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Local Perception in Forest Landscape Restoration Planning: A Case Study From the Brazilian Atlantic Forest

Veronica Maioli [1,2]*, Lara M. Monteiro [1,2], Fernanda Tubenchlak [1,2], Isabelle S. Pepe [1], Yuri B. de Carvalho [3], Fernanda D. Gomes [1,2], Bernardo B. Strassburg [1,2] and Agnieszka E. Latawiec [1,2,4,5]

[1] International Institute for Sustainability, Rio de Janeiro, Brazil, [2] Conservation and Sustainability Science Centre, Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro, Brazil, [3] Department of Geography, Pontifical Catholic University of Rio de Janeiro, Rio de Janeiro, Brazil, [4] Department of Production Engineering, Logistics and Applied Computer Science, Faculty of Production and Power Engineering, University of Agriculture in Kraków, Kraków, Poland, [5] School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom

Understanding local stakeholders' perception and their relation with the landscape and its natural resources is an important step for successfully implementing Forest Landscape Restoration (FLR). Here, we present a case study on FLR in the context of a global biodiversity hotspot—the Brazilian Atlantic Forest, using a participatory approach to include local stakeholders' knowledge and perception of the landscape into project planning. We analyzed the land use and cover, and organized a workshop with focus group methodology associated with maps and other visual representations to assess local perceptions of economic activities, production chains and their impacts on the landscape and ecosystem services. The study area encompasses seven municipalities mainly covered by native vegetation and pastures. Despite pastureland being the prominent land use in the region, they are not engaged in associations, most do not live in the region, and few participated in the workshop. Most participants were small and medium-scale landowners involved in agricultural activities who demonstrated a detailed knowledge of the territory, a disposition toward combining conservation with production practices, and a positive perception regarding ecotourism, agroecological approaches, water, and soil conservation. The participatory approach proved effective to complement the initial assessment while revealing novel aspects of the landscape and the landowners, helping test our hypotheses and adjust the engaging narratives for future FLR activities planning in the region, including environmental law compliance. More studies associating social and natural science, including participatory methods and local communities' perception, are needed to fully comprehend the drivers of stakeholders' engagement. This case study provides useful insights for other researchers and practitioners to design more effective plans for future land management.

Keywords: ecosystem services, forest restoration and conservation, public policy, rural landowners, participatory approach, private lands

INTRODUCTION

Forest Landscape Restoration (FLR) is a planned process seeking to restore multifunctional landscapes, including forest and agricultural production areas in degraded forest land (Mansourian et al., 2017). People depend on natural resources for food, shelter, and other ecosystem services (ES), and the quality of those resources affects human's well-being in several ways (MEA, 2005; Dave et al., 2017). FLR should therefore be implemented to satisfy not only conservation purposes but also socioeconomic needs and values (Wehi and Lord, 2017; Chazdon et al., 2020; Melo et al., 2020). To incorporate social perspectives into FLR it is paramount to understand local stakeholders' motivations, their relationship with the landscape and its natural resources, and their obstacles regarding sustainable land use (Alves-Pinto et al., 2017; Latawiec et al., 2017), particularly in the beginning of project planning (Bennett, 2016).

One way to assess those aspects is through bottom-up approaches, including local stakeholders' involvement and participation (Adams et al., 2016; Bennett et al., 2016; Holl, 2017; Morales-Reyes et al., 2017; Sterling et al., 2017; De Pinto et al., 2020; Melo et al., 2020; Sánchez-Mercado et al., 2020; Castelli et al., 2021), in accordance with the principles of social sustainability (one of the three pillars of sustainability) (Purvis et al., 2019). This approach discloses local experience and perceptions on the socio-cultural and economic causes behind a specific problem (Pradhananga et al., 2019), indicating what is locally important (Fraser et al., 2006), increasing the empowerment and chances of involvement of local actors, helping gain the social support needed to achieve the multiple goals and a long-term success of FLR (Latawiec et al., 2015; Schweizer et al., 2019).

Despite its relevance, social science methods, particularly perception analysis, are seen as subjective and often dismissed in evidence-based environmental science (Bennett, 2016). However, the definition of strategies guided by locals' perceptions provides effective insights to improve understanding and communication between stakeholders, supporting the construction of engaging narratives (Ecker, 2016; Tisovec-Dufner et al., 2019), that are especially important when planning activities to incentivize stakeholders to adopt sustainable land management practices. Consulting local stakeholders should, therefore, be a priority in the planning process aiming at identifying bottlenecks, its drivers, and feasible solutions (Chazdon et al., 2020; Ota et al., 2020), particularly in highly human-influenced landscapes (Cebrián-Piqueras et al., 2020), like the Atlantic Forest.

The Atlantic Forest is currently home to 72% of Brazil's population and has only 8–16% of its original coverage shaped by patches of vegetation fragments (Ribeiro et al., 2009; Rezende et al., 2015). Despites its fragmentation, it is one of the most biodiverse biomes in the world (Mittermeier et al., 1998) that harbors biodiversity hotspots (Myers et al., 2000). It has a history of intense and damaging transformation since the 15th century due to different economic cycles (timber extraction, sugarcane and coffee plantations until the end of the 19th century), followed by urbanization and industrialization processes, and more recently, the expansion of extensive livestock (Dean, 1996;

Young, 2006; Campos, 2011; Cabral, 2014; Maioli et al., 2020). Due to its environmental and socioeconomic importance and high degree of fragmentation, restoration is a priority for the Atlantic forest (Ribeiro et al., 2009; Scarano and Ceotto, 2015), especially in private lands, where land use decisions play a key role in achieving national (e.g., PLANAVEG, BRASIL, 2017) and international conservation and restoration goals (e.g., Crouzeilles et al., 2019; Strassburg et al., 2019; Bonn Challenge, 2020). Furthermore, conservation and FLR initiatives play a major role for the sustainability transition aimed by the Agenda 2030 and expressed in the Sustainable Development Goals (SDGs). Such agreements aim not only to restore the ecological dynamics of the biome, consequently contributing to the provision and maintenance of ES, but also to enhance restoration through participatory planning (goal E- Aichi targets; goal 1 and 11 SDGs; PLANAVEG, BRASIL, 2017).

To foster adoption and involvement in FLR activities, we present a case study using participatory methodology to identify local stakeholders' perception about the landscape, its natural resources, and their main farming activity in the Atlantic Forest. We hope that their perception will help stir and refine the planning and designing of inclusive and appealing strategic FLR approaches to encourage them to adopt better land management practices in the region. More specifically the study focused on: (i) identifying gaps and problems in the agricultural and ranching productive chain, and (ii) testing our hypotheses and its related engagement narratives, to tailor activities toward improving awareness and the involvement of locals in future sustainable land-use practices. We developed four hypotheses associated with engaging narratives to be tested with stakeholders:

1) Water and soil are important ecosystem services perceived by local stakeholders (hypothesis), so activities to improve these ES in the region would be appealing for them (engaging narrative);
2) Forest and rivers are abundant in the study area, representing an opportunity for the development of ecotourism activities in the region (hypothesis), therefore actions that improve tourism and diversify rural income would be well received in the region (engaging narrative);
3) As pasturelands are the predominant land-use in the rural properties of the region, focusing on these areas will maximize FLR impacts (hypothesis), so activities to improve their management and sustainably increase cattle productivity should interest local landowners (engaging narrative);
4) Despite agriculture having a low representativeness in the study total area, stakeholders are engaged in increasing organic production (hypothesis), so actions linked to sustainable and more productive practices would attract local agricultural farmers (engaging narrative).

MATERIALS AND METHODS

Study Area

The case study focused on different stakeholders from the Environmental Protection Area of São João River Basin/Golden Lion Tamarin (APA SJ), a 174.000 hectares area located at

Rio de Janeiro state, Brazil (**Figure 1**). The APA SJ is a protected area with sustainable use (MMA, 2008) embedded in the Atlantic Forest Biome and represents an important place for the conservation of the threatened and endemic golden-lion-tamarin (*Leontopithecus rosalia* L.) (MMA, 2014). The APA SJ encompasses seven municipalities covered by 45% of native vegetation, 42% of pastures, 10.5% of agriculture, 2% of water bodies, and <0.5% of other land uses (e.g., urban infrastructure, silviculture, and other non-vegetated areas, etc.) (**Figure 1**) (Mapbiomas, 2018). Part of the native vegetation in the APA SJ (16%) is protected inside two strict-use protected areas (Biological Reserve of Poço das Antas and União Reserve), and over 30 private natural heritage reserves (RPPN—acronym in portuguese) covering 212,000 hectares approximately. If accounting the land use present only inside private lands (excluding the protected areas), the land use and cover pattern changes considerably—almost 60% is covered by pastures, and only 28% is covered by native vegetation (IBGE, 2017). The APA SJ has roughly 16.000 hectares of environmental debt within private areas, considering the Brazilian Forest Code (Law n° 12.651/2012) (INEA, 2018). The water ecosystem in the APA SJ was severely altered in the 1970s due to rectification and deforestation of its riparian vegetation, and currently faces problems with erosion and siltation (Ribeiro et al., 2018). Additionally, the lack of basic sanitation and high use of pesticides contributes to the deterioration and pollution of the São João river. As a result, health problems have been detected among rural producers, especially in the municipality of Casimiro de Abreu (Brust et al., 2019; Silva et al., 2020).

There are 988 rural properties registered in the APA SJ (SICAR, 2020), but only 60% of landowners live in the properties. More than 60% of the total properties are occupied by small landowners detaining <10% of the agricultural areas and 1% of the pasturelands, contrasting with large landowners concentrating over 95% of the pasturelands and almost 70% of the agricultural lands, exposing the unequally in land distribution and agrarian concentration in the APA SJ (SFB, 2018). The region also faces serious problems related to lack of sewage treatment and frequent cases of flooding during the wet season, due to the São João River silting (IBGE, 2019).

Survey on Local Stakeholders' Perception

We conducted several field trips to the APA SJ to gather socioeconomic data of the region through informal conversations with local stakeholders. We used the snowball methodology (Bryman, 2012) to identify the stakeholders most actively involved in the production, conservation, and restoration activities. However, this method was not applied exhaustively and did not result in a complete list of names, since our aim was merely to get familiar with the local community. We also hired a local person to act as a focal point, reaching, and mobilizing stakeholders for the upcoming activities of this study.

Based on those meetings and the previous contacts of the focal point person, we organized an all-day workshop inviting local landowners, local leaders, and members of local institutions (governmental or 3rd sector). We sent electronic invitations (via WhatsApp and email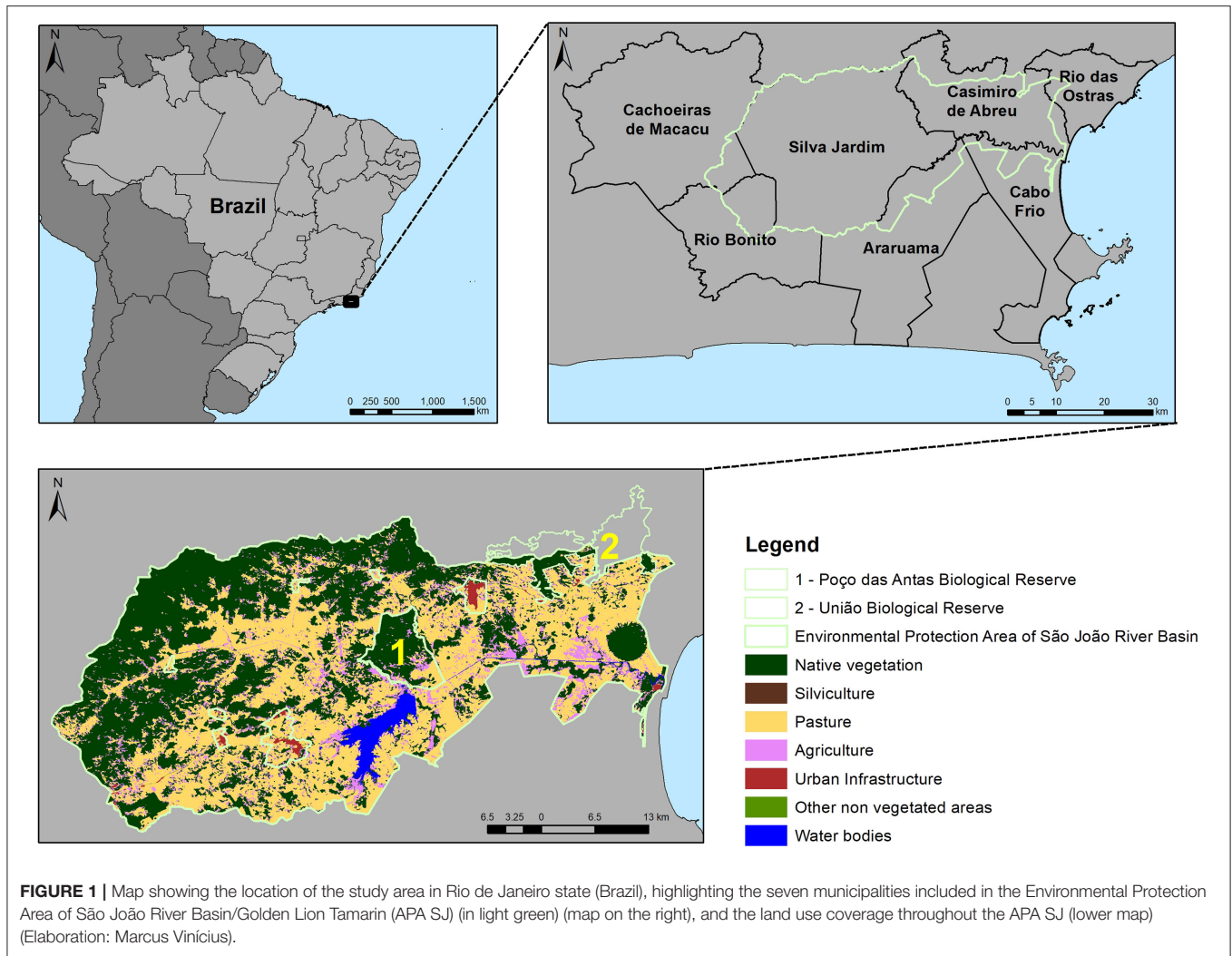), posted flyers, and went door-to-door to invite stakeholders for the workshop, also counting on local partners to reply and reinforce the invitation.

Focus groups were the main methodology used to collect information at the workshop, which often brings contrasting yet complementary views on the topic addressed. If adequately moderated, focus groups facilitate the participants to state the reasoning behind their expressed opinions, an information that may be difficult to assess through individual questionnaires (Newing et al., 2010). The focus groups had a moderator and a rapporteur, both members of the team engaged in the study, who had previous experience in facilitation and participated in a training session prior to the workshop.

The workshop was based in two activities: (I) "*our territory*"—focused on identifying the productive activities and their impact on the landscape and (II) "*productive chain*"—focused on identifying the difficulties and possible solutions throughout the agricultural and ranching productive chain (production, processing and distribution phases) of the APA SJ (**Table 1**). Both activities were prepared to last 2 h. The participants ($N = 100$) were divided in one of the eight available focus groups (between 5 and 15 participants in each group) according to their region of provenance (to have a better geographic representation of their perceptions- activity I), and main source of farming income (to concentrate the discussion around the same type of product—activity II) (**Table 1**). The information used to divide the participants was acquired beforehand, in the workshop registration form. After each activity, participants were encouraged to circulate among other groups and check the results of their discussion, and at the end of the workshop the resulting material was hung on the walls.

In activity I (our territory) each group represented a region of the APA SJ to maximize participants' knowledge of the surroundings. Each group received a printed A3 size map of 2–3 regions (districts) of the APA SJ, two sets of stickers and were instructed to apply the stickers on the printed map. The first set of stickers had visual representations of the main products and economic activities of the region, previously researched by the team through literature review and local experiences (e.g., stickers: cattle, beans, manihot, rice, fruticulture, agroforest, tourism, restoration, etc.). The second set of stickers represented other elements and possible impacts of activities on the region (e.g., stickers: wild animals, pollination, fertile soils, forest restoration, polluted rivers, pesticides, degraded soil, hunting, etc.). We also provided blank stickers allowing the insertion of other elements not previously thought by the team.

In activity II (productive chain), the groups were divided by the main economic activity developed in the property (e.g., cattle ranch, agriculture, seedling nursery, and tourism). Some groups had many participants and were further divided into two to improve discussions. This dynamic was based on a cardboard illustrating the main links of the production chains (production, processing, and distribution) (**Figure 2**), and different stickers with visual representations of the main products sold and their intermediate or final consumers. The cardboard also contained a space for free listing of the main problems and possible solutions related to each production chain. It is important to highlight that the design of both activities entails a minimum previous

FIGURE 1 | Map showing the location of the study area in Rio de Janeiro state (Brazil), highlighting the seven municipalities included in the Environmental Protection Area of São João River Basin/Golden Lion Tamarin (APA SJ) (in light green) (map on the right), and the land use coverage throughout the APA SJ (lower map) (Elaboration: Marcus Vinícius).

knowledge of the region to produce the stickers, such as the main activities or products. The option to use visual material (maps, stickers, and cardboard) instead of written documents was made to include people with reading disabilities (Nind and Vinha, 2014), a common characteristic in rural areas in Brazil.

Data Analysis

After the workshop, we analyzed the materials derived from activity I and II (maps and cardboards) categorizing and transcripting data to excel files. The stickers from activity I were classified into five categories: agricultural production, animal production, forestry, tourism, and restoration/conservation. The stickers representing the other elements of the landscape were classified as positive or negative impacts on the landscape and used as proxies for ES according to IPBES/CICES (Haines-Young and Potschin, 2018) classification, which divided them in regulation, provision, and cultural services (for more details see **Supplementary Table 2**). The information regarding problems and solutions from activity II were organized in four categories (agriculture, cattle ranch, seedling nursery and tourism) based on

the main economic activity from each focus group. Following the stickers analysis, we compiled the data into a final map of APA SJ representing the results of the focus groups held in activity I (**Figure 3**, and **Supplementary Table 4**) (A video about the event and the group activities described in this paper is also available in the **Supplementary Material**).

RESULTS

Around 100 stakeholders attended the workshop, 84% of which were local landowners of both gender developing agriculture (76%), animal production (12%), seedling nursery (8%), and tourism (4%) as their main source of income (**Figure 4**). The landowners represent over 10% of the residents in the APA SJ ($N = 84$ out of 593 of total properties), if we assume that each participant accounts for one property. The remaining participants (16%) represented different local institutions, such as: Technical Assistance and Rural Extension Company (EMATER), the Golden Lion Tamarin Association (AMLD), the Institute responsible for the management and

TABLE 1 | Description of activities I and II held in the workshop with local stakeholders from APA São João River Basin.

|	Specific objectives	Criteria for dividing the participants	Guiding questions
Activity I	1. To map the main land uses and economic activities developed 2. To investigate the impacts of these uses on the landscape	Geographic—by the location of their property	1. Please indicate what are the main activities in your region? 2. How do those activities impact positively and negatively the region (soil, water, etc.)? What are their impacts on your production? 3. Based on that map, what would you like to change? Do you think it is possible to reconcile economic activity with improving the quality of water and land, and the environment in general?
Activity II	1. To map the production chains 2. To identify main difficulties and solutions related to the production chains	Economic—by the main economic activity developed on their property.	1. What are the main products produced on your property and to whom they are sold? 2. What are the main problems between production and distribution? 3. Do you have any suggestions on how to improve these problems?

Both activities lasted 2 h.
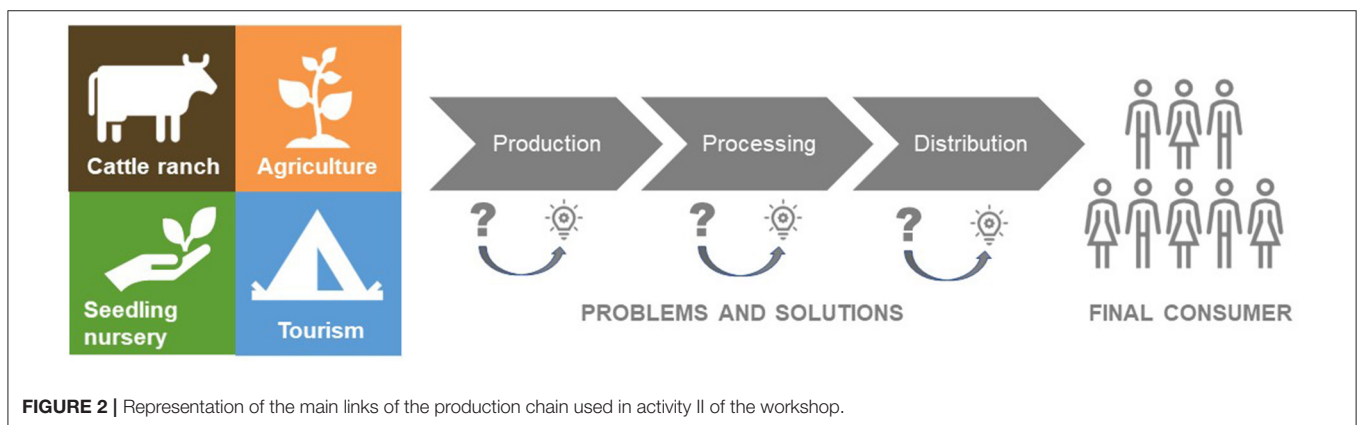
FIGURE 2 | Representation of the main links of the production chain used in activity II of the workshop.

protection of APA São João River Basin (ICMBio—Chico Mendes Institute for Biodiversity Conservation), Agriculture and Tourism Secretaries from different municipalities, among other actors from local and collective organizations/associations (See **Supplementary Table 1** for detail information on participants). The word of mouth (60%) and WhatsApp messages (30%) were the most efficient form of disseminating the event according to the participants.

Regarding the perceptions on land use (activity I), 51.2% of the economic activities indicated on the map represented agricultural production, 20.4% animal production, 13.6% forest production, 9.3% restoration/conservation, 2.3% tourism and 4.5% others (handicraft, charcoal, etc.). All groups ($N = 8$, 100%) indicated the presence of cattle (beef), tourism, seedling nursery, cassava, and citrus in the landscape. Seven groups (88%) registered the presence of cattle (milk), chicken farming, beekeeping, horticulture and corn cultivation, and six groups (75%) indicated the presence of organic and agroecological production, banana cultivation, seed collection, Private Natural Heritage Reserve, sugar cane cultivation, goat, and pig farming in the territory. Fifteen crops had low representation in the APA SJ, being

mentioned by only one group, and 21 new activities or products were added by the participants, mainly related to agriculture activities (e.g., cassava products, coffee production, etc.) (see **Supplementary Table 2** for the list of activities/products used per focus group).

The other aspect considered in activity I, regarded the participants' perception of the other elements and impacts in the APA SJ. Eight groups (100%) mentioned water springs, golden-lion tamarin, silting, and degraded soils. Forest restoration, fertile soils, pests and disease, and floods were mentioned in seven groups (88%). Wild animals, waterfalls and bees were mentioned in six groups (75%), and polluted rivers in five groups (63%). Participants also added seven new elements: pesticides (mentioned in three groups), fire, water shortage (two groups, respectively), hunting, mineral water, seed bank, charcoal production, pollution by a grass factory and poor sewage treatment (mentioned in one group, respectively). The elements identified by the focus groups can be understood as negative (twelve) and positive (eight) impacts. The negative impacts were mainly associated with poor management of pastures, the lack of riparian vegetation and polluted rivers.
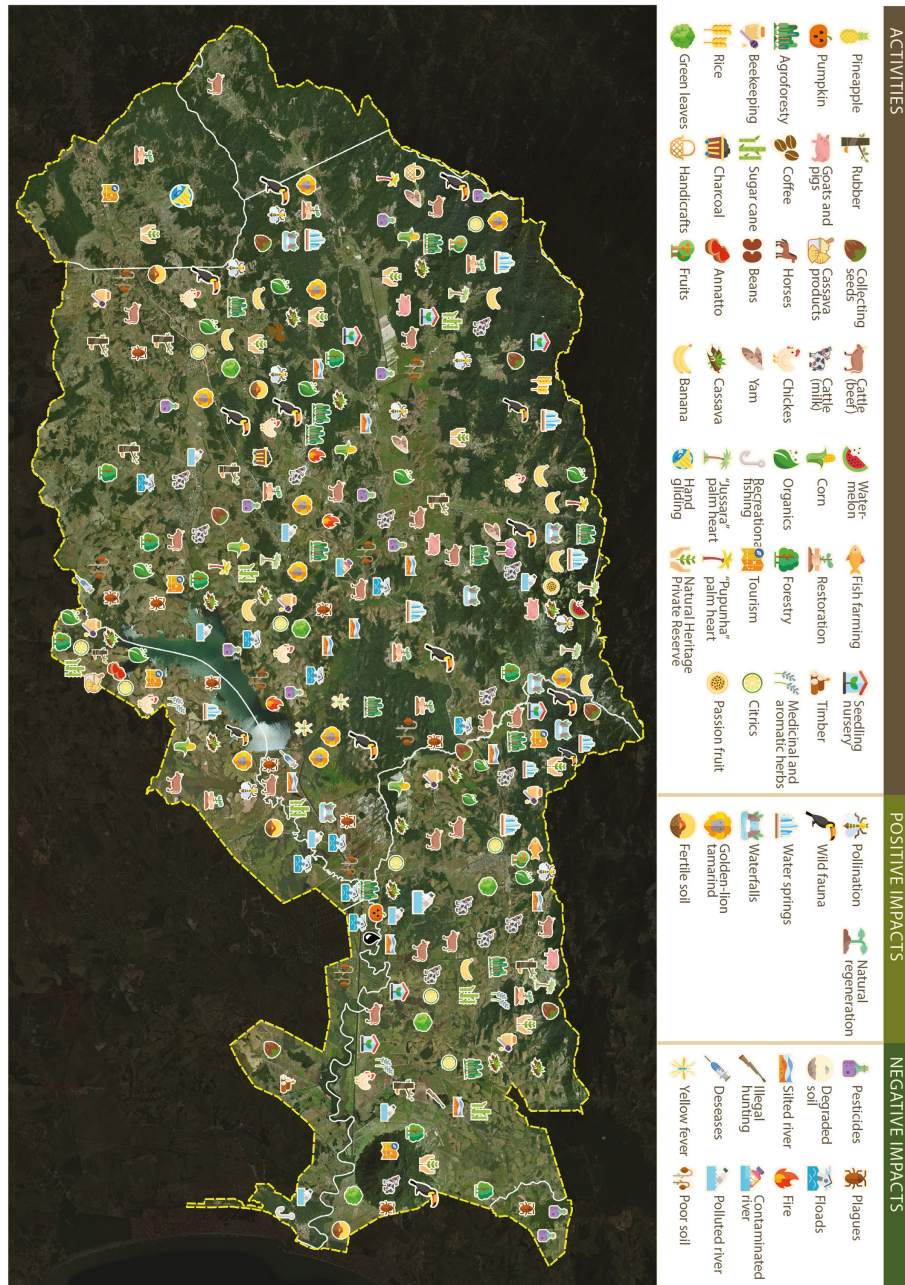
FIGURE 3 | Map of the São João River Basin APA (APA SJ) showing the economic activities and its positive and negative impacts in each region, as identified by local stakeholders in the focus group sessions.

The indication of pests and diseases can be related to poor and unsustainable management, leading to ecological imbalance that directly impacts production costs, incurring high expenses with fertilizers and pesticides. On the positive impacts, participants identified the occurrence of fertile soils associated with organic and agroforestry activities in the map (For more information see **Supplementary Table 3**).

In activity II, most of the participants think it is possible to reconcile economic activities with conservation and restoration

initiatives, if they overcome some barriers. The participants declared many problems between production and distributions of the products such as: (i) production—lack of technical assistance, lack of collective activities, lack of labor training in sustainable production, management and planning, low prices and low production diversity; (ii) processing—difficulties with law compliance, costs and bureaucracy of incentives, financing, and certification, (iii) distribution—problems with logistics and infrastructure, lack of sales strategies, low demand for sustainable

products and the presence and role of a middleman (upscaling the final price or taking all the profit). Further on, the participants of each focus group suggested how to improve or solve some of the problems mentioned, for example: promoting farmers association, providing technical assistance, facilitating the access to public financing, stimulating product diversity (**Figure 5**).

DISCUSSION AND CONCLUSION

Understanding stakeholder's perception and their relationship with the landscape, current problems, mind-set, and future goals can also be a faster stepping-stone toward engaging them in FLR processes and achieving desired outcomes (Bennett, 2016). If FLR is imposed and lacks local stakeholders' involvement, it may lead to opposition, non-involvement in the initiatives and hostility against actions and toward the natural assets (Chomitz et al., 2006). Locals' involvement is particularly relevant within private land conservation and restoration, an increasingly popular approach to protect critical biodiversity (Selinske et al., 2015). Understanding stakeholders' motivation toward FLR and identifying knowledge gaps of sustainable land use is therefore pivotal to incentivize them to adopt better land management practices (Alves-Pinto et al., 2017; Latawiec et al., 2017).

The participatory approach implemented in this case study provided a deeper understanding of local realities and landowners' perceptions about the APA SJ. The workshop itself offered a space for meeting and exchanging information, stimulating social organization and collective work. It was interesting to notice the role of women, especially involved in agricultural activities, that could be further supported in local actions contributing to SDG 5. The visual methodology applied during the focus groups greatly enhanced understanding and communication between the participants. It was particularly important to overcome any reading disabilities that the

landowners might have, including people that are normally excluded from decision making (Nind and Vinha, 2014). It is also worth to mention the importance of the local network of stakeholders in spreading information about the development of the workshop (e.g., word of mouth and WhatsApp messages), highlighting the importance of having local partners and a local person as focal point in the study team, who personally knew the community.

The focus group methodology allowed the observation of behaviors and interactions among different stakeholders while providing a detailed understanding of the socioeconomic and environmental aspects present in the landscape. It also permitted a broader discussion and the inclusion of different perceptions of heterogeneous participants with distinct land sizes, level of formal education, social group, and farming production. Moreover, this participatory approach proved effective to complement an initial assessment (carried out through secondary data review and key-local meetings) and helped test our hypotheses and adjust the engaging narratives for future activities planning in the region.

Perception Over Water and Soil

Water quality and quantity, and soil conditions were indicated by local stakeholders as important aspects in the landscape, validating our hypothesis 1. The perceived positive impacts were associated with the presence of springs and fertile soil, which usually favors agriculture and pasture production, and is a positive outcome, given that soil ecosystem services are generally undermined (Latawiec et al., 2021). However, silting, flooding, and degraded soil were negative impacts often mentioned by the groups, perceived as result of the retification and lack of riparian forest cover along the São João river, the use of pesticides and extensive pastureland over the years, which corroborates with the regional literature (Ribeiro et al., 2018; SISAGUA, 2018; Silva et al., 2020). Being aware that there is a direct relation between reducing the risks of environmental disasters and the presence of riparian vegetation is a promising sign for future adoption of restoration initiatives by local stakeholders. Therefore, adopting narratives highlighting the benefits of the forest to contain floods, erosion process, improving soil fertility and maintaining water quality might attract and engage landowners in activities that boost riparian restoration in the region (Oliveira, 2016; Ribeiro et al., 2018), aiding to achieve SDG 6 and 15. This could be particularly useful for achieving legal compliance in the region, since every landowner has to spare a percentage of their land for conservation and/or restoration, including riparian areas, and compliance is very low among landowners in the region, as well as in the country (Soares-Filho et al., 2014).

Perception Over Tourism Activities

The APA SJ is abundant in forest cover, has a rich aquatic ecosystem, and one of the highest concentrations of RPPNs in Brazil (**Figure 1**), representing a great potential for rural and environmental tourism. The participants recognized this opportunity, validating our hypothesis 2, but indicated that currently have few landowners engaged in this activity, with little infrastructure and knowledge on how to attract and

FIGURE 4 | Number of local landowners at the workshop divided by main economic activity and gender.
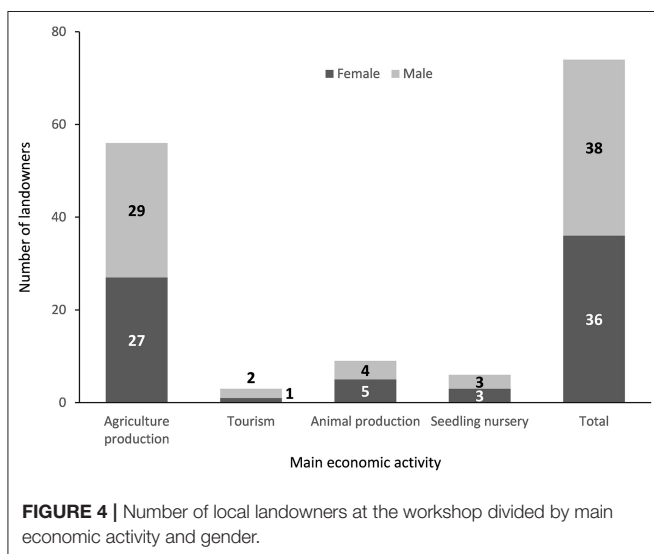
receive tourists. These informations suggest that implementing tourism activities in the region might be a long term idea, relying and demanding time, money, governmental interest, local commitment, and training.

Regardless of being a limited activity presently, participants indicated that there is a growing interest in developing ecotourism through the implementation of activities of bird and golden-lion-tamarin watching, tours to waterfalls, environmental education to children, and gastronomy with native, local and organic products. Landowners perceiving ES (e.g., biodiversity and water) as an attraction to tourism is a positive aspect that can be used to promote FLR practices within private lands in the region (Blangy and Mehta, 2006; Joly et al., 2019). Since tourism in the APA SJ depend on the existing of biodiversity (e.g., golden-lion tamarin) and water (e.g., waterfalls), exclude the conservation of these ES and restoration of their ecosystems can become an essential factor for business sustainability, which should be highlighted to local landowners and accounted for government and conservation NGO (Habibullah et al., 2016). Furthermore, these activities increase opportunities to create jobs, economic development, cultural interchange and value to the rural way of living (Joly et al., 2019).

In that sense, to steer and develop the unexplored tourist potential of the APA SJ, it is vital to assess the possible activities that can be implemented, according to the land-use zoning of the APA SJ and in agreement with locals' interests and will (Ndivo and Cantoni, 2016), and with attention to possible socio-ecological impacts (Cunha, 2010; Souza et al., 2018). It is also important to raise awareness on the possibilities in tourism (Dorobantu and Nistoreanu, 2012), promote local's engagement, train, and increase tourism management capacity of landowners to successfully operate ventures, supported by

government agencies and conservation NGO (Pegas and Castley, 2014).

Perception Over Pastureland

Although pasturelands are the predominant land use in the APA SJ (IBGE, 2017; SFB, 2018), most of its area is restricted to few large-scale landowners that are not engaged in social activities and associations, according to workshop participants. In fact, very few participated in the workshop despite invitations, and most do not reside in their rural property (IBGE, 2017). Furthermore, most local pastures consist of unproductive areas, with few livestock to secure land tenure, especially for large-scale landowners. This is a historical practice in Brazil entrenched in rural culture (Fernandes et al., 2012; Reydon et al., 2015), and it was not different in the analyzed region, indicating that efforts to encourage the adoption of sustainable management and increased animal productivity might be challenging. Hence, it seems unlikely that improving pasture management to increase productivity alone will stimulate land-sparing and allow forest restoration (Strassburg et al., 2014; Phalan et al., 2016). In that case, hypothesis 3 was refuted and our engaging narrative might not attract as many landowners as hoped, nor improve their land use management and productivity.

One way to proceed would be to shift strategy, focusing first on awareness activities to highlight the environmental problems (Gebska et al., 2020), ES and economic benefits of implementing sustainable practices (Gerber et al., 2010). However, awareness alone is not enough to change behavior (Green et al., 2019), and other approaches may be more effective to promote the desired changes, such as a community-based social marketing (McKenzie-Mohr, 2011), transition incentive programs (Alves et al., 2017; Johnson and Ready, 2017), and display practical
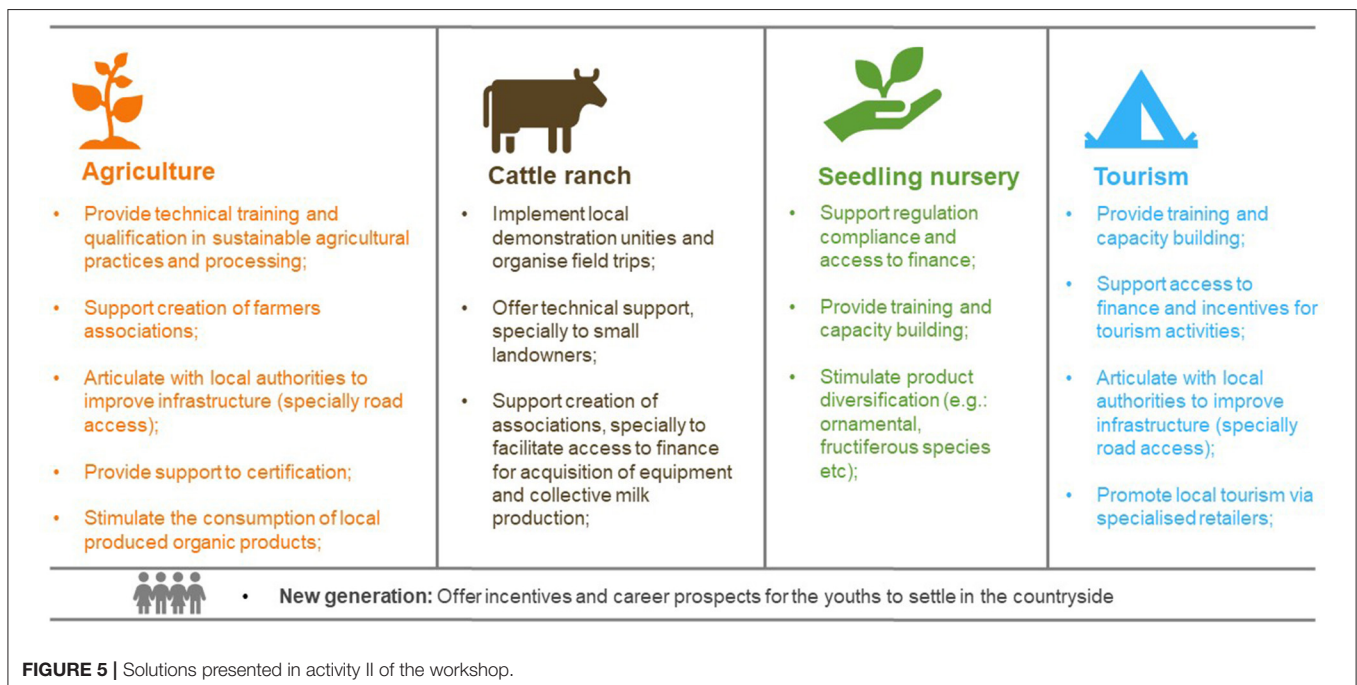

FIGURE 5 | Solutions presented in activity II of the workshop.

examples through implementation of demonstration units in private lands in the region (Elzen et al., 2012; Garibaldi et al., 2017). Nevertheless, those actions would need a long-term effect to achieve FLR impacts with cattle landowners. Moreover, to maximize the possibility that increased productivity will contribute to land sparing and FLR, additional strategies such as land-use zoning and economic instruments (e.g., payments, land taxes, and government subsidies) might be needed (Phalan et al., 2016).

Perception Over Agriculture

Contrasting with cattle raising landowners, agriculture practitioners are engaged in collectives and associations, and interested in organic and agroforestry systems initiatives, as described at the workshop. Despite their low representativeness in land use area in the APA SJ (IBGE, 2017; SFB, 2018), this type of landowners seems to be motivated and more willing to engage in sustainable agricultural activities, especially agroforestry systems, being a strategic group exclude to achieve short term impact with FLR. Furthermore, they can not only engage in FLR actions on their own property, but influence and recruit others, enhancing effectiveness and disseminating best practices on other private lands in the region (Niemiec et al., 2019). This not only validates our hypothesis 4 but highlights the synergies between FLR and agroecological approaches (Latawiec et al., 2018; Mansourian et al., 2019; Tubenchlak et al., 2021). The ecological management of these agroecosystems play an important role in promoting local food security (SDG 2) and reducing health problems derived from pesticides intoxication (SDG 3) (Silva et al., 2020; Tubenchlak et al., 2021); while also contributing to pollination and soil fertility, which are important ES for agriculture, perceived and mapped by the participants of this study.

Perception on Other Themes

Local stakeholders' inputs in activity I and II provided guidance on other possible themes, focus, or approaches to be implemented into the study plan and design. Landowners identified activities that were not described as representative for the region according to governmental data (IBGE, 2017, 2019) but are within the scope of FLR approaches and can be considered in future planning and activity development (e.g., seed collection, seedling nursery, beekeeping, poultry, organic, and agroforestry production). The stakeholders' positive perception of the golden-lion-tamarin, seedling nurseries, and seed collection can be related to the long-term commitment and effort of conservation and restoration from the AMLD (Golden Lion Tamarin Association) (Cullen et al., 2005), and can be further developed in the region as landowners seem to be already aware of its ecological and economic benefits exclude (in the region), supporting the achievement of SDG 15.

Beekeeping was another activity perceived as having a positive impact in the region, and could be incentivized in the APA SJ as it supports and increases many ES (e.g., pollination, biodiversity, food production, etc.), and it can be associated with sustainable farming activities, as agroforestry systems and forest-livestock integration (Wolff and Gomes, 2015; Yusuf et al., 2017). The availability of this important pollinator contributes directly to enhance crop yield and may benefit from agroecological practices in the property, such as hedgerows and wildflower plantings, that increase habitat heterogeneity and food availability for the bees and other pollinators (Garibaldi et al., 2014). To increase the ES potential of beekeeping, it would be interesting to disseminate the use of multiple native bees species (i.e., *Melipona* spp. and *Trigona* spp.), rather than focus on a single species management (i.e., *Apis mellifera*) (Garibaldi et al., 2014; Jaffé et al., 2015), especially as the latter can harm wild native pollinator species (Geldmann and González-Varo, 2018). Furthermore, beekeeping can diversify rural revenues through bee products (e.g., propolis, honey, etc.), hive rental for agriculture profit (Santos et al., 2018), and also pedagogic and ecotourism actions (Jaffé et al., 2015), being a great incentive to support integrated forest management (Elzaki and Tian, 2020). Another activity mentioned by the landowners worth highlighting was poultry farming. This is a traditional and largely implemented activity of great cultural and socioeconomic importance for rural families in Brazil (Sales, 2005). Local stakeholders informed that poultry in the study region is carried through several generations, especially by small-medium landowners whose production is aimed for self-consumption and local commercialization. This activity, however, has room for improvement as it can be associated with organic production within agroecological systems, generating greater animal welfare, using organic forage and natural medicine, and the manure can be used as natural fertilization of agricultural crops (Vaarst et al., 2015). Thus, the agroecological management of poultry can add value to the products, representing an extra income and contributing to the food diversity and resilience of rural families, mainly for small landowners (Sales, 2005; Vaarst et al., 2015).

Perception on Productive Activities

The results from the production chain activity demonstrate considerable barriers that can interfere or inhibit the adoption of sustainable practices in the region. The problems mentioned by the stakeholders are not exclusive to the region as they are common in agricultural and cattle raising production chains in Brazil (Latawiec et al., 2017; Beber et al., 2019). Local stakeholders shared ideas to surpass these barriers (**Figure 5**), although many of these rely on a combined effort of a broad range of stakeholders, such as: the willing of other landowners to join associations, access and availability of municipal and state institutions to provide technical assistance, banks, state, and federal governments to provide public financing, and awareness of the final consumer toward local family farming and/or agroecological products, that can demand time and political alliance to be accomplished. To address these barriers, it is important to consider the entire productive chain, aiming to strengthen local markets, contributing to shortening the circuits of food production and consumption (Altieri and Toledo, 2011;

Gliessman, 2016). A short term strategy might be to show local stakeholders how to access the public funding already available, or contact technical assistance institutions to connect technicians and landowners, offer training in sustainable practices for technicians and landowners, and improve the preparation of process food (e.g. dairying, jams, juices, etc.). The latter can provide additional conservation and shelf-time to fresh products, while helping enhance earnings by adding value to the final products (Aguiar et al., 2018).

One promising remark was that the local landowners were prone to combine conservation with production. By using engaging narratives that focus on landowners' profit and productivity, projects can then associate sustainable practice with the desirable benefits of FLR approaches, such as increasing forest cover, social inclusion, improving ES for soil, water, and biodiversity. Identifying this up hand greatly contributes to the successful outlining of activities, decision making process, and project implementation (Renn, 2006).

Final Remarks

The use of the participatory approaches in our study allowed the assessment of local perceptions and needs, aiding in the construction of tailored narratives that can contribute to local engagement and the future planning of activities to achieve the desirable benefits of FLR approaches. Nevertheless, although the focus group is a useful method to acquire information from different stakeholders, it does not allow to capture specific traits or perceptions of each participant or a particular stakeholder group (i.e., landowners, government, etc.). To that end, other methods (e.g., interviews, questionnaires, etc.) may be more adequate. We were able to test our hypotheses and reach our aim with the applied methodology, but we still need to transform the engaging narratives into activities, and check if they will in fact engage local stakeholders and improve sustainable landscape management in the region in a short-medium time. More studies associating social and natural science, including participatory methods and local communities' perception, are needed to fully comprehend the drivers of stakeholders' engagement.

Finally, we hope to have contributed for the awareness of the multiple benefits of including local participation and perception into planning and decision making associated with sustainable landscape management, such as FLR. The participatory approaches used in this study can provide valuable insights to other researchers and practitioners, helping save time and resources by designing more adequate plans and activities according to participants' view, values and demands, aiming to maximize engagement and increase sustainable behaviors. Although stakeholders' perceptions have local application, the approaches used in this study could be replicated in other regions, influence or set an example for other national initiatives, collaborating to achieve international goals (SDGs, Bonn Challenge, Aichi Targets) helping meet society's needs and boost a sustainable environment and economy on a larger scale.

REFERENCES

Adams, C., Rodrigues, S. T., Calmon, M., and Kumar, C. (2016). Impacts of large-scale forest restoration on socioeconomic status and local livelihoods: what we know and do not know. *Biotropica* 48, 731–744. doi: 10.1111/btp.12385

Aguiar, L. C., DelGrossi, M. E., and Thomé, K. M. (2018). Short food supply chain: characteristics of a family farm. *Ciênc. Rural* 48, 1–8. doi: 10.1590/0103-8478cr20170775

Altieri, M. A., and Toledo, V. M. (2011). The agroecological revolution in Latin America: rescuing nature, ensuring food sovereignty and empowering peasants. *J. Peasant Stud.* 38, 587–612. doi: 10.1080/03066150.2011.582947

Alves, T. C., Jungman, L., and Borschiver, F. (2017). *Climate Smart Cattle Ranching. The Brasil Innovation Lab for Climate Finance.* Instrument Analysis. Available online at: https://www.climatepolicyinitiative.org/wp-content/uploads/2017/10/Brasil-Lab-Instrument-Analysis-Climate-Smart-Cattle-Ranching.pdf (accessed January, 2021).

Alves-Pinto, H. N., Latawiec, A. E., Strassburg, B. B. N., Barros, F. S. M., Sansevero, J. B. B., Iribarrem, A., et al. (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

Beber, C. L., Carpio, A. F. R., Almadani, M. I., and Theuvsen, L. (2019). Dairy supply chain in Southern Brazil: barriers to competitiveness. *Int. Food Agribusiness Manag. Rev.* 22, 651–673. doi: 10.22434/IFAMR2018.0091

Bennett, N. J. (2016). Using perceptions as evidence to improve conservation and environmental management. *Conserv. Biol.* 30, 582–592. doi: 10.1111/cobi.12681

Bennett, N. J., Roth, R., Klain, S. C., Chan, K. M. A., Clark, D. A., Cullman, G., et al. (2016). Mainstreaming the social sciences in conservation. *Conserv. Biol.* 31, 56–66. doi: 10.1111/cobi.12788

Blangy, S., and Mehta, H. (2006). Ecotourism and ecological restoration. *J. Nat. Conserv.* 14, 233–236. doi: 10.1016/j.jnc.2006.05.009

Bonn Challenge. (2020). Available online at: https://www.bonnchallenge.org/content/challenge (accessed August, 2020).

Brust, R. S., Oliveira, L. P. M., Silva, A. C. S. S., Regazzi, I. C. R., Aguiar, G. S., and Knupp, V. M. A. O. (2019). Epidemiological profile of farmworkers from the state of Rio de Janeiro. *Rev. Bras. Enfermagem* 72, 122–128. doi: 10.1590/0034-7167-2017-0555

Bryman, A. (2012). *Social Research Methods.* Oxford: Oxford University Press.

Cabral, D. C. (2014). *Na Presença da Floresta: Mata Atlântica e História Colonial.* Rio de Janeiro: Garamond/FAPERJ.

Campos, M. C. (2011). Modernização da agricultura, expansão da soja no brasil e as transformações socioespaciais no Paraná. *Rev. Geografar Curitiba* 6, 161–191. doi: 10.5380/geografar.v6i1.21808

Castelli, G., Min Oo, W., Maggio, A. D., Fellin, L., Ré, V., and Bresci, E.ci, E. (2021). Participatory analysis of sustainable land and water management practices for integrated rural development in Myanmar. *J. Water Sanit. Hyg. Dev.* 11, 26–36. doi: 10.2166/washdev.2020.166

Cebrián-Piqueras, M. A., Filyushkina, A., Johnson, D. N., Lo, V. B., López-Rodríguez, M. D., March, H., et al. (2020). Scientific and local ecological knowledge, shaping perceptions towards protected areas and related ecosystem services. *Landscape Ecol.* 35, 2549–2567. doi: 10.1007/s10980-020-01107-4

Chazdon, R. L., Herbohn, J., Mukul, S. A., Gregorio, N., Ota, L., Harrison, R. D., et al. (2020). Manila declaration on forest and landscape restoration: making it happen. *Forests* 11, 685. doi: 10.3390/f11060685

Chomitz, K., Da Fonseca, G., Alger, K., Stoms, D., Honzák, M., Landau, E. C., et al. (2006). Viable reserve networks arise from individual landholder responses to conservation incentives. *Ecol. Soc.* 11:40. doi: 10.5751/ES-01902-110240

Crouzeilles, R., Santiami, E., Rosa, M., Pugliese, L., Brancalion, P. H. S., Rodrigues, R. R., et al. (2019). There is hope for achieving ambitious Atlantic Forest restoration commitments. *Perspect Ecol Conserv.* 17, 80–83. doi: 10.1016/j.pecon.2019.04.003

Cullen, L., Alger, K., and Rambaldi, D. M. (2005). Land reform and biodiversity conservation in Brazil in the 1990s: conflict and the articulation of mutual interests. *Conserv. Biol.* 19, 747–755. doi: 10.1111/j.1523-1739.2005.00700.x

Cunha, A. A. (2010). Negative effects of tourism in a Brazilian Atlantic forest National Park. *J. Nat. Conserv.* 18, 291–295. doi: 10.1016/j.jnc.2010.01.001

Dave, R., Saint-Laurent, C., Moraes, M., Simonit, S., Raes, L., and Karangwa, C. (2017). *Bonn Challenge Barometer of Progress: Spotlight Report 2017.* Gland: IUCN.

De Pinto, A., Cenacchi, N., Robertson, R., Kwon, H.-Y., Thomas, T., Koo, J., et al. (2020). The role of crop production in the forest landscape restoration approach-assessing the potential benefits of meeting the Bonn Challenge. *Front Sustain Food Syst.* 4:61. doi: 10.3389/fsufs.2020.00061

Dean, W. (1996). *A Ferro e Fogo: A História e a Devastação da Mata Atlântica Brasileira, 1 edn.* São Paulo: Cia. das Letras.

Dorobantu, M. R., and Nistoreanu, P. (2012). *Rural Tourism and Ecotourism - The Main Priorities in Sustainable Development Orientations of Rural Local Communities in Romania.* MPRA Paper 31480, University Library of Munich, Germany.

Ecker, S. (2016). "Social dimensions of biodiversity conservation programs," in *Learning from Agri-environment Schemes in Australia: Investing in Biodiversity and Other Ecosystem Services on Farms,* eds D. Ansell, F. Gibson, D. Ssalt (Australia: ANU Press), 151–161.

Elzaki, E., and Tian, G. (2020). Economic evaluation of the honey yield from four forest tree species and the future prospect of the forest beekeeping in Sudan. *Agroforest Syst.* 94, 1037–1045. doi: 10.1007/s10457-019-00478-1

Elzen, B., Barbier, M., Cerf, M., and Grin, J. (2012). "Stimulating transitions towards sustainable farming systems," in *Farming Systems Research into the 21st Century: The New Dynamic,* eds. I. Darnhofer, D. Gibbon, and B. Dedieu (Dordrecht: Springer), 431–455.

Fernandes, B. M., Welch, C. A., and Gonçalves, E. C. (2012). *Land Governance in Brazil.* Framing the Debate Series, no. 2 ILC, Rome.

Fraser, E. D. G., Dougill, A. J., Mabee, W. E., Reed, M., and McAlpine, P. (2006). Bottom up and top down: analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *J. Environ. Manag.* 78, 114–127. doi: 10.1016/j.jenvman.2005.04.009

Garibaldi, L. A., Carvalheiro, L. G., Leonhardt, S. D., Aizen, M. A., Blaauw, B. R., Isaacs, R., et al. (2014). From research to action: enhancing crop yield through wild pollinators. *Front. Ecol. Environ.* 12:439–447. doi: 10.1890/130330

Garibaldi, L. A., Gemmill-Herren, B., D'Annolfo, R., Graeub, B. E., Cunningham, S. A., and Breeze, T. D. (2017). Farming approaches for greater biodiversity, livelihoods, and food security. *Trends Ecol. Evol.* 32, 68–80. doi: 10.1016/j.tree.2016.10.001

Gebska, M., Grontkowska, A., Swiderek, W., and Golebiewska, B. (2020). Farmer awareness and implementation of sustainable agriculture practices in different types of farms in Poland. *Sustainability.* 12, 8022. doi: 10.3390/su12198022

Geldmann, J., and González-Varo, J. P. (2018). Conserving honey bees does not help wildlife. *Science* 359, 392–393. doi: 10.1126/science.aar2269

Gerber, P., Vellinga, T., Opio, C., Henderson, B., and Steinfeld, H. (2010). *Greenhouse Gas Emissions from the Dairy Sector: A Life Cycle Assessment.* Africa, 94.

Gliessman, S. R. (2016). Transforming food systems with agroecology. *Agroecol. Sustain. Food Syst.* 40, 187–189. doi: 10.1080/21683565.2015.1130765

Green, K. M., Crawford, B. A., Williamson, K. A., and DeWan, A. A. (2019). A meta-analysis of social marketing campaigns to improve global conservation outcomes. *Soc. Market. Q.* 25, 69–87. doi: 10.1177/1524500418824258

Habibullah, M. S., Din, B. H., Chong, C. W., and Radam, A. (2016). Tourism and biodiversity loss: implications for business sustainability. *Procedia Econ. Finan.* 35, 166–172. doi: 10.1016/S2212-5671(16)00021-6

Haines-Young, R. H., and Potschin, M. B. (2018). *Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure.* Available online at: https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf (accessed August, 2020).

Holl, K. D. (2017). Restoring tropical forests from the bottom up. *Science* 355, 455–456. doi: 10.1126/science.aam5432

IBGE (2017). *Censo Agropecuário 2017.* Instituto Brasileiro de Geografia e Estatística. Available online at: https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2017 (accessed August, 2020).

IBGE (2019). *Produção Agrícola Municipal.* Instituto Brasileiro de Geografia e Estatística. Available online at: https://sidra.ibge.gov.br/pesquisa/pam/tabelas (accessed August, 2020).

INEA (2018). *Uso e Cobertura do Solo-RJ. Car 25 (Arquivo Vetorial)*. Rio de Janeiro: Instituto Estadual do Ambiente. Available online at: http://www.metadados.inde.gov.br/geonetwork/srv/por/metadata.show?uuid=121b632d-cce5-41e5-97cd-88df7f911ecb

Jaffé, R., Pope, N., Carvalho, A. T., Maia, U. M., Blochtein, B., Carvalho, C. A. L., et al. (2015). Bees for development: Brazilian survey reveals how to optimize stingless beekeeping. *PLoS One* 10:e0121157. doi: 10.1371/journal.pone.0121157

Johnson, A., and Ready, G. (2017). *Pathways to Land Access: A Study of the Conservation Reserve Program - Transition Incentives Program in Four States*. Center for Rural Affairs. Available online at:https://sustainableagriculture.net/wp-content/uploads/2017/03/CRP-TIP-Pathways-Report-2017.pdf (accessed January, 2021).

Joly, C. A., Scarano, F. R., Bustamante, M., Gadda, T. M., Metzger, J. P., Seixas, C. S., et al. (2019). Brazilian assessment on biodiversity and ecosystem services: summary for policy makers. *Biota Neotrop.* 19:e20190865. doi: 10.1590/1676-0611-bn-2019-0865

Latawiec, A. E., Reid, B., Rodrigues, A. F., Pena, I. A. B., Gomes, F., Pacheco, V., et al. (2021). More effort is needed to implement and disseminate soil protection measures for tropical soils. *Environ. Res. Lett.* doi: 10.1088/1748-9326/abc196

Latawiec, A. E., Santos, J. S., Maioli, V., Junqueira, A. B., Crouzeilles, R., Jakovac, C. C., et al. (2018). "Forest landscape restoration and land sparing-sharing: shifting the focus towards nature's contributions to people" in *Forest Landscape Restoration Integrated Approaches to Support Effective Implementation*, eds S. Mansourian, J. Parrotta (Routledge), 100–118.

Latawiec, A. E., Strassburg, B. B., Brancalion, P. H., Rodrigues, R. R., and Gardner, T. (2015). Creating space for large-scale restoration in tropical agricultural landscapes. *Front. Ecol. Environ.* 13, 211–218. doi: 10.1890/140052

Latawiec, A. E., Strassburg, B. B. N., Silva, D., Alves-Pinto, H. N., Feltran-Barbieri, R., Castro, A., et al. (2017). Improving land management in Brazil: a perspective from producers. *Agric. Ecosyst. Environ.* 240, 276–286. doi: 10.1016/j.agee.2017.01.043

Maioli, V., Belharte, S., Stuker Kropf, M., and Callado, C. (2020). Timber exploitation in colonial Brazil: a historical perspective of the Atlantic Forest. *Historia Ambiental Latinoamericana Y Caribeña (HALAC) Revista De La Solcha*, 10: 46–73. doi: 10.32991/2237-2717.2020v10i2.p74-101

Mansourian, S., Parrotta, J., Balaji, P., Belwood-Howard, I., Bhasme, S., Bixler, R. P., et al. (2019). Putting the pieces together: Integration for forest landscape restoration implementation. *Land Degrad. Dev.* 31:419–429. doi: 10.1002/ldr.3448

Mansourian, S., Stanturf, J. A., Derkyi, M. A. A., and Engel, V. L. (2017). Forest Landscape Restoration: increasing the positive impacts of forest restoration or simply the area under tree cover? *Restor. Ecol.* 25, 178–183. doi: 10.1111/rec.12489

Mapbiomas. (2018). *Série Anual de Mapas de Cobertura e Uso de Solo do Brasil*. Available online at: https://mapbiomas.org/ (accessed August, 2020).

McKenzie-Mohr, D. (2011). *Fostering Sustainable Behavior: An Introduction to Community-Based Social Marketing, 3rd edn.* Gabriola Island, BC: New Society.

MEA (2005). *Ecosystems and Human Well-Being: Synthesis.* Washington, DC: Island Press. Millennium Ecosystem Assessment. Available online at: https://www.millenniumassessment.org/documents/document.356.aspx.pdf (accessed August, 2020).

Melo, F. P. L., Parry, L., Brancalion, P. H. S., Pinto, S. R. R., Freitas, J., Manhães, A. P., et al. (2020). Adding forests to the water-energy-food nexus. *Nat. Sustain.* 4, 85–92. doi: 10.1038/s41893-020-00608-z

Mittermeier, R., Myers, N., Thomsen, J., Da Fonseca, G. A. B., and Olivieri, S. (1998). Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. *Conserv. Biol.* 12, 516–520. doi: 10.1046/j.1523-1739.1998.012003516.x

MMA (2008). *Plano de Manejo da Área de Proteção Ambiental da Bacia do Rio São João/Mico-Leão-Dourado.* Brasília: Ministério do Meio Ambiente. Available online at: https://www.icmbio.gov.br/portal/images/stories/imgs-unidades-coservacao/apa_bacia_rio_sao_joao.pdf (accessed August, 2020).

MMA (2014). *Lista de Espécies Ameaçadas.* Ministério do Meio Ambiente. Available online at: https://www.icmbio.gov.br/portal/faunabrasileira/2741-lista-de-especies-ameacadas-saiba-mais.html. (accessed August, 2020).

Morales-Reyes, Z., Martín-López, B., Moleón, M., Mateo-Tomás, P., Botella, F., Margalida, A., et al. (2017). Farmer perceptions of the ecosystem services provided by scavengers: what, who, and to whom. *Conserv. Lett.* 11, e12392. doi: 10.1111/conl.12392

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., and Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403, 853–858. doi: 10.1038/35002501

Ndivo, R. M., and Cantoni, L. (2016). Rethinking local community involvement in tourism development. *Ann. Tourism Res.* 57, 275–278. doi: 10.1016/j.annals.2015.11.014

Newing, H., Eagle, C. M., Puri, R., and Watson, C. W. (2010). *Conducting Research in Conservation: Social Science Methods and Practice.* London: Routledge.

Niemiec, R. M., Willer, R., Ardoin, N. M., and Brewer, F. K. (2019). Motivating landowners to recruit neighbors for private land conservation. *Conserv. Biol.* 33, 930–941. doi: 10.1111/cobi.13294

Nind, M., and Vinha, H. (2014). Creative interactions with data: using visual and metaphorical devices in repeated focus groups. *Qual. Res.* 16, 9–26. doi: 10.1177/1468794114557993

Oliveira, C. M. (2016). *Avaliação dos Impactos Ambientais e Qualidade de Águas Superficiais na Região VI do Estado do Rio de Janeiro - RJ.* Master's Thesis, Federal University of Rio de Janeiro—UFRJ, Rio de Janeiro.

Ota, L., Chazdon, R. L., Herbohn, J., Gregorio, N., Mukul, S. A., and Wilson, S. J. (2020). Achieving quality forest and landscape restoration in the tropics. *Forests* 11, 820. doi: 10.3390/f11080820

Pegas, F. V., and Castley, J. G. (2014). Ecotourism as a conservation tool and its adoption by private protected areas in Brazil. *J. Sustain. Tourism* 22, 604–625. doi: 10.1080/09669582.2013.875550

Phalan, B., Green, R. E., Dicks, L. V., Dotta, G., Feniuk, C., Lamb, A., et al. (2016). How can higher-yield farming help to spare nature? *Science* 351, 450–451. doi: 10.1126/science.aad0055

PLANAVEG, BRASIL. (2017). *PLANAVEG - Plano Nacional de Recuperação da Vegetação Nativa.* Brasília: MMA (Ministério do Meio Ambiente), Secretaria de Biodiversidade e Florestas, Departamento de Conservação da Biodiversidade. Available online at: https://www.mma.gov.br/images/arquivos/florestas/planaveg_plano_nacional_recuperacao_vegetacao_nativa.pdf (accessed August, 2020).

Pradhananga, A., Davenport, M., and Green, E. (2019). Cultural narratives on constraints to community engagement in urban water restoration. *J. Contemp. Water Res. Educ.* 166, 79–94. doi: 10.1111/j.1936-704X.2019.03303.x

Purvis, B., Mao, Y., and Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustain. Sci.* 14, 681–695. doi: 10.1007/s11625-018-0627-5

Renn, O. (2006). Participatory processes for designing environmental policies. *Land Use Policy* 23, 34–43. doi: 10.1016/j.landusepol.2004.08.005

Reydon, B. P., Fernandes, V. B., and Telles, T. S. (2015). Land tenure in Brazil: The question of regulation and governance. *Land Use Policy* 42, 509–516. doi: 10.1016/j.landusepol.2014.09.007

Rezende, C. L., Uezu, A., Scarano, F. R., and Araujo, D. S. D. (2015). Atlantic Forest spontaneous regeneration at landscape scale. *Biodivers. Conserv.* 24, 2255–2272. doi: 10.1007/s10531-015-0980-y

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. *Biol. Conserv.* 142, 1141–1153. doi: 10.1016/j.biocon.2009.02.021

Ribeiro, N. B., Formiga-Johnsson, R., Ma., and Martins, M. S. (2018). Risco ecológico da Bacia Hidrográfica Lagos São João, RJ. *Eng. Sanit. Ambient.* 23, 447–458. doi: 10.1590/s1413-41522018160564

Sales, M. N. G. (2005). *Criação de Galinhas em Sistemas Agroecológicos.* Vitória-ES: Incaper.

Sánchez-Mercado, A., Blanco, O., Sucre-Smith, B., Briceño-Linares, J. M., Peláez, C., and Rodríguez, J. P. (2020). Using peoples' perceptions to improve conservation programs: the Yellow-Shouldered Amazon in Venezuela. *Diversity* 12, 342. doi: 10.3390/d12090342

Santos, C. F., Otesbelgue, A., and Blochtein, B. (2018). The dilemma of agricultural pollination in Brazil: beekeeping growth and insecticide use. *PLoS One* 13:e0200286. doi: 10.1371/journal.pone.0200286

Scarano, F. R., and Ceotto, P. (2015). Brazilian Atlantic forest: impact, vulnerability, and adaptation to climate change. *Biodivers. Conserv.* 24, 2319–2331. doi: 10.1007/s10531-015-0972-y

Schweizer, D., Meli, P., Brancalion, P. H. S., and Guariguata, M. R. (2019). Implementing forest landscape restoration in Latin America: stakeholder perceptions on legal frameworks. *Land Use Policy* 104244. doi: 10.1016/j.landusepol.2019.104244

Selinske, M. J., Coetzee, J., Purnell, K., and Knight, A. T. (2015). Understanding the motivations, satisfaction, and retention of landowners in private land conservation programs. *Conserv. Lett.* 8, 282–289. doi: 10.1111/conl.12154

SFB (2018). *Base de Imóveis do SICAR: Sistema Nacional de Cadastro Ambiental Rural*. Serviço Florestal Brasileiro. Available online at: http://www.car.gov.br (accessed August 25, 2020).

SICAR (2020). Sistema Nacional de Cadastro Ambiental Rural. Available online at: https://https://www.car.gov.br/publico/imoveis/index (accessed January, 2021).

Silva, A. P., Camacho, A. C. L. F., Menezes, H. F., Santos, A. C. F. T., Moniz, M. A., Santos, R. D., et al. (2020). Riscos à saúde do trabalhador rural exposto ao agrotóxico. *Saúde Coletiva (Barueri)* 10, 2094–2111. doi: 10.36489/saudecoletiva.2020v10i52p2094-2111

SISAGUA (2018). *Você Bebe Agrotóxicos? Descubra se a Água da Sua Torneira foi Contaminada, de Acordo Com Dados do Sisagua*. Sistema de Informação de Vigilância da Qualidade da Água para Consumo Humano. Available online at: https://portrasdoalimento.info/agrotoxico-na-agua/ (accessed January, 2021).

Soares-Filho, B., Rajao, R., Macedo, M., Carneiro, A., Costa, W., Coe, M., et al. (2014). Cracking Brazil's forest code. *Science* 344, 363–364. doi: 10.1126/science.1246663

Souza, T. V. S. B., Thapa, B., Rodrigues, C. G. O., and Imori, D. (2018). Economic impacts of tourism in protected areas of Brazil. *J. Sustain. Tourism*, 27, 735–749. doi: 10.1080/09669582.2017.1408633

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., et al. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biol. Conserv.* 209, 159–171. doi: 10.1016/j.biocon.2017.02.008

Strassburg, B. B. N., Beyer, H. L., Crouzeilles, R., Iribarrem, A., Barros, F., de Siqueira, M. F., et al. (2019). Strategic approaches to restoring ecosystems can triple conservation gains and halve costs. *Nat. Ecol. Evol.* 3, 62–70. doi: 10.1038/s41559-018-0743-8

Strassburg, B. B. N., Latawiec, A. E., Barioni, L. G., Nobre, C. A., da Silva, V. P., Valentim, J. F., et al. (2014). When enough should be enough: Improving the use of current agricultural lands could meet production demands and spare natural habitats in Brazil. *Glob. Environ. Change* 28, 84–97. doi: 10.1016/j.gloenvcha.2014.06.001

Tisovec-Dufner, K. C., Teixeira, L., Marin, G., de, L., Coudel, E., Morsello, C., et al. (2019). Intention of preserving forest remnants among landowners in the Atlantic Forest: the role of the ecological context via ecosystem services. *People Nat.* doi: 10.1002/pan3.10051

Tubenchlak, F., Badari, C. G., de Freitas Strauch, G., and de Moraes, L. F. D. (2021). "Changing the agriculture paradigm in the Brazilian Atlantic Forest: the importance of agroforestry," in *The Atlantic Forest*, eds M. C. M. Marques and C. E. V. Grelle (Cham: Springer), 369–388.

Vaarst, M., Steenfeldt, S., and Horsted, K. (2015). Sustainable development perspectives of poultry production. *Worlds Poultry Sci. J.* 71, 609–620. doi: 10.1017/S0043933915002433

Wehi, P. M., and Lord, J. M. (2017). Importance of including cultural practices in ecological restoration. *Conserv. Biol.* 31, 1109–1118. doi: 10.1111/cobi.12915

Wolff, L. F., and Gomes, J. C. C. (2015). Beekeeping and agroecological systems for endogenous sustainable development. *Agroecol. Sustain. Food Syst.* 39, 416–435. doi: 10.1080/21683565.2014.991056

Young, C. E. F. (2006). Desmatamento e desemprego rural na Mata Atlântica. *Rev. Flores. Ambient.* 13, 75–88. Available online at: https://www.floram.org/article/588e2214e710ab87018b463f/pdf/floram-13-2-75.pdf (accessed January, 2021).

Yusuf, S. F. G., Cishe, E., and Skenjana, N. (2017). Beekeeping and crop farming integration for sustaining beekeeping cooperative societies: a case study in Amathole District, South Africa. *GeoJournal.* 83, 1035–1051. doi: 10.1007/s10708-017-9814-7