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Forest landscape restoration and local stakeholders: how landowners understand restoration on the farm

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Dissertation presented to obtain the degree of Master in Science. Area: Forest Resources. Option in: Conservation of Natural Ecosystems

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RESUMO

Restauração florestal da paisagem e partes locais interessadas: como os proprietários rurais entendem a restauração na propriedade

Esta dissertação de mestrado trata do estudo da restauração florestal da paisagem (RFP) e a participação das partes locais interessadas (PLI). A RFP é geralmente definida "como o processo de recuperar a funcionalidade ecológica e melhorar o bem-estar humano através da paisagem florestal desmatada ou degradada". As abordagens da RFP apoiam o envolvimento de diferentes atores sociais em processos participativos decisórios. Entre os anos de 2010 e 2014 inúmeras iniciativas foram propostas em escala nacional, regional e global, como o Plano Nacional para Recuperação da Vegetação Nativa (Planaveg) e *Bonn Challenge*, respectivamente, com o intuito de restaurar mais de 350 milhões de hectares de florestas degradadas até o ano de 2030. Em 2019, a Organização das Nações Unidas declarou a década da restauração de ecossistemas, entre os anos de 2021 e 2030. Diante desse cenário, torna-se evidente a necessidade de fomentar a conservação e a restauração da biodiversidade, a mitigação das mudanças climáticas e o bem-estar das pessoas. No entanto, o almejado ganho de escala necessário para que as metas globais sejam alcançadas vai depender, em última instância, das decisões tomadas no nível local, dentro da propriedade rural. No Capítulo 1 se expõe uma introdução geral do trabalho. No Capítulo 2, realizamos uma pesquisa de análise bibliométrica, a nível global, para fornecer uma visão geral das publicações científicas em restauração florestal, RFP e estudos das partes locais interessadas (PLI), e, especificamente, examinar se os estudos (1) reconheceram a relevância dos atores de nível local e (2) coletaram dados primários e/ou secundários sobre as PLI através de diferentes métodos, de publicações relacionadas desde 2000. Foi observado que, somente 50% (99 registros) dos estudos reconheceram a relevância dos atores do nível local e também coletaram dados primários e/ou secundários através de diferentes métodos. No Capítulo 3, determinamos os fatores socioecológicos que levaram as propriedades rurais de diferentes tamanhos (pequenas, médias e grandes), localizadas no estado de São Paulo, sob domínio dos biomas Mata Atlântica e Cerrado, a diminuir (desmatamento), manter (conservação) e/ou aumentar (regeneração natural e/ou restauração florestal) a área de cobertura florestal nativa (CFN) nas propriedades nos últimos 35 anos, e os benefícios/desvantagens da CFN percebidos pelos proprietários. Neste capítulo, foi observado que i) pequenos, médios e grandes proprietários rurais reportaram razões para diminuir, aumentar e manter a CFN dentro de suas propriedades, com grandes proprietários reportando mais razões para diminuir; ii) a percepção dos proprietários sobre os benefícios providos pela floresta nativa se difere entre os proprietários rurais, com pequenos e médios proprietários percebendo mais benefícios e; iii) as características do proprietário rural e da propriedade afetam os benefícios percebidos. No tópico final, apresentamos uma discussão e conclusão geral da dissertação.

Palavras-chave: Mapeamento bibliométrico, Análise de rede, VOSviewer, Restauração florestal, Razões para restaurar, Serviços ecossistêmicos, Percepção, Proprietários rurais, Partes interessadas locais

ABSTRACT

Forest landscape restoration and local stakeholders: how landowners understand restoration on the farm

This master's dissertation deals with the study of forest landscape restoration (FLR) and the participation of local stakeholders (LS). FLR is generally defined "as the process of restoring ecological functionality and improving human well-being across the deforested or degraded forest landscape". FLR approaches support the involvement of different social actors in participatory decision-making processes. Between the years 2010 and 2014 numerous initiatives were proposed on a national, regional, and global scale, such as the National Plan for Native Vegetation Recovery (Planaveg) and *Bonn Challenge*, respectively, aiming to restore more than 350 million hectares of degraded forests by the year 2030. In 2019, the United Nations declared the decade of ecosystem restoration, between the years 2021 and 2030. Given this scenario, the need to promote biodiversity conservation and restoration, climate change mitigation, and people's well-being becomes evident. However, the desired gain in scale needed to achieve the global goals will ultimately depend on the decisions taken at the local level, within the farm. In Chapter 1, a general introduction to the work is presented. In Chapter 2, we conducted a bibliometric analysis survey, on a global level, to provide an overview of scientific publications on forest restoration, FLR, and local stakeholder (LS) studies, and specifically examine whether studies (1) recognized the relevance of local-level actors and (2) collected primary and/or secondary data on LS through different methods, from related publications since 2000. It was observed that, only 50% (99 records) of the studies recognized the relevance of local level actors and also collected primary and/or secondary data through different methods. In Chapter 3, we determined the social-ecological factors that led different-sized farms (small, medium, and large) to decrease (deforestation), maintain (conservation) and/or increase (natural regeneration and/or forest restoration) native forest cover (NFC) area on their farms in the past 35 years, and the perceived benefits or disadvantages of NFC. In this chapter, it was observed that i) small, medium and large scale farmers have reported reasons to decrease, increase and maintain NFC within their properties, with large farmers reporting more reasons to decrease; ii) the perception of farmers on benefits provided by native forest differs among farmers, with small and medium farmers perceiving more benefits and; (iii) farmers and farms characteristics affect the benefits perceived. In the final topic, we present a general conclusion of the dissertation.

Keywords: Bibliometric mapping, Network analysis, VOSviewer, Forest restoration, Reasons to restore, Ecosystem services, Perception, Landowners, Local stakeholders

1. INTRODUCTION: CHAPTER 1

In 2000, the term "forest landscape restoration" (FLR) was first defined as the aim to restore forests at a landscape level and meet both human needs and ecological priorities. It was coined to combine biodiversity conservation and production while serving ecological and economic interests, important aspects that ecological restoration alone did not cover properly [1,2]. According to the Global Partnership for Forest Landscape Restoration (GPFLR), FLR is characterized as being an active and participatory process that integrates people in order to identify, negotiate, and implement practices that restore the balance between ecological, social, and economic benefits of forests and trees embedded in a more comprehensive pattern of land use [3]. At the landscape level, the goal of FLR is to restore ecological functionality and enable improvements to human well-being, especially in degraded landscapes [4].

We currently face challenges in transforming degraded and unproductive lands in to functional landscapes and restored ecosystems that promote multiple benefits to society and future generations. FLR seeks a balance between restoring ecosystem services such as wildlife biodiversity, habitats, water regulation, carbon storage, and supporting the productive functions of land for agriculture and other relevant uses [5]. Furthermore, successful FLR opposes environmental degradation, strengthens landscape resilience, and protects forest-based livelihoods to meet the changing needs of society [6]. The path to FLR needs to be built on solid ground and present a holistic vision, addressing economic, cultural, and political issues, engaging social actors ranging from farmers to smallholders, local communities, forestry agencies, business leaders, policy makers and politicians [7–9]. The local stakeholder's (LS) participation and active engagement in planning restoration interventions is fundamental to restoration initiatives [7–11]. However, engaging LS in both the planning, implementation and monitoring of restoration initiatives is a major challenge, whether in research or in practice [9,12,13].

FLR is centred on the people who live and work in the landscape and whose livelihoods will benefit from and diversify through restoration activities [14]. Thus, restoration decisions at the landscape level necessarily involve stakeholders with different interests, such as rural communities, environmental groups, forest owners, local authorities [8], and stakeholders above the landscape level. In this context, processes to allow LS to present their needs, priorities, and expectations, through constructive discussions for negotiated solutions, are fundamental [15] but also a challenge. When

stakeholder engagement is poor and/or interpersonal relationships are fragile, tenuous involvement towards FLR might fall apart once project funding runs out [8].

Conducting research to understand who the social actors that live in the landscape are (involving social and interdisciplinary sciences) and developing participatory research with co-construction of knowledge contributes to the success of restoration initiatives, in particular, with local stakeholders such as landowners, rural owners, farmers and smallholders, as they are key decision makers for forest restoration on private or communal properties. However, there is still a knowledge gap as to what extent local level actors have been involved in FLR initiatives, and what the main lessons learned are.

In this context, bibliometric methods have been used in qualitative approaches to organise, monitor, describe, and evaluate documents from literature reviews [16]. For example, Bibliometric Mapping analysis (BM) reports the structure of scientific literature using information on authors, countries, organisations, citations or keywords shared among articles. It can also present the impact or influence of a single study on the broader literature, using data on the number and nature of citations that it receives [16,17]. BM has benefitted from recent advances in (big) data text mining and network analysis [16–18] and allows the analysis of changes in the network of publications throughout time, documenting and visualising the progress of a particular scientific field through quantitative and qualitative parameters [19–21].

In this study, we conducted a bibliometric analysis to provide an overview of scientific publications in forest restoration and FLR that (1) recognised the relevance of the local level actors and (2) collected primary and/or secondary data on LS through different methods.

2. CONCLUSIONS: CHAPTER 1

In conclusion, this paper presented a bibliometric analysis of forest restoration, FLR and LS studies in the literature, using WoS and Scopus as bibliographic sources. It was possible to notice an increase in the number of publications on the topic under study from 2014, with more than 10 studies registered per year, representing a recent and developing trend of international interest. However, the studies that recognised the relevance of the stakeholders at the local level were few: only 50% of the articles under study and 25% of the top 20 most cited papers, indicating that there is still a research gap in this topic in which local actors need to be directly involved.

Our bibliometric analysis' limitation was in downloading the articles, as the research areas of the articles were not available, despite us trying to download the articles retrieved more than three times. Furthermore, we used the keywords (landowner, rural owner, farmer, livelihood and smallholder) to represent the LS, which allowed us to perform the analyses and present an important result within the study's theme; however, other keywords that refer to the LS could also be added. We used Web of Science and Scopus as the main bibliographic sources, although we recommend that future studies consider other bibliographic sources to ensure that more articles and journals are covered. Based on our findings, the papers under study addressed the participation of LS in forest restoration, and this approach is important; however, we recommend a more direct involvement and participation of LS in order to increase the number of publications that recognize the relevance of the local level actors collecting primary and/or secondary data on them, as well as the participation of interdisciplinary and social science researchers in teams investigating FLR and the success restoration of the landscape, providing ecological functionality and enabling improvements to human well-being.

REFERENCES

1. WWF. *IUCN Minutes from the Workshop on Forests Reborn in Segovia*; WWF: Gland, Switzerland, 2000.
2. Mansourian, S.; Berrahmouni, N.; Blaser, J.; Dudley, N.; Maginnis, S.; Mumba, M.; Vallauri, D. Reflecting on Twenty Years of Forest Landscape Restoration. *Restor. Ecol.* **2021**, *29*, e13441.
3. Stanturf, J.A.; Kleine, M.; Mansourian, S.; Parrotta, J.; Madsen, P.; Kant, P.; Burns, J.; Bolte, A. Implementing Forest Landscape Restoration under the Bonn Challenge: A Systematic Approach. *Ann. For. Sci.* **2019**, *76*, 50.
4. Lamb, D. *Large-Scale Forest Restoration*; Routledge: London, UK, 2014; ISBN 978-1-135-09606-9.
5. McGuire, D. *Human Resource Development*; SAGE: Thousand Oaks, CA, USA, 2014; ISBN 978-1-4739-0556-6.
6. IUCN; WRI. *A Guide to the Restoration Opportunities Assessment Methodology (ROAM): Assessing Forest Landscape Restoration Opportunities at the National or Sub-National Level*; Working Paper (Road-test edition); IUCN: Gland, Switzerland, 2014.
7. Chazdon, R.; Brancalion, P.; Lamb, D.; Laestadius, L.; Calmon, M.; Kumar, C. A Policy-Driven Knowledge Agenda for Global Forest and Landscape Restoration. *Conserv. Lett.* **2015**, *10*, 125–132.
8. Mansourian, S. Governance and Forest Landscape Restoration: A Framework to Support Decision-Making. *J. Nat. Conserv.* **2017**, *37*, 21–30.
9. van Oosten, C.; Moeliono, M.; Wiersum, F. From Product to Place—Spatializing Governance in a Commodified Landscape. *Environ. Manag.* **2018**, *62*, 157–169.

10. Adams, C.; Rodrigues, S.T.; Calmon, M.; Kumar, C. Impacts of Large-Scale Forest Restoration on Socioeconomic Status and Local Livelihoods: What We Know and Do Not Know. *Biotropica* **2016**, *48*, 731–744.
11. Lazos, E.; Zinda, J.; Bennett, A.; Balvanera, P.; Bloomfield (née Paul), G.; Lindell, C.; Negra, C. Stakeholders and Tropical Reforestation: Challenges, Tradeoffs, and Strategies in Dynamic Environments. *Biotropica* **2016**, *48*, 900–914.
12. Arts, B.; Buizer, M.; Horlings, L.; Ingram, V.; van Oosten, C.; Opdam, P. Landscape Approaches: A State-of-the-Art Review. *Annu. Rev. Environ. Resour.* **2017**, *42*, 439–463.
13. Adams, C.; de Araujo, L.G.; Sanches, R.A.; Futemma, C.R.T.; Buzati, J.R.; Sanches, V.H.; Macedo, G.S.S.R. Governança da restauração florestal da paisagem no Brasil: Desafios e oportunidades. *Desenvolv. E Meio Ambiente* **2021**, 58.
14. Chazdon, R.L.; Uriarte, M. Natural Regeneration in the Context of Large-scale Forest and Landscape Restoration in the Tropics. *Biotropica* **2016**, *48*, 709–715.
15. Sayer, J.; Bull, G.; Elliott, C. Mediating Forest Transitions: Grand Design or Muddling Through. *Conserv. Soc.* **2008**, *6*, 320–327.
16. Zupic, I.; Čater, T. Bibliometric Methods in Management and Organization. *Organ. Res. Methods* **2015**, *18*, 429–472.
17. Cobo, M.J.; López-Herrera, A.G.; Herrera-Viedma, E.; Herrera, F. An Approach for Detecting, Quantifying, and Visualizing the Evolution of a Research Field: A Practical Application to the Fuzzy Sets Theory Field. *J. Informetr.* **2011**, *5*, 146–166.
18. Westgate, M.J.; Barton, P.S.; Pierson, J.C.; Lindenmayer, D.B. Text Analysis Tools for Identification of Emerging Topics and Research Gaps in Conservation Science. *Conserv. Biol.* **2015**, *29*, 1606–1614.
19. Zhang, Y.; Chen, Y. Research Trends and Areas of Focus on the Chinese Loess Plateau: A Bibliometric Analysis during 1991–2018. *CATENA* **2020**, *194*, 104798.
20. Garfield, E. From Citation Indexes to Informetrics: Is the Tail Now Wagging the Dog? *Libre* **1998**, *48*, 67–80.
21. Zhang, W.; Qian, W.; Ho, Y.-S. A Bibliometric Analysis of Research Related to Ocean Circulation. *Scientometrics* **2009**, *80*, 305–316.
22. Web of Science. Available online: **www.webofscience.com** (accessed on 12 October 2022).
23. Boudry, C.; Baudouin, C.; Mouriaux, F. International Publication Trends in Dry Eye Disease Research: A Bibliometric Analysis. *Ocul. Surf.* **2018**, *16*, 173–179.
24. Scopus Scopus Preview. Available online: **https://www.scopus.com/home.uri** (accessed on 12 October 2022).
25. Archambault, É.; Campbell, D.; Gingras, Y.; Larivière, V. Comparing Bibliometric Statistics Obtained from the Web of Science and Scopus. *J. Am. Soc. Inf. Sci. Technol.* **2009**, *60*, 1320–1326.
26. Romanelli, J.P.; Fujimoto, J.T.; Ferreira, M.D.; Milanez, D.H. Assessing Ecological Restoration as a Research Topic Using Bibliometric Indicators. *Ecol. Eng.* **2018**, *120*, 311–320.
27. Martíni, A.F.; Valani, G.P.; Boschi, R.S.; Bovi, R.C.; Simões da Silva, L.F.; Cooper, M. Is Soil Quality a Concern in Sugarcane Cultivation? *A Bibliometric Review. Soil Tillage Res.* **2020**, *204*, 104751.

28. Romanelli, J.P.; Meli, P.; Naves, R.P.; Alves, M.C.; Rodrigues, R.R. Reliability of Evidence-Review Methods in Restoration Ecology. *Conserv. Biol.* **2021**, *35*, 142–154.
29. Garfield, E. KeyWords Plus Takes You beyond Title Words. Part 2. *Expand. J. Cover. Curr. Contents Diskette Incl. Soc. Behav. Sci.* **1990**, *33*, 5–9.
30. Zhang, Y.; Yao, X.; Qin, B. A Critical Review of the Development, Current Hotspots, and Future Directions of Lake Taihu Research from the Bibliometrics Perspective. *Environ. Sci. Pollut. Res.* **2016**, *23*, 12811–12821.
31. Fu, H.-Z.; Fang, K.; Fang, C.-L. Characteristics of Scientific Impact of Resources Conservation and Recycling in the Past 30 Years. *Resour. Conserv. Recycl.* **2018**, *137*, 251–259.
32. Stirbu, S.; Thirion, P.; Schmitz, S.; Haesbroeck, G.; Greco, N. The Utility of Google Scholar When Searching Geographical Literature: Comparison With Three Commercial Bibliographic Databases. *J. Acad. Librariansh.* **2015**, *41*, 322–329.
33. R Development Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2019.
34. Meho, L.I.; Yang, K. Impact of Data Sources on Citation Counts and Rankings of LIS Faculty: Web of Science versus Scopus and Google Scholar. *J. Am. Soc. Inf. Sci. Technol.* **2007**, *58*, 2105–2125.
35. VOSviewer Visualizing Scientific Landscapes. Available online: **https://www.vosviewer.com//** (accessed on 12 October 2022).
36. Cobo, M.J.; Chiclana, F.; Collop, A.; de Ona, J.; Herrera-Viedma, E. A Bibliometric Analysis of the Intelligent Transportation Systems Research Based on Science Mapping. *IEEE Trans. Intell. Transport. Syst.* **2014**, *15*, 901–908.
37. van Eck, N.J.; Waltman, L. Software Survey: VOSviewer, a Computer Program for Bibliometric Mapping. *Scientometrics* **2010**, *84*, 523–538.
38. Van Eck, N.J.; Waltman, L. Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics* **2017**, *111*, 1053–1070.
39. Leopold, A.C.; Andrus, R.; Finkeldey, A.; Knowles, D. Attempting Restoration of Wet Tropical Forests in Costa Rica. *For. Ecol. Manag.* **2001**, *142*, 243–249.
40. Kamwenda, G.J. Ngitili Agrosilvipastoral Systems in the United Republic of Tanzania. *Unasylva 211* **2002**, *53*, 5.
41. Combalicer, E.A.; Perez, M.R.; Im, S.; Combalicer, M.S.; Ahn, S. Realities of Forest Landscape Restoration: The Case of Barobbob Watershed, Philippines. *For. Sci. Technol.* **2007**, *3*, 117–122.
42. Suding, K.; Higgs, E.; Palmer, M.; Callicott, J.B.; Anderson, C.B.; Baker, M.; Gutrich, J.J.; Hondula, K.L.; LaFevor, M.C.; Larson, B.M.H.; et al. Committing to Ecological Restoration. *Science* **2015**, *348*, 638–640.
43. Orsi, F.; Geneletti, D. Identifying Priority Areas for Forest Landscape Restoration in Chiapas (Mexico): An Operational Approach Combining Ecological and Socioeconomic Criteria. *Landsc. Urban Plan.* **2010**, *94*, 20–30.
44. Le, H.D.; Smith, C.; Herbohn, J.; Harrison, S. More than Just Trees: Assessing Reforestation Success in Tropical Developing Countries. *J. Rural Stud.* **2012**, *28*, 5–19.
45. Richards, R.C.; Rerolle, J.; Aronson, J.; Pereira, P.H.; Gonçalves, H.; Brancalion, P.H.S. Governing a Pioneer Program on Payment for Watershed Services: Stakeholder Involvement, Legal Frameworks and Early Lessons from the Atlantic Forest of Brazil. *Ecosyst. Serv.* **2015**, *16*, 23–32.

46. Vieira, D.L.M.; Holl, K.D.; Peneireiro, F.M. Agro-Successional Restoration as a Strategy to Facilitate Tropical Forest Recovery. *Restor. Ecol.* **2009**, *17*, 451–459.
47. Azevedo, A.A.; Rajão, R.; Costa, M.A.; Stabile, M.C.C.; Macedo, M.N.; Dos Reis, T.N.P.; Alencar, A.; Soares-Filho, B.S.; Pacheco, R. Limits of Brazil's Forest Code as a Means to End Illegal Deforestation. *Proc. Natl. Acad. Sci. USA* **2017**, *114*, 7653–7658.
48. He, J.; Sikor, T. Notions of Justice in Payments for Ecosystem Services: Insights from China's Sloping Land Conversion Program in Yunnan Province. *Land Use Policy* **2015**, *43*, 207–216.
49. Huang, L.; Shao, Q.; Liu, J. Forest Restoration to Achieve Both Ecological and Economic Progress, Poyang Lake Basin, China. *Ecol. Eng.* **2012**, *44*, 53–60.
50. Liu, X.; Zhang, L.; Hong, S. Global Biodiversity Research during 1900–2009: A Bibliometric Analysis. *Biodivers. Conserv.* **2011**, *20*, 807–826.
51. Wang, H.; Liu, M.; Hong, S.; Zhuang, Y. A Historical Review and Bibliometric Analysis of GPS Research from 1991–2010. *Scientometrics* **2013**, *95*, 35–44.
52. Li, L.-L.; Ding, G.; Feng, N.; Wang, M.-H.; Ho, Y.-S. Global Stem Cell Research Trend: Bibliometric Analysis as a Tool for Mapping of Trends from 1991 to 2006. *Scientometrics* **2009**, *80*, 39–58.
53. Guo, L.; Xu, F.; Feng, Z.; Zhang, G. A Bibliometric Analysis of Oyster Research from 1991 to 2014. *Aquacult. Int.* **2016**, *24*, 327–344.
54. Medina-Mijangos, R.; Seguí-Amórtegui, L. Research Trends in the Economic Analysis of Municipal Solid Waste Management Systems: A Bibliometric Analysis from 1980 to 2019. *Sustainability* **2020**, *12*, 8509.
55. Chuang, K.-Y.; Huang, Y.-L.; Ho, Y.-S. A Bibliometric and Citation Analysis of Stroke-Related Research in Taiwan. *Scientometrics* **2007**, *72*, 201–212.
56. Brancalion, P.H.S.; Chazdon, R.L. Beyond Hectares: Four Principles to Guide Reforestation in the Context of Tropical Forest and Landscape Restoration. *Restor. Ecol.* **2017**, *25*, 491–496.
57. Brancalion, P.H.S.; Schweizer, D.; Gaudare, U.; Mangueira, J.R.; Lamonato, F.; Farah, F.T.; Nave, A.G.; Rodrigues, R.R. Balancing economic costs and ecological outcomes of passive and active restoration in agricultural landscapes: The case of Brazil. *Biotropica* **2016**, *48*, 856–867.
58. Mansourian, S. Understanding the Relationship between Governance and Forest Landscape Restoration. *Connservation Soc.* **2016**, *14*, 267–278.
59. Guariguata, M.R.; Brancalion, P.H.S. Current Challenges and Perspectives for Governing Forest Restoration. *Forests* **2014**, *5*, 3022–3030.
60. Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action*; Cambridge University Press: Cambridge, UK, 1990.
61. Lopez, M.C.; Moran, E.F. The Legacy of Elinor Ostrom and Its Relevance to Issues of Forest Conservation. *Curr. Opin. Environ. Sustain.* **2016**, *19*, 47–56.
62. Brondizio, E.S.; Ostrom, E.; Young, O.R. Connectivity and the Governance of Multilevel Social-Ecological Systems: The Role of Social Capital. *Annu. Rev. Environ. Resour.* **2009**, *34*, 253–278.
63. Viani, R.A.G.; Bracale, H.; Taffarello, D. Lessons Learned from the Water Producer Project in the Atlantic Forest, Brazil. *Forests* **2019**, *10*, 1031.

3. INTRODUCTION: CHAPTER 2

The global restoration movement has gained momentum in the last 20 years, notably the concept of Forest Landscape Restoration (FLR) (Chazdon et al. 2015; Holl 2017; Zahawi et al. 2014). FLR is generally defined 'as the process of regaining ecological functionality and enhancing human wellbeing across deforested or degraded forest landscape' (Adams et al. 2016; IUCN 2017). In its core, FLR aligns biodiversity conservation (Rother et al. 2019) with livelihood development goals at the landscape level. FLR has been incorporated into many commitments, such as the Bonn Challenge in 2014 at global level (IUCN 2011) and the National Plan for Recovery of Native Vegetation (Planaveg) in Brazil, implemented in 2017 (Brasil 2012). Although many FLR projects highlighted the importance of socio-economic development, the implications of landscape restoration approaches in rural livelihoods and other social stakeholders (e.g., farmers) across the tropics remain understudied (Adams et al. 2016; Erbaugh et al. 2020; Reed et al. 2016).

The FLR vision of linking the production of ecosystem services with human well-being is aligned with the conceptual framework of the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES) (Díaz et al. 2015), which makes explicit the complex and inter-scale interactions existing in social-ecological systems (SES). SES are complex adaptive systems formed by the coupling of human and ecological systems that co-evolve through the interactions between actors, institutions (understood as the rules of the system, formal or informal) and natural resources (Schlüter et al. 2012), and occur on multiple spatial and temporal scales (Ostrom 2009). Rural landscapes are an example of these complex social-ecological adaptive systems, since farmers' decisions about the use of their farmland areas are affected by internal domestic unit issues, as well as by contextual factors at other levels and scales.

Increasing forest cover in a manner integrated with agricultural activities is considered a more suitable alternative than only restoring degraded areas, since the combination of both activities can enable income generation for farmers and promote social and economic development in tropical and subtropical landscapes (Brancalion et al. 2017; Ceccon 2013). Therefore, landowners are the ones who play a key role in making decisions for land-use management on their properties, considering their income, preferences and perspectives, as well as regional ecological characteristics (Defries et al. 2004) and the policy context in which they are embedded. Their decisions to intervene in

ecosystems at the local scale leads to externalities that go beyond the boundaries of their farms (Padovezi et al. 2022), influencing the provision of ecosystem services at the landscape level where they are located (de Groot et al. 2010). Consequently, landowners need to be seen as key players both in research and development programs aiming to conserve and restore ecosystems, biodiversity, and the provision of ecosystem services (Bennett et al. 2017; Campos et al. 2012). Taking into account the interests of different stakeholder groups may enable better connections between science, policy and practice (Braat et al. 2012). Therefore, it is fundamental to understand the perceptions of farmers about ecosystem services and their decision-making process.

The rising interest in FLR has led many studies to designate regions of highest priority and optimal conditions for ecological restoration as global restoration hotspots (Brancalion et al. 2019; Strassburg et al. 2020; Tambosi et al. 2014). In this context, the Brazilian Atlantic forest is regarded as one of the most degraded biomes (Brancalion et al. 2019; Joly et al. 2014). Despite critical degradation and fragmentation it has faced (Joly et al. 2014; Ribeiro et al. 2009), it still maintains the emblematic status of a hotspot for biodiversity conservation and for the provision of essential ecosystem services to millions of urban and rural Brazilians, including water supply and climate regulation (Joly et al. 2014). However, it is necessary to adopt restoration prioritization strategies at multiple levels (landscape, municipality, state and biome) (Mello et al. 2022), that also consider local land tenure and development priorities (Fernandes et al. 2022).

The New Forest Act (Native Vegetation Protection Law N° 12.651/2012) is the main Brazilian policy to protect native vegetation on private lands, which comprise 54% of the remaining Brazilian native vegetation (Brasil 2012). The law requires the establishment of Permanent Preservation Areas (APP), corresponding mostly to riparian vegetation, and of Legal Reserves (LR), corresponding to a given percentage of the farm area that must be covered by native vegetation. This percentage varies from 20% to 80%, depending on the biome. In the Atlantic forest this percentage is 20%. In São Paulo state (Brazil), there is an estimated APP deficit of 768,580 ha (111,785 ha in the Cerrado and 656,795 ha in the Atlantic forest) and 367,403 ha of Legal Reserve deficit (54,890 ha in the Cerrado and 312,513 ha in the Atlantic forest), totaling 1.14 Mha of native vegetation deficit to be restored and/or compensated for (Mello et al. 2022). In Brazil, aligned with the New Forest Act, the Rural Environmental Registry (abbreviated CAR in Portuguese) is a platform to register all rural properties and integrate environmental information from each farm regarding to APP, LR, restricted use areas, forest remnants and other forms of

native vegetation, to create a database for control, monitoring, environmental and economic planning and combating deforestation (Brasil 2012).

In this study, we use São Paulo state as a case study to better understand the farm-level (local) social-ecological factors that influenced land-use decisions in tropical agricultural systems in the Atlantic forest region from 1985-2020 and the benefits/disadvantages of native forest cover (NFC) as perceived by farmers. To do so, we seek to answer the following research questions: (1) What are the underlying reasons for farmers of different size farms (small, medium, and large) to decrease (deforestation), maintain (conservation) and increase (natural regeneration and/or forest restoration) native forest cover (NFC) area in their properties between 1985 and 2020? (2) What benefits or disadvantages related to NFC are perceived by farmers? (3) Do farmers and farms characteristics affect the benefits perceived?

4. CONCLUSIONS: CHAPTER 2

Our study highlights the reasons identified by farmers for the decrease (deforestation), maintenance (conservation) and increase (natural regeneration and/or forest restoration) the native forest cover (NFC) between 1985 and 2020, in São Paulo state, Brazil. Understanding the differences and similarities among the reasons is an important step to engage policymakers, different stakeholders and institutions (e.g., landowners and governmental organizations), research and projects on forest restoration landscape and local level (e.g., farm level). The main reasons identified by farmers for a decrease in NFC were “government incentives”, “increase agricultural area”, “increase owner income” and “greed of man”. Whereas the main reasons for conserving and restoring are “water conservation”, “legislation compliance” and “rural environmental registry”. Farmers recognized the importance of NFC to provide ecosystem services and perceived 16 benefits. Ecosystem services of provision (e.g., water supply, conservation of springs, soil conservation) and regulation (e.g., biodiversity, shadow) were the most perceived by farmers. However, landowners that live on the farm also perceived cultural ecosystems services such as “recreation”, “health” and “improves quality of life”, especially small farmers. Support by policies and institutions is needed to promote forest landscape restoration strategies and provide favorable socio-economic conditions for farmers to integrate agriculture and forest conservation and restoration. Based on our findings, we recommend that this research be applied in other regions of Brazil and the

around the world, so that we can determine and comprehend the social-ecological factors that led different stakeholders (e.g., local, regional and national level) to decrease, maintain and/or increase NFC and, if possible, survey the benefits/disadvantages of NFC as perceived by farmers, and contribute to the process of regaining ecological functionality and enhancing human wellbeing across deforested or degraded forest landscape.

Our research limitations were the overlap any differences between farm sizes, considering that the farms under study range in farm size from small (16-76 ha); medium (61-312 ha) and large (216-9,080 ha). However, this cannot be avoided because we followed the categorization of the National Institute of Colonization and Agrarian Reform (known as Incra in Brazil), which the fiscal module varies in hectares for each municipality (Supplementary Material Table S1), due to the criteria used by Incra for its calculation (EMBRAPA 2022), previously presented. Furthermore, the interviews took place during the pandemic period and for this research to be conducted, 54% of the interviews took place online. On the large farms (sample=30), 60% of the interviews (18) were conducted with the people in charge of the farm and not the farm owners. The owners of the large farms do not live on the property (Figure 6) and have employees that represent them and make decisions for the farm. Despite these limitations we got a good impression of the drivers of the decisions of the farmers in this region to opt for changes in forest cover, which together with farmer's views on ecosystem services, presents informed input for further developing realistic and goal-oriented forest restoration strategies.

REFERENCES

Adams, Cristina et al. 2021. 'Governança da restauração florestal da paisagem no Brasil: desafios e oportunidades'. *Desenvolvimento e Meio Ambiente* 58(0). https://revistas.ufpr.br/made/article/view/78415 (September 26, 2022).

Adams, Cristina, Sidney T. Rodrigues, Miguel Calmon, and Chetan Kumar. 2016. 'Impacts of Large-Scale Forest Restoration on Socioeconomic Status and Local Livelihoods: What We Know and Do Not Know'. *Biotropica* 48(6): 731–44.

Bennett, Nathan J. et al. 2017. 'Conservation Social Science: Understanding and Integrating Human Dimensions to Improve Conservation'. *Biological Conservation* 205: 93–108.

Borda-Niño et al. 2021. 'Integrating Farmers' Decisions on the Assessment of Forest Regeneration Drivers in a Rural Landscape of Southeastern Brazil'. *Perspectives in ecology and conservation* 19(3): 338–44.

Braak, C. J. F. ter, and P. Smilauer. 2012. 'Canoco Reference Manual and User's Guide: Software for Ordination, Version 5.0'. https://research.wur.nl/en/publications/canoco-reference-manual-and-users-guide-software-for-ordination-v (October 7, 2022).

Braat, Leon C., and Rudolf de Groot. 2012. 'The Ecosystem Services Agenda:Bridging the Worlds of Natural Science and Economics, Conservation and Development, and Public and Private Policy'. *Ecosystem Services* 1(1): 4–15.

Brancalion, P H S, R A G Viani, B B N Strassburg, and R R Rodrigues. 2012. 'Finding the Money for Tropical Forest Restoration'. *Unasylva* 63: 10.

Brancalion, Pedro H. S. et al. 2019. 'Global Restoration Opportunities in Tropical Rainforest Landscapes'. *Science Advances* 5(7): eaav3223.

Brancalion, Pedro H. S., and Robin L. Chazdon. 2017. 'Beyond Hectares: Four Principles to Guide Reforestation in the Context of Tropical Forest and Landscape Restoration'. *Restoration Ecology* 25(4): 491–96.

Brancalion, Pedro, and Juliano van Melis. 2017. 'On the Need for Innovation in Ecological Restoration'. *Annals of the Missouri Botanical Garden* 102: 227–36.
Brasil. 2012. 'L12651'. https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm (September 12, 2022).

Cameron, Alison. 2018. 'Restoration of Ecosystems and Ecosystem Services.'

Campos, M. et al. 2012. 'Rural People's Knowledge and Perception of Landscape: A Case Study from the Mexican Pacific Coast'. *Society & natural resources* 25(8): 759–74.

Ceccon, Eliane. 2013. *Restauración En Bosques Tropicales: Fundamentos Ecológicos, Prácticos y Sociales*.

Chazdon, Robin et al. 2015. 'A Policy-Driven Knowledge Agenda for Global Forest and Landscape Restoration'. *Conservation Letters* 10: n/a-n/a.

Costanza et al. 2017. 'Twenty Years of Ecosystem Services: How Far Have We Come and How Far Do We Still Need to Go? | Elsevier Enhanced Reader'. https://reader.elsevier.com/reader/sd/pii/S2212041617304060?token=B425E3AC281B18259CA1F7AF8A87A81856FEA74976391602A4F7FF66B08B0403E2BE6893CE26DF6773A01A1E60E10F33&originRegion=eu-west-1&originCreation=20220901121029 (September 1, 2022).

Costanza, Robert et al. 1997. 'The Value of the World's Ecosystem Services and Natural Capital'. *Nature* 387(6630): 253–60.

Defries, Ruth, Jonathan Foley, and Gregory Asner. 2004. 'Land-Use Choices: Balancing Human Needs and Ecosystem Function'. *Frontiers in Ecology and the Environment* 2: 249.

Díaz, Sandra et al. 2015. 'The IPBES Conceptual Framework — Connecting Nature and People'. *Current Opinion in Environmental Sustainability* 14: 1–16.

van Eck, Nees Jan, and Ludo Waltman. 2010. 'Software Survey: VOSviewer, a Computer Program for Bibliometric Mapping'. *Scientometrics* 84(2): 523–38.

EMBRAPA. 2022. 'Módulos Fiscais - Portal Embrapa'. https://www.embrapa.br/codigo-florestal/area-de-reserva-legal-arl/modulo-fiscal (August 29, 2022).

Erbaugh, J. T. et al. 2020. 'Global Forest Restoration and the Importance of Prioritizing Local Communities'. *Nature Ecology & Evolution* 4(11): 1472–76.

Fernandes, Amanda Augusta et al. 2022. 'Forest Landscape Restoration and Local Stakeholders: A Global Bibliometric Mapping Analysis'. *Sustainability* 14(23): 16165.

Fredo, Carlos Eduardo, and Malimiria Norico Otani. 2009. 'CARACTERIZAÇÃO PRELIMINAR DA AGRICULTURA FAMILIAR NO ESTADO DE SÃO PAULO'. 45(6): 21.

Gamborg, Christian, Jonas Morsing, and Karsten Raulund-Rasmussen. 2019. 'Adjustive Ecological Restoration through Stakeholder Involvement: A Case of Riparian Landscape Restoration on Privately Owned Land with Public Access'. *Restoration Ecology* 27(5): 1073–83.

GPFRL. 2019. 'The Global Partnership on Forest and Landscape Restoration - GPFLR |Policy Support and Governance| Food and Agriculture Organization of the United Nations'. https://www.fao.org/policy-support/mechanisms/mechanisms-details/en/c/448118/ (October 26, 2022).

de Groot, R. S. et al. 2010. 'Challenges in Integrating the Concept of Ecosystem Services and Values in Landscape Planning, Management and Decision Making'. *Ecological Complexity* 7(3): 260–72.

Holl, Karen D. 2017. 'Restoring Tropical Forests from the Bottom Up'. *Science* 355(6324): 455–56.

IBGE. 2016. 'INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA'. *Cidades e Estados*. https://ibge.gov.br/cidades-e-estados/sp.html (August 29, 2022).

IUCN. 2011. 'Bonn Challenge | The Bonn Challenge Is a Global Effort to Restore 150 Million Hectares of the World's Deforested and Degraded Lands by 2020'. https://www.bonnchallenge.org/ (September 12, 2022).

———. 2017. 'Forest Landscape Restoration /IUCN'. *IUCN*. https://www.iucn.org/our-work/nature-based-solutions (September 12, 2022).

Joly, Carlos, Jean Metzger, and Marcelo Tabarelli. 2014. 'Experiences from the Brazilian Atlantic Forest: Ecological Findings and Conservation Initiatives'. *New Phytologist* 204.

Mapbiomas. 2019. 'Https://Mapbiomas.Org/'. https://mapbiomas.org/ (August 29, 2022).
Mello, Kaline de et al. 2021. 'Achieving Private Conservation Targets in Brazil through Restoration and Compensation Schemes without Impairing Productive Lands'. *Environmental Science & Policy* 120: 1–10.

———. 2022. 'Science and Environmental Policy Establishment: The Case of the Forest Act in the State of São Paulo, Brazil'. *Biota Neotrop. (Online, Ed. ingl.)*: e20211373–e20211373.
Melo, Felipe P. L. et al. 2013. 'Priority Setting for Scaling-up Tropical Forest Restoration Projects: Early Lessons from the Atlantic Forest Restoration Pact'. *Environmental Science & Policy* 33: 395–404.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: Synthesis*. Washington, D.C: Island Press.

Myers, Norman et al. 2000. 'Biodiversity Hotspots for Conservation Priorities'. *Nature* 403(6772): 853–58.

van Oosten, Cora. 2013. 'Restoring Landscapes—Governing Place: A Learning Approach to Forest Landscape Restoration'. *Journal of Sustainable Forestry* 32(7): 659–76.

Ostrom, Elinor. 2009. 'A General Framework for Analyzing Sustainability of Social-Ecological Systems'. *Science (New York, N.Y.)* 325(5939): 419–22.

PACTO. 2012. 'Pacto pela Restauração da Mata Atlântica'. *Pacto pela Restauração da Mata Atlântica*. https://pactomataatlantica.org.br/ (October 26, 2022).
Padovezi, Aurelio, Laura Secco, Cristina Adams, and Robin Chazdon. 2022. 'Bridging Social Innovation with Forest and Landscape Restoration'. *Environmental Policy and Governance*.

R Development Core Team, and F. 2019. 'R: A Language and Environment for Statistical Computing'. *R: a language and environment for statistical computing*.

Reed, James et al. 2016. 'Integrated Landscape Approaches to Managing Social and Environmental Issues in the Tropics: Learning from the Past to Guide the Future'. *Global Change Biology* 22(7): 2540–54.

Rezende, C. L. et al. 2018. 'From Hotspot to Hopespot: An Opportunity for the Brazilian Atlantic Forest'. *Perspectives in Ecology and Conservation* 16(4): 208–14.

Ribeiro, Milton et al. 2009. 'Ribeiro MC, Metzger JP, Martensen AC, Ponzoni FJ, Hirota MM.. The Brazilian Atlantic Forest: How Much Is Left, and How Is the Remaining Forest Distributed? Implications for Conservation. Biol Conserv 142: 1141-1153'. *Biological Conservation* 142: 1141–53.

Ribeiro, Milton Cezar et al. 2009. 'The Brazilian Atlantic Forest: How Much Is Left, and How Is the Remaining Forest Distributed? Implications for Conservation'. *Biological Conservation* 142(6): 1141–53.

Rosa, Marcos R. et al. 2021. 'Hidden Destruction of Older Forests Threatens Brazil's Atlantic Forest and Challenges Restoration Programs'. *Science Advances* 7(4): eabc4547.

Rother, Débora Cristina et al. 2019. 'Ecological Restoration Increases Conservation of Taxonomic and Functional Beta Diversity of Woody Plants in a Tropical Fragmented Landscape'. *Forest Ecology and Management* 451: 117538.

Schlüter, A, and R Madrigal. 2012. 'Learning to Be Different: Quantitative Research in Economics and Political Science : Comment on Achim Schlüter and Róger Madrigal, "The SES Framework in a Marine Setting: Methodological Lessons"'. (3): 148–67.

Schweizer, Daniella et al. 2019. 'Narratives Across Scales on Barriers and Strategies for Upscaling Forest Restoration: A Brazilian Case Study'. *Forests* 10(7): 530.

Shennan-Farpón, Yara, Morena Mills, Aline Souza, and Katherine Homewood. 2022. 'The Role of Agroforestry in Restoring Brazil's Atlantic Forest: Opportunities and Challenges for Smallholder Farmers'. *People and Nature* 4(2): 462–80.

SiCAR. 2012. 'Sistema Cadastro Ambiental Rural São Paulo – SICARSP'. http://car.agricultura.sp.gov.br/site/ (August 29, 2022).

SOBRE. 2010. 'A Sociedade Brasileira de Restauração Ecológica - SOBRE'. https://www.sobrestauracao.org/single-post?id=277 (October 26, 2022).

'SOS Mata Atlântica'. 2017. https://www.sosma.org.br/iniciativas/atlas-da-mata-atlantica/ (August 29, 2022).

Strassburg, Bernardo B. N. et al. 2019. 'Strategic Approaches to Restoring Ecosystems Can Triple Conservation Gains and Halve Costs'. *Nature Ecology & Evolution* 3(1): 62–70.

———. 2020. 'Global Priority Areas for Ecosystem Restoration'. *Nature* 586(7831): 724–29.

Tambosi, L, Milton C. Ribeiro, and Jean P. Metzger. 2014. 'A Framework to Optimize Biodiversity Restoration Efforts Based on Habitat Amount and Landscape Connectivity'. *Restoration ecology* 22(2): 169–77.

Teixeira, Heitor Mancini et al. 2018. 'Farmers Show Complex and Contrasting Perceptions on Ecosystem Services and Their Management'. *Ecosystem Services* 33: 44–58.

Townsend, Patricia, and Karen Masters. 2015. 'Lattice-Work Corridors for Climate Change: A Conceptual Framework for Biodiversity Conservation and Social-Ecological Resilience in a Tropical Elevational Gradient'. *Ecology and Society* 20(2). https://www.ecologyandsociety.org/vol20/iss2/art1/ (October 26, 2022).

Waltman, L. et al. 2012. ‘Van Eck, N.J., L. Waltman, A.F.J. van Raan, R.J.M. Klautz, and W.C. Peul (2012) Citation Analysis May Severely Underestimate the Impact of Clinical Research as Compared to Basic Research. ArXiv 1210.0442’.

World Bank. 2013. ‘BioCarbon Fund Launches $280 Million Initiative for Sustainable Forest Landscapes’. *World Bank.* https://www.worldbank.org/en/news/feature/2013/11/20/biocarbon-fund-initiative-promote-sustainable-forest-landscapes (October 26, 2022).

Zahawi, Rakan A., John L. Reid, and Karen D. Holl. 2014. ‘Hidden Costs of Passive Restoration’. *Restoration Ecology* 22(3): 284–87.