Conference Volume	6th Symposium for Research in Protected Areas 2 to 3 November 2017, Salzburg	pages 85 - 88

Environmental damages in the Atlantic Forest Biome: A case study

Michele Santa Catarina Brodt[1], Melissa Bergmann[2], Eli Natáli Broman[1], Gabriela Sanfelice[1], Juliana Duarte Ferreira[1], Larissa Lunardi[1], Alexandre Hüller[2], Lenice De Carli[2]

[1] Instituto Federal Farroupilha, Brazil
[2] Biodiversity Department, Rio Grande do Sul State, Brazil

Abstract

We identify the main impacts, drivers, and restoration projects for Atlantic Forest in Northwest of the Rio Grande do Sul State, Brazil. The objective was to analyze the quantity, distribution, and causes of the environmental crimes in the last fourteen years. The main environmental damage found were deforestation outside permanent preservation area (20%) and those related to Permanent Preservation Area (37%). Environmental crimes in these areas fall into two categories: native and exotic vegetation removal (17%), and impediment to natural regeneration (20%). The sizes of degraded fragments were similar among the five municipalities with a major number of environmental crimes. There was a relationship between the size of the degraded fragment and the restored area. An efficient enforcement by forest authorities together with projects of environmental awareness can minimize and prevent these harmful effects on the environment. Atlantic Forest fragments need to be recognized and preserved as an ecosystem with a unique ecological function by the population and public administration.

Keywords

environmental degradation, forest ecosystem, permanent preservation areas, environmental management

Introduction

Among the environmental damage caused by human over-exploitation are deforestation and forest degradation. Causes of deforestation are land clearing for agriculture, logging, fuelwood collection, population growth, and world timber trade (KAMLUN et al. 2016). Forest fires and selective logging destroy capacity carbon stocks, contribute to the greenhouse gasses emissions, have impacts on forest function, change freshwater biodiversity, stream flow and nutrient retention on watersheds, and cause vulnerability of human populations (TSUJINO et al. 2016; OSONE et al. 2016; DOLNÝ et al. 2012; VALIELA et al. 2013; VALENTE-NETO et al. 2015; FUGÉRE et al. 2016; MORRIS et al. 2016). In Brazil, the Atlantic Forest is one of the most threatened ecosystems. The forest stretches along the coast of Brazil, but due to deforestation, this ecosystem is currently distributed in ~245,000 fragments (RIBEIRO et al. 2009). The remaining forests fragments continue to be degraded by illegal land use in protected areas, biodiversity loss or nutrient stock (TABARELLI et al. 2005; VILLELA et al. 2006; NUNES DE OLIVEIRA et al. 2017). Proposed activities for sustainable land use in the Atlantic Forest include rural tourism, natural regeneration or matrix restoration with structural and functional connectivity (URIARTE & CHAZDON 2016; WHEELER et al. 2016; ALVES-PINTO et al. 2017). The aim of this study was to identify the impacts, drivers, and restoration projects for Atlantic Forest in the last fourteen years. Two research questions were defined: 1) Is the number of environmental crimes related to both area and population of the municipality?; 2) Are the sizes of the degraded fragments related to the restored areas?

Materials and Methods

This work was carried out in the Biodiversity Department of the Rio Grande do Sul State/Brazil. It encompasses 43 municipalities located in the Uruguay River Basin, with a population of ~384,000 inhabitants and 48,000 rural establishments. We analyzed environmental crimes from 2000 to 2014 from fines/infractions of administrative processes. We used analysis of variance (ANOVA) to verify differences in environmental damage for the five municipalities with more quantity of crimes. A logarithmic transformation of damaged areas data and a correlation between restored areas and quantity of seedlings planted was used. A Principal Component Analysis (PCA) was performed on the main environmental damages categories and the population of the municipalities.

Results

We analyzed 915 processes containing 1314 environmental damages. Data were distributed into eight categories (Fig. 1). Thirty-eight percent of the environmental damage occurred inside a permanent preservation area (PPA), vs. 62% that was outside of a PPA. The main environmental damage found were *deforestation outside of a PPA* (20%) and those *related to a PPA* (37%). Environmental crimes inside PPAs fall into two categories: *native and exotic vegetation removal* (17%), and *impediment to natural regeneration* (20%). The latter includes livestock grazing in the riparian forest, crops in both riverbanks and wetlands, buildings, and dams. The majority of the environmental crimes occurred in 2012 (11%), followed by 2008, 2010, and 2013.

The sizes of the degraded fragment were similar among the five municipalities with the higher number of environmental crimes (ANOVA: $p > 0.05$, $F = 1.24$; $df = 241$). The mean size of the damaged area and the municipality geographical area were not related ($p > 0.05$). A total of 682 environmental processes were associated with an environmental restoration project, while 230 did not. The size of the degraded fragment was related to the restored area and the number of seedlings planted ($p < 0.001$). A segregation between the less and the most populous municipalities was found with the PCA analysis along PC1 (51.7%), while PC2 represented 19.2 % of the total variation (Fig.2).

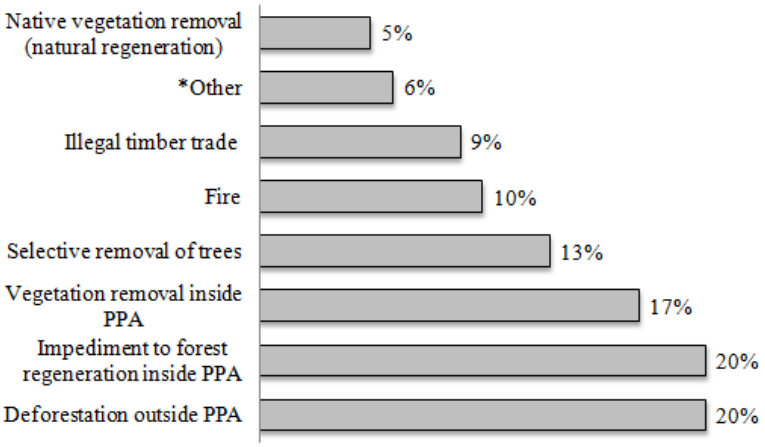

Figure 1: Categories of environmental damages found in the Northwest Rio Grande do Sul State/Brazil from 2000 to 2014. *Other (tree felling without a licence in urban areas, improper waste disposal).

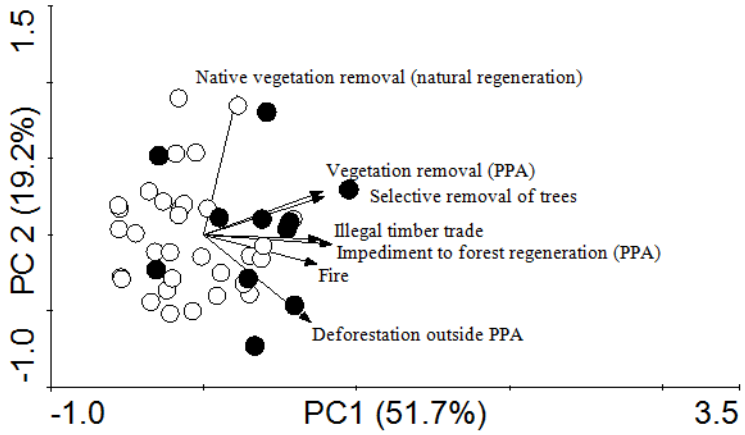

Figure 2: Principal Component Analysis (PCA) of environmental damages and population of the municipalities of the Northwest Rio Grande do Sul State: .....Municipalities with up to 10,000 inhabitants;

Municipalities with more than 10,000 inhabitants.

Discussion

Deforestation drivers both inside and outside of PPAs can be related to agriculture. Although the majority of rural properties in Northwest Rio Grande do Sul State comprise household farmers and subsistence agriculture, 8% of the rural properties are non-family farming and are responsible for the production of larger amounts of soybean, wheat, and corn. Another of the main environmental crime inside of PPAs is removing native and exotic vegetation, regarding mainly to tree plantation of *Eucalyptus sp*. in riparian zones. In the case of protected areas, a licensing is necessary to remove eucalyptus trees, and the area must be recovered by native plants. The size of the degraded areas did not differ significantly between the municipalities, and the average of the areas was 0.10 ha. De Sylos Cintra et al. (2006) also reported that most degraded areas were less than 5 ha in the Cerrado ecosystem. Among municipalities with more environmental crimes, Santa Rosa was the most urbanized (IBGE 2010). Rural exodus has increased in recent years, and the movement of people to the town is associated with great pressures for deforestation and forest degradation (DeFries et al. 2010). Forest restoration projects were based on the native seedling plantation, which objective was the recovery of degraded areas considering different species of plants and the functionality of the system. Strategies for forest restoration include the production of plants resistant to environmental stresses and to allow connectivity and dispersion of forest fragments (Jacobs et al. 2015).

Conclusions

Deforestation and forest degradation have direct or indirect drivers. The most populous municipalities showed the highest number of environmental crimes, and the majority of degraded areas were recovered by planting native seedlings. An efficient enforcement by forest authorities together with projects of environmental awareness can minimize and prevent these harmful effects on the environment. Atlantic Forest fragments need be recognized and preserved as an ecosystem with a unique ecological function by the population and public administration.

References

ALVES-PINTO, H. N., LATAWIEC, A. E., STRASSBURG, B. B. N., BARROS, F. S. M., SANSEVERO, J. B. B., IRIBARREM, A., CROUZEILLES, R., LEMGRUBER, L., C. RANGEL, M. AND SILVA, A. C. P. 2017. Reconciling rural development and ecological restoration: Strategies and policy recommendations for the Brazilian Atlantic Forest, Land Use Policy, 60:419–426. doi: 10.1016/j.landusepol.2016.08.004.

DEFRIES, RUTH S.; RUDEL, THOMAS; URIARTE, MARIA; HANSEN, M. 2010. Deforestation driven by urban population growth and agricultural trade in the twenty-first century, Nature Geoscience, 3:178–181. doi: 10.1038/ngeo756.

DE SYLOS CINTRA, R. H., DOS SANTOS, J. E., MOSCHINI, L. E., PIRES, J. S. R. AND HENKE-OLIVEIRA, C. 2006. Qualitative and quantitative analysis of environmental damages through instauration and registers of lawful documents, Brazilian Archives of Biology and Technology, 49:989–999.

DOLNÝ, A., HARABIS, F., BÁRTA, D., LHOTA, S. AND DROZD, P. 2012. Aquatic insects indicate terrestrial habitat degradation: changes in taxonomical structure and functional diversity of dragonflies in tropical rainforest of East Kalimantan, Tropical Zoology, 25:141–157. doi: 10.1080/03946975.2012.717480.

FUGÈRE, V., KASANGAKI, A. AND CHAPMAN, L. J. 2016. Land use changes in an Afrotropical biodiversity hotspot affect stream alpha and beta diversity, Ecosphere, 7:1–18. doi: 10.1002/ecs2.1355.

IBGE. 2010. Technical information. Rio de Janeiro: IBGE. http://www.ibge.gov.br/home/estatistica/populacao/censo2010/default.shtm. Accessed 20 Jul 2015.

JACOBS, D. F., OLIET, J. A., ARONSON, J., BOLTE, A., BULLOCK, J. M., DONOSO, P. J., LANDHÄUSSER, S. M., MADSEN, P., PENG, S., REY-BENAYAS, J. M. AND WEBER, J. C. 2015 Restoring forests: What constitutes success in the twenty-first century?, New Forests, 46:601–614. doi: 10.1007/s11056-015-9513-5.

KAMLUN, K. U., BÜRGER ARNDT, R. AND PHUA, M. H. 2016. Monitoring deforestation in Malaysia between 1985 and 2013: Insight from South-Western Sabah and its protected peat swamp area, Land Use Policy. 57:418–430. doi: 10.1016/j.landusepol.2016.06.011.

MORRIS, A. L., GUÉGAN, J.-F., ANDREOU, D., MARSOLLIER, L., CAROLAN, K., LE CROLLER, M., SANHUEZA, D. AND GOZLAN, R. E. 2016. Deforestation-driven food-web collapse linked to emerging tropical infectious disease, Mycobacterium ulcerans, Science Advances, 2:1–8. doi: 10.1126/sciadv.1600387.

NUNES DE OLIVEIRA, S., ABÍLIO DE CARVALHO JÚNIOR, O., TRANCOSO GOMES, R. A., FONTES GUIMARÃES, R. AND MCMANUS, C. M. 2017. Deforestation analysis in protected areas and scenario simulation for structural corridors in the agricultural frontier of Western Bahia, Brazil, Land Use Policy. 61:40–52. doi: 10.1016/j.landusepol.2016.10.046.

OSONE, Y., TOMA, T., WARSUDI, SUTEDJO AND SATO, T. 2016. High stocks of coarse woody debris in a tropical rainforest, East Kalimantan: Coupled impact of forest fires and selective logging, Forest Ecology and Management. Elsevier B.V., 374:93–101. doi: 10.1016/j.foreco.2016.04.027.

RIBEIRO, M. C., METZGER, J. P., MARTENSEN, A. C., PONZONI, F. J. AND HIROTA, M. M. 2009. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation, Biological Conservation, 142:1141–1153. doi: 10.1016/j.biocon.2009.02.021.

TABARELLI, M., PINTO, L. P., SILVA, J. M. C., HIROTA, M., BEDE, L. AND JOS, E. 2005. Challenges and opportunities for Biodiversity conservation in the Brazilian Atlantic forest, Conservation Biology, 19:695–700. doi: 10.1111/j.1523-1739.2005.00694.x.

TSUJINO, R., YUMOTO, T., KITAMURA, S., DJAMALUDDIN, I. AND DARNAEDI, D. 2016. History of forest loss and degradation in Indonesia, Land Use Policy. 57:335–347. doi: 10.1016/j.landusepol.2016.05.034.

URIARTE, M. AND CHAZDON, R. L. 2016. Incorporating natural regeneration in forest landscape restoration in tropical regions: synthesis and key research gaps, Biotropica, 48:915–924. doi: 10.1111/btp.12411.

VALENTE-NETO, F., KOROIVA, R., FONSECA-GESSNER, A. A. AND ROQUE, F. DE O. 2015. The effect of riparian deforestation on macroinvertebrates associated with submerged woody debris, Aquatic Ecology, 49:115–125. doi: 10.1007/s10452-015-9510-y.

VALIELA, I., BARTH-JENSEN, C., STONE, T., CRUSIUS, J., FOX, S. AND BARTHOLOMEW, M. 2013. Deforestation of watersheds of Panama: Nutrient retention and export to streams, Biogeochemistry, 115:299–315. doi: 10.1007/s10533-013-9836-2.

VILLELA, D. M., NASCIMENTO, M. T., DE ARAGÃO, L. E. O. C. AND DA GAMA, D. M. 2006. Effect of selective logging on forest structure and nutrient cycling in a seasonally dry Brazilian Atlantic forest, Journal of Biogeography, 33:506–516. doi: 10.1111/j.1365-2699.2005.01453.x.

WHEELER, C. E., OMEJA, P. A., CHAPMAN, C. A., GLIPIN, M., TUMWESIGYE, C. AND LEWIS, S. L. 2016. Carbon sequestration and biodiversity following 18 years of active tropical forest restoration, Forest Ecology and Management, 373:44–55. doi: 10.1016/j.foreco.2016.04.025.

Contact

Melissa Bergmann
biomelis@yahoo.com.br
26, Isidoro Baptista Street, 2º Left
3030-778, Vale das Flores, Coimbra
Portugal
OR
Biodiversity Department
Rua Buriti, nº 175,
98900-000, Centro, Santa Rosa, Rio Grande do Sul
Brazil

Michele Brodt
michele.brodt@iffarroupilha.edu.br; michelebrodt@gmail.com
Instituto Federal Farroupilha
Brazil

Alexandre Huller
alexandre.huller@gmail.com
Biodiversity Department, Rio Grande do Sul State
Brazil