**Australian Journal of Basic and Applied Sciences**, 9(20) June 2015, Pages: 273-281

ISSN:1991-8178

**Australian Journal of Basic and Applied Sciences**

Journal home page: www.ajbasweb.com

# GIS Tools use to Identify Routes for Ecological Corridors formation between Atlantic Forest (Mata Atlântica) Fragments in the south region OFESPÍRITO Santo, Brazil

[1]Idalúcia Schimith Bergher, [2]Mauro Eloi Nappo, [1]Aderbal Gomes da Silva, [1]Alexandre Rosa dos Santos, [1]José Eduardo Simon, [1]Ana Paula Gelli de Faria

[1]*Universidade Federal do Espírito Santo - UFES. ForestSciencesand WoodDepartment.Avenida Governador Lindemberg, nº 316, Centro, Post Code 29550-000, Jerônimo Monteiro, ES.*
[2]*Universidade de Brasília - UnB. Forest EngineeringDepartment. Campus Darcy Ribeiro s/n, Post Code 71910-000, Brasília-DF.*

**ARTICLE INFO**

***Article history:***
*Received 16 April 2015*
*Accepted 12 June 2015*
*Available online 1 July 2015*

***Keywords:***
*Fragments connectivity, Atlantic Forest (Mata Atlântica), Ecological Corridors.*

**ABSTRACT**

Connecting forest fragments is one of the most used biodiversity conservation and preservation strategies. However, the fact that part of the human action that causes fragmentation is necessary to society maintenance cannot be ignored; also, those activities are under law protection. Considering that, this research aims to identify the least conflicting areas for ecological corridors construction between the Cafundó RPPN's Atlantic Forest (Mata Atlântica) fragments and the Boa Esperança Farm fragments, using a GIS tool. Mappings of the current land use and occupation, of owners' perception and acceptance and current forestry laws were made, aiming to elaborate conflict maps. According to these mappings 32.70% (165.70ha) of the permanent preservation areas are conflicted with soil occupation and exploration, protected by law. Owners' perception/acceptance does not conflict with law. The GIS tools were effective to analyze landscape and photomosaic formation, allowing identification of the least conflicting routes for fragment connecting.



**To Cite This Article:** Idalúcia Schimith Bergher, Mauro Eloi Nappo, Aderbal Gomes da Silva, Alexandre Rosa dos Santos, José Eduardo Simon, Ana Paula Gelli de Faria, GIS Tools use to Identify Routes for Ecological Corridors formation between Atlantic Forest (Mata Atlântica) Fragments in the south region OFESPÍRITO Santo, Brazil. ***Aust. J. Basic & Appl. Sci.**, 9(20): 273-281, 2015*

## INTRODUCTION

The Atlantic Forest (Mata Atlântica) is one of the world's richest and most threatened ecosystems, is located at the Brazilian coast, with huge biodiversity and endemism (RIBEIRO *et al*., 2009). At Espírito Santo's Atlantic Forest (Mata Atlântica) biome, the remaining vegetation is forming several small forest fragments, but they are distant from each other (GASCON; WILLIAMSON; FONSECA, 2000) due intense human action.

Under that perspective, Epirito Santos's environment and water resources state institute (IEMA - InstitutoEstadual de MeioAmbiente e RecursosHídricos) proposed to arrange ten ecological corridors. One of them being the Burarama - Pacotuba – Cafundó corridor, located at the Itapemirim River watershed, whose range reaches Burarama forest fragments, the Pacotuba National Forest (FLONA) (450.59 ha) and the Cafundó's Natural Heritage Private Reservation (CafundóRPPN) (517.00ha), located at Boa Esperança Farm.

Forest fragments prevention or reduction, landscape continuity restoration or maintenance, water resources maintenance and population genetic flow favoring are examples of ecological corridors functions (Pereira *et al.*, 2007; Muchailh *et al.*, 2010). Knowing such environments is necessary to understand fragments conservation and preservation mechanisms and to guide activities aiming environment restoration (Pereira *et al*., 2007).

Considering that, the best route for corridor formation is the one that allows fragment connection and reaches the most degraded areas, while respecting land use and occupation legally, mapping those factors is extremely important for planning purposes (Jensen, 2009; Ferrari *et al*., 2012).

It is necessary to know that almost all areas that enshrine Atlantic Forest (Mata Atlântica)'s vegetation fragments in the Espírito Santo south region are private, and also are surrounded by human action. For the connecting process, it is necessary to show owners how important corridors are. This research aims to identify which route they consider least conflicting betweenexploration, occupation, and natural resources conservation.

**Corresponding Author:** Mauro Eloi Nappo, Universidade de Brasília - UnB. Forest EngineeringDepartment. Campus Darcy Ribeiro s/n, Post Code 71910-000, Brasília-DF.
Tel: (55 61) 3107-5629. E-mail: mauronappo@yahoo.com.br.

## MATERIALS AND METHODS

This research was made at the Cafundó RPPN (517.00ha), part of the Boa Esperança Farm territory (1,819.10ha), located under the coordinates 20° 43' South latitude and 41° 13' West longitude, at the Pacotuba/Conduru District, at the Cachoeiro de Itapemirim region, inEspírito Santo's (Brazil) south region (Figure 1). The Cafundó RPPN is Espírito Santo's second largest, and the greatest and best-preserved Atlantic Forest (Mata Altântica) area at the Itapemirim river region.

Region's weather is Cwa according to the Köppen classification system, its average annual rainfall is 1,293mm. The drought period (winter) goes from July to September and the moist period (summer) goes from November to January, showing a water deficit of 233mm and a 185mmannual water excess according to the bio-climatic zoning. The minimum average temperature on the coldest month varies from 11.8 to 18ºC and the maximum average on the hottest month varies from 30.7 to 34ºC (Klippel *et al*., 2013).

The watershed's relief is formed by huge flat areas, distant from each other, with small elevations and rocky outcrops on distinct areas. At the mountaintop, in a huge part of the valleys and at lower areas is possible to observe exuberant vegetation, forming areas with an exotic aspect and a scenic landscape. The slopes can reach a 300m height, and its average height is 130m above sea level (BAUER, 1999). The predominant soil type is Red-Yellow Dystrophic Latosol(LVAd), according to the Brazilian soil classification system (Brazil's Agricultural Research Enterprise/ EmpresaBrasileira de PesquisaAgropecuária - EMBRAPA, 2013).

The studied area vegetation is classified as Seasonal Semi-deciduous Sub-montane Forest, characterized by seasonal leaves growth of the stronger tree species, conditioned by a well-defined climatic seasoning (drought period and rainy period) and by low temperature during a certain period of the year. At those phyto-physiognomies the percentage of deciduous trees varies from 20 to 50%, as an adaptation mechanism to the water or climatic agitation, also, they are frequent in primary forests or regenerated forests. The Sub-motane classification is due its occurrence in high ranges measuring between 50 and 500m (Veloso; Rangel Filho; Lima, 1991). The Seasonal Semi-deciduous Sub-montane Forest is Espírito Santo's second most important vegetation formation (Atlantic Forest Research Institute/ INSTITUTO DE PESQUISAS DA MATA ATLÂNTICA - IPEMA, 2005).

The remaining parts of Seasonal Semi-deciduous Sub-montane Forest of the studied area measures around 721.40ha, distributed in five fragments. Abreu *et al* (2013) identified 253 tree species that belonged to 52 botanical families, emphasizing that besides its diversity, there were 89 rare species (35.20%), which *Melanoxylonbrauna* Schott, *Moldenhawerapapillanthera* L.P. Queiroz, GP.Lewis &Allkin, *Myrciafollii*G .Barroso & Peixoto, *Trigoniodendronspiritusanctense* E.F.Guim. & J.Miguel, *Aspidospermaillustre* (Vell.) Kuhlm. & Pirajá, *Aspidospermapolyneuron* Müll. Arg., *Cabralea canjerana* (Vell.) Mart., *Carinianalegalis* (Mart.) Kuntzeand*Dalbergianigra* (Vell.) AllemãoexBenth are endangered according to the Ministério do Meio Ambiente (Martinelli; Moraes, 2013).

The fauna registered at the studied area is diverse, were noted 19 fish species, 14 amphibians species, 10 reptiles species, 258 birds and 55 mammals. Were registered 26 endangered terrestrial vertebrates, considering state, national and global analysis levels, such as: *Chelonoidesdenticulata*; *Tinamussolitaries*, *Crypturellusnoctivagus*, *Pyrrhuracruentata*, *Amazonarhodocorytha*, *Dysithamnusplumbeus*, *Tripophagamacroura*, *Neopelmaaurifrons*, *Callicebuspersonatus*, *Leoparduspardalis* and *Pantheraonca*( Bauer, 1999, Paz; Venturini, 2008).

The existence of so many specimens of fauna and flora encourages new studies aiming to create conservation strategies, with the ecological corridors being an alternative considered in several researches, such as Viana's (1990), Chetkiewicz; Clair's; Boyce's (2006), Anjos' (2008), Viera's (2008), Ribeiro's *et al* (2009), Muchailh's *et al* (2010) andAbreu; Silva; Silva's (2013). Those corridors turn fragments connection and vegetal covering increasing possible.

Forest fragment mapping was performed with the ArcGIS 9.2 and was digitalized by using image interpretation techniques of the IKONOS satellite pictures, with a 1m space resolution. Area calculation and statistic data was obtained with the Idrisi 3.2 app; the "Pathway" mode was used to trace the best paths, representing the best route, cost or effort between two spots, which enabled different possibilities for corridor construction considering the real condition of area's forest fragments. Vectors editing for line's construction and correction, polygons and points for classification of soil use was made using Cartalinx 1.2.

Picture geo-referencing was performed using the ArcGIS 9.2 program, and the satellite images were corrected based on the Estrela do Norte river shape files archives and on the property outline. The coordinates system studies UTM was used in meters, with Datum SAD-69.

A cartographic base about land uses classes was built; its space resolution was 1m (Forest in medium and advanced regeneration stage, Forest in Primary Regeneration stage, Forestation, Dirty Pasture, Clean Pasture, Rivers/Streams, Crops, Roads and Built Environment). Field checking was performed aiming to analyze land use and occupation.

In order to introduce ecological corridors concept, its functions andrelevancea questionnaire with six items was elaborated to evaluate owners' acceptance concerning its installation and possible routes. A scale with five options was established so owners could evaluate their wiliness in allow corridors deploying in their territory.

Conflict maps were elaborated in order to separate areas with different restrictions or potential for corridors construction. Considering the current forestry laws, and consulting researchers and Boa Esperança Farm owners as well, the conflict rating was defined (Table 1).

The Buffer module (covering area) of the computer program ArcGIS 9.2 was used to quantify water springs outlines (50m) and riparian forests (100m for the Itapemirim river and 30m for the Estrela do Norte stream and other watercourses), as mentioned in the current forestry laws.

To identify slope areas above 45º (100%), the mapping was constructed from the contour vectors with a 50m equidistance, which generated a triangular grid using the Denaulay interpolator. Slope map was constructed using TIN, and generated a variation slicing measuring 15º, which corresponded the ranges above 45º, those areas were defined as Permanent Preservation Areas as established by the Código Florestal Brasileiro (Brazil's forestry laws) – Law n. 12651 of May 25$^{th}$, 2012 (BRASIL, 2012).

Montaintopwere observed in order to map those areas, whom are considered permanent preservation areas, according to the Código Florestal Brasileiro (Brazil's forestry laws) – Law n. 12651 of May 25$^{th}$, 2012 (BRASIL, 2012). The mapping was made by applying techniques evolving GIS and digital elevation modeling.

Water fountain spots were localized in field by using the Garmin 12 GPS, and the drainage system was digitalized using ArcGIS, with images taken from the IKONOS satellite.

The fountains were classified in tree conservation categories: (1) preserved, when they presented at least 50m of natural vegetation around it, calculated from visual estimates. (2) Ill, when they were well conserved, but presented less than 50m natural vegetation around they, also those areas were occupied with pasture, agricultural activities or roads. (3) Degraded, when they presented less than 50m of natural vegetation and the soil was compactedmechanically, or with ravines / gullies or with drainage or degraded by human action.

The slopeestmate was generated based on height data from IBEGE 1:50,000 cartography scale. The relief surface was reproduced from area's contour and by the spots collected using Delaunay triangulation (TIN Model) as isolines interpolator. Then a matrix in the MNT category was generated, with a 10 matters mesh. The slope map is result of slope slicing. The slope classes were established according to the methodology proposed by De Biase (1993).

All exploration, human occupation, and lack of native vegetal covering existing at the water fountain areas, watercourses, mountaintop and slopes, whose inclination was above 45º, was considered disagreeing with the Código Florestal Brasileiro (Brazil's forestry laws) – Law n. 12651 of May 25$^{th}$, 2012 (BRASIL, 2012).

Data concerning permanent preservation areas and forest fragments, with or without vegetal covering, were crossed in order to create a map about those areas.

To understand owners' perception/acceptance regarding to ecological corridors construction and to establish a plan considering those aspects a questionnaire was applied to all Boa Esperança Farm owners with the following subjects: 1 - Interest in constructing the corridor on areas under your domain, yes or no. 2 – Why? Generate profit with tourism, to gain public or private resources, make the territory more vulnerable or stronger against social movements like the agrarian reform. 3- Which areas could be used to establish the corridors? Riparian Forests, highway margins, Agro-forestry systems – SAF's (living hedge, windbreakers and pasture forestation), others (which?). 4 – In a scale from 0 to 5, how much are you willing to discuss corridors construction? 5 – Concerning to the corridor type, which one do you prefer? Continuous, non-continuous, specific tree species. 6- Free speech.

Then, the data obtained was crossed using the Geographic Information System (GIS) data, also, was re-classified considering suitability levels, and a friction map for corridors construction was generated, concluding that areas with higher rates, were the least adequate for its construction.

## RESULTS AND DISCUSSIONS

Land use and occupation was mapped at the Boa Esperança farm areas, which also reaches the Cafundó RPPN, the results were: Soil in medium and advanced regeneration state occupied 721.99ha (39.7%), divided in four fragments. Clean Pasture occupied 706.04ha (38.8%). Dirty Pasture occupied 283.79ha (15.6%). Roads occupied 35.02ha (1.9%). Areas in initial regeneration state occupied 33.94ha (1.8%). Rivers/Streams/Water Springs occupied 14.21ha (0.8%). Crops occupied 9.26ha (0.5%). Forestation occupied 7.32ha (0.4%); and Built environments occupied 6.79ha (0.4%) (Figure 2).

The Boa Esperança farm is surrounded through 2.8km of its south/southeast region by the Itapemirim river bank. At the central region, is surrounded by 9.7km of the Estrela do Norte stream and by other smaller watercourses through 8.53km. So, permanent preservation areas with water resources sum 133.30ha, which only 52.90ha (39%) is not affected by human action. Then, the amount of permanent preservation areas with water resources affected by human action sums 80.30ha (61%).

Twenty-tree perennial water springs (6punctual and 17 diffuse) were found. But, 18 (78%) of them are degraded, three are modified(13%) and only two (8.7%) are preserved (Table 2). Major damaging sources are animal flow, watering near the waterhole, deforestation and planted pasture.

Six narrow water springs represent 26%, and its slope classes are 12-20% and 20-40%. These slope classes occupy wavy to highly wavy reliefs and highly wavy and mountainous reliefs, respectively.

Seventeen diffuse water springs represent 74% and its slope classes are 6-12% and 12-20%. These classes can be found at swamps, gullies, plane forests in lower altitudes and with mild relief, in lower regions or in plane and large caves, allowing water level rise and soil soaking.

Lacking of native vegetation that could enable fountain preservation is an alarming factor at the studied area, since 149.47ha (91%) of the territory was affected by human action.

Permanent preservation areas with slopes, whose inclination is above 45º, sum 207.20ha, whose 147.73ha (71.20%) was not affected by human action and was covered by native vegetation in an advanced regeneration stage. Then, areas affected by human action sum 59.57ha (28.80%), which obeys forestry laws.

Permanent preservation areas more complaint with forestry laws' land use and occupation rules are the mountaintop. These areas sum 319.20ha of which 309.60ha (93.7%) was not affected by human action, also, these areas are covered by native vegetation inmedium or advanced regeneration stage. This preservation and conservation situation might be associated to its lack of agricultural inclination. The total of areas affected by human action sums 9.60ha (6.30%).On figure 3, Boa Esperança farm permanent preservation areas are identified according to current forestry laws.

Fulfill the law in order to improve permanent preservation areas condition by area total planting, enrichment planting and natural regeneration conduction, following correct maintenance practices, associating that to ordering access to animal watering, would guarantee in medium and long-terms vegetation recovering. It would represent major advances regarding to fragment connectivity and stability by increasing its size and controlling fragmentation undesirable effects.

All six owners were interested in constructing the corridors in areas under their domain, especially in areas surrounding riparian forests, which all interviewed indicated as a possible place for corridor construction. Their concern about connecting fragments in order to conserve and preserve fauna and flora species variety was visible.

Five out of six owners did not allow corridors construction on roads and highways. Regarding to use vegetation frontiers, such as windbreakers or living hedges, five out of six interviewed agreed, with a 5m range. As for pasture forestation as an agro-forestry system, only two out of six were interested.

When asked about how willing they were to discuss corridors construction in their territory in a scale from 1 to 5, only one gave 3, the other gave 5.

Other matters were discussed, like;whether ecological corridor construction would contribute for Boa Esperança farm maintenance. Tree out of six interviewed believed so, due fountain protection and water production, two believed that the corridors would contribute for the Cafundó RPPN maintenance, but would not affect the farm directly. One of them believed that corridor construction would not contribute at all.

As for ecological corridor touristic potential and the possibility of generate income with this activity, four out of six considered this alternative, although, they emphasized its instability. Two did not consider and did not intent to implant touristic activities. Concerning to fund-raising from public and private institutions, all of them consider this potential.

Regarding to increase farm's vulnerability or strength against social movements such as agrarian reform, all believed that the ecological corridors would fortify the farm.

As for the corridor type, three prefer the continuous corridor in permanent preservation areas and in pasture forestation. Only one considered vegetation Islands and dry perches, one did not have any preferences, but emphasized needing routes for animal watering and the last one would analyze it better.

Questionnaire results show that most owners agree with ecological corridor construction and all of them are interested in adequate permanent preservation areas (mountaintop, slopes > 45º, watercourses outlines) land use and occupation to forestry laws' resolutions, including its accesses for animal watering.

Owners did not agree in construct ecological corridors in areas that are not for permanent preservation, since there are no legal restrictions to land use and occupation. Other results express conflict rating for corridor construction. In areas where owners restricted corridors construction, permanent preservation areas sum less than 1%, they also represent areas with high conflict rates.

Figure 4 shows the map created based on owners acceptance regarding to ecological corridors construction at the Boa Esperança farm territory.

Five fragments at the studied area enable different strategies for fragment connection, considering land use and occupation and current forestry laws.

Fragments number 1 and 2 are in a 500m average distance and 190m minimum distance. The surrounding matrix is composed by vegetation in a primary regeneration stage and dirty pasture. Both are permanent preservation areas (slopes > 45º). To connect these fragments is necessary to adequate permanent preservation areas land use and occupation in 0.95ha (190x50m) by conducting natural regeneration. That would provide minimal effective connectivity, as shown in figure 5, number 1.

Average distance between fragments 3 and 4 is 40m and the minimum distance is 17m; there is a dirt road measuring 7m between them. The surrounding matrix is occupied mostly by clean pasture, then dirty pasture. Both are permanent preservation areas (slopes > 45º). These aspects favor fragment connectivity while attending law's resolution. Fragmentation can be reduced by a 3.20ha reforestation, as shown in figure 5, number 2.

The distance between fragments 4 and 5 is 500m, there is a dirt road measuring 7m between them. At the surrounding matrix pasture is predominant, which do not classify them as permanent preservation areas. However in 2007 the area was reforested through 1.72ha by 35m, in a primary development stage. Population development will guarantee fragment connectivity, it will be necessary to observe and evaluate connection effectiveness.

Fragments 2 and 3 are the most distant from each other, once the closest spots distance is 900m. Their surrounding matrix is the most diverse, clean pasture is predominant (92%), dirty pastures next (5%) and primary regeneration stage (3%), they are crossed by permanent preservation areas (watercourse outlines). The least conflicting path for connectivity is permanent preservation areas reforestation through its 1,270m, summing 7.62ha (1,270x60m). This is necessary to include both watercourses outlines and its minimal preservation area measuring 30m, according to forestry laws, as seen in figure 5, number 3A. For an effective fragment connection would still remain 156m, at the surrounding matrix occupied by clean pasture, in a non-conflicting area according to the owners, summing 0.78ha (156x50m) to be reforested, as seen in figure 5 number 3B.

To establish a minimal connection among five fragments of a Semi-deciduous sub-montane forest in the Cafundó RPPN and Boa Esperança farm, according to the strategies proposed, it is necessary to adequate land use and occupation through 9.55ha, being 6.77ha (95%) in permanent preservation areas, with 5.82ha by reforestation and 0.95ha by natural regeneration conduction, the remaining 0.78ha (5%) in clean pasture areas by reforestation.

Boa Esperança farm liabilities regarding to land use and occupation in permanent preservation areas is 149.47ha. Considering areas full adequacy and law fulfillment, fragments 1 and 2 would become one (A) and fragments 3.4 and 5 would form another fragment (B).

In this scenery fragments A and B distance would be 156m, whose surrounding matrix is occupied by clean pasture, in a non-conflicting area according to owners for corridor formation.

In this situation vegetal covering would increase, reaching 871.46ha (47.91%), it also would contribute to permanent preservation areas (associated to watercourses and topography) protection and water springs conservation, it would also allow mosaic-reconciled formation forhuman action (Figure 6).

Several advances have been registered when it comes to ecological corridors planning, as can be seen in studies from deAnjos (2008), Jensen (2009), Muchailh *et al* (2010), Seoane *et al* (2010), Ferrari *et al*. (2012) and Peluzio *et al* (2013), whose approach are similar to this research's. They contain strategies for route identification considering physical and biological attributes, and human action as well.

However, vegetal fragment connection does not guarantee resources, fauna, flora, relief, water and landscape preservation on its own. It is necessary to consider land uses and occupation that are important to fulfill society needs. Constructing territorial models that consider habitat composition and configuration parameters (Chetkiewicz; Clair; Boyce, 2006; Moser *et al*, 2007) and possible uses must be considered while defining route territory for ecological corridors construction.

### *Conclusions:*

The GIS tools were effective for territory analysis and photo-mosaic formation, which allowed identifying least conflicting routes for fragment connection at Boa Esperança farm reaching the Cafundó RPPN.

Minimal fragment connection can be made by a 9.55ha reforestation in non-conflicting areas regarding to land use and occupation.

Current forestry laws fulfillment while attending land use and occupation needs in permanent preservation areas allow connecting fragments 1 and 2 (A) and fragments 3, 4 and 5 (B). It also allows developing a diverse mosaic of the surrounding matrix while increasing vegetal covering of the studied area.

**Table 1:** Attributes considered while elaborating conflict maps to propose ecological corridors in the Cafundó RPPN, Boa Esperança farm in Espírito Santo.

| Attributes | | Rating |
|---|---|---|
| Land use and occupation | Forest in medium and advanced native vegetation regeneration stage | 1 |
| | Forest in a primary native vegetation regeneration stage | 5 |
| | Reforestation | 5 |
| | Dirty pasture | 25 |

| | | |
|---|---|---|
| | River/Stream | 25 |
| | Clean Pasture | 50 |
| | Crops | 75 |
| | Roads | 75 |
| | Built Environments | 100 |
| Use potential | Slope < 20º – Huge capacity for agricultural activities on the A,B and C management levels. | 100 |
| | Slope variation from 20 to 45º - Restrict capacity for agricultural activities on the C management level. | 50 |
| | Slope >45º, watercourses outlines and mountaintop – PPA's | 1 |
| Deployment Restriction | Total Restriction | 100 |
| | High Restriction | 75 |
| | Medium Restriction | 50 |
| | Low Restriction | 25 |
| | No Restriction | 1 |

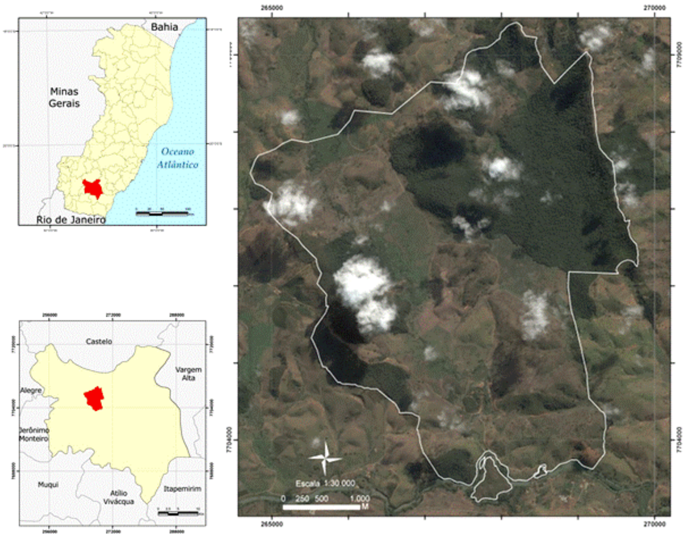


**Fig. 1:** Studied Area.Boa Esperança Farm at the Cachoeiro de Itapemirim region. At Espírito Santo, Brazil.

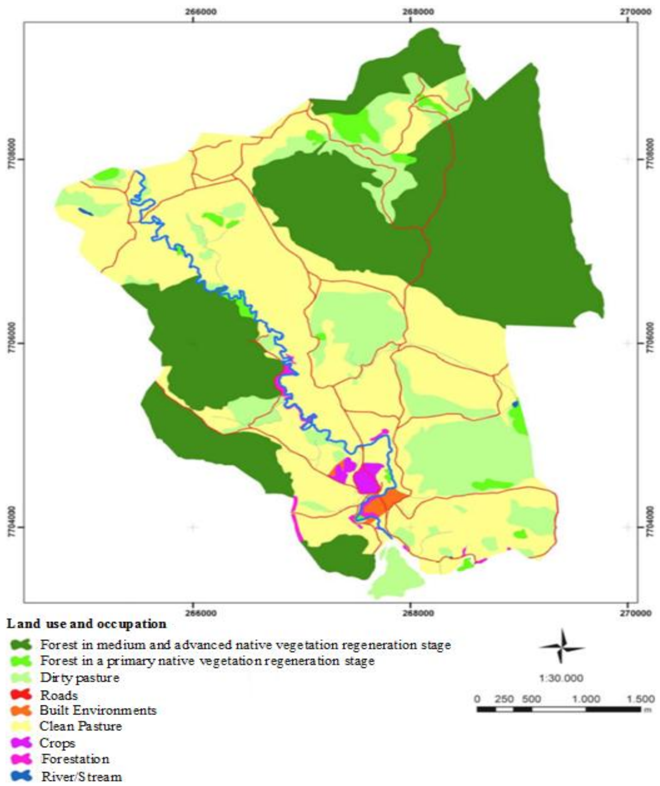


**Fig. 2:** Cafundó RPPN land use and classification, at Boa Esperança farm. Cachoeiro de Itapemirim, Epirito Santo, Brazil.

Australian Journal of Basic and Applied Sciences, 9(20) June 2015, Pages: 273-281

**Table 2:** Boa Esperança farm fountain classification concerning to conservation level and the water spring type associated with them.

| Type | Classification | | | Total |
|---|---|---|---|---|
| | Preserved | Modified | Degraded | |
| Water PunctualSprings | 0 (0%) | 2 (8.7%) | 15 (65%) | 17 (74%) |
| Water Diffuse Springs | 2 (8.7%) | 1 (4.3%) | 3 (13%) | 6 (26%) |
| Total | 2 (8.7%) | 3 (13%) | 18 (78%) | 23 (100%) |

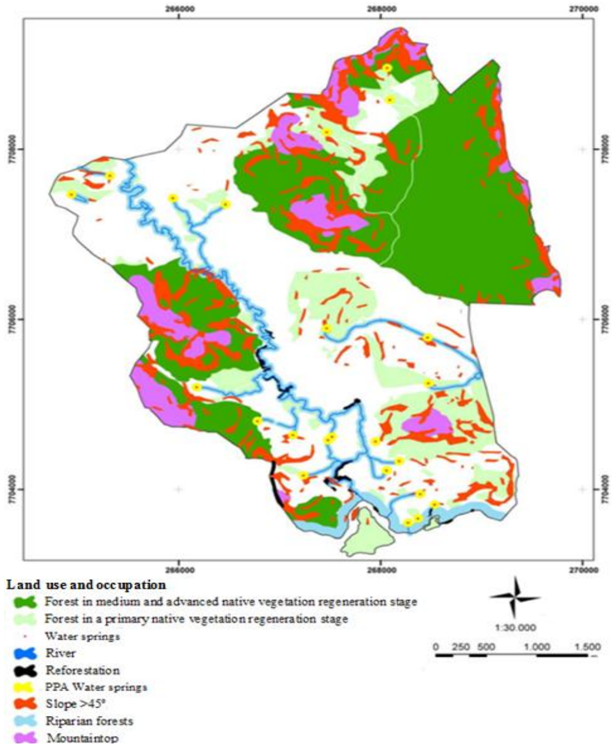


**Fig. 3:** Boa Esperança farm permanent preservation areas (PPA).

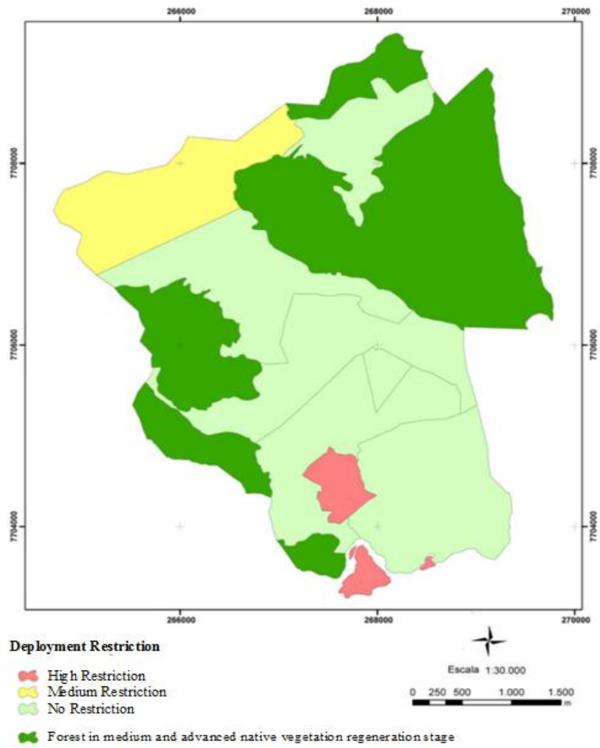


**Fig. 4:** Owners perception/acceptance regarding to ecological corridor construction for the Cafundó RPPN, at Boa Esperança farm in Cachoeiro de Itapemirim, Espírito Santo – Brazil.

Australian Journal of Basic and Applied Sciences, 9(20) June 2015, Pages: 273-281

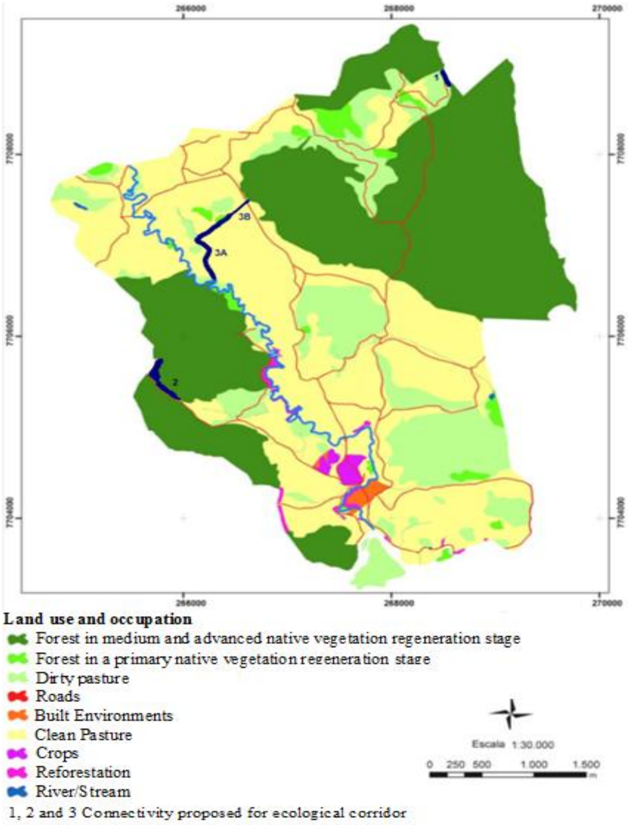


**Fig. 5:** Minimal connectivity proposed for ecological corridor formation at the Cafundó RPPN and other fragments at Boa Esperança farm in Espírito Santo.

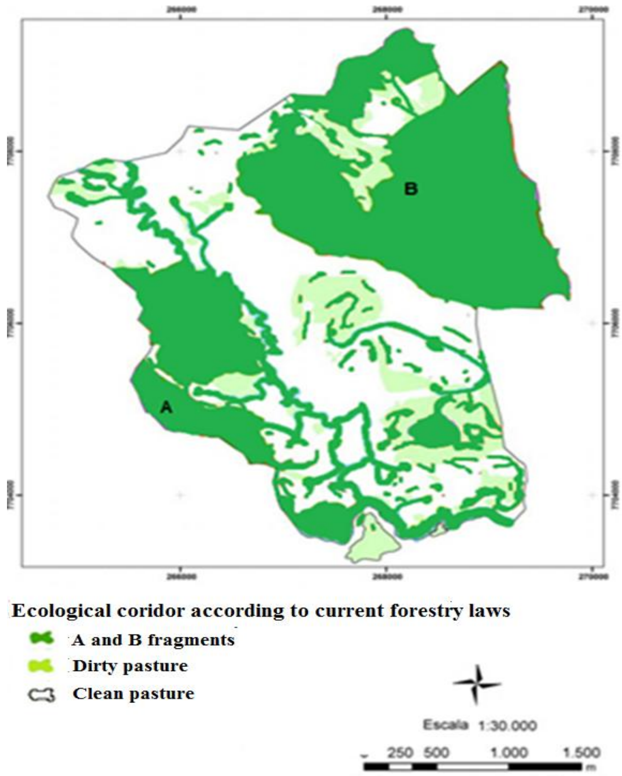


**Fig. 6:** Ecological corridor formation route for Cafundó RPPN and other Boa Esperança farm fragments, according to current forestry laws.

Australian Journal of Basic and Applied Sciences, 9(20) June 2015, Pages: 273-281

## REFERENCES

Abreu, K.M.P., G.F. Silva, A.G. Silva, 2013. Análise fitossociológica da Floresta Nacional de Pacotuba, Cachoeiro de Itapemirim, ES - Brasil. *CERNE*, 19: 157-168.

Anjos, H.O., 2008. Avaliação de riscos ambientais na delimitação de áreas potenciais para corredores ecológicos na sub-bacia hidrográfica do rio das almas (Goiás). 2008. 156. f. Tese (Doutorado em Ciências Florestais)-Universidade de Brasília, Brasília.

Bauer, C., 1999. Padrões atuais de distribuição de aves florestais na região sul do estado do Espírito Santo, Brasil. 158 f. Dissertação (Mestrado em Ciências Biológicas - Zoologia)-Universidade Federal do Rio de Janeiro, Rio de Janeiro.

BRASIL, 2012. Presidência da República. Lei Federal n. 12.651 de 25 de maio de 2012. Dispõe sobre a proteção da vegetação nativa; altera as Leis n^os^ 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis n^os^ 4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória n^o^ 2.166-67, de 24 de agosto de 2001; e dá outras providências. *Diário Oficial da União*, Brasília, DF, 28 maio.

Chetkiewicz, C.L., C.C. Clair, M.S. Boyce, 2006. Corridors for Conservation: IntegratingPatternandProcess. *AnnualReviewofEcology, Evolution, andSystematics*, 37: 317-342.

De BIASE, M.A., 1993. Carta clinográfica: os métodos de representação e sua confecção. *Revista de Geografia*, 6: 45-60.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, 2013. *Sistema brasileiro de classificação de solos*. Rio de Janeiro: EMBRAPA, pp: 355.

Ferrari, J.L., S.F. Silva, A.R. Santos, R.F. Garcia, 2012. Corredores ecológicos potenciais na sub-bacia hidrográfica do córrego Horizonte, Alegre, ES, indicados por meio de SIG. *Agrária*, 7: 133-141.

Gascon, C., G.B. Williamson, G.A.B. Fonseca, 2000. Receding forest edges and vanishing reserves.*Science*, 288: 1356-1358.

Instituto de Pesquisas da Mata Atlântica, 2005. *Conservação da Mata Atlântica no Estado do Espírito Santo: cobertura florestal e unidades de conservação*. Vitória: IPEMA, pp: 152.

Jensen, J.R., 2009. *Sensoriamento remoto do ambiente: uma perspectiva em recursos terrestres*. São José dos Campos: Parênteses, pp: 598.

Klippel, V. H., J.E.M. Pezzopane, J.R.M. Pezzopane, R.A. Cecílio, F.S. Castro, L. Pimenta, 2013. Zoneamento agroclimático para Teca, Cedro Australiano, Nim Indiano e Pupunha no estado do Espírito Santo. *Revista Floresta*, 43: 671-680.

Martinelli, G., M.A. Moraes, 2013. *Livro vermelho da flora do Brasil*. Rio de Janeiro: Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, pp: 1100.

Moser, B., J. Jaeger, U. Tappeiner, E. Tasser, B. Eiselt, 2007. Modification of the effective mesh size for measuring landscape fragmentation to solve the boundary problem. *LandscapeEcology*, 22: 447-459.

Muchailh, M.C., C.V. Roderjan, J.B. CampoS, A.L.T. Machado, G.R. Curcio, 2010. Metodologia de planejamento de paisagens fragmentadas visando a formação de corredores ecológicos. *Revista Floresta,* 40(1): 147-162.

Paz, P.R., A.C. Venturini, 2008. *Estudo da fauna de vertebrados terrestres do verde vale do Itapemirim: Anfíbios, Répteis, Aves e Mamíferos*. Cachoeiro de Itapemirim: Tramirim, pp: 104.

Pereira, M.A.S, N.A.G.S. Neves, D.F.C. Figueiredo, 2007. Considerações sobre a fragmentação territorial e as redes de corredores ecológicos. *Geografia*, v. 16, n. 2.

Ribeiro, M.C., J. P. Metzger, A.C. Martensen, F.J. Ponzoni, M.M. Hirota, 2009. The Brazilian Atlantic Forest: how much is left, and how is the remaining forest distributed?: implications for conservation. *BiologicalConservation*, 142(6): 1141-1153.

Santos, A.R., N.C. Fiedler, M.O. Bauer, G.O. Garcia, J.B.P. Simão, J.B.E. Peluzio, 2013. Comparação fotointerpretativa entre aerofoto e imagem de satélite. *Ciência Florestal*, 23: 539-546.

Seoane, C.E., V.S. Diaz, T.L. Santos, L.C.M. Froufe, 2010. Corredores ecológicos como ferramenta para a desfragmentação de florestas tropicais. *Pesquisa Florestal Brasileira*, 30(63): 207-216.

Veloso, H.P., A.L.R. Rangel Filho, J.C.A. Lima, 1991. *Classificação da vegetação brasileira, adaptada a um sistema universal*. Rio de Janeiro: IBGE, pp: 123.