Revista Brasileira de Geografia Física
ISSN:1984-2295
Homepage: https://periodicos.ufpe.br/revistas/rbgfe

The ecological corridor as a strategy for connectivity between Atlantic Forest fragments in Northeast Brazil

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Artigo recebido em 04/02/2025 e aceito em 20/12/2025.

ABSTRACT
The Atlantic Forest, in the state of Bahia, Brazil, is a fragmented hotspot that faces challenges in order to overcome environmental degradation. Ecological connectivity is one strategy that may mitigate environmental impacts. This study aimed to develop a spatial proposal for an ecological corridor between the forest fragment of the Sosígenes Costa University Campus of the Federal University of Southern Bahia (UFSB), the Private Reserve of Natural Heritage (RPPN) Estação Veracel and the Pau Brasil National Park, as well as to suggest public-private support strategies for its implementation. The topographic, socioeconomic, ecological and legal characteristics were evaluated in a geographic information system and incorporated as a factor for corridor modeling. Using the least-cost method, potential areas were modeled for a spatial mapping of connectivity between the areas and integrated using multi-criteria analysis. The spatial layout delimited for the implementation of the ecological corridor is 9.78 km long and 978.70 m wide, it will create a physical connection between public areas, private areas and educational institutions. The proposal is strategic because it expands the potential of biodiversity, gene flow, species reproduction, maintenance of fauna and flora species and contributes to the recovery of ecosystems.
Keywords: Forest Vegetation; Landscape; Conservation; Ecosystems.

O corredor ecológico como estratégia de conectividade entre fragmentos de Mata Atlântica no Nordeste do Brasil

RESUMO
A Mata Atlântica, no estado da Bahia, Brasil, é um *hotspot* fragmentado que enfrenta desafios para superar a degradação ambiental. A conectividade ecológica é uma estratégia que pode mitigar os impactos ambientais. Este estudo objetivou elaborar uma proposta espacial para um corredor ecológico entre o fragmento florestal do Campus Universitário Sosígenes Costa da Universidade Federal do Sul da Bahia (UFSB), a Reserva Particular do Patrimônio Natural (RPPN) Estação Veracel e o Parque Nacional do Pau Brasil, além de indicar estratégias de apoio público-privado para a sua implantação. As características topográficas, socioeconômicas, ecológicas e legais foram avaliadas em sistema de informações geográficas e inseridas como um fator para modelagem do corredor. Utilizando o método do custo mínimo, as áreas potenciais foram modeladas para um mapeamento espacial da conectividade entre as áreas e integradas utilizando a análise multicritério. O traçado espacial delimitado para implantação do corredor ecológico tem 9,78 km de extensão e 978,70 m de largura, criando uma conexão entre áreas públicas, áreas privadas e instituições de ensino. A proposta amplia o potencial da biodiversidade, do fluxo gênico, da reprodução de espécies, da manutenção de espécies de fauna e flora e contribui para a recuperação de ecossistemas.
Palavras-chave: Vegetação Florestal; Paisagem; Conservação; Ecossistemas.

Introduction

In 2018, the remaining vegetation of the Brazilian Atlantic Forest reached 12.4% of its original area and, annually, it has continued to diminish (SOS Mata Atlântica, 2022). The state of Bahia is responsible for a large part of the deforestation in the Atlantic Forest in Brazil and continues to be part of the five states that have reduced the most natural areas since 2018, thus drastically altering the landscape and causing forest patches that increase the edge effects in these fragments (Walder et al., 2024; SOS Mata Atlântica 2021; 2022).

Bahia ranks second in the ranking of Brazilian states that deforested at the highest rate in Brazil in 2023. The state had 290,606 ha deforested in 2023, behind only Maranhão, with 331,225 ha. This results in the suppression of natural areas and ends up affecting ecosystem services, reduces water quality and quantity, increases greenhouse gas emissions, in addition to causing changes that affect soil fertility and food production and forces the migration of people in search of income (Silva Junior et al., 2020; Rabbi e Kovács, 2024; MapBiomas, 2024; Qu Xinjing et al., 2024).

Rampant deforestation in Brazil causes a cluster of small forest patches throughout the territory. In the municipality of Porto Seguro, up until 2014, there was 40% of the vegetation cover was of remnants of the Atlantic Forest. Currently, Currently, the existing forest cover is inserted in an isolated manner in public and private protected areas. Due to the challenges of forest conservation and restoration, strategies must be developed for the connection of natural areas, maintenance of biodiversity, gene flow, reduction of road deaths of animals, reduction of heat islands in urban spaces and recharging of water courses (MEA, 2005; Magioli et al., 2021; Carrillo-Niquete et al., 2022; Gatti, 2025).

Among the strategies that could reduce the harmful effects of fragmentation are ecological corridors, which function as planning units and are aligned both with the United Nations (UN) Decade for Ecosystem Restoration (2021 and 2030) and with the Sustainable Development Goals (SDGs) of protecting life on Earth, ensuring healthy lives, protecting, restoring and sustainably managing forests, combating desertification, halting and reversing land degradation and biodiversity loss, as well as enabling the connection and integration between private areas and protected areas (Thiago et al., 2020; Oliveira et al., 2024; Gangenova et al., 2025).

Studies for the implementation of ecological corridors are mechanisms for identifying and proposing the recovery of degraded areas, with technical and scientific support, in addition to enabling the development of partnerships for sustainable cities and between public and private institutions. It is in this perspective that this study aimed to develop a spatial proposal for an ecological corridor between the forest fragment of the Sosígenes Costa University Campus of the Federal University of Southern Bahia (UFSB), the Private Reserve of Natural Heritage (RPPN) Estação Veracel and the Pau Brasil National Park, as well as to suggest public-private support strategies for its implementation.

We sought to answer the question of what would be the appropriate spatial layout for the delimitation of an ecological corridor that would connect protected areas and educational institutions within the perspective of forest restoration and sustainability.

Methodology

Study area

The study area comprises three sites in the Atlantic Forest biome that are located in the municipality of Porto Seguro, in northeastern Brazil: the Pau Brazil National Park, the private Natural Heritage Reserve Estação Veracel and the Federal University of Southern Bahia (UFSB) (Figure 1). The Pau Brazil National Park was created by decree on April 20th, 1999, in an area of 19,027.22 ha that is a rich repository of fauna and flora of the Atlantic Forest. Its purpose is the development of environmental education activities, recreation and ecological tourism and conducting of scientific research (MMA, 2016).

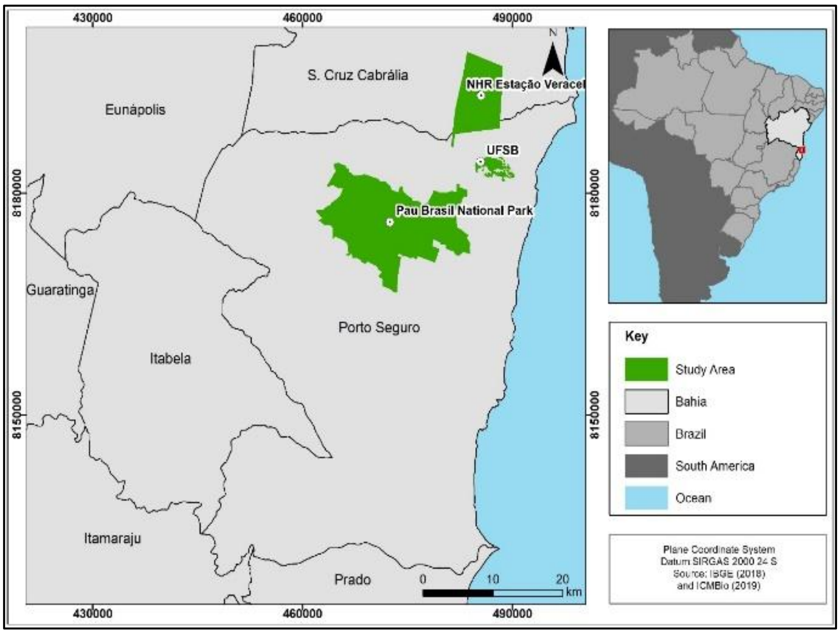

Figure 1 - Study area in the municipality of Porto Seguro.

The Federal University of Southern Bahia (UFSB) was created in 2013 by Law 12,818/2013, with the dean's offices in Itabuna and campuses in Teixeira de Freitas and Porto Seguro. The forest fragment is located on the Sosigenes Costa University campus, in Porto Seguro, in an area of 232,000 m^2 and comprises a botanical garden (Pinto et al., 2019).

The PRNH Estação Veracel is the largest private reserve in northeastern Brazil and the second largest in the Atlantic Forest biome. It is home to significant populations of globally endangered species and internationally recognized as a Natural World Heritage Site, which was granted by UNESCO in 1999 (RPPN Estação Veracel, 2016).

Definition and evaluation of the ecological corridor

A cartographic base was built with the official planimetric, altimetric and geographical vector files of the municipality of Porto Seguro, including the limits of the conservation units, which were acquired from the database of the Brazilian Institute of Geography and Statistics (IBGE) and are at a scale of 1:250,000.

The layout of the ecological corridor was proposed considering the topographic (slope and proximity to the drainage network), socioeconomic (distance from the road network and urban area), ecological and legal (proximity to forest fragments and areas of permanent preservation) factors, so that each factor became spatial data and analyzed in a geographic information system.

The slope was developed by obtaining the Digital Elevation Model (DEM) from the PALSAR sensor of the ALOS (Advanced Land Observing Satellite) satellite, which was launched in 2006 by the Japan Aerospace Exploration Agency (JAXA) mission. The DEM was obtained from the ASF (Alaska Satellite Facility) platform, corrected and projected on the Universal Transverse Mercator system at a spatial resolution of 12.50 m (Asf Daac, 2020). In the terrain analysis module, the slope was calculated and classified into slope percentages according to morphological classification. i.e., flat relief, gently undulating, undulating, strongly undulating, mountainous and steep (EMBRAPA, 2006).

The land use of the urban area of Porto Seguro, in vector format, was obtained from the database of the soil use and coverage monitoring platform in Southern Bahia of the Bahia Forestry Forum, available at scale 1:25,000 (FFB, 2018). The road system in vector format was obtained from the Street View database, available with representations of main and secondary roads. To adapt the factors to proximity or distance, the factors were processed in the Euclidean distance spatial module, which allows the generation of files with linear distance/proximity.

The permanent preservation areas (PPAs) were defined with the creation of marginal areas using the drainage network, according to Law n. 12,651 of May 2012, which defines the areas of permanent preservation of native vegetation in Brazil (Brasil, 2012).

The minimum cost methodology was employed and was based on five steps: assigning weights to each variable; obtaining areas of minimum spatial cost; layout and spatial width of the corridor; and corridor viability.

For each factor, a weight was assigned that ranged from 1 to 100, in which the higher the value, the greater the requirement for the implementation of the corridor. These weights were defined via consensus among the researchers, in order to satisfy the coherence of the implementation of the corridor, the environmental quality and the maintenance of natural resources. Additionally, it is important to highlight that the assignment of weights aims to classify the area that has greater ease for the implementation of the corridor (or not) and, therefore, the cost does not refer to a financial analysis of implementation, although we consider that characteristics of the area influence a greater or lesser economic investment at the time of implementation.

With the weighted files, a paired matrix was constructed to judge the importance of the factors and obtain the statistical weights of each factor, using the analytical hierarchy process (AHP), which aimed to establish in the process greater emphasis on the factors and areas with lower costs. The coefficient of coherence of the weights of the attributes was calculated to attest to the validity of the process when less than 10% (Saaty, 2007).

The paired judgment matrix of the multicriteria analysis can be seen in Table 1 and the weights for each factor were determined by consulting the literature, using digital scientific databases, books and scientific articles related to the importance of these factors for the maintenance, establishment and viability of forest areas. When such information was not available, the weights were assigned through discussion rounds, considering the technical perceptions of the existing area.

Table 1 - Paired judgment matrix for the importance of factors.

Category	Slope	Permanent Preservation Areas	Proximity of the drainage network	Distance from the road system	Distance from the urban area	Distance from the forest areas	Final weight
Slope	1	1	0.25	7	4	1	18.20
PPA	1	1	1	6	4	1	21.30
Proximity of the drainage network	4	1	1	6	6	1	31.40
Distance from the road system	0.14	0.17	0.17	1	1	0.25	4.00
Distance from the urban area	0.25	0.25	0.17	1	1	0.20	4.40
Distance from the forest areas	1	1	1	4	5	1	20.70
Consistency Index (CI)							4.10

The corridor layout presented was modeled from the identification of areas whose minimum spatial cost for its implementation was considered low and which had an environmental requirement to promote the most appropriate areas to plot its route. To obtain an integrated file of minimum spatial cost capable of defining the best route of the corridor, the spatial crossing of each environmental factor described above was performed, using the adapted equation of Louzada et al. (2012):

MSC = Rslope * P1 + Rdn * P2 + Rrs * P3 + Rua * P4 Rfrag * P5 + Rppa * P6

Where: MSC - minimum spatial cost raster; P1, P2, P3, P4 and P5: statistical weight of each factor; Rslope: slope raster; Rdn: proximity raster of the drainage network; Rrs: distance raster of the road system; Rua: distance raster of the urban area; Rfrag: proximity raster of the fragments; Rppa: PPA raster.

For the establishment of appropriate areas for the implementation of the corridor, the cost connectivity tool was used, using the minimum spatial cost raster and forest fragments inserted in the study areaThe corridor proposal was obtained in line format and, for the generation of the corridor area, a corresponding marginal area was generated with 10% of the total length of the corridor, in accordance with CONAMA Resolution nº 09/1996 (Brasil, 1996).

The viability of the ecological corridor was assessed through visual interpretation and fieldwork, using GIS to analyze the spatial characteristics suitable for indicating the ecological corridor's route. Initially, the corridor was segmented into three sections of analysis: Section I, relating to the connection between the RPPN Estação Veracel and UFSB and Section II, the connection between Pau Brazil National Park and UFSB. The spatial analyses involved evaluating the predominant quantities of anthropogenic and natural land use, fragmentation, successional quality according to CONAMA Resolution n. 10/1993 (Brasil, 1993) and its amendments, pedology, geology and local geomorphology, as well as the existence or proximity of water resources along the proposed route. Field visits were conducted to validate the information, with collective discussion rounds to assess the feasibility of implementing the proposed corridor, through spreadsheet records, photographs and the collection of geographic coordinates.

Positive and pertinent issues for the implementation of the corridor and alternatives for rerouting sections of the corridor with impediments or physical barriers, were compiled in a section on perspectives for the implementation of ecological corridors. This section aims to suggest and contribute to similar studies, as well as the future possibility of implementation in the study area.

Results

Figure 2 shows the topographic, ecological and legal factors of the municipality of Porto Seguro, which were taken into consideration for the ecological corridor proposal. Porto Seguro has a high availability of water resources, covering the entire municipality with an extension of 1,966.77 km² (Figure 2A). The study area has significant proximity to water bodies, distributed mainly between the Mangues, Buranhém and Frades rivers, which are the main water resources in the region.

The road system in the municipality of Porto Seguro extends 643.57 km, with the study area being crossed by state highways BA-001, BA-986 and federal highway BR-367 (Figure 2B). In the region where the Conservation Units (Pau Brazil National Park and Private Natural Heritage Reserve) are located, as well as the Sosigenes Costa University Campus of the Federal University of Southern Bahia, the main access route is BR-367, which connects the district of Arraial d'Ajuda to the urban area of Porto Seguro.

Urban areas restrict the movement of animals and, therefore, are zones that the ecological corridor should avoid. In Porto Seguro, these areas are concentrated in the northeast, east and southeast regions, with no overlap with the Private Natural Heritage Reserve (RPPN), the National Park, or the University Campus, in Figure 2C.

The ecological factor related to the proximity of forest fragments within the municipality of Porto Seguro is presented in Figure 2D. Near the potential ecological corridor, there are both areas more than 1,000 meters away from forest fragments and areas only 100 meters away.

Regarding the legal factor of permanent preservation areas (Figure 2E), these areas are homogeneously distributed throughout the municipality of Porto Seguro. Since these areas are present within the study area—mainly along watercourses and around springs—there will be greater access to water. Water resources enhance plant growth and serve as an additional attraction for wildlife, which facilitates the implementation of the corridor between the conservation units and the higher education institution.

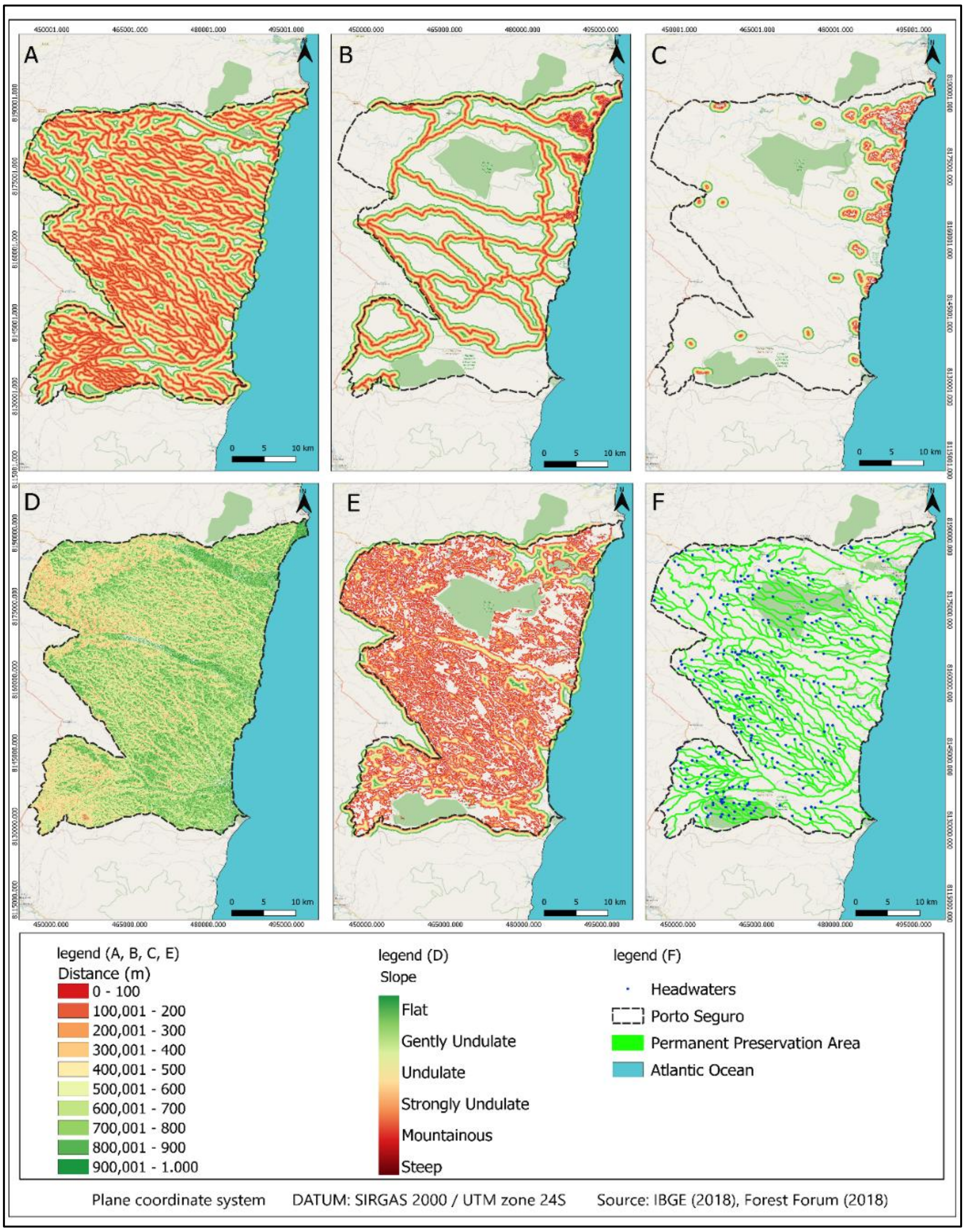

Figure 2 - Topographic, socioeconomic, ecological and legal factors for the delimitation of the corridor in Porto Seguro. (a) – topographic factor of proximity of the drainage network. (b) – socio-economic factor of distance from the road system. (c) – socio-economic factor of distance from the urban area. (d) – Topographic factor of slope. (e) - ecological factor of proximity of forest fragments. (f) – legal factor of permanent preservation areas.

When analyzing the potential of the areas that can connect the ecological corridor (Pau Brasil National Park, NHR Estação Veracel and the Federal University of Southern Bahia) while considering their different types of vegetation at initial, medium and advanced stages, a greater representation of areas in an advanced stage of regeneration is noted (Figure 3).

The total area of the fragments amounts to 24,533.89 ha of interconnected land. Among these interconnected areas, advanced-stage forests comprise the largest representation at 94.50%, while the medium stage of regeneration accounts for 5.30% and the initial stage represents only 0.19%.

Among the interconnected fragments, Pau Brasil National Park stands out in terms of size. Its advanced-stage forests represent 70.01%, while forests in the medium and initial stages have little representation, at 1.61% and 0.19%, respectively.

The Natural Heritage Reserve (NHR) Estação Veracel contains 24.49% advanced-stage forest, while the medium stage represents 0.15% and the initial stage represents only 0.0034%. The UFSB fragment exclusively consists of fragments in a medium stage of regeneration (3.54%). The areas surrounding UFSB and NHR Veracel are affected by BR-367 (Figure 4A), as well as the expansion of urban and suburban developments defined by municipal zoning, prioritizing these areas for growth. This situation required a model capable of identifying the ideal spatial path to connect them and make environmental adjustments feasible for ecosystem restoration. Pau Brasil National Park has a surrounding area with lower environmental constraints, which is favored by the regularization of the conservation unit, from the management plan to zoning.

The proposed corridor is 9.78 km long, 978.70 m wide and has a total area of 942.70 ha. It contains both public and private areas and interacts with the districts of Vale Verde and Arraial d'Ajuda, thus connecting the eastern part of Pau Brasil National Park, the northern-central fragment at UFSB and the southern part of NHR Estação Veracel. It passes through areas where costs are minimized, as shown in Figure 4B.

The sections that form the corridor feature degraded Permanent Preservation Areas (PPAs), with forest fragments at medium successional stages located where the terrain varies from flat to undulating, including small valleys and the presence of water resources such as springs, ponds, or streams. There is significant vehicular and pedestrian traffic due to the city's tourism characteristics, as well as surrounding districts, villages and private properties within the corridor.

Additionally, the corridor is characterized by predominantly yellow dystrophic latosol soils, common in tropical and subtropical areas of Brazil due to sedimentary deposits from the Barreiras Formation. Within the corridor, anthropogenic uses and land cover account for 58.50% (Table 2), with pasture being the predominant land-use matrix within the proposed corridor, while the urban area and road networks are included but in minimal proportions. Regarding natural coverage (41.50%), forest fragments in medium and advanced regeneration stages are predominant and are mainly concentrated around water resources.

From a spatial perspective, natural areas are well-distributed throughout the proposed ecological corridor, as shown in Figure 5.

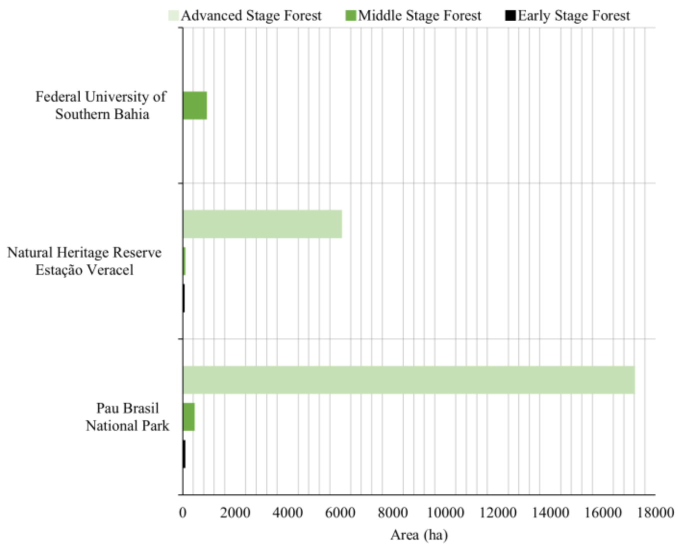

Figure 3 - Conserved forests interconnected by the proposed ecological corridor sites.

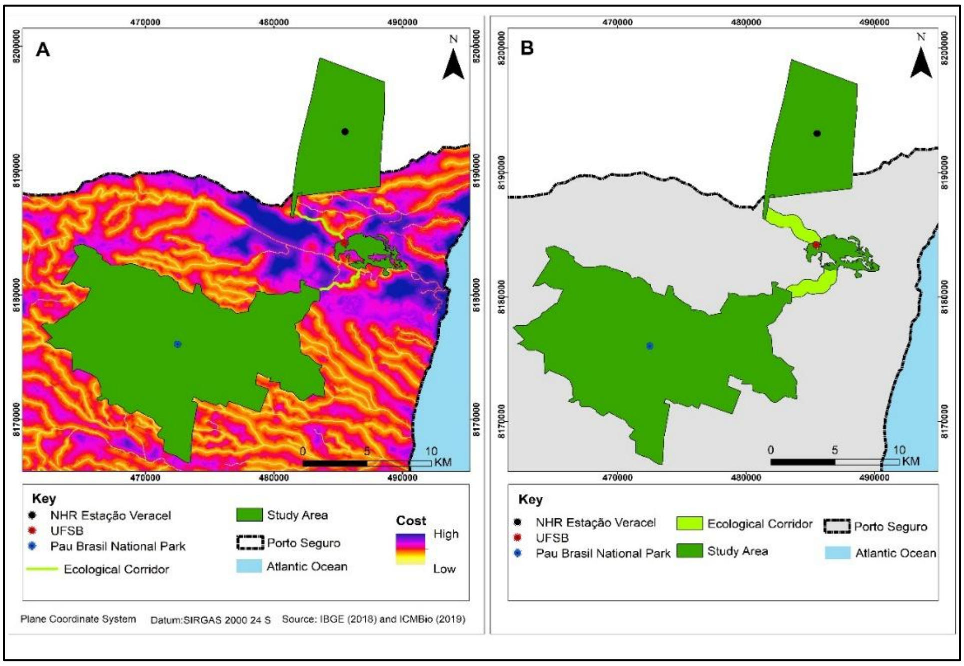

Figure 4 - Proposed ecological corridor between UFSB, NHR Veracel and Pau Brazil National Park. A – minimum spatial cost. B – ecological corridor.

Table 2 - Land use within the ecological corridor.

Land use	**Area (ha)**	**%**
Initial regeneration stage forest	206.65	21.92
Medium regeneration stage forest	158.68	16.83
Advanced regeneration stage forest	9.21	0.98
Wetland	0.09	0.01
Dam, lakes and rivers	16.60	1.76
Pasture	365.23	38.74
Countryside pasture	119.57	12.68
Urban área	62.72	6.65
Road system	3.92	0.43
Total	942.67	100.00

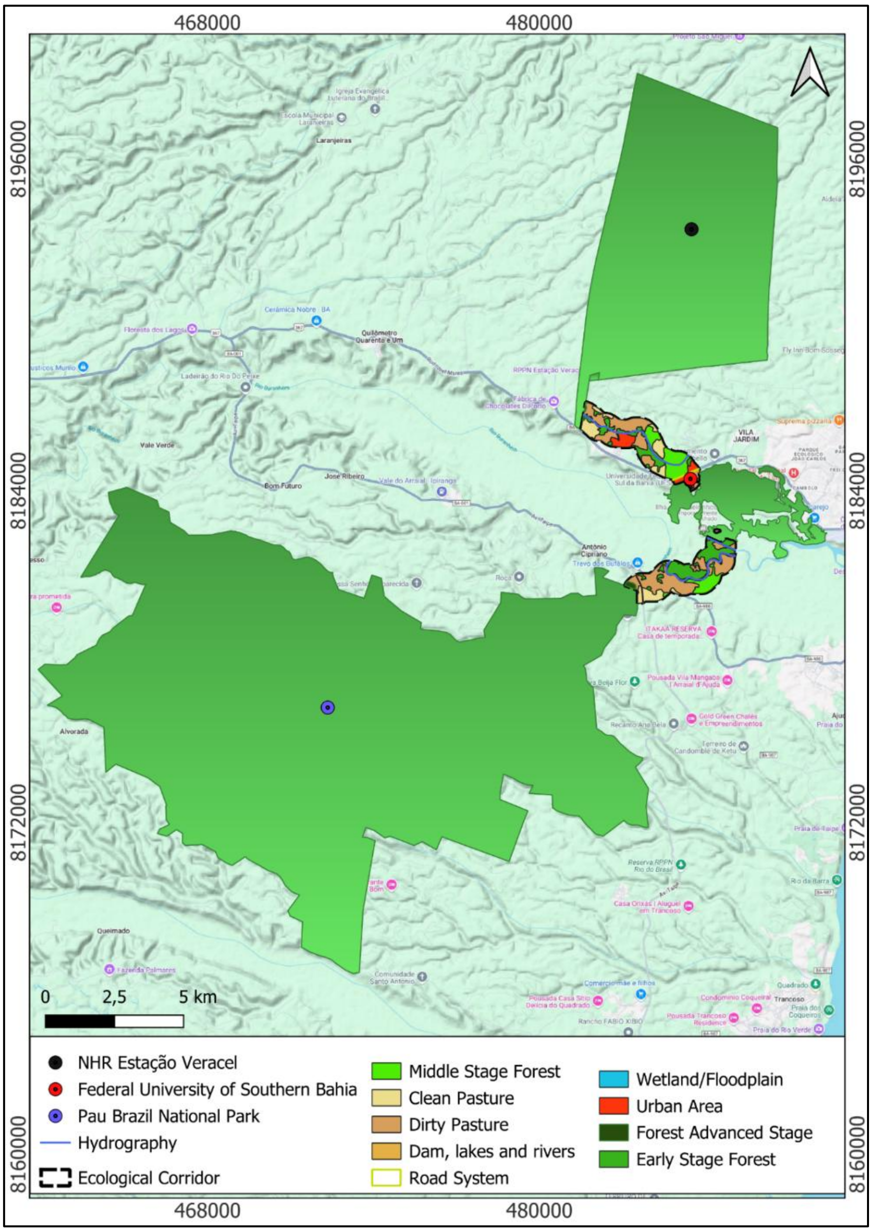

Figure 5 - Land Use and Cover in the proposed Ecological Corridor.

Discussion

The municipality of Porto Seguro is characterized mainly by gently rolling and undulating terrain, which leads to a higher likelihood of anthropogenic pressure. This factor could potentially hinder the implementation of the ecological corridor, increase expenses, and limit ecological functions in the long term (Souza et al., 2022). Other mechanisms related to topography may also influence corridor proposals, as terrains with steeper slopes heighten ecological resistance and directly affect temperature, precipitation, and regional soil characteristics (Wu et al., 2021; Liu et al., 2023; Oliveira et al., 2024).

On the other hand, the soils in the region are characterized by a yellow coloration, moisture retention, permeability, a medium to clayey texture, and good drainage. The hydrological system is an important factor in local dynamics, given the city's well-developed drainage network, which favors the implementation of the corridor since aquatic environments located near or within a vegetated area serve as an attraction for wildlife (Van Helden et al., 2024). Additionally, from a hydrological perspective, forest cover influences both the mechanism of water infiltration into the soil and evapotranspiration, thereby contributing to the hydrological cycle (François et al., 2024).

Several assets contribute to the viability of the proposed corridor, among which the predominance of water resources, forest fragments, and floodplain areas stand out, as these ecosystems are essential for the survival and development of plant and animal species and provide ecosystem services such as regulation and support, while also reducing the cost of implementing the ecological corridor (Petsch et al., 2023; Beltrão et al., 2024). These points are further emphasized by Walston et al. (2021), who consider these spaces to be a source of ecosystem services for societal development and environmental conservation.

The great importance of the drainage network and the Permanent Preservation Areas (PPAs) in the spatial layout of the corridor is evident, as there is a clear need for vegetation cover around Brazil's water resources. These elements naturally work together to support wildlife watering and ensure compliance with environmental legislation (Ribeiro et al., 2024; Santos and Medeiros, 2023; Metzger et al., 2019; Brasil, 2012). These areas also favor biodiversity and species migration, enhance viability potential, and facilitate implementation, since they are also prioritized for conservation (Louzada et al., 2012; Silva et al., 2024).

This strategic role is exemplified in the study by Oliveira et al. (2024), who proposed the creation of an ecological corridor connecting important areas. The proposed route follows a legally protected area with native vegetation, which reinforces its function in maintaining ecological flows and promoting the movement of fauna.

The sections with anthropic conditions in which the modeling indicated a higher spatial cost compared to the other areas do not make the implementation of the proposal unfeasible, but they require impact mitigation strategies that allow for the recovery and monitoring of non-buildable sections, such as pastures and agriculture, as well as the movement of local fauna in buildable spaces, such as the road system or urbanized areas. Regarding monitoring, Massarelli (2024) states that technologies can be used to monitor the ecological corridor, such as drones, artificial intelligence, environmental DNA analysis (eDNA), camera traps, GPS, telemetry, and acoustic sensors, in order to improve ecological connectivity and ecosystem protection and, at the same time, mitigate negative impacts, enabling the corridor to fulfill its objectives.

As the proposed ecological corridor includes areas with a federal highway and urban buildings, which are a negative factor since they are barriers to the movement of species due to the flow of vehicles, accidents, and people, it is necessary to propose measures and strategies that reduce environmental impacts. In this case, the passage of aerial fauna is recommended, which is effective for mitigating accidents (Alho et al., 2019), installation of signs, speed cameras, and speed bumps in areas that are more critical and have an intense flow of vehicles and people.

For the maintenance of the forest fragments, soils, or areas with degraded PPAs, it is necessary to recompose riparian forests, since revegetation with native species protects the riverbanks against erosion through the development and maintenance of roots and also acts as an important factor to maintain the gene flow of species (Paolino et al., 2018; Palagi et al., 2019). Higher education institutions can also develop research projects targeting the local community that focus on the importance of ecological restoration and the maintenance of the local ecosystem (Araya-López et al., 2024; Tavares et al., 2024).

For the permanent maintenance of the corridor, the institutionalization of awareness programs of low-impact activities in the areas of influence of the corridor should be developed for farmers in the interior and surroundings, thus promoting new perceptions in the population and economically sustainable development, since maintaining ecological connectivity generates environmental services.

The implementation of the ecological corridor is a necessary action for conservation, restoration and sustainable use as it will allow the integration of two conservation units, the NHR Estação Veracel and the Pau Brazil National Park, which play an ecological role in the location, as well as the forest fragment of the UFSB, as was also developed in the work of Morandi et al. (2020). In addition to the variables analyzed, the process of establishing an ecological corridor should consider local characteristics, changes in habits of social actors within the corridor, as well as strategies to mitigate impacts associated with the passage of animals in places of tension (Santos et al., 2018; Rosot et al., 2018).

Proposals and prospects for the implementation and conservation of the ecological corridor in Atlantic Forest

The implementation of the ecological corridor is a necessary action for conservation, restoration and sustainable use as it will allow the integration of two conservation units, the NHR Estação Veracel and the Pau Brazil National Park, which play an ecological role in the location, as well as the forest fragment of the UFSB, as was also developed in the work of Morandi et al. (2020). In addition to the variables analyzed, the process of establishing an ecological corridor should consider local characteristics, changes in habits of social actors within the corridor, as well as strategies to mitigate impacts associated with the passage of animals in places of tension (Kučas et al., 2023; Santos et al., 2018; Rosot et al., 2018).

As the proposed ecological corridor includes areas with a federal highway and urban buildings, which are a negative factor since they are barriers to the movement of species due to the flow of vehicles, accidents and people, it is necessary to propose measures and strategies that reduce environmental impacts (Secco et al., 2024; Caires et al., 2019 Louzada et al., 2012). In this case, the passage of aerial fauna is recommended, which is effective for mitigating accidents (Alho et al., 2019), installation of signs, speed cameras and speed bumps in areas that are more critical and that have an intense flow of vehicles and people.

Educational campaigns should also be developed on highways, warning about areas where there is a greater risk of wild animals being run over, preferably in stretches with a high flow of vehicles (Vasconcelos et al., 2021). It is worth mentioning that the conservation units studied have reports of endangered species such as *Panthera onca, Puma concolor* and *Leopardus wiedii* (Falcão et al., 2012).

In the case of unpaved roads and streets close to urban agglomerations, public–private actions and partnerships should be created to prohibit artificial lighting at strategic points of fauna passage, insertion of signs that signal the existence of the ecological corridor with fauna passage, in order to minimize accidents and incidents in the area in question. Educational campaigns that engage local residents and make them cooperative stewards of the corridor should also be encouraged (Hong et al., 2017; Gregory et al., 2021).

The areas composed of pastures demand forest restoration with the planting of native species, in alignment with their local characteristics. In Porto Seguro, there is a great number of plant species that are considered native and of economic importance, among them *Dichorisandra marantoides, Catasetum purum* and *Passiflora quadrangularis* (Pinto et al., 2019). The agroforestry system is also recommended in rural properties, as it consists of the integration of crops, livestock and forest, which is a sustainable production strategy and seeks synergistic effects between the components of the agroecosystem (Awazi, 2024; Souza et al., 2025).

For the maintenance of the forest fragments, of soil, or in areas with degraded PPAs, it is necessary to recompose riparian forests, since revegetation with native species protects the riverbanks against erosion through the development and maintenance of roots and serves as an important factor for maintaining the gene flow of species (Paolino et al., 2018; Palagi et al., 2019; Pienkowski et al., 2024; Araújo e Martensen, 2025). Higher education institutions can also promote courses and lectures for the local community that focus on the importance of ecological restoration and keeping the PPAs preserved.

The production of handicrafts, development of PPA protection techniques, and tourism and ecotourism activities in the corridor and nearby areas (Louzada et al., 2012) in rural properties within the corridor are encouraged in order to stimulate activities that generate local income for communities and contribute to the maintenance of the ecological corridor. Incentives can also come from agricultural companies, extension agencies, agricultural community organizations, and public agencies such as agricultural secretariats and universities (Gregory et al., 2021).

For the long-term maintenance of the corridor, the establishment of awareness programs focused on low-impact activities in the areas surrounding the corridor should be developed for farmers in both the interior and nearby areas, thus fostering a shift in perceptions within the population and promoting economically sustainable development, since maintaining ecological connectivity generates environmental services (Sun et al., 2024).

Conclusion

The spatial layout delimited for the implementation of the ecological corridor is 9.78 km long and 978.70 m wide; it will establish a physical connection between public areas, private areas, and educational institutions. With 41.50% of natural land uses, the proposed corridor offers cost savings for implementation, as it is close to protected areas, water resources, and forest fragments.

The proposal is also strategic since it expands the potential for biodiversity, gene flow, species reproduction, the maintenance of fauna and flora species, and contributes to the recovery of ecosystems, which are critical issues and are widely debated today. It is also relevant in the Decade on Ecosystem Restoration, which aims collectively to prevent, halt, and reverse degradation.

References

Alho, C.J., Costa, F.V., Figueiredo, M.A., Penha, J.M., 2019. Threats to the biodiversity of the Brazilian Pantanal due to land use and occupation. Ambiente & Sociedade (Online) 22, e01891. Available at: https://doi.org/10.1590/18094422asoc201701891vu2019L3AO. Accessed on: 20 fev. 2024.

Araújo, G.P., Lima, M.P., Benin, G., Hein, P.R.G., 2021. A low-cost monitoring system of stem water control: Development and application to Brazilian forest species. Smart Agricultural Technology (Online) 1, 100012. Available at: https://doi.org/10.1016/j.atech.2021.100012. Accessed on: 18 abr. 2024.

Araújo, J. C. L. D., Martensen, A. C., 2025. restauraRapp–An R package to subsidize forest restoration planning in Riparian Permanent Preservation Areas (PPAs). Biota Neotropica 25(1), e20241666. Available at: https://doi.org/10.1590/1676-0611-BN-2024-1666. Accessed on: 5 mar. 2024.

Araya-López, R., Wartman, M., Duarte de Paula Costa, M., Macreadie, P. I., 2024. Learnings from the past to inform future ecosystem restoration projects: an Australian perspective. Restoration Ecology 32(7), e14241. Available at: https://doi.org/10.1111/rec.14241. Accessed on: 10 mai. 2024.

ASF DAAC. Alaska Satellite Facility Distributed Active Archive Center. Available at: <https://www.asf.alaska.edu/sar-data/palsar/about-palsar/>. Accessed on: 07 abr. 2020.

Awazi, N. P. (2024, June). The Future of Agroforestry Systems for Sustainable Livelihoods: Policy and Governance Dimensions. In Turbulence & Energy Laboratory Annual Conference (pp. 187-208). Cham: Springer Nature Switzerland. Available at: https://doi.org/10.1007/978-3-031-73486-1_10. Accessed on: 10 mai. 2024.

Beltrão, M. G., Gonçalves, C. F., Brancalion, P. H., Carmignotto, A. P., Silveira, L. F., Galetti Jr, P. M., Galetti, M., 2024. Priority areas and implementation of ecological corridor through forest restoration to safeguard biodiversity. Scientific Reports 14(1), 30837. Available at: https://doi.org/10.1038/s41598-024-81483-y. Accessed on: 25 jun. 2024.

BRASIL. CONSELHO NACIONAL DO MEIO AMBIENTE, 1996. Resolução n. 09, 24 de outubro de julho de 1996. Dispõe sobre corredor de vegetação entre remanescentes como área de trânsito para a fauna. Accessed on: <http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=208>. Accessed on: 07 abr. 2023.

BRASIL. Lei nº 12.651, de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa. Diário Oficial da União. Retrieved February 20, 2025, from https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.

Caires, H.S., Gurgel, H.C.B., Machado, R.B., Schneider, A., 2019. Roadkilled mammals in the northern Amazon region and comparisons with roadways in other regions of Brazil. Iheringia. Série Zoologia (Online) 109. Available at: https://doi.org/10.1590/1678-4766e2019036. Accessed on: 12 jul. 2024.

Carrillo-Niquete, G. A. andrade, J. L., Valdez-Lazalde, J. R., Reyes-García, C., Hernández-Stefanoni, J. L., 2022. Characterizing spatial and temporal deforestation and its effects on surface urban heat islands in a tropical city using Landsat time series. Landscape and Urban Planning 217, 104280. Available at: https://doi.org/10.1016/j.landurbplan.2021.104280. Accessed on: 30 ago. 2024.

EMBRAPA. Empresa Brasileira de Pesquisa Agropecuária. Centro Nacional de Pesquisa de Solos, 2006. Sistema Brasileiro de Classificação de Solos. EMBRAPA, Rio de Janeiro.

Falcão, F., Guanaes, D., Paglia, A., 2012. Medium and large-sized mammals of RPPN Estação Veracel, southernmost Bahia, Brazil. Check List (Online) 8(5), 929-935. Available at: https://doi.org/10.15560/8.5.929. Accessed on: 15 set. 2024.

FFB. Fórum Florestal da Bahia, 2018. Monitoramento de Uso e Cobertura do Solo no Sul da Bahia. Available at: https://forumflorestalfbahiaworldresources.hub.arcgis.com/pages/baixar-shapefiles. Accessed on: 10 mai. 2024.

François, M., de Aguiar Jr, T. R., Mielke, M. S., Rousseau, A. N., Faria, D., Mariano-Neto, E., 2024. Interactions Between Forest Cover and Watershed Hydrology: A Conceptual Meta-Analysis. Water 16(23), 3350. Available at: https://doi.org/10.3390/w16233350. Accessed on: 22 out. 2024.

Gangenova, E., Varela, D., Zurano, J. P., Di Sallo, F., Costa, S., De Araujo, C. B., Zurita, G. A., 2025. Forest corridors preserve biodiversity in tree plantation landscapes of the Southern Atlantic Forest: a multi-taxa approach using passive sampling methods. Forest Ecology and Management 580, 122522. Available at: https://doi.org/10.1016/j.foreco.2025.122522. Accessed on: 5 nov. 2024.

Gatti, R. C., 2025. Ecological Peace Corridors: A new conservation strategy to protect human and biological diversity. Biological Conservation 302, 110947. Available at: https://doi.org/10.1016/j.biocon.2024.110947. Accessed on: 18 dez. 2024.

Gregory, A., Spence, E., Beier, P., Garding, E., 2021. Toward best management practices for ecological corridors. Land 10(2), 140. Available at: https://doi.org/10.3390/land10020140. Accessed on: 10 jan. 2025.

Hong, W., Guo, R., Su, M., Tang, H., Chen, L., Hu, W., 2017. Sensitivity evaluation and land-use control of urban ecological corridors: A case study of Shenzhen, China. Land Use Policy 62, 316-325. Available at: https://doi.org/10.1016/j.landusepol.2017.01.010. Accessed on: 25 jan. 2025.

Kučas, A., Balčiauskas, L., Lavalle, C., 2023. Identification of Urban and Wildlife Terrestrial Corridor Intersections for Planning of Wildlife-Vehicle Collision Mitigation Measures. Land 12(4), 758. Available at: https://doi.org/10.3390/land12040758. Accessed on: 5 fev. 2025.

Liu, S., Xia, Y., Ji, Y., Lai, W., Li, J., Yin, Y., Sun, H., 2023. Balancing Urban Expansion and Ecological Connectivity through Ecological Network Optimization—A Case Study of ChangSha County. Land 12(7), 1379. Available at: https://doi.org/10.3390/land12071379. Accessed on: 10 fev. 2025.

Louzada, F.L., Ribeiro, O., Pardini, R., Metzger, J.P., 2012. Proposta de corredores ecológicos para interligação de parques estaduais utilizando geotecnologia, Espírito Santo (ES)-Brasil. Revista Geográfica Venezolana (Online) 53(2), 239-254. Available at: [link ausente]. Accessed on: 2 mar. 2024.

Magioli, M.; Ferraz, K.M.P.M.B.; Galetti, M.; Setz, E.Z.F.; Paglia, A.P.; Abrego, N.; Ribeiro, M.C.; Ovaskainen, O., 2021. Land-use changes lead to functional loss of terrestrial mammals in a Neotropical rainforest. Perspectives in Ecology and Conservation (Online), v. 19, 161-170. Available at: https://doi.org/10.1016/j.pecon.2021.02.006. Accessed on: 20 fev. 2024.

MapBiomas, 2024. Relatório anual do desmatamento no Brasil. Relatório Anual do Desmatamento do Brasil – 2023. https://alerta.mapbiomas.org/relatorio/

Massarelli, C., 2024. Developing a Calculation Workflow for Designing and Monitoring Urban Ecological Corridors: A Case Study. Urban Science, 8(4), 169. Available at: https://doi.org/10.3390/urbansci8040169. Accessed on: 25 mar. 2024.

MEA. Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being. Millennium Ecosystem Assessment. Island Press, Washington, DC. 156 p.

Metzger, J.P.; Martensen, A.C.; Dixo, M.; Bernacci, L.C.; Ribeiro, M.C.; Teixeira, A.M.G., 2019. Why Brazil needs its legal reserves. Perspectives in Ecology and Conservation (Online), v. 17(3), 91-103. Available at:

https://doi.org/10.1016/j.pecon.2019.07.002. Accessed on: 10 abr. 2024.

MMA. Ministério do Meio Ambiente. (2016). ICMBio. Instituto Chico Mendes de Conservação da Biodiversidade. Parna do Pau Brasil. Available at: https://www.gov.br/icmbio/ptbr/assuntos/biodiversidade/unidade-de-conservacao/. Accessed on: 10 feb. 2024.

Morandi, D.T.; Araújo, E.A.R.; Martins, J.R.; Santos, F.A.M., 2020. Delimitation of ecological corridors between conservation units in the Brazilian Cerrado using a GIS and AHP approach. Ecological Indicators (Online), v. 115, 106440. Available at: https://doi.org/10.1016/j.ecolind.2020.106440. Accessed on: 15 mai. 2024.

Nery, L. M.; de Lima Andrade, E.; Simonetti, V. C.; Arantes, L. T.; dos Santos, A. P.; e Silva, D. C. D. C., 2024. Methodological Proposal for AN Ecological Corridor and Financial Cost Estimate: a way to Help Conserve Biodiversity. Journal for Nature Conservation, 79, 126606. Available at: https://doi.org/10.1016/j.jnc.2024.126606. Accessed on: 22 jun. 2024.

Paes, É.C.; Farias, R.C.; Ramos, L.R.; Melo, L.C., 2021. Different soil management systems promote improvements in nutrient content and litter input. Journal of Sustainable Forestry (Online), v. 40(5), 528-538. Available at: https://doi.org/10.1080/10549811.2020.1788953. Accessed on: 5 jul. 2024.

Palagi, A.C.; Amorim, R.S.S.; Castro, M.H., 2019. Plano Estratégico de Pagamento por Serviços Ambientais na bacia hidrográfica do Arroio Itaquarinchim (RS): integrando responsabilidades. Engenharia Sanitária e Ambiental (Online), v. 24, 1081-1087. Available at: https://doi.org/10.1590/S1413415220191316 37. Accessed on: 18 ago. 2024.

Paolino, R.M.; Metzger, J.P.; Haig, S.M.; Ribeiro, M.C., 2018. Importance of riparian forest corridors for the ocelot in agricultural landscapes. Journal of Mammalogy (Online), v. 99(4), 874-884. Available at: https://doi.org/10.1093/jmammal/gyy075. Accessed on: 2 set. 2024.

Petsch, D. K.; Cionek, V. D. M.; Thomaz, S. M.; Dos Santos, N. C. L., 2023. Ecosystem services provided by river-floodplain ecosystems. Hydrobiologia, 850(12), 2563-2584. Available at: https://doi.org/10.1007/s10750-022-04916-7. Accessed on: 15 out. 2024.

Pienkowski, T.; Freni Sterrantino, A.; Tedesco, A. M.; Clark, M.; Brancalion, P. H.; Jagadish, A.; Mills, M., 2025. Spatial predictors of landowners' engagement in the restoration of the Brazilian Atlantic Forest. People and Nature, 7(1), 247-264. Available at: https://doi.org/10.1002/pan3.10765. Accessed on: 5 nov. 2024.

Pinto, A.C.; Rocha, I.C.; Henriques, R.P., 2019. Composição florística de um fragmento de floresta no Corredor Central da Mata Atlântica, sul da Bahia, Brasil. Paubrasilia (Online), v. 2(2), 14-27. Available at: https://doi.org/10.33447/paubrasilia.v2i2.22. Accessed on: 20 jan. 2025.

Qu, X., Li, X., Bardgett, R. D., Kuzyakov, Y., Revillini, D., Sonne, C., ... & Delgado-Baquerizo, M., 2024. Deforestation impacts soil biodiversity and ecosystem services worldwide. Proceedings of the National Academy of Sciences [online] 121(13). Available at: https://doi.org/10.1073/pnas.2318475121. Accessed on: 20 fev. 2024.

Rabbi, M. F., & Kovács, S., 2024. Quantifying global warming potential variations from greenhouse gas emission sources in forest ecosystems. Carbon Research [online] 3(1), 70. Available at: https://doi.org/10.1007/s44246-024-00156-7. Accessed on: 22 fev. 2024.

Ribeiro, J. V. M., Mendes, T. S. G., Simões, S. J. C., Martins, I. M., Ferreira, C. C., Camarinha, P. I. M., & Massi, K. G., 2024. Planning and implementing ecological corridors in the southeast Atlantic Forest: Challenges and opportunities. Anais da Academia Brasileira de Ciências [online] 96(suppl 3), e20230768. Available at: https://doi.org/10.1590/0001376520242023 0768. Accessed on: 1 mar. 2024.

Rosot, M.A.D.; da Silva, M.R.; Silva, J.S.; Freitas, C.L.S., 2018. Riparian forest corridors: A prioritization analysis to the Landscape Sample Units of the Brazilian National Forest

Inventory. Ecological Indicators [online] v. 93, 501-511. Available at: https://doi.org/10.1016/j.ecolind.2018.03.071. Accessed on: 5 mar. 2024.

RPPN Estação Veracel, 2016. Plano de Manejo. Eunápolis: Veracel Celulose, Gerência de Sustentabilidade, e Conservação Internacional. Available at: https://www.veracel.com.br/wpcontent/uploads/2020/05/PMEVC_2016.pdf. Accessed on: 7 mar. 2024.

Saaty, T. L., 2006. Rank from comparisons and from ratings in the analytic hierarchy/network processes. European Journal of Operational Research [online] v. 168, n. 2, p. 557-570. Available at: https://doi.org/10.1016/j.ejor.2004.04.032. Accessed on: 23 fev. 2024.

Santos, EDO, & Medeiros, PRP, 2023. Anthropogenic action and the eutrophication process in the Paraíba do Meio River. Society & Nature [online] 35, e66441. Available at: https://doi.org/10.14393/SN-v35-2023-66441. Accessed on: 15 mar. 2024.

Secco, H., Farina, L. F., da Costa, V. O., Beiroz, W., Guerreiro, M., & Gonçalves, P. R., 2024. Identifying roadkill hotspots for mammals in the Brazilian Atlantic Forest using a functional group approach. Environmental Management [online] 73(2), 365-377. Available at: https://doi.org/10.1007/s00267-023-01844-7. Accessed on: 20 mar. 2024.

Silva Junior, C.H.L.; Brancalion, P.H.S.; Rodrigues, R.R., 2020. Benchmark maps of 33 years of secondary forest age for Brazil. Scientific Data [online] v. 7(1), 269. Available at: https://doi.org/10.1038/s41597-020-00600-4. Accessed on: 10 mar. 2024.

Silva, M. A. P. D., Evangelista, L. P., Silva, W. H. O., Santo, F. D. S. D. E., 2024. Diagnosis and strategies for conservation or restoration of springs in environments subject to human action. Forest Science [online] 34(3), e71553. Available at: https://doi.org/10.5902/1980509871553. Accessed on: 25 mar. 2024.

SOS MATA ATLÂNTICA, 2021. Relatório Anual 2021. Período 2019/2020. Available at: https://cms.sosma.org.br/wp-content/uploads/2021/05/SOSMA_Atlas-da-Mata-Atlantica_2019-2020.pdf. Accessed on: 26 mar. 2024.

SOS MATA ATLÂNTICA, 2022. Relatório Anual 2022. Período 2020/2022. Available at: https://cms.sosma.org.br/wp-content/uploads/2022/05/Sosma-Atlas-2022-1.pdf. Accessed on: 26 mar. 2024.

Souza, D.C.; da Silva, F.R.; Lunardi, V.O.; Souza, E.R.; Eisenlohr, P.V., 2022. Effect of slope on the forest structure of the Atlantic Forest domain in southern Brazil. Brazilian Journal of Biology [online] v. 84. Available at: https://doi.org/10.1590/1519-6984.258048. Accessed on: 2 abr. 2024.

Souza, F. E. D., dos Santos Oliveira, J. D. N., dos Santos, C. R. C., de Oliveira Ferreira, E. V., da Silva, R. T. L., de Paula, M. T., ... Martins, W. B. R., 2025. Physical and chemical soil quality and litter stock in agroforestry systems in the Eastern Amazonia. Agriculture, Ecosystems & Environment [online] 382, 109479. Available at: https://doi.org/10.1016/j.agee.2025.109479. Accessed on: 10 abr. 2024.

Sun, B., Wang, X., Luo, P., Zhao, Y., & Rijal, M., 2024. Importance of Farmers' Awareness on Ecological Revitalization to Promote Sustainable Development. Sustainability [online] 16(22), 10134. Available at: https://doi.org/10.3390/su162210134. Accessed on: 15 abr. 2024.

Tavares, M. F., Gallo, P., Nascimento, N., Bauhus, J., Brancalion, P. H., & Feurer, M., 2024. Smallholders' perspectives, motivations and incentives for restoring the Brazilian Atlantic Forest. Restoration Ecology [online] 32(8), e14270. Available at: https://doi.org/10.1111/rec.14270. Accessed on: 20 abr. 2024.

Thiago, C.R.L.; Magalhães, I.A.L.; Santos, A.R., 2020. Identificação de Fragmentos Florestais Potenciais para a delimitação de Corredores Ecológicos na bacia hidrográfica do Rio Itapemirim, ES por meio de técnicas de Sensoriamento Remoto. Revista Brasileira de Geografia Física [online] v. 13(02), 595-612. Available at: https://doi.org/10.26848/rbgf.v13.2.p595-612. Accessed on: 25 abr. 2024.

Van Helden, B. E., Skates, L. M., & Close, P. G., 2024. Use of wildlife-friendly structures in residential gardens by animal wildlife: evidence from citizen scientists in a global biodiversity hotspot. Urban Ecosystems [online] 1-15. Available at: https://doi.org/10.1007/s11252-024-01530-4. Accessed on: 30 abr. 2024.

Vasconcelos, A. R. P., da Silva, É. I., & de Carvalho, A. V., 2021. Avaliação dos atropelamentos de animais silvestres na BR-153, trecho Guaraí-Tabocão. Research, Society and Development [online] 10(15), e332101523834-e332101523834. Available at: https://doi.org/10.33448/rsd-v10i15.23834. Accessed on: 5 mai. 2024.

Walder, M. T., de Oliveira, C. L., Morante-Filho, J. C., & Benchimol, M., 2024. Agricultural Expansion and Landscape Heterogeneity Explain Vegetation Degradation in Brazilian Atlantic Forest Landscapes. Land Degradation & Development [online] 36(4), 1121-1132. Available at: https://doi.org/10.1002/ldr.5415. Accessed on: 15 mai. 2024.

Walston, L.J.; Ferrato, A.L.; Gagnon, G.A., 2021. Modeling the ecosystem services of native vegetation management practices at solar energy facilities in the Midwestern United States. Ecosystem Services [online] v. 47, 101227. Available at: https://doi.org/10.1016/j.ecoser.2020.101227. Accessed on: 10 mai. 2024.

Wu, H.; Zhang, Y.; Cheng, Y., 2021. A novel remote sensing ecological vulnerability index on a large scale: A case study of the China-Pakistan Economic Corridor region. Ecological Indicators [online] v. 129, 107955. Available at: https://doi.org/10.1016/j.ecolind.2021.107955. Accessed on: 20 mai. 2024.