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Economic impact assessment of a forest pest invasion in Uruguay – Main challenges and opportunities

Abschätzung der wirtschaftlichen Auswirkungen einer eingeschleppten Blatterkrankung in Uruguay – Herausforderungen und Möglichkeiten

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Schlüsselbegriffe: Kosten-Nutzen-Analyse, Eukalyptus, Pflanzenpathologie

Summary:

No study exists detailing the economic impact of diseases and forest pests in Uruguay, despite the growing importance of the forestry sector in the economy. This research is part of a project to assess the economic impact caused by the introduction of the foliar pathogen *Teratosphaeria nubilosa* in Uruguay, in order to contribute to the consolidation of the forestry sector from the perspective of economic sustainability. The pathogen was accidentally introduced in 2007 and has caused significant defoliation in young plantations of *Eucalyptus globulus*. The cost-benefit approach was applied

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at the economy level since this analysis is used to assess the economic efficiency of decisions affecting the use of scarce resources. The project is ongoing and during the application of the method, several challenges and opportunities were identified. The baseline scenario is defined as the situation before the introduction of the disease. Different scenarios were then defined in terms of: (1) the amount of volume of wood that was lost due to the pest, (2) replacement of *E. globulus* by other species of eucalyptus. Data were collected from available secondary information and interviews with informants and forestry producers. The use of cost-benefit analysis to study the economic impact of a forest pest for the country represents a first step for such studies. The environmental impact and the estimation of externalities caused by forest pests is to be added in future research. The results would be useful for decision makers to determine whether to allocate resources to prevent the introduction of forest pests.

Zusammenfassung:

Trotz der wachsenden wirtschaftlichen Bedeutung des Forstsektors in Uruguay gibt es noch keine Untersuchungen über die ökonomischen Auswirkungen von Schädlingsbefall in bewirtschafteten Wäldern. Diese Arbeit ist Teil eines Projektes zur Abschätzung des ökonomischen Einflusses der in Uruguay eingeschleppten Blatterkrankung *Teratosphaeria nubilosa* unter dem Gesichtspunkt der ökonomischen Nachhaltigkeit. Der Krankheitserreger wurde 2007 unbeabsichtigt eingeschleppt und hat zu umfangreicher Entlaubung in jungen *Eucalyptus globulus*-Plantagen geführt. Da es sich bei der Fragestellung um die Wirtschaftlichkeit bei der Verwendung knapper Ressourcen handelt, wurde als Forschungsansatz die Kosten-Nutzen-Analyse gewählt. Im Zuge der bisherigen Bearbeitung des noch laufenden Projektes wurden zahlreiche Herausforderungen und Möglichkeiten identifiziert. Das Referenzszenario ist die Situation vor der Einschleppung des Krankheitserregers. Darauf aufbauend wurden mehrere Szenarien entwickelt die sich in folgenden Punkten unterscheiden: (1) Der Menge an durch den Befall verlorenem Holz, (2) dem Ersatz von *E. globulus* durch andere Eukalyptusarten. Die Daten wurden durch Analyse verfügbarer Sekundärdaten sowie aus Interviews mit Experten und Holzproduzenten gewonnen. Die Kosten-Nutzen-Analyse zur Untersuchung der ökonomischen Auswirkungen der Erkrankung stellt den ersten Schritt der Studie dar. Die Auswirkungen auf die Umwelt und die Abschätzung von externen Effekten sollten Teil zukünftiger Untersuchungen sein. Die Ergebnisse dieser Arbeit sollen Entscheidungsträger bei der Allokation von Ressourcen zur Vorbeugung von Waldkrankheiten unterstützen.

1. Introduction

The forest sector in Uruguay based on exotic plantations started developing in the late 1980s under Forestry Law 15939 (Parliament of Uruguay, 1988). The total planted area by species increased from less than 50,000 hectares (ha) to 695,093 effective ha as of

2012 (around 900,000 ha affected) (Forest Division, 2012, 2016). The main industries are pulpmills and sawmills. The sector is export-oriented and its contribution to the Gross Domestic Product (GDP) was 4.8% in 2015. *E. globulus* was the most planted species in Uruguay; however, the area cultivated with this species has been decreasing over the last several years. The main reasons have been related to a poor adaptation to soils and climate and the recent unintended introduction of a forest pest, the fungal leaf spot *T. nubilosa*, which affects tree plantations at early ages.

There are many examples in the literature of introductions of forest pests and diseases in the world. The vast majority of these studies address the taxonomic identity, vehicles, backgrounds and guests colonized by the organism pest (e.g. Wingfield et al, 2008; Brasier, 2008; Elmer, 2001). However, there are still very few studies that deal with the economic impact of these biological introductions (Holmes, 2010; Holmes et al., 2009), with the exception of some research in Canada and the United States. Some studies estimated the economic impact of declining raw material supply by external factors such as the appearance of a pest or a change of control factors (Holmes, 1991; Alavalapati et al. 1998; Zhang et al., 2005; Patriquin et al., 2007; Kirschner, 2010). The methods used by these studies are of interest to study the economic impact of a forest pest because one of the main impacts identified was the reduction of the harvest volume. In the US, two episodes can be identified: the inclusion of a species of spotted owl (known as spotted owl or *Strix occidentalis*) as a protected species, and the appearance of pine beetles (mountain pine beetle). The inclusion of the spotted owl as protected species in the Western United States resulted in a ban on harvesting forest plantations where the presence of this species was identified. The first effect of this ban was an increased timber harvesting in the South of the country and the closure of several production facilities in the West. In Canada, the pine beetle attack is endemic. Starting in 1999, the affected area went from 165,000 ha to 7 million ha, strongly affecting the livelihood of the region. In this case, the immediate effect was an increase in wood supply due to the need to cut infested trees standing and take advantage of its timber, and then a decrease in supply for the anticipated shortage. The results of this work have been recommended to design forest policy actions (Holmes, 1991; Alavalapati et al., 1998; Patriquin and White, 2004; Patriquin et al., 2007).

The working hypothesis of the project presented here is that the introduction of *T. nubilosa* in 2007 had a negative economic impact on *E. globulus* plantations and consequently on the national economy. It was proposed to conduct an economic assessment of the impact of the emergence of *T. nubilosa* in *E. globulus* plantations using a cost-benefit analysis. The objective of this paper is to discuss the feasibility of conducting a cost-benefit analysis to assess the introduction of the forest pest in Uruguay.

2. Material and Method

The analysis of the economic impact of a change in a sector of the economy can be performed using three different methods: input-output analysis, general equilibrium analysis, and cost-benefit analysis. The input-output-analysis could not be used because Uruguay does not have an updated input-output matrix. The general equilibrium analysis had a complexity which exceeds this project. Therefore the cost-benefit analysis was selected to conduct the research. Cost-benefit analysis is used at a national level to assess the economic efficiency of the decisions that affect the use of scarce resources (Roche, 2013; Nas, 1996), such as the introduction of a new activity, the disappearance of an activity, the implementation of a policy or regulation in the economy of a country or a region. It is also used to analyze the suitability of a project from the perspective of the economy as a whole. The method seeks to determine the impact of the change in the country's welfare, as measured by the availability of goods and services (OPP, 2014). The starting point for the cost-benefit analysis is the correct identification of costs and benefits, i.e., consider those that will affect the well-being of society as a whole and which are generated from the changes in the sector (Roche, 2013).

A base case scenario was defined as the situation before the pest was introduced. From there, different scenarios were defined depending on: (1) how much volume was lost due to the pest, (2) the substitution of *E. globulus* by other Eucalyptus species.

The first step was to identify costs and benefits. The costs were planting costs, maintenance costs, harvesting costs, transportation costs, and industrialization costs. The benefits were *E. globulus* wood exports. Data were gathered from different sources: available secondary information and personal interviews with producers and qualified people.

Secondary information was divided into three main groups: forest areas, exports, and forest producers. Forest areas in order to analyse how much *E. globulus* area decreased; exports in order to analyse the benefits composition and trends; and forest producers in order to characterize their decision making process and to gather costs and wood volume data.

Regarding forest areas, the available information was insufficient to meet the objectives of this project. The most appropriate information for these purposes was emerging from the Forest Charts 2004 and 2012 (Dell Aqua et al, 2006; Forest Division, 2012). However, it needed an update in order to compare the evolution in time of *E. globulus* areas. Regarding export information available the most appropriate for this project was from data provided by Uruguay XXI Institute for Promotion of Exports and Investments. The data were aggregated by species: coniferous and non-coniferous, and by company and destination. Regarding forest producers information, the available secondary information was revised and supplemented by primary information.

According to the Forest Charts from 2004 and 2012, the area planted with *E. globulus* declined by 27% (Table 1). From the analysis by region, in Canelones (located in the South of the country) the area more than duplicated. This fact was explained by a new company planting in the region. On the other extreme, in Tacuarembó (located in the North of the country) the area disappeared due to the adaption problems of the species. *E. globulus* is a species that needs to be close to the sea. Therefore, adaptation problems combined with the pest introduction lead to a decrease in the *E. globulus* planted area.

Table 1: Changes in forest areas with E. globulus by region

Tabelle 1: Änderungen der Waldfläche mit *E. globulus* nach Region

Region	Area in ha 2004	Area in ha 2012	Δ 2012-2004
Canelones	4435	10613	139%
Cerro Largo	16143	5819	-64%
Durazno	15025	7577	-50%
Florida	25713	12443	-52%
Lavalleja	41761	31559	-24%
Maldonado	18782	26954	44%
Paysandú	17005	10854	-36%
Rocha	20902	27773	33%
Río Negro	17726	18032	2%
Soriano	12298	10564	-14%
Tacuarembó	41336	3026	-93%
Uruguay total	**244760**	**177756**	**-27%**
% of the total	**94.43%**	**92.94%**	

Sources: Forest Division, 2012; Dell'Acqua et all., 2006.

The benefits identified in the research were *E. globulus* product exports. The first problem found was that export prices were not available. However, the Institute Uruguay XXI provided export data in volume and in value. As a result, a proxy for export prices by product was calculated by dividing exports in value over exports in volume. Companies that export *E. globulus* wood chips and roundwood by country of destination were identified. From the interviews it was confirmed that the only species of eucalyptus that is processed in chip mills is *E. globulus*, therefore it was possible to isolate those data. The wood was exported either as pulpwood or chips. Therefore, industrial costs of processing the roundwood should be included as well. However, modelling pulp industry costs exceeded the scope of this project. Therefore, it was assumed that

pulpwood was exported as roundwood as they went to Free Trade Zones, which were considered "exports" by the country. For chip mills' cost data, two interviews were conducted as only two mills were operating in the country. Currently, estimates are being developed based on the information provided.

The Uruguay XXI data for 2001 to 2015 were analyzed to determine the composition of *E. globulus* wood exports by product, company and destination. It was not possible to establish a pattern of exports, as the trend changes over the period of analysis (Table 2). However, some stability was observed in the composition of exports between 2009 and 2015, with a share of about 80 - 85% of the volume exported as chips and 15-20% exported as roundwood. These proportions were used to project exports until the end of the period of analysis. Average roundwood export prices were 79.2 dollars per ton (USD/ton) for the period 2001-2015, with a minimum of 58.6 USD/ton in 2006 and a maximum of 108.1 USD/ton in 2014. Average chips export prices were 87.7 USD/ton for the period 2003-2015, with a minimum of 62.7 USD/ton in 2009 and a maximum of 107.5 USD/ton in 2012.

Table 2: Estimated E. globulus exports (´000 USD)

Tabelle 2: Geschätzter Export von *E. globulus* (´000 USD)

Year	Roundwood	Chips
2001	23609	-
2002	23309	-
2003	16450	10499
2004	3081	33401
2005	1586	60182
2006	2071	71637
2007	16189	63922
2008	3407	161521
2009	11406	73382
2010	27119	129933
2011	21746	164450
2012	17308	73133
2013	38933	82061
2014	19542	65399
2015	17471	61305

Source: own estimates based on Uruguay XXI data (personal communication).

Primary information was obtained from interviews with forestry companies, producers and informants as well as from personal communication with contractors. Interviews with forestry companies and producers of E. globulus in the country were made. The

interviews were conducted according to a pre-established questionnaire that included the following chapters: (1) general information about the company, (2) forest resource, (3) impact of the disease caused by T. nubilosa, (4) replacing E. globulus by alternative forest species, (5) marketing E. globulus wood and alternative species and (6) future production of E. globulus in Uruguay and perspectives. The objectives of the interviews were to characterize the production sector of E. globulus in Uruguay and to gather information for the Cost-Benefit analysis. The selection of respondents was conducted with the support of the Society of Forest Producers (SPF). Respondents were contacted by email. After they agreed to the interview, they were sent the questionnaire and an individual personal interview was coordinated to enrich the exchange with the interviewee. Between 24 November 2014 and 25 May 2015 15 interviews, including 11 producers and forestry companies and 4 informants were performed.

Costs at market prices are presented in Table 3. Planting costs were composed of labor (70%) and material (30%). The inputs to be considered in the analysis were generally imported, e.g., glyphosate and fertilizer accounting for 2.5% of the total. To estimate the shadow price of maintaining costs, it was assumed that the share of labor and inputs was the same as for the cost of planting, recognizing that it may not be exact but very similar. The composition of harvesting costs was 20% gasoline, 8% labor, and the rest other inputs. Transportation costs were composed by 50% labor, 15% gasoline, and the rest were other inputs.

Table 3: Costs in market values

Tabelle 3: Kosten zu Marktpreisen

Description	Value
Plantation costs (USD/ha)	1,211
Maintenance costs (USD/ha)	198
Harvesting costs (USD/ton)	20
Transportation costs (USD/ton/km)	0.12

Sources: interviews, personal communication

The Mean Annual Increment (MAI) by species is not available; therefore the volume loss due to the pest could not be obtained. Volume yields for the base case (no pest) were not easily available from secondary information. In the interviews, average yields were obtained and used for the base case. Inventory information from plots before the pest were gathered from producers by region. However, not much data were available. Furthermore, data from the Agricultural and Livestock National Research Institute (INIA) were used. Even though these had not been collected for this research, they

were considered useful. Finally, inventory data of forests with the pest were collected between March-July 2015 for four regions: Rocha, Lavalleja, Florida and Canelones.

To conduct a cost-benefit analysis, it is often necessary to correct market prices for distortions caused by taxes, subsidies or monopoly prices, for which accounting prices or shadow prices are used, reflecting the opportunity cost of the use of the resource for the economy (Londero and Cervini, 2003). Shadow prices result from a change in welfare due to changes in the supply or demand of goods (Londero and Cervini, 2003). Therefore, these prices should reflect the opportunity cost for the economy of allocating resources to a certain sector. Shadow prices can be estimated from input-output matrices, using linear programming, the partial equilibrium approach or general equilibrium functions (Londero and Cervini, 2003; Harou, 1987, Squire and Van der Tak, 1975 as cited in Morales Olmos, 2007).

In order to correct this distortion, the shadow price ratio (SPR) is estimated to correct the market prices. Shadow prices can be obtained by multiplying the market price with the SPR which reflects the opportunity cost of using the resource (Equation 1)

$$SPRi = SPi / Pi \qquad (1)$$

with *SPRi* = shadow price ratio of price i

SPi = shadow price of good i

Pi = market price of good i

In many countries the Planning Offices or Ministries of Finance or Economics are in charge of calculating the main shadow prices, namely: for labor, the discount rate, and foreign exchange (Roura and Cepeda, 1999). In Uruguay, the latest shadow price estimates were published in 2014 (OPP, 2014). These estimates were considered appropriate for this research as these prices reflect recent economic conditions of the Uruguayan economy. In the case of labor, shadow costs were derived from studying the impact on labor supply due to (1) an additional labor demand, (2) a reduction in the good and services production, or (3) both (Amarante and Ferrando, 2011). In the case of the discount rate, the authors used a weighted average approach (Oddone, 2011). In the case of foreign exchange a partial equilibrium model was applied, measuring the changes in the welfare of producers and consumers caused by a change in the value of the foreign exchange (Aboal, 2012).

Labor and foreign exchange shadow prices were used to correct for market distortions. For labor, it is necessary to identify the opportunity cost of allocating workers to the activity in question rather than allocating them to alternative uses, which are to be employed in another sector or being unemployed. A SPR of semi-skilled labor in the urban interior of 0.53 was used. This value implies that if one unit is spent on labor, the impact on the economy will be less than one. For foreign exchange, the SPR is 1.21, indicating that decreasing exports by one foreign exchange unit, social costs of 1.21 foreign exchange units are triggered.

An incremental cash flow was estimated, and the Economic Net Present Value (NPVe) was calculated using a social rate of discount. The NPVe is the sum of discounted net cash flows at a selected discount rate. If the impact of the pest was negative, the incremental NPVe would be negative for the economy; if the impact was positive, the incremental NPVe would be positive; if there was not impact, the incremental NPVe would be zero. Finally, a social interest rate of 6.5% was used to discount and the period of analysis was 2007-2031 in order to include the year when the pest was introduced, 2007, and two rotations.

The economic analysis in the case of forestry is usually done in a long-term framework because there are usually many years between the initial investment is done and the first benefit is obtained. In Uruguay for a pulp regime, the period between plantation and harvest ranges between 9-12 years. Therefore, conducting a Cost-Benefit analysis considering the time horizon mentioned above and using cash flows and correcting the values using shadow prices seemed to be an appropriate approach for addressing the problem.

3. Results

Regarding forest area, a loss of around 27% of the area was observed between 2004 and 2012. Some of the loss could be explained by the species poor adaptation but most of the loss was explained by the introduction of *T. nubilosa* as it was stated by the producers in the interviews. Producers and companies recognized the fact that the introduction of the pest was important to make the decision to change the species. However, the decision was different whether it was made by a forest company or by a producer. The forest companies were more risk adverse than the producers. Therefore, they had changed the species as soon as the pest was detected in their plantations.

Regarding volume loss, the challenges were diverse. From the analysis it was observed that forests were planted with different seedlings or clones. This variety might lead to an issue when comparing plantation yields with and without the pest. Preliminary results showed that the 20% loss in the harvest volume expected by the producers had not been reached. Instead, a range from 3-5% in terms of loss was found. When

this paper was written, a discussion with producers was held and the causes of the differences between their expectations and actual results were addressed. The main reason identified was the different seedlings or clones. Also, they recognized that they did not have much data available as the harvest of the first plantations with *T. nubilosa* infections are currently going on. The pest was introduced in 2007 and the rotation age for these management regimes are 9-12 years.

As it was stated before, the *E. globulus* is a high value species. Therefore, even though the loss of volume was not as high as expected by the producers, a fact that yet needs to be confirmed, the loss can be high in terms of value. Furthermore, as it is a species exported as chips mainly and sold to Free Trade Zones and knowing that foreign exchange has an opportunity cost of 1.21 the decrease of exports would be associated with a leverage of 21%.

Preliminary results under these assumptions showed that a loss of 3% of the volume would lead to a loss of 2.9 million USD in exports for the period 2014-2031 and a loss of 5% would lead to a loss of 4.9 million USD. The research has yet to be completed.

4. Discussion

The cost - benefit approach is particularly relevant in the case of forestry projects because these are long-term investments, generating revenues and costs at different points in time which make them comparable in the present (Harrison et al., 2002). However, data availability is a challenge in the forest sector in Uruguay, particularly economic data.

The use of cost-benefit analysis to estimate the economic impact of the forest pest *T. nubilosa* on the Uruguayan economy is considered to be appropriate. However, implementation presents challenges, mainly related to data availability for the forest sector in Uruguay. It also presents opportunities as the impact of a forest pest on the economy is investigated for the first time.

The economic information for the forest sector in Uruguay for this type of research is scarce and incomplete. For the primary sector, plantation costs are not available from secondary information and researchers have to rely on information from contractors. For the industrial sector, the problems are related with costs of the industrial process.

In addition to the economic data, volumes and areas by species and regions are also lacking. Average Mean Annual Increments (MAIs) by species and regions, as well as reliable information on areas by species, age and region, are needed in order to assess the impact of a forest pest. For MAIs estimates, an additional challenge is that the *E. globulus* sector has been changing the seedlings and in some cases introduced clones,

so that it is all but straightforward to isolate the causes of the changes in harvest volume. Therefore it is of interest to keep track of these changes in the inventory data. For areas estimates, an update from the government is needed in order to learn how much area planted with *E. globulus* has been actually substituted and with which species. The species chosen has implications regarding yields and markets. In addition, it has implications for the estimates of whether the volumes would be exported or consumed locally. It was mentioned that *E. globulus* prices are higher than other species prices; therefore if the species was substituted by other species, the economic loss would be high.

The information identified as important for an economic impact study would be of interest for companies operating in the country as well as investors either from Uruguay or abroad. Finally, the use of cost - benefit analysis to investigate the economic impact of a forest pest for the country represents a first step to this type of studies. The environmental impact and the estimation of externalities caused by forest pests should be added in future research. The results would be useful for policy makers determining whether to allocate resources to prevent the introduction of forest pests.

References

Aboal, D. 2011. National System of Public Investment. Component: Accounting price. Sub-component: foreign exchange social price. Agreement OPP-Economics Faculty. UdelaR. Internal document.

Amarante, V. and Ferrando, M. 2011. National System of Public Investment. Component: Accounting price Sub-component labor social price. Agreement OPP-Economics Faculty. UdelaR. Internal document.

Alavalapati, J.R.R., Adamowicz, W.L., White, W.A. 1998. A comparison of economic impact assessment methods: the case of forestry developments in Alberta. Canadian Journal of Forest Research 28, 711-719.

Brasier, C. M. 2008. The biosecurity threat to the UK and global environment from international trade in plants. Plant Pathology, 57(5), 792-808. doi: 10.1111/j.1365-3059.2008.01886.x

Dell'Acqua, M., Petraglia, C., San Román, D. 2006. Results of the interpretation of satellite images for forestry and land use of forestry priority soils (In Spanish). Yearbook OPYPA 2006. Agricultural, Livestock and Fisheries Ministry.

Elmer, W. H. 2001. Seeds as Vehicles for Pathogen Importation. Biological Invasions 3(3), 263-271. doi: 10.1023/A:1015217308477.

Forest Division. 2012. Forest resource. Total forest area. Forest Chart 2012 (In Spanish). Available at: http://www.mgap.gub.uy/portal/hgxpp001.aspx?7,20,441,O,S,0,MNU;E;134;2;MNU. Uruguay. Last accessed: June 20, 2016.

Forest Division. 2016. Forest resource. Total forest area. Registered forests (In Spanish). Available at: http://www.mgap.gub.uy/portal/hgxpp001.aspx?7,20,441,O,S,0,MNU;E;134;2;MNU. Uruguay. Last accessed: June 20, 2016.

Harrison, S., Herbohn, J., Mangaoang, E., Vanclay, J. 2002. Cost-benefit Analysis in Forestry Research, in Socio-economic Research Methods in Forestry: A Training Manual, chapter 15, 165-175. Proceeding of an International Training Workshop, 4-10 February 2002. College of Forestry at Leyte State University, Visca, Baybay, The Philippines. Cooperative Research Centre for Tropical Rainforest Ecologyand Management. Rainforest CRC, Cairns.

Holmes, T. P. 2010. Confronting challenges to economic analysis of biological invasions in forests. New Zealand Journal of Forestry Science, 40 suppl., S105-116. ISSN 1179-5395.

Holmes, T. P., Aukema, J. E., Von Holle, B., Liebhold, A. ,Sillse, E., S. 2009. Economic impacts of invasive species in forests: past, present, and future. Annals of the New York Academic of Science, 1162,18-38. doi: 10.1111/j.1749-6632.2009.04446.x.

Kirschner, A.R. 2010. Understanding poverty and unemployment on the Olympic Peninsula after the Spotted Owl. The Social Science Journal 47, 344-358.

Londero, E. H., Cervini, H. 2003. Shadow prices for project appraisal: theory and practice, Cheltenham, UK; Northampton, MA. Edward Elgar Pub.

Morales Olmos, V. 2007. The economic impact of the forest sector in Uruguay: A Cost Benefit Analysis. MSc Thesis. University of Georgia. Athens, Georgia, USA. 157 pp.

Nas, T. F. 1996. Cost-benefit analysis: theory and application, Thousand Oaks, California. SAGE Publications, Inc.

Oddone, G. 2011. National System of Public Investment. Component: Accounting price. Social discount rate. In collaboration with A. Capurro, S. Ithurralde, M. Pedreira and J. Reyes. Agreement OPP-Economics Faculty. UdelaR. Internal document.

OPP (Budgeting and Planning Office). 2014. National System of Public Investment. Social Prices and Technical Guidelines for Socioeconomic Evaluation (in Spanish). OPP. Montevideo, Uruguay.

Parliament of Uruguay. 1988. Forestry Law 15939 (in Spanish: Ley Forestal 15939). Available at: https://parlamento.gub.uy/documentosyleyes/leyes?Ly_Nro=15939&Searchtext=&Ly_fechaDePromulgacion%5Bmin%5D%5Bdate%5D=03-12-2015&Ly_fechaDePromulgacion%5Bmax%5D%5Bdate%5D=20-06-2016 Uruguay. Last accessed: June 20, 2016.

Patriquin, M.N., Wellstead, A.M., White, W.A., 2007. Beetles, trees, and people: Regional economic impact sensitivity and policy considerations related to the mountain pine beetle infestation in British Columbia, Canada. Forest Policy and Economics 9, 938-946.

Patriquin, M.N., White, W.A., 2004. Estimating the Economic Impacts of Mountain Pine Beetle Disturbance Using a Regional CGE Model Southern Forest Economists Workshop (SOFEW), 284-293.

Roche, H. 2013. General and Sectorial Methodologies. General methodology (in Spanish). OPP. Montevideo, Uruguay.

Roura, H., Cepeda, H. 1999. Handbook of identification, formulation and evaluation of rural development projects (in Spanish). Latin American and Caribbean Institute

for Economic and Social Planning-ILPES. Project Management and Investment Programming. Santiago de Chile, Chile.

Wingfield, M., Slippers, B., Roux, J., Wingfield, B. 2001. Worldwide movement of exotic forest fungi especially in the tropics and Southern Hemisphere. Bioscience, 51(2), 134-40. doi: 10.1641/0006-3568(2001)051[0134:WMOEFF]2.0.C