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Proposal of priority areas interconnecting conservation units in Alto Iguaçu – PR.

Proposta de áreas prioritárias interconectando as unidades de conservação do Alto Iguaçu – PR.

Ana Carolina da Silva [*], Franklin Galvão [**], Pyramon Accioly [***]

[*] Programa de Pós-Graduação em Engenharia Florestal, Universidade Federal do Paraná, anac.florestal@gmail.com
[**] Programa de Pós-Graduação em Engenharia Florestal, Universidade Federal do Paraná, f.galvao@ufpr.br
[***] Escola Politécnica, Universidade Bagozzi, pyramon@gmail.com

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Abstract

In Paraná, the Alto Iguacu basin is listed as one of the most important regions of the south of Brazil for water supply, in addition to the presence of several Conservation Units of different categories to protect the biodiversity of fauna and flora in the Atlantic Forest. This study aims to indicate relevant areas for the creation of ecological corridors in the Alto Iguaçu Basin using a GIS multi-criteria methodology, evaluating the plant typology, land use, and soil characteristics, and the diverse environments with the Phyto-environmental Units (UFAs) project. Tree areas were proposed to interconnect the protected areas covering the Mixed Rain Forest, Dense Rain Forest, and steppes, guaranteeing the representativeness of all Phyto-physiognomies present in the basin.

Keywords:
Connections, multicriteria analysis, ecological planning.

Resumo

No Paraná, a bacia do Alto Iguaçu consta como uma das mais importantes regiões do Sul do Brasil para abastecimento de água, além da presença de várias Unidades de Conservação de diversas categorias com o objetivo de proteção da biodiversidade da fauna e flora da Mata Atlântica. Este estudo indica áreas relevantes para a conservação da natureza e criação corredores ecológicos na Bacia do Alto Iguaçu pela metodologia de multicritérios usando SIG, avaliando a tipologia vegetal, o uso do solo e característica do solo, além de garantir a representatividade de todas fitofisionomias nos corredores. Foram propostas três regiões indicadas a criação de corredores interligando as Unidades abrangendo Floresta Ombrófila Mista, Floresta Ombrófila Densa e Estepe, garantindo a representatividade dos ambientes.

Palavras-chave:
Conexões, análise de multicritérios, planejamento ecológico.

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I. INTRODUCTION

The Brazilian natural heritage is undeniably recognized as the most significant on the planet. This natural richness is expressed by the continental extension, the diversity, and endemism of biological species and their genetic heritage, as well as by the ecosystem variety of biomes, ecotones, ecoregions, and bioregions (ARRUDA, 2004). In Paraná, the Alto Iguaçu basin is one of the most important regions in the state for water supply, in addition to the presence of several Conservation Units of different categories to protect the biodiversity of the fauna and flora of the Atlantic Forest.

The enhancement of the efficiency of Conservation Units, especially in regions with excessive anthropogenic, it's important for the formation of an integrated system of these protected areas. The connectivity of these fragments helps in the flow of genes, through increased pollination and seed dispersal, in addition to the displacement of fauna, thus serving its great conservation purpose. Because of it, one of the greatest difficulties faced by parks and reserves in Brazil is their growing isolation from other natural areas, protected or not by the fragmentation of these environments. Due to this isolation, the need arises to protect several populations of the same species (meta-populations), as the conservation of biological diversity requires, in addition to preservation at the species level, the preservation of genetic diversity contained in different populations (AYRES *et al.,* 2005, p. 20).

Planning for the implementation of ecological corridors must prioritize the adoption of techniques that ensure the conservation of the most fragile areas, stability, and maintenance of the functionalities of each environment, as well as increased connectivity, aiming to minimize the effects of ecosystem fragmentation. Factors such as corridor width and matrix permeability characteristics can influence flows differently, depending on species characteristics. Therefore, for the implementation of the exact area of a corridor, several studies must be carried out in advance, and regarding the evaluation of the effectiveness of the implementation of corridors (functional connectivity), it can only be measured in population ecology studies and gene flow between fragments, among other methods that can measure according to the sensitivity of each target species (MUCHAULH, *et al*. 2010).

Another important aspect is the analysis of fragility to discover which place is more recommendable for conservation, must be as objective as possible, to eliminate the character of subjectivity. As the analysis of environmental fragility was applied to a site destined for the implementation of a Conservation Unit (or ecological corridor), it had as a basic premise that the more degraded the area, the less fragile and the more

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radical the interferences it could suffer; the less degraded, the greater its fragility, and should be subject to milder interventions (GUAPYASSSÚ, 1998).

The use of selection tools for key areas for biodiversity has great application potential, especially when considering that the global planning of the Protected Areas system is still very inexpressive in Brazil (MACHADO, 2004). It is increasingly seen necessary to advance in research on methods of implementation, where the selection criteria must be rigorous and detailed so the forest fragments or fields present are protected and connected, creating an efficient protection network.

This study aimed to map areas of environmental relevance and project regions suitable for the possible creation of ecological corridors in the Alto Iguaçu basin region - PR, under the assessment of land use, water resources, and plant typology in the region, using a GIS multi-criteria methodology to fill the gaps in the formation recommendation areas for ecological corridors that also cover rural areas and other biogeography regions normally hidden in the connections proposals.

II. MATERIALS AND METHODS

Study area

The Iguaçu hydrographic basin has a total area, in Paraná, of 54,820.4 km² (SEMA, 2007), about 28% of the total area of the state, and a population of 4.405.882 inhabitants (IBGE, 2004), around 43% of the state. It is noteworthy that the Iguaçu Basin is divided into the following Hydrographic Units for Water Resources Management, following Resolution No. 49/2006/CERH/PR: Baixo Iguaçu, Médio Iguaçu, and Alto Iguaçu (SEMA, 2010). The Alto Iguaçu hydrographic basin is considered one of the most significant in the state of Paraná. According to the State Department of the Environment, this basin has an area of approximately 2881.73 km² (SUDERHSA, 2007) and 30 sub-basins, located on the west slope of the Serra do Mar and the first plateau of Paraná, and represents part of what is the largest basin in the state (Figure 01).

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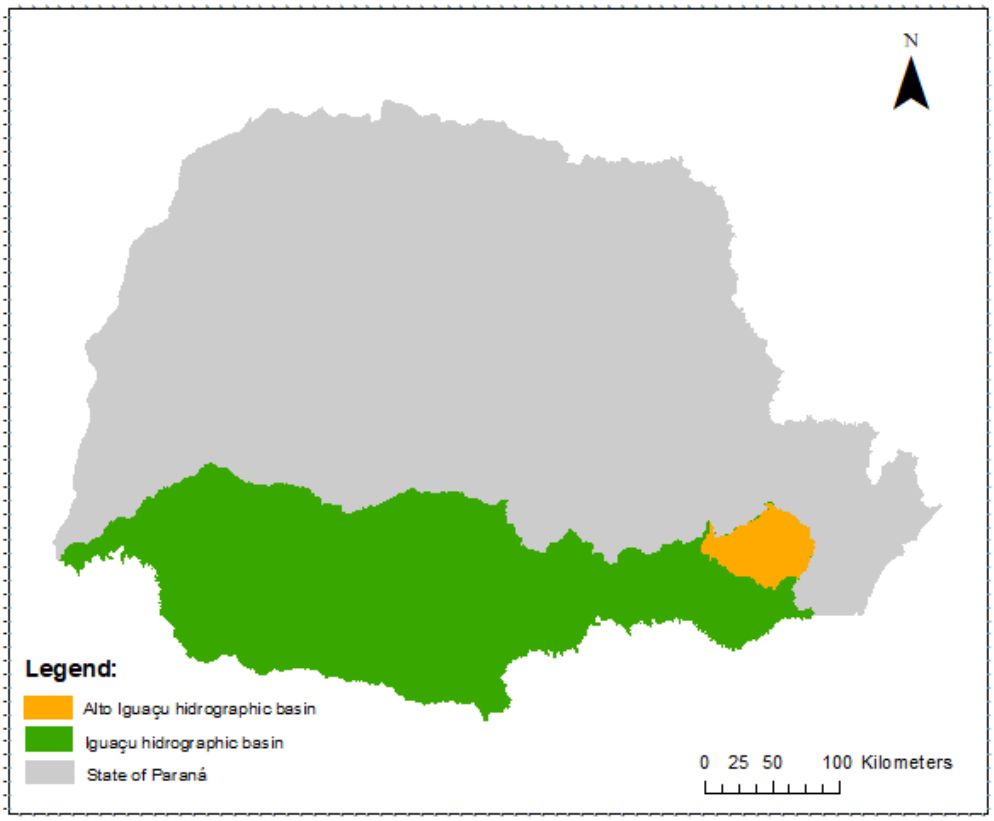

Figure 01. Location of Iguaçu Basin (Author)

The Alto Iguaçu basin, according to Castro (2005) has partially or totally comprises the municipalities of Almirante Tamandaré, Araucária, Campina Grande do Sul, Campo Largo, Colombo, Contenda, Curitiba, Fazenda Rio Grande, Mandirituba, Pinhais, Piraquara, Quatro Barras and São José dos Pinhais, which are part of the RMC (Metropolitan Region of Curitiba). According to the count carried out by the IBGE (Brazilian Institute of Geography and Statistics), the population of the Alto Iguaçu basin represented 94% of the total of the RMC, that is ~3 million inhabitants (IBGE, 2010). Following the climate classification by Köppen (2012) and Alvares *et al.* (2013), the Alto Iguaçu basin region is under a Cfb climate, temperate, super-humid, mesothermic, with cool summers and harsh winters, with frequent frosts and an occasional snowfall.

Maack (1981) states that the vegetation of the place fits as Mixed Ombrophilous Forest and Dense Ombrophilous Forest, with some fragments of Steppes. The Dense Ombrophilous Forest is observed in the extreme east of the municipalities of Piraquara and São José dos Pinhais, the other municipalities have a predominance of the Mixed Ombrophilous Forest and Steppe, in addition to pioneer fluvial-lacustrine vegetation in the floodplains of the main rivers (KERSTEN, 2006). According to Silva (2014), these pioneer formations are also known as wetlands, swamps, or floodplains, which are environments of high environmental

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fragility. This conditioning, imposed by water dynamics, configures edaphically unstable ecosystems in constant ecological succession (MANABE; SILVA, 2010), occurring predominantly on Organosols and Gleissolos, dispersed over several regions of the state of Paraná, as in the present basin.

Much of the Mixed Ombrophilous Forest in this watershed is classified as Montana, and lies between 800 and 1200 m a.s.l. In this region, stand out the presence of Brazilian Pine (*Araucaria angustifolia*), Imbuia (*Ocotea porosa*), Cinnamon tallow (*Ocotea purubela*), Wild pine (*Podocarpus lambertii*), Yerba mate (*Ilex paraguariensis*), Rose cedar (*Cedrela fissilis*), Canjerana (*Cabralea canjerana*) Caroba (*Jacaranda puberula*), Pitanga (*Eugenia uniflora*) and the Horsetail (*Luehea divaricata*), among others (RODERJAN *et al*. 2002).

The Alto Iguaçu Mixed Ombrophilous Forest Alluvial Formation is very diverse, both in composition and in the form of occupation of the plain, constituting photomosaics whose distributions are specifically governed by patterns of flow magnification, river bed configuration, geomorphological features of the plains and soil water saturation regimes (CURCIO, 2006). In the upper stratum, there are species like Branquilho (*Gymnanthes klotzschiana*), Aroeira (*Shinus terebenthifolius*), Vacum (*Allophyllus edulis*), Jerivá (*Syagrus romanzoffiana*), Myrtle (*Blepharocalix salicifolius*), and Tarumã (*Vitex megapotamica*). In the lower strata, there is the presence of Cambui (*Myrciaria tenella*) and Pasto-de-Anta (*Psychotria carthaginensis*) (RODERJAN *et al.* 2002).

The Steppes have an essentially grassy constitution on smooth-undulated terrain. This region makes up a characteristic feature of the landscape of the southern Brazilian highlands. Its origin dates back to the beginning of the current post-glacial period, as a colonizer of the barren surface resulting from the previous climate. Are typical in this place the *Poaceae* of the genera *Aristida*, *Paspalum*, *Andopogon*, *Eragrotis*, and *Panicum*, in addition to *Asteraceae*, *Lamaceae*, *Verbenacceae*, *Polygalaceae*, *Fabaceae*, *Mimosaceae*, *Asclepiadaceae* (MORO *et al*. 1996).

There are 12 federal and state Conservation Units located under the Alto Iguaçu basin, as can be seen in Figure 02 from the data taken from the State Secretariat for the Environment (SEMA) and the Water and Land Institute (IAT), and classified as for fully protected or sustainable use in Table 01.

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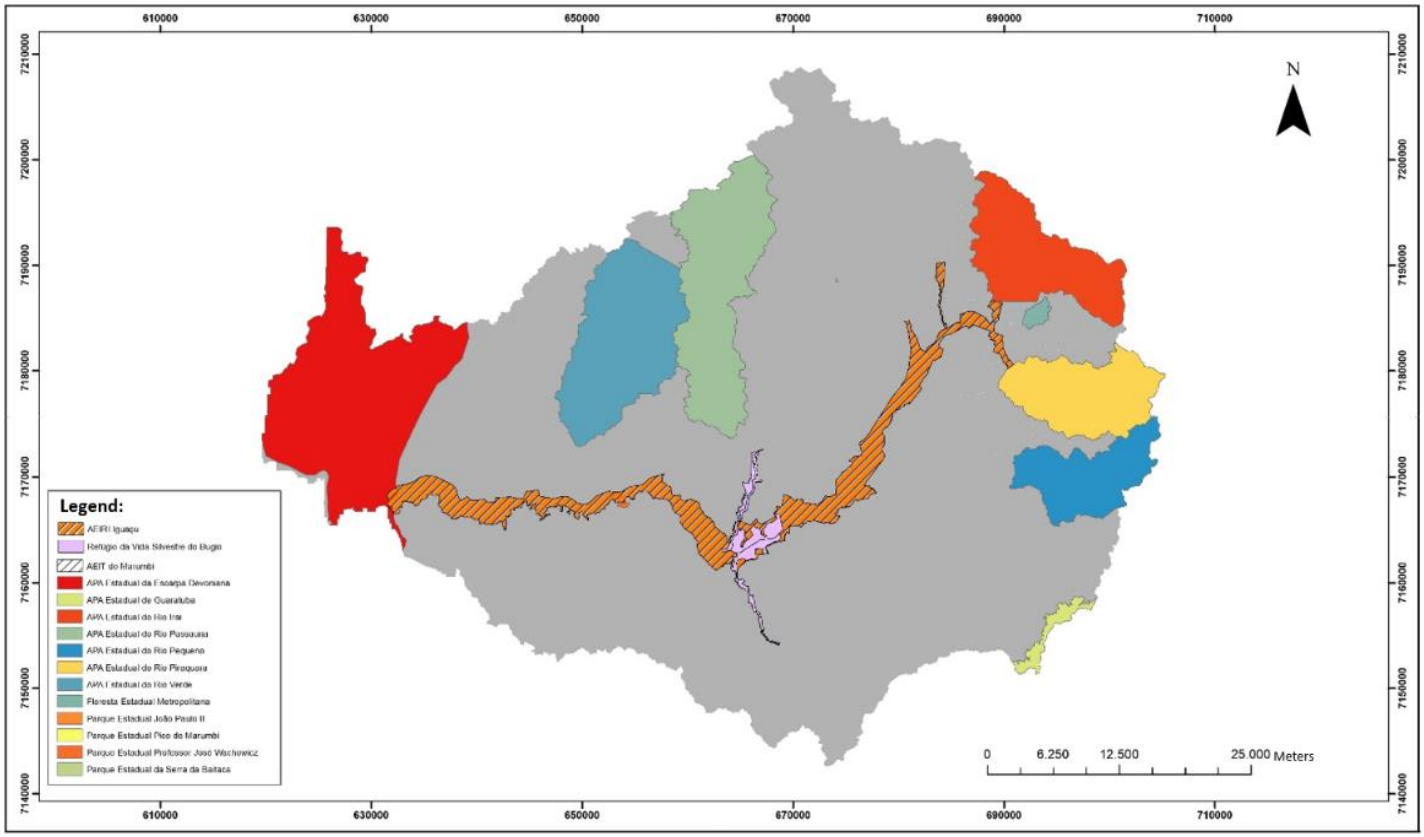

Figure 02. Conservation units in the Alto Iguaçu basin (SEMA, 2010, adapted by the author)

Table 01. Classification of state and federal conservation units of Alto Iguaçu.

Classification	Conservation Units
Fully protection	Parque João Paulo II Parque Estadual Professor José Wachowicz Refúgio da Vida Silvestre do Bugio
Sustainable Use	AEIT Marumbi AEIT Iguaçu APA Escapa Devoniana APA Guaratuba APA Iraí APA Rio Passaúna APA Rio Piraquara APA Rio Verde Floresta Estadual Metropolitana

(Sema and IAT, 2020, adapted by author)

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Multicriteria analysis

Multi-criteria analysis has already been used in several subjects for decision making, it is a quality-quantitative technique that allows the decision to be based on criteria considered relevant to decision-makers (JANNUZZI *et al.* 2009). The multicriteria analysis methodology for the forest area was first used by Santos *et al*. (2010) for the delimitation of ecological corridors between two Conservation Units in Espírito Santo, where variables such as permanent preservation areas (APP), slope, and land use were used. In the applied methodology, each of these variables is converted to matrix format and reclassified, the weights being the values assigned to each thematic class of the variable. Classes that implement ecologically relevant areas unfeasible received lower values, on a scale ranging from 1 to 100. Almeida *et al.* (2010), also used the multicriteria analysis methodology for the implementation of ecological corridors in the Atlantic Forest, studying fragments of Pratigi EPA in Bahia, the mapping of the areas followed the same proposed values as Santos *et al.* (2010) using data on the slope, land use and occupation and permanent preservation areas (APP). The results obtained by both surveys showed the efficiency of the methodology applied to indicate routes for ecological corridors.

For the study in the Alto Iguaçu basin, the database files provided by the Instituto das Águas do Paraná (2000) were used. These files were reviewed with the help of Google Earth® and processed with ArcGis® 10.5 software, where the multi-criteria analysis methodology was applied. Also was used the geographic layers of hydrography, land use, relief, geology, and vegetation were used, scale 1:20000 in UTM, datum SAD 69. These layers were classified into many variables and were then grouped into similar classes to reduce and simplify their conversions into values, using Google Earth Pro some polygons were updated, changing from vegetation areas to urban areas, following the growth of cities, the polygons were analyzed according to their importance for conservation and degree of environmental fragility for the recovery to receive its valuation accordingly, in Table 02 are the justification of each value for the layers.

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Table 02. Justificative for the values of the multicriteria analysis.

Class	Values	Ecological Relevance	Justification
Rocky outcrop, Floodplains, Grassland, Hydrography, Forest, Shrubs, and Hydromorphic soil	100 and 75	High	These are areas of rich biodiversity and preserved environments, with great potential for genetic exchange and areas sensitive to impacts. They have areas of great hydrological importance for the preservation of the environment and water quality
Forest plantation, Exposed soil, and Non-hydromorphic soil	50	Medium	Areas that may have already been anthropized (ex: artificial steppes resulting from vegetation cuts), but which have the possibility of harboring native flora and fauna. Environments that are recovered can return to an environment that integrates nature
Industrial area, Urban area, Dumping ground, Mining, and Agriculture	1 and 25	Low	Areas with high levels of anthropization or polluting agents that do not have the possibility of restoration and return to a natural environment that shelters local biodiversity

To establish the values of the variables in this study, areas where environmental protection would result in greater environmental gains, were prioritized, that is, areas of hydromorphic soil, watercourses, forest areas, or native fields, to always cover the diversity of Phyto-physiognomies. This phase, being one of the most important of the project, had the help of other researchers who, based on their experiences, helped in the assembly of the weight table, in addition to bibliographic research.

In all previous research (ALMEIDA *et al*. 2010; SANTOS *et al*. 2010; MARTINS *et al.* 2017), they used the multi-criteria analysis methodology and classified the field areas as moderately relevant and the rocky outcrop as not relevant. These aspects were changed in the present research to values of highly relevant areas since the region of studies has a natural grassland area and has great importance for the local fauna and flora. The hydromorphic grasslands are formed on organ soils in a saturation state (CURCIO, 2006) with great potential for hydrographic preservation and are extremely sensitive to impacts. The rocky outcrops were also addressed as priority conservation areas in this research, as they harbor very particular vegetation, many of these flora species that occur in these areas have a series of characteristics that allow their survival in an environment with poor and sandy soil, with extreme heat stroke and large temperature fluctuations between day and night (GIULIETTI *et al*, 1997). Several studies indicate that there are high values of diversity indices and a high occurrence of endemism in these rocky outcrop regions (OLIVEIRA AND GODOY, 2007).

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Therefore, by this variable classification methodology, the areas recommended for preservation are evident on the map, formed by the values in the tables below (Tables 03 and 04), being evaluated from increasing values according to the degree of fragility of the environment and the possibility of recovery.

Table 03. Classification of land use and values.

Classification	Values
Rocky outcrop	100
Agriculture	25
Floodplains	100
Industrial area	1
Urban area	1
Dumping ground	1
Grassland	75
Hydrography	100
Mining	1
Forest plantation	50
Exposed soil	50
Forest	100
Shrub	100

(Author)

The classification for non-hydromorphic and hydromorphic soils was performed according to the geology layer data, demonstrating the final weight classification in Table 04.

Table 04. Soil classification and values.

Classification	Values
Hydromorphic soil	100
Non-hydromorphic soil	50

(Author)

Using ArcGis® 10.5 software, the values allocated to each layer were assigned to the variables and overlaid. The sum of the assigned values was made using the "Attributes table" and "Field Calculator" tools, resulting in a map that gathers all the assigned values.

This study used the Phyto-environmental Units to ensure the diversity of ecosystems is listed for protection, these Phyto-environmental Units (UFAs) originated from a project carried out in 2007 in partnership with the Government of the State of Paraná, the Environmental Institute of Paraná, EMBRAPA and the Federal University of Paraná (UFPR), for the creation of a tool to assist in public policies in the restoration of vegetation cover, as well serving as a complementary parameter to the Atlantic Forest Law nº 11.428/2006. These units are described as minimally homogeneous landscape compartments based on physiographic, geological,

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hydrographic, altimetric, and plant criteria, being a basic condition for licensing or authorization of the suppression of native vegetation and were classified as 171 units.

Then, the areas prioritized for corridors were designed to cover the maximum diversity of plant physiognomies, ensuring that the greatest amount in any variety of biome is covered by an ecological corridor and can remain protected.

III. Results and Discussion

Classification of ecological relevance

Before carrying out the relevance classification, the percentage of land use in the entire Iguaçu basin was calculated, resulting in a large part of natural arboreal vegetation with 38% of the area, followed by the steppes with 27%, this demonstrates the importance of the grassland within this ecosystem. Pillar (2003) argues that there are extensive regions of southern Brazil predominated by grassland vegetation, but neglected and threatened by the increase in agricultural areas and forest plantations, and by a lenient application of Brazilian environmental legislation as if these open natural formations do not have the same importance as forests, perhaps because their secular use with livestock exploitation has not implied their destruction.

The criteria that were established in the methodology for applying the values made it possible to separate the variations of relevance into highly relevant areas, moderately relevant, and with low ecological relevance. In this way, the sums, with totals from 176 to 200, are considered sensitive and priority areas for conservation, the sum in the range from 126 to 175 corresponds to areas subject to recovery and the sum areas between 02 to 125 are areas that are not recommended for conservation or that have an impacting and unlikely reversal anthropic occupation, being classified as not very relevant to occupation by an ecological corridor. This classification was composed of the variables of land use, hydrography, and soil type, resulting in the following grouped classes presented in Table 05:

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Table 05. Combination of classes.

Classification	Values	Class combinations
Highly relevant	176 to 200	Rocky outcrop/ Natural Forest and shrub/ Floodplain/ Steppes/ Hydromorfic soil
Moderately relevant	126 to 175	Forest plantation/ Exposed soil/ Natural Forest and shrub/ Floodplain/ Steppes/ Hydromorfic soil/ Non-hydromorfic soil
Low relevant	02 to 125	Agriculture/ Mining/ Dumping ground/ Urban Area/ Industrial area / Hydromorfic soil/ Non-hydromorfic soil

Table 06 shows the classifications in the multicriteria analysis, the area in hectares within the Alto Iguaçu basin, and the percentage of this classification inside the basin.

Table 06. Degree of relevance in the Alto Iguaçu basin.

Classification	Values	Area (ha)	% Of area inside the basin
Highly relevant	176 a 200	45,645.61	68.81
Moderaly relevant	126 a 175	14,878.36	22.45
Low relevant	02 a 125	5,802.77	8.74

The classification of values was important to ensure that fragile areas were classified as relevant for conservation even if combined with land use that affects their fragility, such as hydromorphic soil which has a classification of 100, as they are areas of great importance and fragility. Even combined with environments already anthropized such as urban areas and agriculture, they are regions that have great importance for the fauna of small animals and for the maintenance of water, an important factor in this watershed is that has 5 dams that provide water distribution to the region. However, if the region has only high fragility points, as would be the case of a hydromorphic area within an urban area, it would not be chosen as a passage of an ecological corridor because they do not have sufficient continuity. Given this, it shows that the choice of values together with the methodology of tracing the regions oriented to include an ecological corridor following the largest fragments of fragility and diversity of ecosystems imply a good way to find these environments recommended for ecological corridors. The Conservation Units of the Alto Iguaçu basin overlap, generating the map (Figure 03) that allows the visibility of the relevant areas around them.

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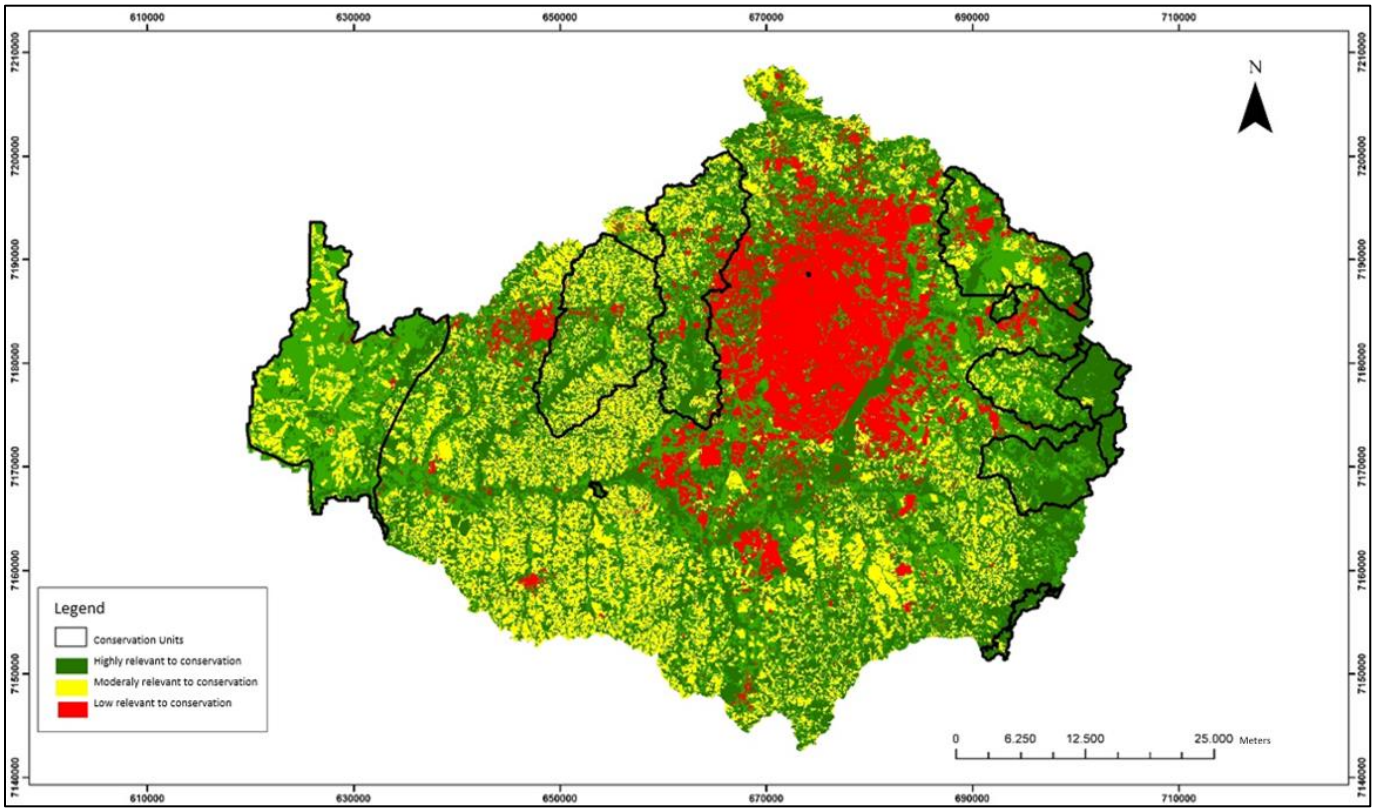

Figure 03. Areas of ecological relevance for conservation in Alto Iguaçu basin (Author)

Priority areas for the creation of ecological corridors

The Phyto-environmental Units are areas with unique ecological characteristics, being classified into 171 units for the state of Paraná by Galvão and Augustin, in 2011. These units were confronted with the methodology applied within the Alto Iguaçu basin in the GIS software, to identify characteristics of environmental singularities, thus facilitating the coverage of priority areas the creation of corridors with greater Phyto-physiognomic diversity ecosystems for possible regions where ecological corridors should be installed, as shown in Figure 04, where these regions are highlighted with a red outline.

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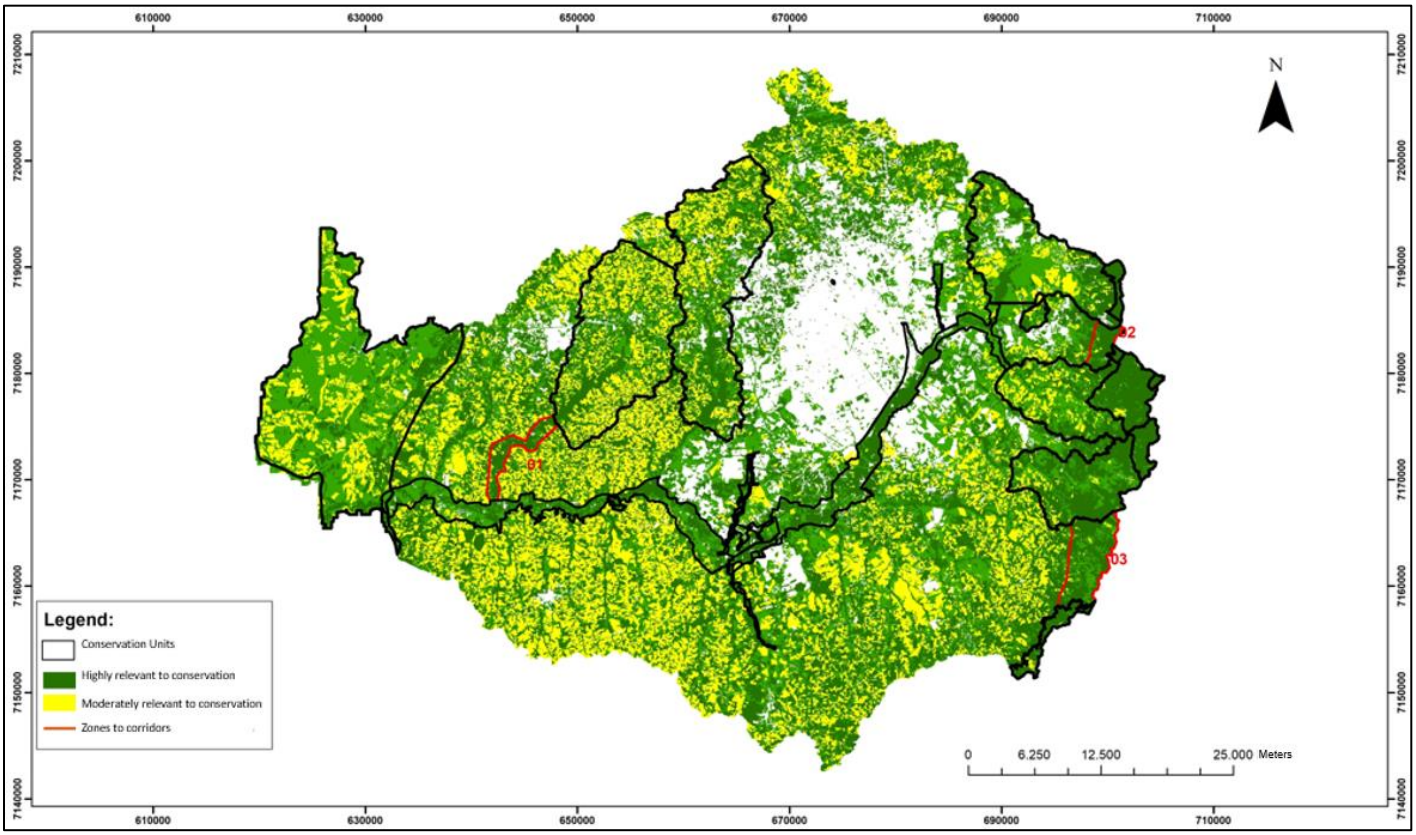

Figure 04. Recommended areas for the location of ecological corridors (Author)

These regions recommended for the creation of ecological corridors in this research group a high number of areas classified as "highly relevant" and some points as "moderately relevant", giving priority to areas with natural environments with greater Phyto-physiognomic diversity, according to land use criteria evaluated, with all ecosystems present represented in the regions, with that is possible to recommend the creation of ecological corridors in tree regions connecting the conservation units according to the criteria for the flora ecosystem, highlighted in red on the map.

Area 01, which is between the conservation units of the APA Rio Verde and the APA Escarpa Devoniana, has the most region with areas of native forest (58%), steppes (15%), and agriculture (11%) in the municipality of Balsa Nova, and Area 02 is connecting the APA Estadual do Iraí, APA Estadual de Piraquara and AEIT do Marumbi in an area covered by vegetation consistent with Mixed Ombrophilous Forest and Dense Ombrophilous Forest, featuring an ecotone between the two typologies, with 82 % of its area covered by forests and 13% by Steppes, which is the area with the largest vegetation cover to be preserved. The proposed area covers the region between the two municipalities of Curitiba and Almirante Tamandaré, being the only part with a field in this region. The proposed conservation area 03, is between the Conservation Units APA Estadual do Rio Pequeno and APA Estadual de Guaratuba, which cover the two forest typologies in the region, with 69% of

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forests, with great importance to conservation, as ecotones are relevant zones due to the presence of endemic species in unique environments. Figure 05 shows the percentage of land use within each region with recommended conservation through corridors.

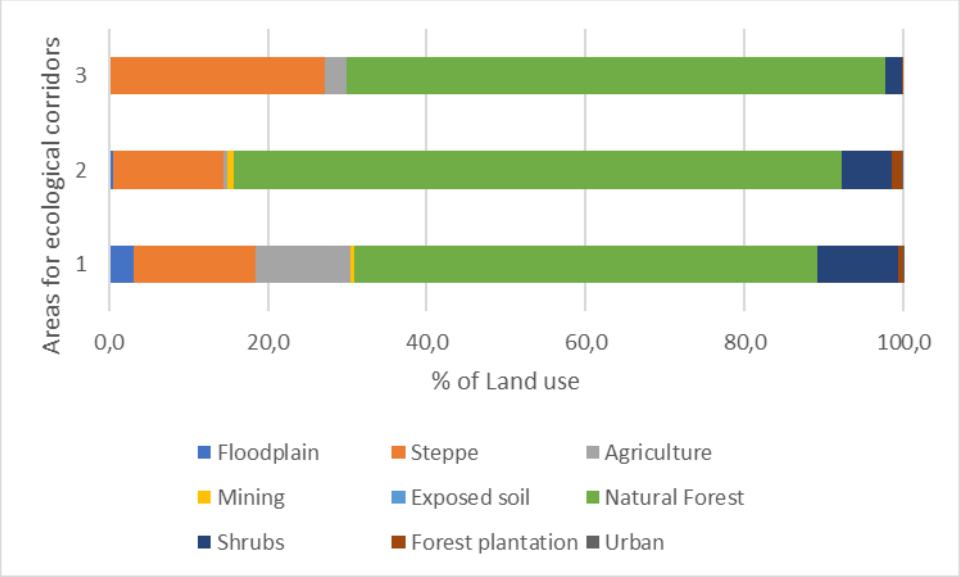

Figure 05. Land use in the recommendation areas for ecological corridors (Author)

The position of the presented corridors agrees with the multi-criteria analysis methodology, where the areas of greatest ecological relevance, with the greatest diversity of Phyto-environmental Units and connecting the protected areas were chosen, these polygons of proposed ecological corridors are not leading into consideration of the exact size of a corridor, but the most appropriate zone for their allocation. For better detailing, it will be necessary to expand the mapping to APP (Permanent Protection Areas) and municipal protected areas, even if they are smaller, in addition to surveys of the region's fauna.

Recently, the multicriteria analysis was also used by Louzada *et al.* (2012) to trace potential corridors in the Espírito Santo mountain range, between the Parque Estadual Forno Grande and the Parque Estadual Pedra Azul. Lelis *et al.* (2013) presented a methodology for identifying potential ecological corridors by multispectral imaging in the city of Dois Vizinhos in Paraná, demonstrating possible corridors through alluvial forest areas, where it can be stated that the APP has the potential to be an ecological corridor, as it guarantees the mobility of flora and fauna species, promoting the restoration of poorly preserved ecosystems. Martins *et al.* (2017) also used the same methodology to create corridors in the eastern region of the Alto Iguaçu basin, connecting the APAs of Iraí, Piraquara, Rio Pequeno, and Guaratuba, forming this proposal in APP areas. The multi-criteria

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methodology proves to be widely used for this purpose, and its adaptation to new selection criteria is important for improvement.

The vast majority of protected areas in the basin do not have a buffer zone, as they are classify in APAs, further highlighting the importance of creating these corridors for the provision of systemic services provided by these regions, especially water resources. To ensure reach in corridor planning, Arruda (2003) argues that mapping landscapes and analyzing changes in land use help to measure the degree of deforestation in tropical environments. Another approach to be analyses for implementation is the evaluation of public policies that help in the planning of corridors and the legal issues related to them. The inclusion of APAs for connectivity is important for biodiversity, because despite having a differentiated management of integral protection areas, these regions contribute to a sustainable use of the land, strengthening the connection between the community and the natural environment, bringing, in addition to ecological benefits, the social benefit to the environment.

The transforming characteristic of an environment is link to urbanization, modifying the natural environment in paved, waterproofed, and built areas. The suppression of the natural environment by the artificial one enhances the problems related to socioeconomic and environmental issues, intensified by the lack of urban planning (SCHEUER, 2016). Rückert (2007) comments that the Ecological Economic Zoning (ZEE) promotes regional development and planning of the Brazilian territory, through the planning of occupation and use of space in a sustainable manner, the responsibility of these projects is shared with states and municipalities, according to MMA Complementary Law 140/2011, the ecological corridors are a good way to protect these areas of non-planning urbanization which happen in the metropolitan regions of the big cities in Brazil.

Data from Briski *et al*. (2005) prove that the Alto Iguaçu Basin region is occupied 47% inadequately by poor populations, most part in the Metropolitan Region Zone, who seek an opportunity for economic growth in large cities but end up being marginalized and settling in inappropriate places, setting up occupations in floodplains and other regions that have legal protection and restriction. Undoubtedly, this situation causes several social and environmental problems, where there are inhuman housing conditions for the needy population, exposure to the risks of flooding and sanitary problems, bringing health risks, in addition to significant degradation, especially to those who live there and to the water resources.

However not every creation of an ecological corridor should imply the expulsion of owners and residents from their lands, nor prohibit tourist visitation. When housing is regularize and does not present risks, the citizen who resides within the ecological corridor becomes a potential inspection agent against possible depredations, invasions by hunters, forest fires, garbage dumping, and water pollution. Each farmer/resident will be able to

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continue planting food and raising animals on his rural property. Since it is an inspection agent, it must respect sustainability standards (...) and will allocate the legal reserve to a new design of ecological corridor connectivity (BRITO, 2012).

The greater effort in the analysis and study of interactions between individuals and territory, the more doubts arise in the planning of ecological corridor networks, but it is unanimous that it should always produce maximum positive results for conservation and society and minimum costs for being well accepted.

IV. CONCLUSIONS

The multi-criteria methodology proved to be a good tool in identifying priority areas for conservation and if combined with other data, it can help and refine decision-making and becomes much more reliable when applied to different criteria to analyze.

The gains from these corridor applications go beyond the interconnection of Conservation Units, genetic exchange, and ensuring the longevity of local species, as the implementation of these protected areas increases the opportunities for researching flora, fauna, natural resource management, and environmental education, involving the community in specific actions and solving local conflicts.

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