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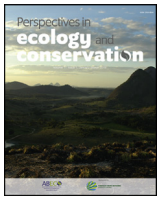

Policy Forums

# There is hope for achieving ambitious Atlantic Forest restoration commitments

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ABSTRACT

Achieving ambitious global restoration commitments is a huge challenge. The Atlantic Forest Restoration Pact, created in 2009 as a movement to restore 15 Mha of degraded/deforested lands by 2050, pledged 1 Mha towards the 2020 Bonn Challenge. We documented the restoration of an estimated 673,510–740,555 ha of native forests from 2011 to 2015 in the Atlantic Forest, and expect that a total of 1.35–1.48 Mha will be under recovery by 2020. The Pact is one of the first Brazilian restoration initiatives to monitor an international restoration commitment and to demonstrate that ambitious targets can be reached. Part of this success in large-scale restoration is related to three main Pact activities: (i) development of restoration governance, communication and articulation; (ii) promotion of strategies to influence public policies; and (iii) establishment of restoration monitoring systems. The experience and lessons learned by the Pact could inspire and inform other restoration initiatives worldwide.



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The achievement of ambitious global restoration commitments (www.bonnchallenge.org) is a huge challenge. A key question is how these commitments can overcome barriers such as high restoration costs, lack of investments, limited technical assistance, and poor governance in certain regions (Chazdon et al., 2017; Strassburg et al., 2019). Brazil made an ambitious pledge of 12 Mha of native vegetation recovery as a contribution to the Bonn Challenge global target, which aims to promote restoration in 150 and 350 Mha of degraded/deforested lands by 2020 and 2030, respectively (www.bonnchallenge.org). This restoration commitment is also part of Brazil's pledge to the Paris Climate Agreement (http://www.mma.gov.br/images/arquivo/80108/BRASIL%20iNDC%20portugues%20FINAL.pdf) and its National Policy for Native Vegetation Recovery (http://www.mma.gov.br/images/arquivos/florestas/planaveg_plano_nacional_recuperacao_vegetacao_nativa.pdf). New data on forest cover obtained in the Brazilian Atlantic Forest biome, one of the world's most threatened biodiversity conservation hotspots, bring hope for the achievement of these ambitious commitments (Rezende et al., 2018).

The Atlantic Forest Restoration Pact (hereafter Pact) was created in 2009 as a bottom-up, multi-stakeholder movement to restore 15 Mha of degraded/deforested lands by 2050 (http://www.pactomataatlantica.org.br/). The Pact pledged in 2011 1 Mha to the 2020 Bonn Challenge (www.bonnchallenge.org). We offer here evidence that this ambitious restoration commitments can be achieved, thanks in part to the action of the Pact. The Pact is one of the first Brazilian restoration initiatives to monitor its pledge to an international restoration commitment as the Bonn Challenge. The experience and lessons learned by the Pact could be used: (i) to guide, systematically, official governments and organizations monitoring reports about progress towards national and global commitments; (ii) to inspire other restoration initiatives and commitments; (iii) as a roadmap of how to create enabling conditions for large scale restoration to contribute to achieving global restoration commitments; and (iv) to present a "bottom-up", smart governance mechanism that promotes stakeholders' participation and engagement.

The Pact's pledged to the Bonn Challenge, which is a global commitment founded on a "Forest and Landscape Restoration" approach. According to this approach, landscape restoration can be reached through a broad set of actions, including an increase in the amount of native vegetation recovered, or in the area of commercial tree plantations, or also in the extension of land with management improvements (e.g. sustainable agriculture intensification) (https://www.iucn.org/theme/forests/our-work/forest-landscape-restoration). However, recognizing that these three actions do not provide similar ecological benefits the Pact decided to account only for native vegetation recovery in order to better achieve the Pact's aims of promoting biodiversity conservation, nature's contribution to people, a native species-based economy, and contribute to the implementation of public policies requiring ecological restoration.

To estimate the total amount of "restored forest" (defined here as native forests under either passive or active recovery that may not have yet reached the attributes of reference ecosystems) in the Brazilian Atlantic Forest between 2011 and 2017, we used a 30 m resolution land use and cover mapping product ("Mapbiomas", version 3.0; http://mapbiomas.org/pages/database/mapbiomas_collection). Mapbiomas is a collaborative initiative involving Non-Governmental Organizations, private companies, and research organizations to annually monitor land use change across all Brazilian biogeographical regions. Five conservative criteria were used to identify restored forest. The area should: (i) be previously classified as agriculture or pasture for at least five consecutive years; (ii) have at least five connected pixels also classified as restored forest; (iii) be classified as forest in 2017; (iv) be classified as forest for at least three consecutive years; and (v) should not be a commercial tree plantation (databases in http://www.globalforestwatch.org; geo.fbds.org.br). All areas meeting these criteria were summed up to estimate restored forest between 2011 and 2015 (and standing in 2017). Due to criterion iv, restored forests were not detected for 2016 and 2017.

The accuracy of the resulting restored forest estimate was assessed using a manual interpretation of 482 randomly selected forest restoration pixels with high resolution Google Earth (TM) images for the same year the pixel was turned to forest (minimum sample size required = 264 pixels). This approach estimates only the proportion of pixels misclassified as forest restoration (commission error), but provides no information about failure to detect forest restoration areas (omission error), that is, reporting an underestimated and conservative restored forest estimates. The uncertainty of estimates were calculated with 95% confidence interval (Casella and Berger, 2016). Sensitivity analyses were also conducted by changing the number of consecutive years that a pixel must be previously classified as agriculture or pasture (from five to four or six), and by changing the minimum number of pixels that needs to be connected (from five to four or six).

The Pact detected 906,452 ha of degraded/deforested lands under restoration from 2011 to 2015 (and maintained up to 2017) within the Atlantic Forest. The restored forest classification accuracy was 78%, with most misclassification arising from commercial tree plantations (14%) and old-growth forest (6%). On this basis we estimate that 673,510 and 740,555 ha of forest was restored between 2011 and 2015. Altering the classification criteria in the sensitivity analyses resulted in estimates between 607,668 and 865,016 ha. There is a tendency of a slightly increase in the amount of restored forest in the last few years (Fig. 1). On the assumption that the average annual rate of forest restoration from 2011 to 2015 (180, 290 ha $yr^{-1}$; Fig. 1) continues for the next five years, we estimate the total forest restored from 2011 to 2020 will be 1.35–1.48 Mha, exceeding the 1 Mha commitment to the Bonn Challenge.

We found restored forests widespread across the Atlantic Forest, but larger areas were found in the states of Santa Catarina, Rio de Janeiro and Espirito Santo (Table 1). Extensive degraded/deforested areas have regrown over the last decade, following agricultural abandonment or the cessation of disturbance (e.g. Rezende et al., 2015). Natural regeneration can potentially reduce implementation costs for restoration, yet the enabling conditions for natural regeneration are not uniformly distributed across the biome (e.g. Molin et al., 2018). Thus, it is also critical to consider tree planting as a key restoration intervention to forest recovery in regions with lower

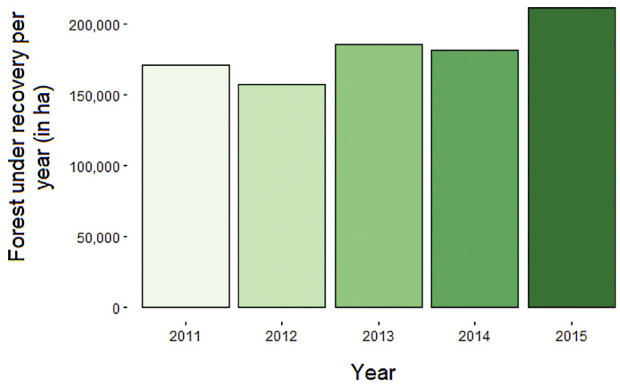


**Fig. 1.** Amount of restored forest detected for the first time in each year since 2011 (when the Atlantic Forest Restoration Pact committed to the Bonn Challenge), and maintained up to 2017 in the Brazilian Atlantic Forest. The sum of the bars results in the amount of restored forest detected between 2011 and 2015. The last two years (2016 and 2017) are not shown, as one criterion to map a pixel as a restored forest is that it must persist for at least three consecutive years.

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**Table 1**
Amount of restored forest detected for the first time in each year (since Atlantic Forest Restoration Pact committed to the Bonn Challenge and maintained up to 2017) within the states of the Brazilian Atlantic Forest (in ha).

| | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Rio Grande do Sul | 21.057 | 19.937 | 21.178 | 24.375 | 23.837 |
| Santa Catarina | 20.603 | 17.104 | 17.617 | 18.080 | 20.149 |
| Paraná | 37.778 | 25.738 | 39.616 | 33.863 | 48.394 |
| São Paulo | 17.261 | 14.234 | 16.265 | 19.157 | 18.859 |
| Rio de Janeiro | 4.255 | 4.977 | 5.134 | 5.395 | 11.743 |
| Espírito Santo | 3.619 | 4.277 | 4.728 | 4.959 | 6.812 |
| Minas Gerais | 38.892 | 37.045 | 47.310 | 47.821 | 43.305 |
| Bahia | 20.315 | 22.652 | 23.066 | 20.476 | 22.244 |
| Mato Grosso do Sul | 2.152 | 3.320 | 2.793 | 2.891 | 5.696 |
| Rio Grande do Norte | 227 | 186 | 450 | 130 | 461 |
| Pernambuco | 2.301 | 3.306 | 3.033 | 1.316 | 3.519 |
| Sergipe | 494 | 943 | 1.226 | 900 | 2.369 |
| Alagoas | 973 | 2.768 | 1.747 | 1.151 | 2.461 |
| Paraíba | 799 | 595 | 1.590 | 737 | 1.792 |

resilience or higher competition for land. A preliminary estimation performed with the Pact's database of restoration projects suggests that nearly 300,000 ha of restored forests have been established through active restoration interventions by its ~350 members. This area of active restoration is likely to be part of our restored forest estimates, but it was not possible to confirm this due to the lack of spatially explicit information about all areas of active restoration.

Part of the Pact's success in promoting large-scale forest restoration may be related to three main Pact activities to create enabling conditions for restoration. First, *the development of governance, communication and articulation strategies* (e.g. Guariguata and Brancalion, 2014) to engage and connect multi-stakeholders through a decentralized coordination, composed of working groups, regional units, and an online platform (http://www.pactomataatlantica.org.br/). Local engagement and articulation efforts took place in 14 of the 17 states of the Atlantic Forest through communication efforts in regional units that promoted capacity building and involvement of different actors in the restoration supply chain. These actions were further reinforced through technical material developed by working groups and disseminated in reports, field guides, primers, videos, peer-reviewed articles, and in the online platform (e.g. Rodrigues et al., 2009). Second, *the establishment of a monitoring system* (e.g. Kristen et al., 2018) based on both remote sensing and field data. Both information are hosted and available in an online platform. Third, the promotion of a *vision and strategies* to influence public policies and actions at multiple levels. The Pact is a bottom-up movement that allows for the integration of different actors in the effort to recover native vegetation through a common vision of social engagement, governance and planning that helps to achieve global restoration targets (Holl, 2017).

Other important factors contributing to forest restoration include: (i) the Atlantic Forest Law (http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2006/Lei/L11428.htm), which prohibited deforestation in secondary Atlantic forests of intermediate and advanced stages of succession – then a higher amount of restored forest can be detected through time; (ii) improved monitoring and enforcement actions, for example, through the systematically monitoring of the deforestation (SOS Mata Atlântica and INPE, 2018); and (iii) land abandonment due to the average low productivity of pasturelands, mostly concentrated in steep slopes in this region, compared to international standards (Latawiec et al., 2015). We cannot determine the relative importance of the various socio-ecological factors influencing forest restoration processes, but believe the Pact also has helped to scale up forest restoration by creating enabling conditions and developing processes for monitoring and reporting.

We highlight four main lessons learned from the Pact during the monitoring of its restoration pledge to the Bonn Challenge. First, clear criteria have to be defined to classify an area as restored. The Pact used an operational definition that focus on the recovery of native forest cover, as this maximizes the achievement of Pact's overarching objectives. Second, it is necessary to use reliable remote sensing images or land use and cover maps (i.e. with appropriate resolution, based on standardized approaches, and repeated over time) to monitor restoration commitments at large scale (e.g. Boillat et al., 2017). The partnership between Pact and Mapbiomas was key in this context, as Pact members counted on a robust methodology, developed by several independent experts and organizations, to monitoring its restoration commitment. Third, it is crucial to define robust criteria to analyze remote sensing images or land use and cover maps. Although these data can be available and feasible to be used for monitoring large-scale restoration, specific criteria need to be defined to avoid under- or over-estimation of the area undergoing restoration. The Pact's criteria were conservative in that they excluded commercial tree plantations, ensured a minimum of three years of forest persistence, and did not use omission error estimates to inflate restoration area estimates. Fourth, the Pact engaged the whole restoration community and attracted public support for the restoration commitment, thereby fostering a culture of public accountability. Although the definitions, data and criteria used by the Pact to monitor its commitment could be used directly by other countries and organizations, or as guidance on how to monitor global restoration targets.

The next challenges faced by the Pact and the Brazilian government are to: (i) maintain and protect restored forests over time by eliminating illegal deforestation/degradation through monitoring and enforcement actions; (ii) improve both on-the-ground monitoring to quantify restoration quality and large-scale monitoring to increase accuracy and robustness of estimates; and (iii) increase economic incentives (e.g. payments for ecosystem services, production of native timber and non-timber forest products) and financing for restoration. Initiatives such as the International Union for Conservation of Nature-Bonn Challenge Barometer of Progress (https://www.iucn.org/theme/forests/projects/bonn-challenge-barometer), National Determined Contribution-United Nations Framework Convention on Climate Change, United Nation Convention on Biological Diversity Aichi targets and Sustainable Development Goals commitments, and the National Commission on Native Vegetation Recovery (http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/decreto/d8972.htm) have instigated discussions on how to monitor the advancement of the restoration area in different national and subnational pledges, yet no official guidelines or standard yet exist to check progress towards the achievement of international restoration pledges. The experiences and lessons learned by the Pact could be useful to other restoration initiatives worldwide to operationalize the accountability of the global restoration agenda.

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