

Chapter 9

Synergies and Trade-Offs of National Conservation Policy and Agro-Forestry Management Over Forest Loss in Argentina During the Last Decade



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Abstract One reason for the decline of natural forest is that many ecosystem services (ESs) are usually not priced and values were only considered provisioning services. Argentina enacted the National Law 26,331/07, which regulates protection, enrichment, restoration and management of native forests and its environmental services. The objective is to determine the ecological and sociopolitical factors that influence the dynamics of forest cover loss before and after the law implementation and discuss the effectiveness of conservation and forest management policies. Satellite images, national ordination, forest regions maps and other variables were combined in GIS with national databases (social, agriculture, industry) to determine the evolution of potential drivers of forest changes. The main potential drivers were: (i) population

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growth, (ii) road density, (iii) crops area, (iv) livestock and (v) fires. Payment of incentives by government cannot fully stop the deforestation but decrease the forest loss rate. New approaches must be considered to built-in flexibility actions according to local conditions and constraints, which are influenced by social and economic contexts. Thus, it is necessary to establish new regional policies associated with the factors linked to the loss of forest cover, in the search for sustainable management alternatives that combine economic and conservation proposals.

Keywords Ecosystem services · Drivers of change · Sustainable management · Soybean crops · Law 26,331/07

1 Introduction

Argentina is characterised by a great diversity of climates and environments that favoured the establishment of different productive initiatives related to agricultural and forestry activities based on exotic species (cattle, extensive crops and forest plantations). When these productive initiatives are based on goods and services provided by the natural ecosystems, positive synergies can be achieved allowing effective conservation management proposals. However, there are often trade-offs between production and conservation that lead to changes in land use cover over time (Luque et al. 2010). Argentina bases its economy in the production of agroindustrial commodities for export. The expansion of livestock keeping and agricultural fields generated changes in the structure and assemblage of typical species in natural ecosystems, leading to an artificialization of the natural landscapes (e.g. monocultures for agriculture or forestry production) and local species extinction. Recently, new alternatives have been proposed that combine economic and conservation purposes in the same area (e.g. Lindenmayer et al. 2012). However, this new management perspective has not affected the artificialization of the natural ecosystems in Argentina.

These synergies and trade-offs of land use generate higher controversies in the society, which demands a well-being based on productive activities (e.g. provision ecosystem services), but also claim for the benefits of other ecosystem services (e.g. regulatory, support, or cultural ecosystem services) and biodiversity conservation (Martínez Pastur et al. 2017, 2018; Turkelboom et al. 2018). To find a solution for these trade-offs, many governments established a dialogue among the different actors of the society and generated regulatory mechanisms to promote the provision of ecosystem services of regulation and biodiversity conservation (Saarikoski et al. 2018; Engel et al. 2008; Zheng et al. 2013). In this context, the National Law 26,331/07 was promulgated in Argentina, and it was named as “Minimum Budgets for Environmental Protection of the Native Forests”. This law involves many challenges: (i) changes in forest management and forest cover proposed by the owners must be complemented by a social awareness (e.g. protection of natural environments classified as high conservation value); (ii) modifications in the original forest cover must be accompanied by the proposal of new practices that must be in accordance

with the law (e.g. silvopastoral systems instead of forest removal and pasture implantation); (iii) changes in the forest cover imply several administrative restrictions; and (iv) the policies must be designed for the long-term, so the proposals must be solid and resilient to the socio-economic changes over the years.

This chapter presents a brief description of the promulgation and implementation of the National Law 26,331/07 in Argentina. Also, it presents the changes in forest cover that occurred during this process and the effects of the law enforcement. Finally, it describes the synergies and trade-offs among the agro-forestry management proposals over the forest loss in Argentina during the last decade.

2 National Law 26,331/07

The first available information of native forest area of Argentina corresponded to the National Agricultural Census of 1937 (MAyDS 2017), which indicated the existence of about 37.5 million hectares. In the First National Inventory of Native Forests in 1998, specific data were available about the surface of native forest at national, regional and provincial levels for the first time, which were monitored along the years until today (MAyDS 2017). During this inventory, the Application National Authority (ANA) surveyed 31.4 million hectares, but the forest cover continuously declined until today (27.2 million hectares in 2016). The loss of forest cover represented a continuous process since the first census, due to the native forests were considered a barrier to agricultural and urban development, and forest removal was in many cases favoured by public policies that encouraged the expansion of agriculture. Deforestation also implies the loss of biological diversity and several ecosystem services, as well as the displacement of local and aboriginal communities (Luque et al. 2010).

This continuous forest loss generated an increasing concern in groups linked to the environmental conservation. Miguel Bonasso, Journalist and Writer, propose the first draft of a law for native forest protection, supported by several environmental NGOs that increased the social interest about excessive forest loss. In this framework, a debate was generated between Greenpeace, the Argentine Forestry Association (AFoA), FundesNOA and Vida Silvestre, considering the spirit of another National Law (13,771/48). Consequently, the Argentinean government enacted the National Law 26,331 for the Environmental Protection of Native Forests in 2007, whose main aim is to promote the conservation of native forests through land planning. The law defines the minimum environmental protection budgets for the enrichment, restoration, conservation and sustainable management of the native forests, using as a frame the environmental services that the forests provide to the society (MAyDS 2017). The objectives are detailed in the article 3: (i) to promote the conservation through the land-use planning process (LUPP) and regulate the expansion of the agricultural frontier as well as any change in land use; (ii) to implement the regulations and controls to decrease forest loss, promoting the maintenance of the native forest cover; (iii) to improve and maintain the ecological and cultural values in native forests that benefit the society; (iv) preventive principles must prevail in the proposals,

maintaining the native forests for the environmental benefits that they provide; and (v) to encourage the activities of enrichment, conservation, restoration and sustainable management of native forests. National Law 26,331/07 requires to all the provinces to develop a Land Use Planning Process (LUPP) (article 6) to create consensus about the environmental valuation of native forests in a participatory fashion. Also, it creates the National Program for the Protection of Native Forests (PNPBN) (article 12) and the National Budgets for the Enrichment and Conservation of Native Forests (FNECBN) (article 30), to compensate and promote the proposed activities in the forests. Moreover, it establishes the needs of conservation or sustainable management plans before any intervention on native forests (MAyDS 2017). Also, the law defines as ANA to the Ministry of Environment and Sustainable Development of Argentina and as local authorities to the organisms that each province designates for its implementation (article 10). The National Law was regulated by the Decree 91 of the National Government in February 2009, more than one year after it was sanctioned.

3 Land-Use Planning Process (LUPP)

National Law 26,331/07 (chapter 2 of the law) and its regulatory Decree define the concepts, terms, criteria and actions related to LUPP. A period of one year was defined to achieve this task (article 6), and the regulatory Decree established an obligatory LUPP update every 5 years maximum. Beyond the established deadlines, and due to the complexity of the participatory processes, few provinces achieved the tasks on time. The first province to legislate its LUPP was Salta (December 2008) and the latter Buenos Aires (December 2016) (Table 1). Although the 23 provinces currently have LUPP laws, the ANA has not accredited some of them due to technical problems (MAyDS 2017).

The distribution of the forest area, the connectivity, the link with existing protected network areas, the biological values, the conservation status, timber potential, the potential for agricultural sustainability, watershed conservation, indigenous and local community uses were the main criteria defined in the law for the LUPP categorisation, for which three categories were defined (article 9): (i) red (high conservation value forests for ancestral uses, gathering of non-timber forest products, scientific research, conservation plans, ecological restoration); (ii) yellow (medium conservation value forests for sustainable productive activities and tourism under the guidelines of management and conservation plans); and (iii) green (low conservation value forest where land-use change is allowed).

The consultation process with the society leads to define the conservation value of the forests for each province in each of these three categories. As a result, 53.6

Table 1 Province regulations and its updating for the land-use planning process (LUPP)

Province	Provincial law	Date	Actualisation	Update
Buenos Aires	14,888	21/12/16		
Catamarca	5311	09/09/10		
Chaco	6409	24/09/09		
Chubut	XVII-92	17/06/10		
Córdoba	9814	05/08/10		
Corrientes	5974	26/05/10		
Entre Ríos	10,284	28/03/14		
Formosa	1552	09/06/10		
Jujuy	5676	14/04/11		
La Pampa	2624	16/06/11		
La Rioja	9711	01/09/15		
Mendoza	8195	14/07/10		
Misiones	105	02/09/10		
Neuquén	2780	09/11/11		
Río Negro	4552	08/07/10		
Salta	7543	16/12/08		
San Juan	8174	11/11/10	1439-L	18/07/16
San Luis	IX-0697-2009	16/12/09		
Santa Cruz	3142	17/08/10		
Santa Fe	13,372	11/12/13		
Santiago del Estero	6942	17/03/09	3133	23/12/15
Tierra del Fuego	869/12	25/04/12		
Tucumán	8304	24/06/10		

Source M_AyDS (2017)

million hectares were declared by the provinces (Fig. 1), where 10.4 million hectares (19%) were red, 32 million hectares (61%) were yellow, and 10.5 million hectares (20%) were green (M_AyDS 2017). Consequently, 81% of the area covered by native forests was declared as valuable to be incorporated into the productive matrix of the country, which constitutes the most important challenge of the law. Within the framework of article 33, the provinces sent to the ANA the corresponding LUPP (Table 1 and Fig. 1). This ordination process was conducted for all the provinces during 2009–2016. The process of updating and progressive adjustment of LUPPs started again during 2015.

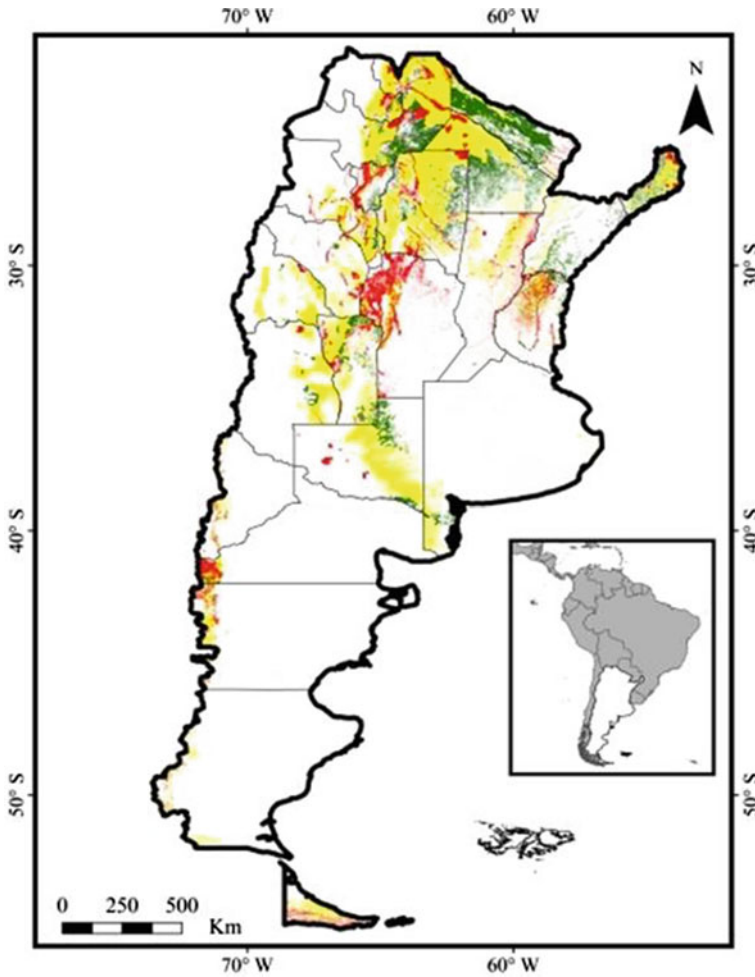


Fig. 1 Land use planning process (LUPP) proposed for Argentina according to the information and legislation provided by the provinces (Table 1)

4 Changes in Forest Cover of Argentina Within the Framework of the Implementation of the National Law 26,331/07

In order to understand the success of the law, it is necessary to analyse the observed changes in forest cover. For this, we analysed the evolution of forest cover (2000–2016) by region and province, within the categories defined by their LUPPs. Analyses were carried out on a geographical information system (GIS) based on products available in the Web, uploaded by the provinces and the Ministry of

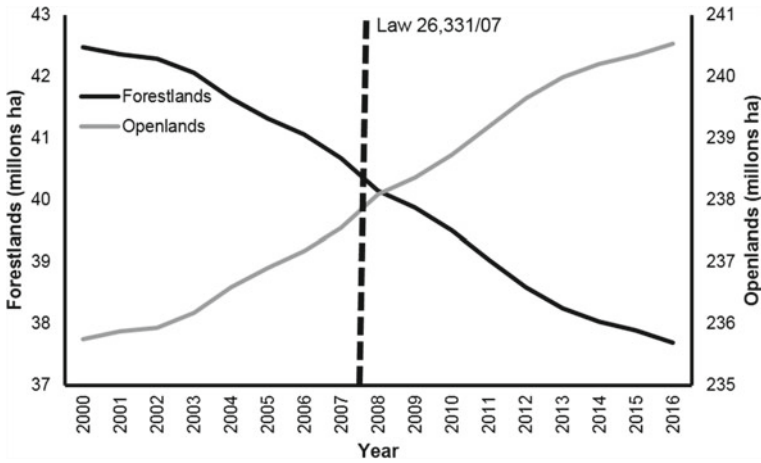


Fig. 2 Changes in forest cover and openlands of Argentina (period 2000–2016), before and after the implementation of the National Law 26,331/07

Environment and Sustainable Development of Argentina. We combined these shapes with raster data of loss and gain of forest cover (<https://earthenginepartners.appspot.com>). At country level, there is a continuous loss of forest cover for the analysed period, from 42.4 to 37.7 million hectares (Fig. 2). The rates of gain varied between 240 and 450 km² year⁻¹, while losses varied between 1,000 and 5,750 km² year⁻¹. The gains are associated with recovery of the native forest after natural (e.g. windthrows), anthropogenic disturbances (e.g. regeneration growth after harvesting) and indirect human effects (e.g. fires). In addition, some gains are due to exotic forest plantations for commercial or other purposes (e.g. windbreak plantations to protect crops).

The gain in forest cover maintained an approximate rate of 400 km² year⁻¹ for 2000–2016, with a decrease in 2009–2012, which could be explained by the different rates in the harvesting of forest plantations. The gains in forest area due to forest plantations with exotic species do not compensate the loss of most of the ecosystem services related to deforestation of native forests; e.g., plantations may increase some ecosystem services (as the volume of harvesting for industrial uses in timber saw or pulpwood) but may affect negatively other environmental services. In contrast, cover loss showed different rates, with an increase from 2000 to 2008 when National Law 26,331/07 was promulgated. The maximum deforestation rate was reached when the law was promulgated (5,756.7 km² year⁻¹), and although the loss rates decreased on time until 2016, they did not reach the minimum levels observed in 2002 (Fig. 3).

Another way to analyse the success of National Law 26,331/07 and the implementation of the LUPPs is through the percentage of the different categories (green–yellow–red) in the annual loss of forest cover. In this analysis, we only considered the losses occurred within the LUPPs reported by the provinces (e.g., plantations or native forests that have not entered in the LUPP are not included). The highest

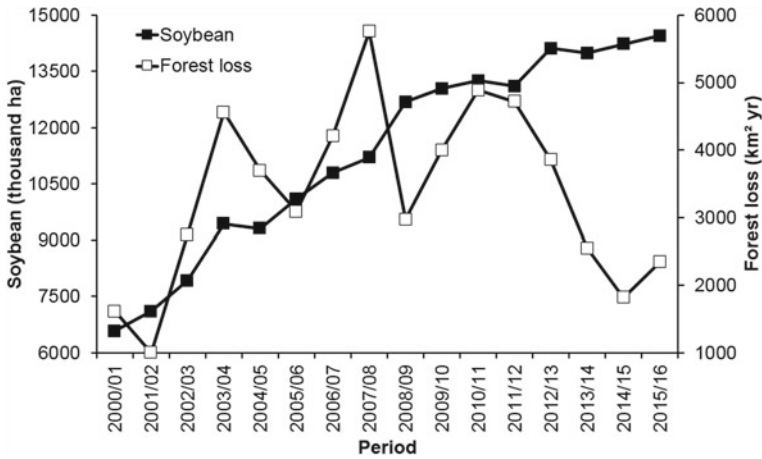


Fig. 3 Cultivated area with soybean in Argentina and forest loss (white points belongs to right axis in km² year⁻¹) for the period 2010–2016. Sources MAyDS (2017) and <http://ide.agroindustria.gob.ar>

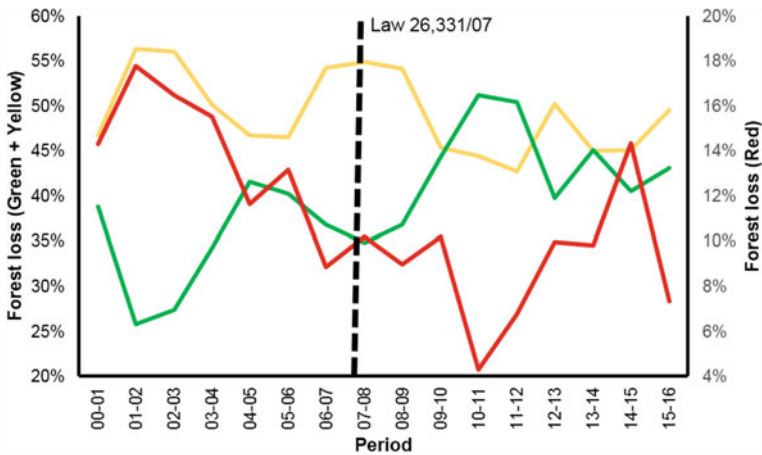


Fig. 4 Changes in forest cover (period 2000–2016) and forest loss percentage of each LUPP category at country level

percentage of losses were observed in the yellow (42–56%) and green (26–51%) categories, compared with the red category (4–18%) (Fig. 4).

The promulgation of the National Law 26,331/07 has not fully modified the rates of forest cover loss in the yellow category, with an evident increase in the green category rates. However, a decline in the red category was observed for the period 2000–2011, followed by an increase for 2011–2016 period. These results showed a partial arrangement of the forest areas where total (green category) or partial removals (yellow category) were conducted, which temporarily appear as forest losses and can

underestimate the present analysis. Other harvestings that also reduce significantly the forest cover (e.g. thinnings for silvopastoral purposes) may recover after some time, or if they are very intense (e.g. silvopastoral systems proposed for Chaco and Formosa), may continue the loss of cover due to windthrows of the remaining trees. Other forest losses in the red forest category may be associated with natural or anthropic impacts such as fires. However, beyond these considerations, it was observed that the implementation of the National Law 26,331/07 has not been able to reduce the loss rates in forest areas of higher conservation value (red category), although the loss rates observed during 2000–2004 decreased.

These trends and magnitudes changed when the different forest regions proposed by the “Unidad de Manejo del Sistema de Evaluación Forestal” (UMSEF 2014) were considered. The Andean-Patagonian forests presented losses that range from 20 to 40 km² year⁻¹, with some maximums (2011–2012 and 2014–2015) that can be related to fire events or other natural phenomena (e.g. windthrows or volcanic eruptions). The Espinal region had significant gains in forest cover that sometimes exceed forest losses (e.g. 2000–2003 and 2014–2016), which varied around 90–175 km² year⁻¹. However, the losses showed a growing trend from 2000 to 2014, presenting a decrease in deforestation rates only during the recent years. The Monte region also presents greater increases in forest cover than losses, except for three of the analysed periods (6–7 km² year⁻¹), with an increase in recent years (2012–2016). The losses were very variable (2–12 km² year⁻¹), with two strong peaks observed in 2004–2005 and 2012–2014. The Chaco region has low rates of recovery (55–90 km² year⁻¹) compared to the deforestation rates, which reached their maximum during the discussion, sanction and first years of implementation of the National Law 26,331/07 (2000–4000 km² year⁻¹). This loss rate decreased in recent years (2013–2016), but did not reach the minimum observed in 2001–2002. The region of Misiones Rainforest presented greater increases in forest area (45–190 km² year⁻¹), which far exceed the losses (50–260 km² year⁻¹) for the period 2000–2007. The general tendency showed that loss of forest cover increased over time. This output was influenced by forest plantations of exotic species (e.g. *Pinus* representing 80% and *Eucalyptus* representing 7% of the total plantations that occupy about 3700 km²) (Izquierdo et al. 2008). The region of the Bolivia-Tucumán Forests presented small gains in forest cover (10–20 km² year⁻¹) compared to deforestation rates (125–926 km² year⁻¹). The rates of deforestation remained constant during the discussion, sanction and first years of implementation of National Law 26,331/07, but a maximum was observed during 2007–2008 period, which can be related to an increase in the removal of forests associated with the proximity of the moment of sanction of the law. Although in recent years (2014–2016) there has been a downward trend in deforestation rates, reaching the 2000–2002 values, it represents huge areas of forest loss compared to other forest regions (120–140 km² year⁻¹).

The tendencies described at country and forest region levels maintained the same trends and magnitudes when the different provinces were considered. However, an analysis by province is of interest due to particularities related to the implementation of the provincial policies, or due to some regional economies or contrasting social realities.

In the southern provinces (Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego), forest area gain is very low (<0.13% of the total forest of each province). The loss rates are generally lower than 0.15%, except for exceptional events that were mostly related to fires that affected large areas of forests, e.g. (i) in Neuquén, 20 km² for the period 2013–2014 (0.21% of the forest loss); (ii) in Río Negro, 12 km² for the periods 2001–2002 and 2011–2012 (0.24% of the forests); (iii) in Chubut, the three largest events corresponded to 2014–2015 (243 km², 2.59% of the forests), 2011–2012 (28 km², 0.30% of the forests) and 2012–2013 (20 km², 0.21% of the forests); (iv) in Santa Cruz, 37 km² for the period 2011–2012 (1.13% of the forests); and (v) in Tierra del Fuego, the 2007–2012 period is remarkable, with loss rates of 13–23 km² year⁻¹, representing 0.13–0.22% of the forests.

In the provinces of the centre of the country (Mendoza, San Luis, San Juan, La Pampa, Buenos Aires and Córdoba), forest gains rarely exceed 0.13% of the total forest of each province, with the exception of Buenos Aires, which was around 0.24–0.35%. However, the rates of forest loss were variable according to the province. In Mendoza, annual losses were close to 1.0 km² year⁻¹, except for 2012–2013, when it reached 2.35 km² (0.31% of the province forests). San Luis presented important loss rates reaching in some years more than 6% of the total forests, e.g. 2007–2008, year of promulgation of the National Law 26,331/07, and 2009–2010, year of the promulgation of the provincial law IX-0697-2009. In San Juan, the loss rates were low, less than 0.20%, the highest rate (1.0 km² year⁻¹) occurring during the period 2013–2014. La Pampa presented variable trends in forest losses (<2.0 km² year⁻¹), but increased after the promulgation of the provincial law 2624 (6.8, 6.5 and 12.3 km² year⁻¹ for the periods 2011–2012, 2012–2013 and 2013–2014, respectively) reaching values of 0.3–0.6% of the total province forests. Buenos Aires had variable rates of loss (0.1–1.5% of the total forests) which represents between 8 and 95 km² year⁻¹. Finally, Córdoba presented an increased loss of its forest cover (between 1 and 2%, close to 150–300 km² year⁻¹), but in recent years it decreased after the enactment of the National Law 26,331/07 and the provincial law 9814, reaching a loss of about 0.2% of the forest cover for the period 2014–2016.

In the northwest provinces (La Rioja, Catamarca, Tucumán, Salta, Jujuy and Santiago del Estero), the forest gain is very low (<0.06% of the total forests of each province), with the exception of La Rioja that presented 0.20–0.30%. Forest loss rates are highly variable in percentage and magnitude according to the considered province. La Rioja presented forest loss rates lower than 0.5% of the total forests, except for 2006 and 2010, when National Law 26,331/07 and provincial law 9,711 were sanctioned (7–13 km² year⁻¹). Catamarca presented different patterns of forest loss (from 160 to 7 km² year⁻¹), with a continuous decrease from 2000 to 2016 (from a maximum of 1.7–0.1% of its total forest cover). In Tucumán, there is a sustained forest loss (0.4–1.5%) with maximums that exceed 100 km² year⁻¹ during 2003–2004, 2007–2008, 2010–2011, 2012–2013, where the second and third periods were coincident with the sanctions of the National Law 26,331/07 and the provincial law 8304. Salta is one of the provinces with greater forest loss, observing a gradual increase of rates for the periods between 2000 and 2008, when National Law 26,331/07 and the provincial law 7543 were promulgated. The maximum of losses

were 2,148 km² year⁻¹ (3.2% of the province forests) and maintaining a high rate (close to or greater than 1%) until recent years (2014–2016) when it drops to <0.6% (about 330–370 km² year⁻¹). Jujuy also presented high loss rates between 14 and 63 km² year⁻¹ (<0.7% loss in relation to the total forest cover), with the presence of two maximums (>110 km² year⁻¹) during the periods 2009–2010 and 2012–2013. These maximums occurred after the sanctions of the National Law 26,331/07 and the provincial law 5676. Finally, Santiago del Estero is another of the provinces with the highest deforestation rates, both in magnitude (250–1855 km² year⁻¹) and in percentage (up to 3.0% annually respect to the total forest cover). The loss rate increased along the years and then gradually decreased to date.

In the north-eastern provinces (Santa Fe, Entre Ríos, Corrientes, Misiones, Chaco and Formosa), the forest gain was variable according to the considered provinces. Chaco and Formosa presented lower gain rates (<0.02%), Entre Ríos and Misiones intermediate values (0.2–0.8%), while Santa Fe and Corrientes presented values close to 1% per year. The loss rates were also variable in percentage and magnitude according to the province. Santa Fe presented a constant loss rate of 1% (approximately 140 km² year⁻¹), while in Entre Ríos it is less than 0.3% (<50 km² year⁻¹). Corrientes also presented a stable loss rate of 0.5–1.0% (90–175 km² year⁻¹). These provinces showed a combination of loss of native forest cover (e.g. extraction of firewood) and commercial plantations (mostly *Pinus* and *Eucalyptus*), which is also showed in the gain rates due to new plantations. Chaco and Formosa were very different, where losses were directly related to the advance of the agricultural frontier. The loss in Chaco was variable, between 55 and 515 km² year⁻¹, representing between 0.1 and 1.0% of annual forest cover loss, with the presence of an unusual increase (2010–2012) in the years after the sanctions of the National Law 26,331/07 and the provincial law 6409 (>900 km² year⁻¹). Formosa deforestation presented annual rates of <1.0% (40–440 km² year⁻¹), with an increase after 2009–2010 (years of the sanctions of the National Law 26,331/07 and the provincial law 1552) reaching more than 700 km² year⁻¹ of forest cover loss. During the last years (2013–2016), the loss rates returned to the previous values, but maintaining higher values (200–400 km² year⁻¹) compared to other provinces.

5 Investments Made by the National Government in Management and Conservation Projects of Native Forests

The interest in the concept of payment for ecosystem services (PES) increased during the last decade, both for scientists and managers, due to its greatest advantages to connect natural ecosystems and society (MEA 2005; Swallow et al. 2009; Reyers et al. 2013). Also, PES allowed the integration of ecological, sociocultural and economic topics, giving a framework that supports future legal policies and guidelines (de Groot et al. 2010; Chan et al. 2012; Martínez Pastur et al. 2016). Usually, ecosys-

tem services were evaluated through their monetary valuation (e.g. cubic metres of timber for the sawmill industry), where non-monetary provision services have been not considered (e.g. non-timber forest products for family consumption, firewood by local inhabitants) as well as those regulatory, supporting or cultural services (e.g. water basin protection, pollination, recreation, archaeological heritage, scenic beauty, CO₂ capture and storage). In this sense, the payment to owners for the conservation of this ecosystem is valued by the monetary and not by the non-monetary services. We can consider that PES generates a new paradigm in the ecosystem valuation, where natural areas should be valued, both by the monetary and non-monetary services that it provides to the society.

The first approach of conservation both in biodiversity values and in the provision of ecosystem services was based on the preservation of wild or natural environments within reserves. This strategy creates a division in landscape management and planning: (i) within the reserves where the inalterable nature of the ecosystem was promoted, and (ii) outside reserves where transformation to maximise provisioning services is feasible to implement (Swallow et al. 2009). However, this strategy was ineffective to conserve the provision of non-monetary ecosystem services and all the biodiversity at a regional level, and fails to protect the species for which many of these reserves were created (Lindenmayer et al. 2012). Argentina, like many other countries, has based its conservation strategy on the creation of National Parks located in remote or border areas (Hopkins 1995; Izquierdo and Grau 2009; Swallow et al. 2009), while the rest of the landscape is under a continuous process of deforestation and land-use change. This process generates a significant decrease of the natural ecosystem areas, affecting original communities (Boletta et al. 2006; Gasparri and Grau 2009; Cáceres 2015).

The main drivers of changes on the native forest ecosystems were the intensive agriculture and crops with high value in the international markets (e.g. soybean), fires due to human activities, increase of livestock pressure due to the advance of agriculture (e.g. displacement towards marginal forest areas), forest plantations with exotic species and the increase of the human population (Grau et al. 2005; Zak et al. 2008; Seghezzo et al. 2011; Hoyos et al. 2013). The decline of these natural ecosystems is related to the undervaluation of the main ecosystem services that they provide (regulation, support and culture), especially for policymakers (Swallow et al. 2009). In this sense, PES is an effective mechanism to transfer non-monetary valuation of ecosystem services within a financial market, through incentives to local actors (governments, institutions and private sector, which make decisions about native forests) to maintain the provision of those services over time. This mechanism allowed the achievement of these goals, integrating them in the same proposal both for conservation and socio-economic development purposes (Engel et al. 2008; Zheng et al. 2013). This strategy allowed the development of multipurpose in situ objectives for the ecosystems under management.

In this international context, the National Law 26,331 (November 2007) was enacted to regulate the protection, enrichment, restoration, use and management of native forests and the environmental services that they produce (Seghezzo et al. 2011). This law finances actions to strengthen the institutions and forest producers

Table 2 Budget assigned (2010–2016) by the National Government to the National Law 26,331/07

Year	Budget
2010	300,000,000 \$ (74,812,968 US\$)
2011	300,000,000 \$ (69,444,444 US\$)
2012	300,085,190 \$ (60,992,925 US\$)
2013	253,000,000 \$ (38,744,257 US\$)
2014	247,043,707 \$ (28,792,973 US\$)
2015	246,450,000 \$ (18,350,707 US\$)
2016	265,009,000 \$ (16,258,221 US\$)
Total	1,911,587,897 \$ (307,396,495 US\$)

In Argentinean, pesos and dollars (value of December 31 of each year)

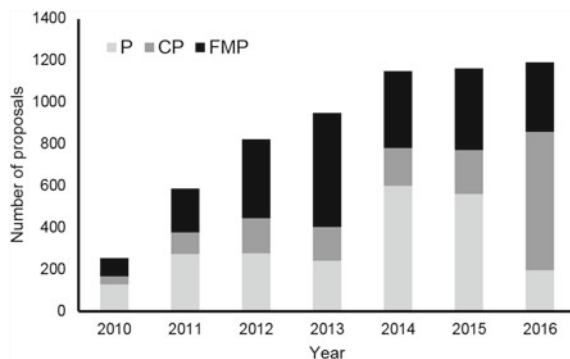
Source MAyDS (2017)

(provincial governments, institutions and private sector) to ensure and maintain the provision of ecosystem services over time. This payment includes: (i) to limit the land-use change in the native forestlands, (ii) to conduct sustainable management practices and (iii) to increase biodiversity preservation areas within the matrix of the productive landscape. There is a lack of this type of initiatives in the World, and it is of interest to understand how these investments have been implemented within the framework of this National Law, and to analyse the impact of this initiative.

The Argentinean national government has assigned annual fundings for the implementation of the National Law 26,331/07 (Table 2), mainly invested by: (i) National Fund for the Enrichment and Conservation of the Native Forests (FNECBN) created by the article 30, and (ii) the National Programme for the Protection of the Native Forests (PNPBN) created by the article 12; but also for financing the (iii) Experimental Programme of Management and Conservation of the Native Forests (Res. SAyDS 256/09), and (iv) the implementation of the first LUPP across the country. While the funds allocated to PNPBN were used by the national government (22% of the funds allocated during the period 2010–2016), FNECBN funds (78% of the funds allocated during the period 2010–2016) were distributed among the provincial forest authorities (30%) and projects (70%) (MAyDS 2017). It must be mentioned that provincial and municipal governments can also apply to the national funds, and then, a large percentage of these funds have being allocated to public institutions and not the private sector. For the fund distribution among the provinces, the Federal Environment Council of Argentina (CoFeMA) has defined a methodology that considered the area of native forests of each province, the relationship between the previous forest area and the total area of the province, and the conservation categories established according to the article 32 (MAyDS 2017).

There is a strong variation with a downward trend for the period 2010–2016, between 247 and 300 million AR\$ (Argentinean pesos) per year. And this variation is quite significative if it is presented in United States dollars (USD) (75–16 million USD per year). Among the funds arrived at FNECBN, approximately

Fig. 5 Number of formulation projects (P), conservation (CP) and sustainable forest management plans (FPM) per year (bars) during 2010–2016. *Source* MAyDS (2017)



30% was allocated to the provincial forest authorities (427.4 million AR\$ for the period 2010–2016) and the rest to the projects (1413.1 million AR\$ for the period 2010–2016). The projects can be classified into three types: (i) formulation plans (e.g. elaboration of proposals for management and conservation without concrete actions in the forests), (ii) management plans and (iii) conservation plans (37, 25 and 38%, respectively, of a total of 6,122 annual projects financed between 2010 and 2016) (MAyDS 2017) (Fig. 5). Formulation plan receive 50% of the total funds. Thus, while 294.7 million pesos have been allocated for formulation plans (period 2010–2016), 690.9 million pesos represented actions for sustainable forest management in the territory (43% for conservation plans and 57% for forest management plans). Beside this, the number of granted projects increased progressively from 2010 to 2014 and stabilised in the subsequent periods (2014–2016) reaching to approximately 1200 projects per year.

The investment made since the enactment of the National Law 26,331/07 was unprecedented in Argentina, and there were few initiatives that can be compared in other countries of the World (Costanza et al. 1997, Swallow et al. 2009; Gómez-Baggethun et al. 2010, Farley and Costanza 2010). Although these actions cannot stop totally forest loss, they helped to reduce the deforestation process in the last 30 years. At a country scale (see Figs. 2 and 4), there is a tendency to decrease the deforestation rate (approx. from 5000 to 2000 km²) and an increase in forest gain (approximately 250–400 km²), which can be correlated with the number of projects financed per year.

The financing received by the forest institutions, both at national and provincial level, generated a change in the perceptions of communities that living in the forests and using the forest products, as well as ranch owners about the native forest, based on the presence of technical professionals in the field and the extension actions. Also, there are plans that combine multiple objectives. We have seen that several funds have been allocated to improve the management and administrative structures related to management of native forest (excluding the National Park Administration that already had their own financing). However, one question remains unsolved: Are payments made to the forest owners effectively PES? To be considered a PES, the payment

must finance concrete actions for forest management, as compensation for effectively improved the provision of ecosystem services (monetary and non-monetary provision services) or as a compensation for losses in the economic benefits for expanding conservation or improving sustainable management practices? In the payments of the National Law 26,331/07, the formulation plans cannot be fully considered as PES, due to the fact that the activities and payments are not real actions into the forests. Besides this, most of the actions included in the payments were invested to improve the timber production (e.g. increase the growth rates), thinnings for silvopastoral purposes, or for fences to manage livestock production increasing conservation and provision of some ecosystem services.

This approach to ecosystem management at landscape scale began 30 years ago (Swallow et al. 2009) with the following objectives: (i) to generate more effective biodiversity conservation beyond the natural reserve networks, (ii) to increase the community participation in the management, conservation and rural development proposals and (iii) to create job opportunities for the rural population. Worldwide, the main constraint for these initiatives is the financial sustenance in the medium and the long term, which rarely coincides with the expectation of the community and managers (Swallow et al. 2009; Gómez-Baggethun et al. 2010). PES emerged as an alternative to solve these shortcomings, and it became the most powerful tool to implement these proposals. In this sense, the main strength of PES is to legitimise the people rights who live in the natural landscapes (both for management and conservation purposes) and receive the payments for conserving the provision of the ecosystem services on time (Ferraro and Kiss 2002; Swallow et al. 2009).

For this reason, the payment programme established by the National Law 26,331/07 does not comply with several of the suggested principles for PES initiative and should be modified towards their main principles. In few words, the payments of the National Law 26,331/07 should cover not only the improvement of monetary provision services, and it also should compensate other services (e.g. provision of non-monetary services or conservation forests categorised as red) according to the predisposition to implement these actions by the community, as well as the identification and presentation of the ecosystem services to the society that receives the benefits (Patterson and Coelho 2009; Zheng et al. 2013).

Finally, we conclude that, like any other process, longer periods are needed to assess the effectiveness of the implemented actions. Although at the beginning of the process (before, during and immediately sanctioned the national and provincial legislations), the reaction of the agricultural sector generated a strong negative impact on forest cover, after generated the payments and incentives the tendency of the indicators improved. It is difficult to quantify how much of this decrease is due to the payments, and how much is due to the restrictions imposed by the legislation itself.

6 Synergies and Trade-Offs of Monetary Activities that Influence Over the Persistence of the Native Forests

Argentina based its economy in the primary industry, mainly in agricultural products (crops and meat). This strategy generated a rapid development of those areas with greater agricultural potential, and those areas with low potential in marginal regions remain unattended. This development was related to the population growth and infrastructure (e.g. routes) that affected the continuity of the natural ecosystems. For example, urban centres required more materials such as lumber and timber wood from forests, and the accessibility generates greater impacts over the biodiversity, both directly (e.g. hunting or extraction of non-timber forest products) and indirectly (e.g. invasion of exotic species). Likewise, livestock and farming also increase, either due to the proximity of cities or to accessibility, or by a displacement of activities with greater profitability (e.g. soybean crops). Another activity is the forest industry, based on exotic species under the supposition that they grow faster, which it is often not true, and due to the greater acceptance of the species in international markets (e.g. *Pinus* or *Eucalyptus*). Finally, higher human presence in the natural ecosystems drives fires or increases land-use conversion (e.g. removal of woody biomass and implant pastures for livestock). Here, we related the forest loss cover described before with some drivers, and try to understand the synergies and trade-offs generated with the ecosystem services provision of the native forests. We analysed official data on agriculture, livestock and forestry, and data of forest loss cover across Argentina

The selected drivers strongly varied among the different regions and provinces: (i) population increases in the less developed areas (e.g. Patagonian provinces), while regions with lowest changes in human population are those with good agricultural development or industry (e.g. Santa Fe, Corrientes, La Pampa and Entre Ríos). (ii) The highest route density was observed in provinces such as Misiones, Tucumán and Jujuy, related to forest loss and degradation of natural ecosystems. (iii) The greatest area of crops is found in the central Argentina (Buenos Aires, Santa Fe and Córdoba) while in other provinces the crops presented a scarce development (e.g. Patagonia and north-eastern territory). When we analysed the changes (before and after the promulgation of National Law 26,331/07), we observed a great variation between provinces related to the forest loss cover at a regional scale. For example, some provinces in central Argentina (Buenos Aires and Córdoba) increased their crop area by 21%, which indicates that many of the fields used for livestock were converted to crops. Then, this livestock was moved to marginal sectors of lower productivity but with higher indices of naturalness. Likewise, other provinces presented unusual increases of crop areas, e.g. San Luis (131%), Santiago del Estero (68%) and Salta (29%), which was associated with deforestation due to the advance of the agricultural frontier. (iv) Livestock presented the same pattern, where largest producers are also in the central Argentina (Buenos Aires, Santa Fe and Córdoba) and showed changes in the activity before and after the enactment of National Law 26,331/07 (−0.9, −1.9 and −22.0%, respectively). Other provinces also presented a retraction of livestock activity, but associated with other economic drivers or business oppor-

tunities (e.g. La Pampa, La Rioja and Río Negro). Similarly, other provinces showed greater changes associated with the livestock displacement from central Argentina, such as Salta (67%), Santiago del Estero (30%), Tucumán (27%), Misiones (24%), Formosa (22%) and Jujuy (20%). There are other reasons that explain the increase in livestock production (e.g. recoveries after natural disasters such as the Hudson volcano activity or reconversions from sheep to cattle as in Southern Patagonia), e.g. Santa Cruz (38%), Chubut (29%) and Tierra del Fuego (29%). (v) Harvesting of timber products from native forests showed a strong retraction during the recent years comparing data before and after the enactment of the National Law 26,331/07 (-27% in average), including the largest producers (Misiones, Santiago del Estero and Córdoba). However, the timber products increased in those regions with greater forest loss rates destined to crops and livestock production, e.g. Salta (26%), Jujuy (10%) and Formosa (5%). (vi) Fire occurrence in forests is quite common in some provinces and much more sporadic in others always related to human activities (e.g. Southern Patagonia). The provinces with the highest incidence of fires for the studied period were La Pampa, Mendoza, San Luis and Río Negro. (vii) Finally, forest plantations with exotic species can be found in few provinces (mainly in Corrientes, Misiones, Neuquén and Chubut) and not greatly increased during the last years.

Not all the drivers explained the forest loss cover, being the soybean crops a good proxy for the studied period (Grau et al. 2005; Carreño et al. 2012). The forest loss at country level and the area of soybean crops did not present a significant correlation ($0.27, p = 0.305$) represented by two periods, one where it accompanies the deforestation processes (2000–2012) and another where it dissociates (2012–2016) (Fig. 3). Several provinces follow this pattern: (i) Buenos Aires ($0.42, p = 0.101$) with the two described periods with a slightly displaced (2000–2014, 2014–2016), and which strongly influences the pattern described for all of Argentina due to sharing most of the total area planted; (ii) Córdoba is similar ($-0.49, p = 0.050$) with a positively correlated period (2000–2007) and negatively correlated period (2007–2016); (iii) Entre Ríos also showed a similar trend ($0.49, p = 0.050$) with a positively correlated period (2000–2013) and negatively correlated period (2013–2016); and (iv) San Luis ($-0.09, p = 0.739$) with a positively correlated period (2000–2010) and negatively correlated period (2010–2016). There is a second group of provinces, where the land pattern cultivated with soybean and the forest loss is coincident and positively correlated: (i) Chaco ($0.37, p = 0.148$); (ii) Corrientes ($0.49, p = 0.040$); (iii) Jujuy ($0.56, p = 0.022$); (iv) Salta ($0.45, p = 0.070$); (v) Santa Fe ($0.28, p = 0.283$); (vi) Santiago del Estero ($0.20, p = 0.443$); and (vii) Tucumán ($0.27, p = 0.302$). Finally, a third group of provinces has a more erratic correlation when we compare these two factors, such as Catamarca ($0.25, p = 0.339$), Formosa ($0.03, p = 0.902$), La Pampa ($0.36, p = 0.167$) and Misiones ($-0.71, p = 0.002$).

Therefore, it was possible to identify the provinces where the advance of soybean crops had influenced the forest loss during 2000–2016. The conflict between the expansion of plantations with exotic forest species and the native forest occurred mostly outside the studied period (e.g. decade from 70s to 90s) (Grau et al. 2005; Carreño et al. 2012), as it occurred previously with other crops (e.g. sugar cane or beans in northern Argentina) (Aguerre and Denegri 1996; Gasparri et al. 2008). In

this sense, it is necessary to understand that a trade-off varies over time. We can remark that it is necessary to conduct studies that identify the drivers to elaborate specific policies to mitigate the potential negative impacts. Likewise, it is also clear from the analysis that the drivers that affected the forest cover are moving from agricultural–livestock areas to the peripheries. For this reason, the factors that occurred in the central area of Argentina (core of the agricultural zone) can affect other less productive provinces.

7 Conclusions

The National Law 26,331/07 constitutes an unusual legal norm for a country in which the use of natural resources for productive purposes was prioritized without limitations along its history. This generated different reactions in the society, and the national and provincial authorities had to adjust their structure and operations for successfully implement the law along the country. It is not possible to relate the application of the law to the stop of the deforestation processes; however, we can relate this process to a decrease in the forest loss rate. Still, we do not know if in the future the price in some crops can press again over the forests with the consequent deforestation. The national law, through their instruments (e.g. LUPP), achieved the effective ordination of the new agricultural production initiatives, limiting their operations to those areas classified as green. Besides this, an intense debate was installed in the society, as a result of which many sectors were able to increase their knowledge about native forests and their importance as producers of ecosystem goods. However, the implementation of the law was not perfect. It is very important to detect the points in which the process of approval of plans was delayed or paralysed, and it is necessary to remove those bottlenecks and achieve times compatible with the expectations of the producers.

The native forests of Argentina presented significant changes in their forest cover during the last years. These changes were influenced by the promulgation of the National Law 26,331/07 and the associated provincial legislations, and change on time according to the LUPP that were made in each province. Sometimes deforestation rates increased prior to law enactments, and in others, the new legislations did not change forest loss rates. However, over the years there was a decrease in deforestation rates that can be associated with the results derived from the investment in management and conservation plans financed by the National Law 26,331/07. In this sense, the effectiveness of the payments made for the native forests resulted in a useful tool to reduce the conversion rates, but this tool did not stop the deforestation process completely. On the other hand, some causes of forest loss may be due to natural factors (e.g. landslides, windthrows) or derived from human actions, both indirect (e.g. fires) and directly related to productive activities. These factors varied among the provinces, mainly associated with population density, agricultural activity and livestock, which is also related to the fires and harvesting. In the particular case of soybean crops, they can explain most of the deforestation in many provinces and

can be associated with some periods, decreasing in significance during the last years (2012–2016).

In few words, the lack of knowledge about the social actors, the land tenure problems, technological developments and the biophysical status of the forests determined that very few plans, once the law was applied, were destined for logging and that the majority of the proposals were to improve livestock in marginal areas. In this chapter, we described the impacts produced by the trade-offs that exist in the different land uses, between native forest and other productive activities, as well as quantify the damages and benefits of the implementation of the National Law 26,331/07. It also highlighted the need to promote initiatives such as LUPP and the payment programmes for the provision of ecosystem services in the long term. Finally, these analyses and discussion reveal the need to establish regional policies associated with the factors linked to forest loss looking for sustainable management alternatives that combine economic and conservation proposals.

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