketing costs (Sturzenegger 2006). In 2002, the government announced the application of withholdings to exports primary products, and both agricultural and industrial manufactures (Colomé 2008). The tax retentions were by 2015, 23% for wheat, 20% for corn, and 35% for soy. In 2016, a new government adopted different measures such as the elimination of withholdings to exports wheat, corn, and meat and a 5% decrease for soybean retention (MA 2015).

From the mid-1990s, timber production has experienced significant growth driven by legislation that promoted forest plantations. In 1999, a law of Investments in Forestry in Planted Forests (Nº 25,080) was promulgated and later expanded in 2019 (Law Nº 27,487). The aim was to increase the stock from 1.3 to 2 million ha of cultivated forests by 2030, which contributed both to sustainable development goals and the climate change commitments assumed with the Paris Agreement (MAGyP 2018). This law established a regime that promotes investments made in new forestry ventures and the expansion of existing forests. It also favors the initiation of forest industry enterprises and the development of existing ones, as long as the timber supply is increased through the introduction of new forests. The benefits granted are tax stability for at least 30 years, tax benefits, and non-reimbursable economic support which will consist of an amount per hectare, variable by zone, species, and forestry activity. These ventures must comply with the zoning of forestry basins that must respect the territorial planning of native forests established by national law of minimum budgets for

Table 1. Summary of Nature´s Contribution to People (NCP) studied in the Río de La Plata Grasslands (RPG) based on the scientific paper review. The NCP is organized based on the generalizing perspective of the IPBES framework, and 18 reported categories are distinguished (Díaz et al. 2018*): 1. Habitat creation and maintenance; 2. Pollination and dispersal of seeds and other propagules; 3. Regulation of air quality; 4. Regulation of climate; 5. Regulation of ocean acidification; 6. Regulation of freshwater quantity, location, and timing; 7. Regulation of freshwater and coastal water quality; 8. Formation, protection, and decontamination of soils and sediments; 9. Regulation of hazards and extreme events; 10. Regulation of detrimental organisms and biological processes; 11. Energy; 12. Food and feed; 13. Materials, companionship, and labor; 14. Medicinal, biochemical and genetic resources; 15. Learning and inspiration; 16. Physical and psychological experiences; 17. Supporting identities and 18. Maintenance of options.* The NCP categories are divided into three broad groups depending on the type of contribution they provide to people into Material, Non-material, and Regulating (Díaz et al. 2018). The studied region of each paper is specified: Argentina (ARG), Uruguay (URU), Brazil (BR); the entire region (All).

Type of contribution	NCP Categories	ES	Specification	Drivers of the loss of the BES	Reference
Regulating	2, 14 and 18	Biodiversity and ecosystem functioning	Pollination	LULC change, agriculture intensification	Sabatino et al. 2016 (ARG), Marrero et al. 2017 (ARG)
Regulating	14 and 18		Species richness and diversity	Expansion of eucalyptus plantations, land-use type, loss of natural and semi-natural habitats and farming intensification	Phifer et al. 2016 (ARG), Hodara & Poggio 2016 (ARG), Winck et al. 2017 (BR)
Regulating	1, 14 and 18	Biodiversity and ecosystem functioning	Plant diversity	Low forage, high stocking rates, invasion of exotic species, expansion of crops and implanted pastures, overgrazing	Modernel et al. 2016 (All)
Regulating	14 and 18	Biodiversity and ecosystem functioning	Animal diversity (endemic species, migratory species)	Landscape perturbation and homogeneity, agricultural expansion (high proportions of cereal crops and forest), habitat loss and fragmentation, hunting pressure and zoonotic diseases introduced by exotic	Modernel et al. 2016 (All). Pedrana et al. 2015, 2018 (ARG), Bilenca & Miñarro 2004 (ARG)
Regulating	10	Biological control of insects and weeds by grassland species	ES provided by bird species	Agricultural intensification and monoculture, hunting pressure	Goijman et al. 2015 (ARG), Gorosábel et al. 2019 (ARG)
Regulating	10			Expansion of eucalyptus plantations	Phifer et al. 2016 (ARG)
Regulating	2	Seed dispersal by bird species		Expansion of eucalyptus plantations	Phifer et al. 2016 (ARG)
Regulating	6 and 7	Water quality and availability	Groundwater contamination control	LULC change, type and management of the crop	Rositano et al. 2018 (ARG), Modernel et al. 2016 (All), Eguren et al. 2018 (URU)
Regulating	6		Regional hydrology	LULC change (from native grasslands to crop)	Modernel et al. 2016 (All), Garcia et al. 2019 (ARG)
Regulating	6		Groundwater levels	Afforestation, agricultural expansion	Cerri et al.2015 (All), Modernel et al. 2016 (All)
Regulating	6 and 9	Flooding mitigation (water regulation)	Flood regulation	Agricultural expansion	Cerri et al 2015 (All), Barral et al. 2019 (ARG), Garcia et al. 2019 (ARG)
Regulating	4	Climate regulation and/or mitigation	Soil organic carbon stock	LULC change (from native grasslands to crops)	Modernel et al.2016 (All), Villarino et al. 2019 (ARG)
Regulating	4		N2O emission control	Type and management of the crop	Rositano et al. 2018 (ARG)
Regulating	4		Carbon footprint	Beef production	Modernel et al. 2016 (All)

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Regulating	8	Soil conservation	Soil C and N balance	Type and management of the crop	Rositano et al. 2018 (ARG), Ferraro & Gagliostro 2017 (ARG), Lara et al. 2018 (ARG), Villarino et al. 2019 (ARG)
Regulating	8		Aboveground net primary productivity	Precipitation and water balance, climate change, energy and biomass flows.	Durante et al. 2016 (ARG), Modernel et al. 2016 (All), Baeza et al. 2018 (All)
Regulating	8		Carbon and nitrogen cycling	Agricultural intensification	Bedano & Dominguez 2016 (ARG), D'Acunto et al. 2018 (ARG)
Regulating	8		Soil erosion	Land use transformation (grassland to crops)	Cerri et al. 2015 (All), Modernel et al 2016 (All), Villarino et al. 2019 (ARG)
Material	12	Food and feed provision	Low input, cattle grazing beef production	LULC change Indirect: Soil productivity, transportation cost, economic gains	Piquer-Rodríguez et al. 2018 (ARG), Modernel et al. 2018 (All)
Non-material	15, 16 and 17	Cultural identity		Industrial agriculture and economic values	Modernel et al. 2016 (All), Auer et al. 2017 (ARG)

environmental protection of native forests (Law Nº 26,331). This zoning aims to conserve native forests, but not other native ecosystems.

In Brazil, several policies that favor the expansion of different types of land-use activities have existed for decades. Within these activities are agriculture, mainly corn, soy and wheat crops, afforestation, and cattle ranching. Additionally, policies have been directed to manage productivity in beef cattle in pastures, through the establishment of minimum stocking rates (number of a particular type of animal per unit area). As a result of these policies, in 1970, there were 14,078 million hectares of natural pastures, but by 1996, only 10,524 million hectares remained. An example of cattle management was the project S3CR11 (1969/1970), which involved a forage improvement phase of the native grasslands of Rio Grande do Sul (Pillar et al. 2009).

Recently, the National Strengthening Program for Family Farming (PRONAF in Portuguese) was enforced. Although this program contributed socially and economically, it has negative environmental impacts. Grisa & Schneider (2015) state that in the municipality of Rio Grande do Sul, this program was predominantly oriented towards productive developments based on the use of chemical inputs. It also promotes a specialization in grain production and other agricultural commodities, which has led to the development of environmentally detrimental agricultural production models.

Finally, in Uruguay, internal policies regarding afforestation had a significant impact on the quantity and distribution of LULC changes (Cubbage et al. 2012). In 1987, Forestry Law (Nº 15,939), was approved as a commitment to supporting and growing the forestry sector. Its objective was to replace marginal and unprofitable farming and ranching on poor soils with afforestation and pulpwood production to supply mainly European markets (Snoeck et al. 2008). This law identified priority regions for afforestation and provided financial incentives such as subsidies, tax reliefs, and exemptions and targeted loans to investors (Cubbage et al. 2012). These incentives encouraged large-scale plantations and forest products manufacturing facilities (Mendell et al. 2007, Redo et al. 2012). Consequently, the tree plantations area in Uruguay increased rapidly, reaching the highest afforestation rate in Latin America between 1988 and 1998 (Mendell et al. 2007, Cubbage et al. 2012). However, in the early to mid-2000s, all incentives were revoked leading to a 24% decline in plantation areas between 2001–2009 (Redo et al. 2012). More recently forest companies are trying to promote joint ventures with cattle ranchers who own land by leasing their plantations to local farmers, forming silvopastoral systems (Cubbage et al. 2012).

Before the beginning of the century, soybean was not considered an essential crop within other agricultural staples in Uruguay. However, between 2000 and 2009, a soybean production boom exceeded the most dominant crop in the country, wheat, occurring at the expense of the country's herbaceous cover (Redo et al. 2012). Global demand and prices have played an essential role in driving soy expansion post-2002 (Oyhantçabal & Narbondo 2011). However, price alone cannot account for the sudden expansion, considering that the price was already relatively high in the mid-1990s. For this, it is essential to take into consideration external policies. The soybean export taxes in Argentina had a direct impact on the quantity and distribution of LULC changes in Uruguay (Redo et al. 2012). Between 2002-2013, the soybean area increased from 10,000 ha to 1.2 million ha (Souto 2012). On one hand, this increase was mainly due to the lower land prices and the lack of export taxes in Uruguay; and on the other, high land prices and high agricultural taxes in Argentina introduced in the early 2000s (Redo et al. 2012).

2.2. Conservation efforts in RPG at the international level

At an international level, there are two important initiatives focused on the RPG: (1) The Southern Cone Grassland Alliance (Alianza del Pastizal in Spanish) created in 2006 with the support of BirdLife International and in collaboration with NGOs (non-governmental organizations) from Argentina, Uruguay, Paraguay, and Brazil. This alliance seeks to protect the habitat of migratory birds and grassland diversity in general by working with different stakeholders (cattle ranchers, environmental NGOs, provincial and national governments, and researchers). In 2010, the Southern Cone Grassland Alliance developed a certification label for meat producers who protected 50% of their grasslands. In 2012, meat produced under this label became available to consumers (Alianza del Pastizal 2019). (2) The 'Official Incentives Project for the Conservation of Natural Grasslands of the Southern Cone of South America' that seeks to protect the BES in the region (Alianza Pastizal 2019). This project began in 2012, and its main goal was to promote an incentive system (payment for ES scheme) for cattle ranchers who carry out conservation management of natural grasslands on their lands (Parera et al. 2012). For this purpose, a technical tool (Grassland Conservation Index) was built to evaluate and quantify the rancher's contribution to grassland conservation, thereby enabling estimation of the amount of their economic compensation. However, objectives were only partially achieved, and in no case, the payments were done (Weyland et al. 2019). One possible reason for this result was that the scheme coincided with the end of the government's mandate and the change in the authorities (Weyland et al. 2019).

2.3. Conservation efforts in RPG at a national level

In each country, different policies or private initiatives have been attempted in order to protect biodiversity and the environment of the RPG (Table 2). To date, conservation initiatives in Argentina are mostly driven by NGOs in collaboration with researchers with the goal of boosting sustainable management practices as well as identifying areas for potential conservation (Table 2). Contrary, in recent decades, Brazil has made significant progress to link biodiversity conservation and economic development, which has played an essential role in international discussions related to conservation. The triggering within the Brazilian society of a specific concern regarding the Campos Sulinos appears to be related to two public discussions: the legal prohibition of burning as a practice of management of the fields in the Rio Grande do Sul (established under the State Constitution of 1989) and the debate surrounding the future of the Pampa biome alongside the announcement of extensive plantations of exotic trees for pulp production (Pillar et al. 2009). Finally, in Uruguay, conservation strategies promoted institutional strengthening, participatory research, and good management practices, by the government in an inter-institutional frame and international organizations (Table 2). All of them focus only on this environment, recognizing natural fields as one of the most important assets of the country in terms of biodiversity.

Based on these initiatives, different levels of conservation were reached in each country. Regarding the scientific community consideration, a natural region is adequately protected when at least 10-15 % of the area is protected by law (Burkart 1999, Bertonatti & Corcuera 2000) but this condition is not met in any country. Argentina protects 1.05% of the Pampas eco-region (Moreno et al. 2008, Burkart 2006, Sistema de Estadística Ambiental 2019), while Brazil protects 2.23% with the integration of federal level protected areas (Bilenca & Miñarro 2004). In Uruguay, the National System of Protected Areas (SNAP) constitutes approximately 0.98% of the national territory but with a high representation of specific species and ecosystems for conservation (Ávila et al. 2018, MVOTMA 2019). However, its low connectivity and surrounding landscapes (intensified production systems) are hostile to biodiversity and accentuating their biological isolation.

3. An approach to applying the IPBES conceptual framework to the RPG

It is important to note, that as the RPG extend into Argentina, Brazil and Uruguay, the associated values are affected not only by the spatial scale under analysis (local, regional, national or international), but also by micro and macro cultural, social, and political dynamics and complexities.

The conceptual framework we have developed for the RPG (Figure 2) has LULC changes as the main focal point and as the principal direct driver for the grassland BES. Based on our literature and policy review, there is a clear tendency to focus on the material contributions, which are traceable to the meat production history of the area (Viglizzo et al. 2001), as well as a distinct trend to increase crop production and afforestation with various incentives. The identification, valuation, and study of non-material values are scarce (such as learning and inspiration, physical and psychological experiences, and supporting cultural identities). Finally, the regulating contributions are becoming more relevant in the literature, especially in the face of climate change, but there is still a long way to go regarding policy application and implementation. However, in this framework, we emphasize the importance of all three of these interrelated components.

On one hand, LULC changes as the primary direct driver of change in the RPG includes three main elements: cattle grazing, crop production, and afforestation. The framework also articulates the values (NCP categories of IPBES framework) provided by these land uses, as a result of recognizing its social-economic importance. A relevant note regarding LULC changes is that the values provided, and the negative impacts on grasslands can profoundly differ according to the management applied. Traditional uses such as low-density cattle grazing or family farming will be more compatible with conservation concerns related to grasslands; intensive agriculture and afforestation, in turn, would be more detrimental to grassland's BES. Therefore, we assume that the transformations of this landscape are mostly to high-intensity LULC changes with inherent ecological consequences.

On the other hand, we organized the indirect drivers of LULC changes into two groups. The first one integrates technology, climate change, and international commodity prices. Technology, through technological advances, allows increasing productivity per unit area leading to less area needed. Climate change has the capacity to alter (un)suitable land uses and international commodity prices as market forces for higher or lower pressures from specific uses. Therefore, all these are affecting the weight that agricultural activities put on the remaining grasslands. The second group reflects the importance of highlighting the influence of politics and inherent political instability in the LULC changes, but also its integration in the remaining indirect drivers. Lastly, direct and indirect drivers' dynamics are viewed as a two-way relationship.

Table 2. National policies and conservation initiatives in the Río de la Plata Grasslands (RPG). NA: not applicable, or information not available.

Country	Initiatives	Level	% Area protected or to be protected	Public/private promotion	Conservation goals	Year	Law	Outcomes	Other remarks and challenges	References
Argentina	National System of Protected Areas (PAs), and other preservation areas	National	1.05% of total grasslands within the national territory	Public	To conserve pristine grassland areas representative of the region for its biodiversity and scenic values	1980	Law Nº 22,351; other policies	493 PAs of different biomes at different levels (national, provincial)	To increase representation of at-risk ecosystems within the protected network. To increase budget for protected area management	Burkart 2006, Moreno et al. 2008, Sistema de Estadística Ambiental 2019, SAyDS 2020
	Sustainable livestock grazing	National	NA	Private: Fundación Aves Argentinas and Fundación Vida Silvestre Argentina	To generate knowledge on good management of natural grasslands to improve meat production and economic gains, without compromising grasslands sustainability	2012	NA	Several workshops and technical documents aiming at grassland management	To reach a greater number of local producers and stakeholders; replacement of input technology with process technology; to reach a sustainable development public-policy management	Aves Argentinas 2019
	Inventory of Important Birds Areas (IBAs)	National (based on regional initiative)	10.4% of the total RPG	Private: Fundación Aves Argentinas and BirdLife International	To identify and protect a network of critical sites based on the presence of globally threatened species, restricted distributions and/or confined to a singular biome, and/or congregating species	2000	NA	33 IBAs in Argentina; updated population data; monitoring and action plans were improved. Partnerships (Committee for the Conservation of Pampas Biodiversity, BIOPAMPA)	Some IBAs and Valuable Grassland Areas (VGAs) are overlapped	Bilenca & Miñarro 2004, Di Giacomo & Krapovickas 2005, Di Giacomo et al. 2007
	Valuable Grassland Areas (VGAs)	National (based on regional initiative)	3.5% of the Argentinean RPG	Private: Fundación Vida Silvestre Argentina (FVSA)	To define and identify well preserved natural grasslands, based on biodiversity, endemism, indicator species, land tenure and law, and cultural relevance	2002	NA	36 VGAs were identified in Argentinean Pampas and Campos	61% of VGAs overlapped total o partially with existing PAs; 47% on private lands, and most within areas with little agriculture aptitude. VGAs should be considered as “priority areas for protection by law” in future declarations (i.e. National Strategy on Biodiversity 2016-2020)	Bilenca & Miñarro 2004, Miñarro & Bilenca 2008, MAyDS 2017a
	Conservation strategy of Fundación Vida Silvestre Argentina (FVSA)	National (applied within regional approach)	NA	Private: FVSA	Creation of new PAs (public and private) and supporting existing ones; to promote policies and incentives for sustainable practices; conservation of flagship species; training, education and outreach for grassland conservation; partnership with entities experienced in grassland conservation.	2004	NA	Creation of public areas ("Campos del Tuyú") and private areas ("Refugio de Vida Silvestre Bahía Samborombón"), where the goals were undertaken.	NA	Miñarro & Bilenca 2008

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Brazil	National System of Conservation Unit (SNUC, in Portuguese)	Federal, state and municipal	3.24% of Pampas Biome in Brazil (0.7% within Full protection and 2.5% within sustainable use areas) in private and public lands	Public: Brazilian government	Regulation of PAs (federal, state and municipal areas)	2000	Law Nº 9,985	Land classification in two groups according to use and management strategy: fully protected and those that allow sustainable use.	To protect 17% of the area representative of the biome until 2020, under Convention on Biological Diversity (CONABIO 06/2013)	MMA 2019
	National Biodiversity Policy	National	Promote the conservation of 10% of the Pampa Biome (i.e. Campos)	Public: Brazilian government	Biodiversity conservation by promoting sustainable practices involving government and NGOs pertaining to resource use and valuations, considering economic, environmental, social and cultural values.	2002	Law Nº 4,339	Biodiversity valuation determined by its ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic contribution.	To link benefits of conservation to people wellbeing	MMA 2006
	Environmental Zoning plan for silviculture	State level (Rio Grande do Sul, Campos)	NA	Public: State Council	To conserve biodiversity (especially natural grasslands) and prevent expansion of agricultural frontier, particularly of large-scale industrial afforestation	2004	Resolution Nº 84/2004	Establishment of maximum plantation size buffering distances. Established of 3.5 million hectares as afforestation prone.	Disagreements between silviculture companies, activist groups and governmental institutions led to a reformulation with less restrictions	Gautreau & Velez 2011
	Legal Reserve law	National	Variable between biomes (20% in the case of the Campos)	Public: Brazilian government	To ensure the sustainable use of natural resources, assisting the conservation and rehabilitation of ecological processes that maintain biodiversity.	2012	Law Nº 12,727	Instrument applied on private land including Permanent Preservation Areas (protecting water resources, soil and biodiversity) and Legal Reserves (required on all private rural land, to preserve portions of native areas). Allowed alternative albeit compatible with conservation goals.	Effective implementation.	Silva & Ranieri 2014
Uruguay	National System of PAs(SNAP)	National	0.98% of the total territory are PAs along adjacency zones	Public: Uruguayan Congress	To harmonize planning and area management criteria; adoption of landscape level approach	2000	Law Nº 17,234	16 PAs identified. Strategic plans that articulate socio-economic and conservation aspects were generated; technical documents were produced for responsible land use and management.	To continue generating opportunities compatible with conservation (recreation, tourism, education, research and production) and increase native grasslands representation within PAs.	Ávila et al. 2018, Moraes Salvio & Ribeiro Gómez 2018, MVOTMA 2019
	Inventory of Important Birds Areas (IBAs)	National (based on regional initiative)	18% total IBAs area of the total territorial extension	Private: Aves Uruguay, Birdlife International	To identify and protect a network of critical sites for bird species based on the presence of globally threatened species, the existence of species with restricted distribution and the presence of species confined to a specific biome and/or species that form big bird congregations	2008	NA	22 IBAS proposed. Updated population data; monitoring and action plans were improved.	NA	Aldabe et al. 2009

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	Livestock Bureau in Natural Fields	National	NA	Public: Ministerio de Ganadería, Agricultura y Pesca (MGAP)	Cattle ranching management practices compatible with conservation and efficient use from an integral perspective; to identify and promote benefits obtained from native grasslands, and valuation regarding production and BES, especially resilience capacity to face climate change.	2012 to present	NA	Training workshops and meetings among ranchers to promote sustainable management and integrate research institutions with government sectors; GIS mapping of natural grasslands; institutional strengthening for conservation action; education and outreach; participatory research integrating farmer's knowledge.	NA	Pereira-Machín & Morales 2012, Jaurena et. al 2013, IICA 2017
	Climate Change Adaptation Development Project (DAAC)	National	NA	Public: MGAP	To support rural producers for the sustainable use of natural resources, while generating greater adaptation and resilience to climate change.	2012-2021	NA	Application of sustainable land management practices; project financing; strengthening capacities of farmer organizations; support for the Land Use and Management policy (National Agricultural Information System)	NA	Pereira-Machín & Morales 2012, Banco Mundial 2017
	National Plan for Adaptation to Variability and Climate Change for the Agricultural Sector	National	NA	Public and International: National System of Response to Climate Change and Variability (SRNCC); MGAP; Food and Agriculture Organization of the United Nations (FAO)	To guide public policies with a long-term vision (2025-2050) around the productive, environmental, social and institutional dimensions	2019	NA	Participative process involving different stakeholders	NA	OPYPA 2019
	Climate-smart Livestock Production and Land Restoration project (GCP/ URU/034/GFF)	National	4 Ecoregions with direct and indirect intervention	Public and International: Global Environment Facility; MGAP; MVOTMA; FAO	To mitigate climate change and restore degraded land through the promotion of climate-smart practices in cattle ranching	2019	NA	More efficient use of resources and lessen environmental impacts; reduction of greenhouse gas emissions; carbon sequestration in soil; positive impacts on biodiversity and other ecosystem services.	NA	OPYPA 2019

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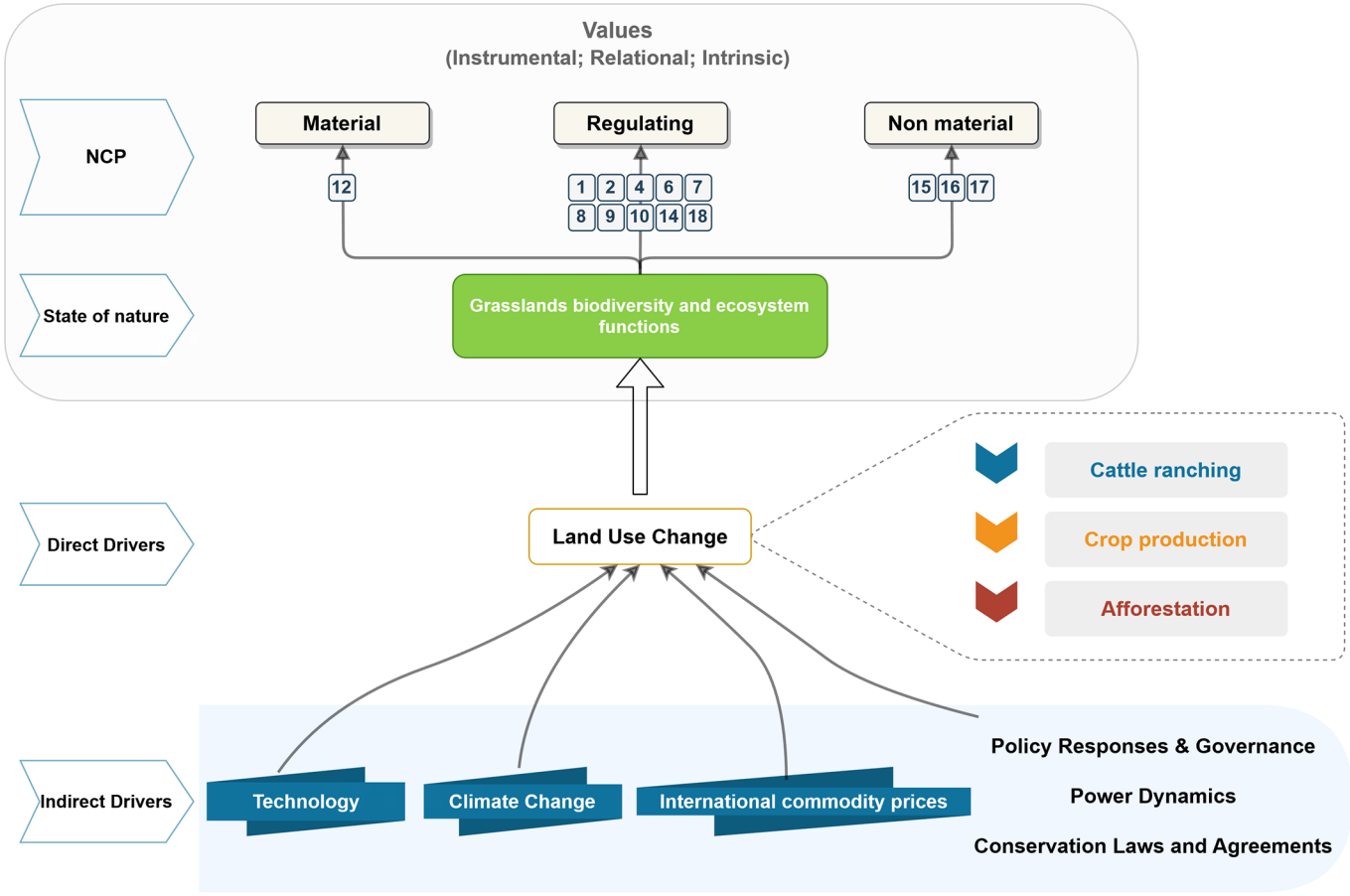

Figure 2. Conceptual framework for policy-based conservation of the Río de la Plata Grasslands (RPG) following the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Nature's Contribution to People (NCP) notion.

Discussion

The main goal of this study was to contribute to policy-based strategies for biodiversity conservation and ecosystem services provision for South America's Río de la Plata Grasslands, within a novel conceptual approach. From our review, we evidenced that the unsustainable practices that have resulted in negative consequences for BES over the RPG are currently still ongoing. We found that the different regions within the RPG share similar drivers of change (e.g. land-use change due to overgrazing, crop expansion, and afforestation, climate change, and invasive species) and are experiencing comparable negative consequences regarding the conservation of BES. Most studies highlighted regulating and material NCPs, while we found scarce information on non-material NCP. Similar results were evidenced by Mastrangelo et al. (2015), showing a tendency to focus on the biophysical processes and patterns of the ES rather than on assessing its cultural component and benefits to people. Thus, the LULC changes have occurred at the expense of the loss and degradation of natural environments, the system's sustainability, and cultural values (Mastrangelo et al. 2015, Modernel et al. 2016, Auer et al. 2017). Consequently, it is essential to develop a regional assessment of the RPG adapted to the cultural, social, political, and economic issues of the region. In addition, a transdisciplinary approach could help strengthen the interface between science and policy-makers while enhancing the participation of different stakeholders.

Current policy approaches for BES conservation differ between regions and countries. Based on our conservation-policy review, we found the pervasive and systemic grassland ecosystem degradation concerning. Although all countries recognize the importance of this biome and consequently express an interest in its conservation, the implementation and execution of plans and actions have been sparse. Lack of action is reflected in the limited inclusion of protection mechanisms in regional and local land planning strategies, as well as in the very low levels of protected-area coverage of native grassland within the RPG.

Policies for the conservation of BES in the study area are uncommon and incipient, particularly in Argentina and Uruguay (Azpiroz & Rilla Manta 2007, Modernel et al. 2016), while Brazil appears on the lead as far as current existing laws for grassland's BES conservation. To date, most conservation initiatives in Argentina are non-normative and territorial planning that includes grasslands is lacking. The Argentinian legislation considers only native forests as a priority for conservation when it regulates the promotion of productive developments. We propose that different types of biomes should be included, in order to reduce the potential threats to other vulnerable ecosystems. These could help increase the recognition of the grasslands´ ecological value and its conservation, from regional to national scales (Bond & Parr 2010, Overbeck et al. 2007). Thus, there is an urgent need to implement initiatives that establish a minimum proportion of grasslands to be

protected, with special emphasis on at-risk areas, along with strategic territorial planning initiatives. These could ensure that productive activities do not represent a threat to vulnerable ecosystems, especially where the most natural tracts of grasslands still remain. In Uruguay, a series of governmental initiatives were proposed in the last decades, which aimed at sustainable management of cattle ranching in natural fields and conservation of its BES (Bartesaghi et al. 2015, Ávila et al. 2018). Although there are concrete actions in the conservation of grasslands, it is necessary to create national legislation to regulate and enforce conservation policies. Contrary to these sustainable proposals, a recent law aims at intensifying agricultural production (Irrigation Law, Nº 19,553, 2017), which could negatively affect the grassland conservation.

In Argentina and Uruguay, conservation policies are more oriented towards the protection of a few threatened grassland species and their habitats (Di Giacomo et al. 2007, Soutullo et al. 2013, MAyDS 2017b). On the other hand, Brazilian policies for grassland conservation present a more optimistic perspective for the future. Expectations are on the enforcement of the Environmental Rural Registry code, which has the potential to constitute a reserve of preserved native grasslands. The possibility of linking the Permanent Preservation Areas and Legal Reserves should safeguard a minimum of 20% of the private grassland areas, and those within the governmental protected areas. However, grasslands in southern Brazil are considered a "neglected biome" (Overbeck et al. 2007), since it is not given adequate consideration and protection in comparison to other Brazilian biomes, and where policies focusing on farming intensification pose a significant threat to the BES sustainability of the grassland ecosystem.

We agree with Hoekstra et al. (2005) that conservation efforts should be addressed at large scales, as national and regional perspectives are the scales at which conservation policies will be more effective in halting habitat and biodiversity loss across the RPG (e.g. Di Minin et al. 2017). As previously mentioned, the management of the region has been mainly driven by national policies centered on rural economic development. Nevertheless, there are international initiatives that are applied to RPG conservation, mostly driven by NGOs actors. These initiatives are encouraging, but require institutional support enabled by national political approaches to reach a broad, transnational, and effective conservation outcome. There are several examples of successful multinational conservation efforts that transcend geographical boundaries and work together in pursuit of conservation, such as Natura 2000 network in the European Union through the EU's Birds (79/409/EEC), Habitats Directives (92/43/EEC) and the UN Convention on Biological Diversity. Regarding grassland management and conservation in the RPG, it is possible to address some similarities in comparison with European conservation approaches. Identified threats to European grasslands (Silvia et al. 2008) are in line with the ones found in our case study (EEA 2012). Concerning protected areas, different EU Member States define different approaches toward conservation. In effect, 25% of the 27 EU terrestrial lands are protected under either Natura 2000 (where human activities must be harmonious with the conservation of sites of natural importance), national designations, or a combination of both. Grasslands ecosystem share was 9.2% of the total area of protected sites in Europe, while for the total of areas included in Natura 2000, 11% were classified as grasslands (EEA 2012). Some of the policy proposals for these areas include the promotion of high nature value farmland or payments to farmers for the environmental services provided (Silvia et al. 2008).

Following the IPBES framework and the NCP concept, we sought to link scientific knowledge on biodiversity and ecosystem function, the values for society, and the policies that could promote conservation in the RPG. We concluded that the different regions in the RPG have in common not only the drivers but also the underlined negative consequences regarding the conservation of BES. Therefore, the conceptual framework built in this study is generalizable to the full extent of the RPG. This framework could be used as a tool to communicate the relevance and the benefits to society of preserving native grassland's BES in this region. Also, it could help to focus attention on the consequences of not applying sustainable management, which can result in the direct loss of the long-term productive capacity and resilience of this ecosystem (Foley et al. 2005, MEA 2005). Furthermore, this model would also aid in detecting the lack of information and policies in some areas, and serve as a base model to integrate new information. Lastly, the framework could be useful as a primary input in qualitative or quantitative modelling of relevant socio-economic scenarios and conservation outcomes (for instance, the Shared Socioeconomic Pathways; O'Neill et al. 2014), identification of policy options for future management (e.g. Anton et al. 2010, Paracchini et al. 2011), and to construct spatial models for synergies or trade-offs between different ecosystem functions and its conflicts (e.g. Zhang et al. 2019b).

1. Conservation policy proposal

Taking into consideration the "emerg[ent] biome crisis" (Hoekstra et al. 2005) that temperate grasslands face, and based on the threats identified in this study, we highlight a combination of policy mechanisms for conservation of the RPG. Based on the proposed framework, the following initiatives could enhance and/or maintain the existing biodiversity as well as increase connectivity throughout the RPG. In addition, we associate the different values and NCPs that these policies could enhance. However, we acknowledge that these efforts are not an end but a starting point to reach long-term conservation goals.

First and foremost, an expansion of the natural protected areas in the RPG is crucial. Dinerstein et al. (2019) state that there is a small window of opportunity of 10 years to halt climate change below 1.5°C and to prevent 'points of no return' in terms of habitat loss and species extinction. Following this idea, we concur that a higher percentage of the RPG should be under some form of protection. Protection here is understood as defined by the International Union for Conservation of Nature (Dudley 2008). In order to protect all subregions in the RPG, each country could use a combination of the following: (1) establish multiple protected areas through legal mechanisms in zones identified as hotspots for BES, including the creation of buffer zones and natural corridors within agricultural landscapes (e.g. Nin et al. 2016, Schröter et al. 2017) to increase interconnectedness throughout the RPG; (2) Create incentives (in the form of tax breaks or payments for ES) for landowners who allocate part of their properties to grassland conservation (Alianza del Pastizal 2019). (3) Argentina and Uruguay could adapt and implement similar measures to that of Brazil (Environmental Rural Registry) to protect 20% of each private property.

We are aware that effective grassland biodiversity conservation outcomes cannot be achieved through protected areas alone (Harlio et

al. 2019). Thus, it is important to take into consideration the connectivity of these conservation areas to minimize landscape fragmentation and its detrimental effect on biodiversity (Batáry et al. 2011). The connectivity of these natural areas is essential to dispersal success, persistence, and genetic diversity of species in fragmented landscapes (Schooley & Branch 2011). Some of the agri-environment schemes implemented by the European Union's Common Agricultural Policy did not have a positive effect on biodiversity and it was associated with the lack of regional and landscape conservation planning in farmlands (Batáry et al. 2011; Harlio et al. 2019). Looking at the trends of the RPG, there is an increase in cropland areas, so the maintenance of rural roadside could play an important role. Roadsides can host a diverse and representative flora and fauna of the region, supporting their importance as refuges and reservoirs of biodiversity (Saez et al. 2014; Arenas et al. 2017). Herrera et al. (2017) suggested a novel and simple index to assess the conservation status of roadsides that could serve as an initiative to implement in other areas and to take these landscape elements into consideration in decision-making.

Second, the regulation of LULC changes throughout the RPG is fundamental to the long-term conservation of this biome. Existing economic regional bodies such as MERCOSUR (Common Market of South America) could be used to establish biome-wide conservation goals, legislation, and control mechanisms that align with each country's economic growth models (Soutullo & Gudynas 2006). Such actions could include, but are not limited to, the establishment of national zoning and land use regulation schemes based on socio-economic information and BES hotspots identification (Nin et al. 2016; Di Minin et al. 2017). This process could be expanded to the entire RPG region, and even to larger spatial scales within a multi-biome land-use prioritization approach (i.e. the entire Del Plata Basin; Viglizzo & Frank 2006). These guidelines could help reach an agreement between countries about land-use policies focusing on particular areas that are crucial for the RPG's biodiversity and ecosystem services provision. This will require control mechanisms that can verify such activities are following and meeting national and regional agreements. Coordinated actions between the involved countries, along with well-defined management objectives and regulations, could represent a key strategy for developing an effective regional network of conservation strategies inside and outside of protected areas (Bicknell et al. 2017; Moraes Salvio & Ribeiro Gómez 2018).

Lastly, the inclusion of socio-cultural values into all management policies and plans is necessary. The identification and comprehension of the different nature values and worldviews are essential steps to link the NCP and their influence on human well-being. This approach is applicable to initiatives at the science-policy interface in order to obtain sustainable management of the environment (Pascual et al. 2017). Policies that consider stakeholder's welfare based on local and scientific knowledge and allow compatibility between different land uses could support long-term sustainable use of grassland ecosystems (see examples on Pillar et al. 2009). Effective conservation measures must be implemented with the full support of local communities (Modernel et al. 2016). Furthermore, Dujin et al. (2008) identified three major types of values related to protected areas: economic, social and environmental, which presents benefits that can be enjoyed at multiple levels: local, regional, cross-border, international or global benefits, including the public and private sectors (Kettunen et al. 2009).

Protected areas are the cornerstone of conservation, but taking into consideration the economic relevance of the region to each country, biodiversity conservation cannot rely only on those areas. Sustainable conservation also requires policies for managing the entire region, including areas dedicated to agricultural activities, within a regional perspective, and taking into consideration people's outlooks and values (Margules & Pressey 2000, Tscharntke et al. 2005, Harlio et al. 2019). Following IPBES' aim to promote the conservation and sustainable use of biodiversity, long-term human well-being, and sustainable development, our study addresses the main drivers of change in the RPG. Our conceptual framework can provide an approach to integrate international policies and increase the conservation level of this biome, connecting it with the different grassland values. We are aware of the complexity of these efforts and the implementation of international policies highlighted in this study. However, national and local governments should realize the importance of conserving the RPG and the consequences of not addressing the drivers affecting it.

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Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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