Forest Restoration in the State of Rio De Janeiro: Adherence to Legislation

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ABSTRACT

This study evaluated forest restoration projects filed at the state environmental agency of Rio de Janeiro (Inea), regarding the requirements contained in the Resolution Nº 36/2011. Legal, technical, environmental and ecological parameters of 65 restoration projects in the design and implementation phases were analyzed. Only 29% of the projects met the requirements of Resolution Nº 36/2011. The low compliance with the requirements of the resolution evidences the lack of knowledge of the current regulations in the state of Rio de Janeiro by the technical users of the system. This condition implies a longer time of environmental licensing. Recently, Inea has revoked Res. Nº 36/2011 through Res. Nº 143/2017, which, in addition to simplifying the presentation of restoration projects, gave rise to the State System for Monitoring and Evaluation of Forest Restoration – SEMAR.

Keywords: forest restoration, PRAD, Inea Resolution Nº 36/2011, Inea Resolution Nº 143/2017.

1. INTRODUCTION

Despite the increasing efforts to restore degraded areas, ecological restoration is still a relatively recent scientific discipline (Aronson et al., 2011). In this sense, scientific advances are necessary for restoration programs to be truly effective (Brancalion et al., 2010), which means that the results of new studies need to be incorporated into forest restoration projects.

The current paradigm based primarily on ecosystem knowledge and species growth capacity (Hobbs & Harris, 2001) is not sufficient to ensure the success of forest restoration efforts.

From this perspective, forest restoration is adopted as a compensatory measure within the environmental licensing system (Lopes & Ribeiro, 2016).

In general, new enterprises demand an authorisation for the removal of native vegetation in order to install their infrastructure. Associated with the mechanisms of environmental compensation, deforestation seeks to reconcile economic interests such as the expansion of productive activity, the maintenance of environmental services, the conservation of biodiversity and the preservation of the landscape.

However, current environmental compensation mechanisms need to be improved to resolve issues such as the time lag between the planting establishment of a new forest, the high degree of uncertainty in restoration processes, and the application of the economic value established in the environmental compensation measures (Maron et al., 2012).

Although initiatives aimed at forest restoration have been practiced regularly in the state of Rio de Janeiro for more than 25 years, such as the Mutirão Reforestation Project, an initiative of the Municipal Government of Rio de Janeiro, they struggle against technical, political and market failures (Richards, 1999). However, some of the failures on forest restoration practice are in its origin, during the design phase of the project, which disregards the local characteristics and apply methods independently of the ecology patterns of each region (Kollmann et al., 2016).

With the intention of improving the quality of the restoration projects submitted to the Rio de Janeiro State Environmental Institute – Inea –, Resolution Inea Nº 143 was published on June 14, 2017 (Rio de Janeiro, 2017), establishing the State System for Monitoring and Evaluation of Forest Restoration (SEMAR). This resolution revoked Inea Resolution Nº 36/2011 (Rio de Janeiro, 2011), which established the term of reference (TR) for the elaboration of forest restoration projects (PRAD).

In this sense, this work brings together an unprecedented diagnosis of the situation of forest restoration projects in the state of Rio de Janeiro in light of the main normative instrument, Inea Resolution Nº 36/2011, presenting the minimum content to be contemplated by forest restoration projects. This resolution provided a blueprint to a precise diagnosis of the target area of the project, the adoption of methods compatible with the site, the indication of species being consonant with the physical, and the chemical and biological characteristics of the area, allowing a detailed description of the field operations and a timetable for the proposed goals.

The objective of this paper was to evaluate the level of adoption and adequacy of the projects in terms of Inea Resolution Nº 36/2011, with the overall aim to generate an analysis of the effectiveness and understanding of this regulation, based on the analysis of projects registered within the Forest Service Management – GESEF –, providing new information and perspectives on the management of forest restoration in the state of Rio de Janeiro.

2. MATERIAL AND METHODS

2.1. Study area

The state of Rio de Janeiro, located in the southeast of Brazil, is composed of 92 municipalities organized in eight administrative regions, covering an area of 43,696,054 km². The highly diverse landscape consists of mountains and lowlands, headlands, lagoons, bays and tropical forests (IBGE, 2010).

2.2. Data collection and analysis

The collection of data was limited to actions derived from commitments to recompose the legal reserve or environmental compensation on the Atlantic Forest context in Rio de Janeiro, under the light of Res. Inea Nº 36/2011. For this, a survey of 300 administrative processes was carried out in the Forest Service Management – GESEF / Inea. Of these, 65 processes

presented projects of forest restoration (PRAD), motivated by mechanisms of environmental compensation linked to the licensing of economic activities and the approval of legal reserves (RL), granted by Inea between 2005 and 2014, and regulated by the Inea Resolution Nº 36 of July 8, 2011. Analysis of the periods prior to 2011 was carried out with the purpose of providing an assessment of the impact of the normative instrument in the pre- and post-resolution environment.

Regardless of whether the motivation is RL registration or environmental compensation, the preparation of the PRAD should follow the term of reference published through the Resolution Inea Nº 36.

For analysis and verification of the adequacy level to the legislation of the administrative processes and their respective projects, the systematization of the data was adopted in the project phase, subdivided into two sub-phases, namely 1 (diagnosis) and 2 (silvicultural). The legal parameters, as well as technical, environmental and ecological assessments, are presented in Table 1. From this systematization, it was possible to carry out the descriptive diagnosis of the situation of the restoration projects underway in Inea. After obtaining the data, the analyses were carried out using spreadsheets in Microsoft Excel.

Table 1. Data collection framework.

Sub-phase diagnosis	Sub-phase silviculture
Legal parameters	*Technical parameters*
PRAD motivation	Plant spacing
Attendance to Res. 36/2011 (Rio de Janeiro, 2011)	Seedling size
Technical parameters	Soil fertilization
Project area	Use of water-holding polymer
Direction of slopes	Forest protection
Average slope	Use of mechanization
Actual vegetation cover	*Ecological parameters*
Presence of water bodies	Seedling origin
Georeferencing	Ecological groups
Soil analysis	Seed dispersion syndrome
Project timeline	
Environmental parameters	
Average rainfall	
Average temperature	
Phytophysiognomy	
Relief description	
Proximity to forest patches	
Presence of naturally regenerated areas	

3. RESULTS

Out of the 65 PRADs analyzed, only 22% met the recommendations established by Resolution Nº 36/2011. Considering only PRADs after 2011, when the resolution was launched, the level of compliance with the legislation remains relatively low, 30% (Table 2).

Regarding the motivation of the restoration commitment, of the 65 PRADs analyzed, 79% were derived from environmental compensation commitments linked to the environmental licensing of potentially or effectively polluting activities and 11% of the legal reserve (RL) recomposition commitments, as recommended by the Brazilian Forest Code. The rest was motivated by voluntary initiatives or Inea notifications, which are not under the regulation of the Resolution Nº 36/2011.

The projects analyzed covered 2.702 hectares (ha), with an average size of 51.0 ha per PRAD, ranging from 0.03 to over 700 hectares, which reflects the heterogeneity of the projects in process. The indications of the direction of slopes, average slope and the presence of water bodies in the projects were considered unsatisfactory, making it impossible to analyze and/or extrapolate the results, as the supplied data were not standardized.

In relation to the content of the protocoled projects, 49% presented geo-referenced planialtimetric maps that consider the three-dimensional model of the terrain, as required by the TR of Resolution Nº 36/2011. About 37% of the projects presented soil analysis results; in 50% of the PRADs, this information was not presented, and about 13% of the projects did not even mention this requirement (Table 3).

The predominant land cover in the PRAD areas analyzed is marked by the occurrence of exotic grasses, appearing in 47.7% of the total projects. Secondary forests and other land use types followed, each accounting

Table 2. Proportion of attendance to the Resolution Inea 36/2011 (Rio de Janeiro, 2011) in the analyzed administrative processes (AP).

Year of the administrative process	Nº of projects	% compliance with the Res. Nº 36/2011
Before 2011	34	15
After 2011	31	29
Total (2005–2014)	65	22

for 16.9%. These results reinforce data indicating that 81% of the area of the state of Rio de Janeiro is deforested (Fundação SOS Mata Atlântica, 2014).

The project timeline was presented in 50.7% of the PRADs analyzed, showing negligence regarding planning and predictability in restoration programs.

The results indicate that the main forest phytophysiognomy object of the PRADs analyzed was the Ombrophilous Dense Forest (FOD) in the lowland, submontane and montane formations. Information on the characterization of forest phytophysiognomy was omitted in 20% of the analyzed projects.

Data on average rainfall were available in about 50% of the projects, with average rainfall of around 1,500 mm/year. Temperature data were provided in 44% of the projects, with an average value of 22 °C, ranging between 15 and 40 °C.

The PRAD analysis indicated that 63% of the areas were located less than 100 meters away from forest fragments; however, only 31% of the projects considered the presence of natural regeneration as an element to be managed in the restoration effort.

The total area planting method was considered in 83% of the projects, while natural regeneration was indicated as a strategy in 9% of the projects studied. In 8% of the projects, the planting methodology was not described.

Planting methods usually applied two spacings, namely 2 × 2 m and 3 × 2 m, indicated in 24 and 18 PRADs, respectively. Other spacings, e.g. 2 × 2.5 m, 2.5 × 2.5 m, 4 × 4 m, were used infrequently.

Only 12% of the projects considered the requirement contained in the reference term of the Inea Resolution Nº. 36/2011 in relation to the minimum seedling size of 60 cm. Across all analyzed projects, 88% did not even consider this requirement, and there is no indication of understanding or adopting the regulation.

The application of soil fertilizer to the plantations was considered in 80% of the PRADs; however, coverage fertilization was only considered in 58% of the projects. In most projects, the commercial fertilizer NPK was predominantly used, followed by limestone, manure, simple superphosphate, natural phosphate, potassium chloride, ammonium sulphate, and urea (Table 4).

Table 3. Main results of the analysis of compliance of sub-phase 1 with Resolution Inea 36/2011 (Rio de Janeiro, 2011) in administrative processes between the years 2005 and 2014.

Sub-phase diagnosis	Level of compliance (%)
Legal parameters	
Attendance to Res. 36/2011	29.0
Technical parameters	
Project area	100.0
Soil analysis	37.0
Project timeline	50.7
Environmental parameters	
Average rainfall	50.0
Average temperature	44.0
Phytophysiognomy	80.0
Proximity to forest patches	63.0

Table 4. Main results of the analysis of compliance of sub-phase 2 with Resolution Inea 36/2011 (Rio de Janeiro, 2011) in administrative processes between the years 2005 and 2014.

Sub-phase silviculture	Level of compliance (%)
Technical parameters	
Plant spacing	80.0
Seedling size	12.0
Soil fertilisation	80.0
Use of water-holding polymer	23.0
Forest protection	32.0
Use of mechanisation	20.0

The use of herbicides to control exotic grasses, which were indicated in half of the PRADs, was considered low, with only 5% of the projects applying them.

Forest protection measures in the analyzed PRADs were represented by fences (32%) and fire lines (29%) as the most usual strategies. In 52.5% of the projects, no protection measures were taken, and no information on the adoption of protective measures was provided.

Throughout the analyzed projects, mechanization was considered low, 20% on average, representing mowing, plant spot opening or seedling transport.

Only in a small number of the projects (15 out of 65; 23%), water-holding polymer gel was applied.

Ecological restoration with the use of autochthonous species was the standard and represented by 80% of the protocoled projects. Among the species used in restoration programs, there was a relative balance in the

proportion of species with anemochory and zoochory dispersion syndromes. It is worth mentioning that in 15% of the projects, this information was not presented.

The successional stage (pioneer and non-pioneer species) of the plants used in the restoration projects was reported in 90% of the projects.

Based on the results of the evaluation of adherence and understanding of Resolution Nº 36/2011 (Rio de Janeiro, 2011), workshops, documentary reviews and monitoring of field projects were carried out, which resulted in the creation of the State System for Monitoring and Evaluation of Restoration – SEMAR –, now regulated by Resolution Inea Nº 143/2017 (Rio de Janeiro, 2017). In this sense, SEMAR standardized the project models, technical report and forest restoration commitment deadline, and created the monitoring and evaluation protocol.

4. DISCUSSION

The data presented here indicated the low level of knowledge about restoration practices and adherence to Inea Resolution Nº 36/2011, since only about one third of the projects submitted fully met the TR requirements. The formulation of public regulations by itself is not sufficient to correct policy failures, and a communication strategy plan must be considered during design and implementation.

Public policies should provide the guidelines, rules and procedures for relations between public power and the society. In this sense, the creation of the TR, object of Inea Resolution Nº 36/2011, served as a guideline and positioned the state as a protagonist, reducing bureaucracy and diminishing subjectivity in environmental licensing and compensation processes.

However, the low level of adherence to the regulation, evidenced in the forest restoration projects analyzed, requires the state to seek ways to redirect its policy, making it more effective and maximizing results to correct existing flaws.

The implementation of public policies can be considered as the apex of the environmental policy process. Policy success should ultimately be assessed by its impacts in practice, but despite many institutional initiatives, implementation failures are recurrent and are not unique to any of the public-sector entities.

Understanding the mistakes and successes in the implementation of policies and realizing the responsibilities and interests of the main actors involved in the implementation of policies, as well as opening channels of discussion of possible solutions to the goals and results of policies, are elements that guarantee the success of environmental policies (Jordan, 1999).

The impact of the creation of Resolution Nº 36/2011 can be considered incipient when compared to the period prior to the publication of the resolution, given the unsatisfactory number of projects that present the set of information required by the current legislation at the time. The attendance level below 30% shows that there were flaws in the understanding of the rules by users of the system and also in the disclosure and effectiveness of communication by Inea.

The consequence of not complying with the regulations implies a longer time in the administrative process of the project, generating delays in the evaluation of projects and in all licensing systems, besides generating rework for the entrepreneur and the public service. It should be noted that if the project does not include all the information required by current regulations, it cannot be approved by the public server.

Regarding the technical criteria evaluated in the diagnostic and silviculture sub-phases, these were inconsistent, since they did not present the minimally necessary information required. The format of the projects presentation was not systematized, and the volume of information was sometimes excessive and inaccurate, making it difficult for the environmental agency technicians to analyze them, generating rework and delays.

The quality of the projects can still be questioned, as they disregarded the interaction of the areas to be restored with their surroundings. As an example, 63% of the projects were located near primary forest fragments, and only 31% considered the management of elements of natural regeneration as a restoration strategy, with only 9% of the projects using this technique effectively.

This shows that, although new strategies have been developed and improved in recent years (i.e. seed rain management, litter transposition, seedling bank activation, nucleation, use of artificial perches, among others), the recurrent technique used in restoration projects in the Atlantic Forest of Rio de Janeiro continues to be the planting of native species across the entire area to be

restored. In this sense, this choice significantly increases the implementation and maintenance costs, and the projects may become unfeasible from the financial point of view over time (Rodrigues et al., 2009).

A critical point was observed in relation to the technical specification of the minimum size of the seedlings, and 88% of the analyzed projects did not comply with the regulations. Currently, the requirement of a minimum seedling size of 60 cm has been revoked with the new resolution that instituted SEMAR.

Soil analysis was performed in less than 40% of the projects analyzed. The lack of analysis as well as fertilization recommendations can be justified with the small number of soil analysis laboratories in the state. Another factor may be the scarcity of data on nutrient accumulation of native forest species.

Herbicides were applied only in 5% of the projects, setting a low level of use of this resource in silvicultural practices in the forest restoration projects implemented in the state. In addition, exotic grasses were present in approximately half of the projects, and their control is usually a limiting factor in restoration projects (Hooper et al., 2004; Brancalion et al., 2009). The control of competing grasses is fundamental to avoid compromising the success of the restoration and to eliminate unnecessary risks (Souza & Batista, 2004).

Another source of direct impact on the costs of a project is the observed mortality rate, which implies the replanting of new seedlings. In this sense, the use of practices that reduce this risk is desirable, for example, the application of insecticides for ant control to prevent leafcutter ant attacks on seedlings and the use of water-holding polymer gel, which increases the availability of water to the seedlings at the beginning of their development in the field.

Analyzing the ecological parameters to infer the trajectory of the forest succession process, the use of native species was verified, and the ecological succession patterns were compatible with the phytophysiognomies of the Atlantic Forest (Alves et al., 2005; Oliveira, 2007).

The characterization of phytophysiognomy, among others, is a fundamental element in the elaboration of a forest restoration project, since it is based on the definition of a reference ecosystem that will guide the recomposition of the degraded environment (Hobbs & Harris, 2001; Ruiz-Jaen & Aide, 2005). Therefore, the absence of this information, which was observed

in 20% of the cases, may compromise the quality of the projects presented.

In addition to the selection of species appropriate to the site characteristics and their respective proportions in the different successional stages, the success of reforestation programs also depends on preventive and protective measures. However, the adoption of strategies such as fencing and fire lines was not even indicated in approximately half of the evaluated projects, compromising their success because of competition with cattle and the frequency of forest fires.

It should also be considered that the reproductive strategies of the plants should be evaluated when proposals are made to combine species to reach final communities in restored areas, with the purpose of avoiding reproductive isolation, leading to the failure of restoration programs (Castro et al., 2007).

For zoochory species, the dispersion depends on the movement patterns of the animals, influencing plant recruitment. These effects also depend, in part, on the microhabitats where the seeds are deposited and their influences on seedling growth and mortality (Rother et al., 2013).

Overcoming the biological and site-specific filters that prevent or hinder succession progression towards a forest ecosystem is the challenge imposed on formulators and implementers of restoration projects. Therefore, observing and assimilating the signals the environment itself reveals are fundamental steps to ensure the success of restoration efforts.

5. CONCLUSIONS

The low level of compliance with the resolution and, consequently, the increase in the time of the procedure required a repositioning of the state to obtain greater publicity and clarity for its regulatory mechanisms.

In fact, the number of projects complied with Resolution Nº 36/2011 evidenced the lack of knowledge by the private technical forest sector in terms of the regulations in the state of Rio de Janeiro.

We observed a low level of mechanization as well as a low use of new technologies and innovative approaches in forest restoration in Rio de Janeiro. The underlying causes may be the training of professionals at the universities or even the inexpressive agricultural sector

and or the incipience of a strong forestry culture in the state of Rio de Janeiro.

In this sense, the adoption of technologies and techniques that increase the success of restoration actions should be stimulated through public policies, inducing systematization and regulation, promoting their wide dissemination.

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