General information

Description	A tool to predict the impact of defoliation in Eucalyptus stands productivity and wood production	
Geographical area	Eucalyptus distribution area	
Group of tree species	Eucalyptus species	
Date	June 2018	
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Tool type	Models	Case studies
Tool format	Outputs (graphical scenarios)	
Language	English	
Risk management plans to which the tools can be added	Risk management plans for the Eucalyptus weevil from Portugal, Asturias and Cantabria	
Risk management plans link	https://plurifor.efi.int/wp-content/uploads/WP2/plans/Gonipterus-platensis-risk-plan_ES.pdf https://plurifor.efi.int/wp-content/uploads/WP2/plans/Gonipterus-platensis-risk-plan_PT.pdf	
This tool is…	☒ an improved tool	
Original tool of which this one is an improvement	3PG Model	

Topic

Risk	Eucalyptus weevil risk		
Risk component	☒ hazard	☒ impact	☐ vulnerability
Risk area	Risk planning		
Risk phase	surveilling/monitoring/early warning		
Risk phase (alternative terms)	preparedness		
Level	Global		
Sendai priorities	☐ Priority 1: Understanding disaster risk ☒ Priority 2: Strengthening disaster risk governance to manage disaster risk ☐ Priority 3: Investing in disaster risk reduction for resilience ☐ Priority 4: Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction		
Contribution to Sendai targets	☐ Reduce global disaster mortality ☐ Reduce the number of affected people ☒ Reduce the direct disaster economic loss ☐ Reduce disaster damage to critical infrastructure ☒ Increase the number of national and local disaster risk reduction strategies ☐ Enhance international cooperation to developing countries		

	☒ Increase availability of and access to multi-hazard early warning systems and disaster risk information and assessment

Description and analysis

Summary

This tool consists in the application of the 3PG Model ("**P**hysiological **P**rinciples that **P**redict **G**rowth"), a physiologically based model, that uses physiological principles and environmental variables, allowing, among others, the possibility of predicting the consequences of the effects of pests and diseases that cause defoliation in forest stands. It is used here to simulate the impact of defoliation caused by *Gonipterus platensis* in Eucalyptus stands. The final product is the prediction of the characteristics of the stand, including wood production, based on site and soil descriptors and weather data, taking into account the impact of defoliation. The effect of the application of protection actions such as chemicals to avoid weevil attacks can also be taken into account.

Place in national/regional policy

This tool is part of the weevil risk management plan (RMP) developed for each region. The RMP is a strategic risk plan addressing the research areas and governance measures which need to be adopted and developed in order to minimize this forest risk.

Goals and achievements

The objective of this tool is to simulate the impact of defoliation in Eucalyptus stands, including the effects of the application of chemical treatments, providing information in the definition of management plans and decision-making processes.

Stakeholders involved

Public and private forest managers, forest owners, public administration, researchers, service providers.

Implementation stage

For the implementation of this tool it will be necessary (input data):

- Monthly weather data (temperatures, radiation, precipitation, vapor pressure deficit)
- Descriptors about the site and the soil (latitude, soil texture and maximum water storage capacity, fertility index – fertility "rating" (0-1))
- Stand initial data (biomass of: leaves, woody and roots; population density) may also be provided but are not a requirement

Results come in the form of outputs (graphs of biomass of: leaves, woody and roots and stand data in an yield table format)

State of technical knowledge

The use of the 3PG Model to simulate the impact of defoliation in Eucalyptus stands is yet in investigation. It is necessary to establish field trials to validate 3PG simulations with real data.

Regulatory and/or socio-economic contexts

This tool can be integrated into planning systems, enabling timely decision making, reducing possible loss of forest production associated with pest attacks, and contributing to the maintenance of the various forest functions.

Impacts of the tool

Knowing that there is a gap between demand and supply of Eucalyptus wood in Portugal and Spain, the tool being developed will be important because it will permit to predict the impact of the weevil, expressed in wood loss, in several conditions and treatment scenarios. Given specific health condition of Eucalyptus stands, the tool will allow to predict wood volume loss allowing timely

intervention by owners - small private owners, pulp industries or public administration. Eventually, the tool will allow the quantification of growth losses with and without chemical treatment, an aspect that is essential for the definition of management plans and decision-making processes of the owners and the definition of the medium-term strategies of the industry.

Implementation requirements and durability

Description of the implementation steps

In order to simulate defoliation with this tool, the following steps must be followed: (1) initialization data corresponding to biomass data (leaves, woody and root biomass), (2) introduction of soil data (texture, soil fertility and maximum water storage capacity), (3) introduction of weather data (radiation, temperature, precipitation). Using all this input data, the model calculates the net primary productivity which is then allocated to the different types of biomass. The model then predicts leaf fall (and the corresponding to defoliation can be simulated) and root renewal.

Governance

The tool to simulate defoliation impact is public and can be used by all stakeholders at the regional or national level.

Human resources requirements

In order to analyze the resulting data and interpret the graphs at different levels of damage, personnel with forestry knowledge is needed (e.g. forestry engineers, or even technicians and owners with very good knowledge).

Financial requirements

The implementation of this tool does not involve very high costs.

The 3PG Model is freely available and the required input data are easily obtained, either because they constitute information resulting from the activity of the stakeholders (e.g. biomass data) or they are available at low cost (weather data). Only the data related to the soil may involve higher costs, as the determination of the maximum water storage capacity involves opening a soil profile or consulting a soils expert, and mainly the fertility index that implies the consultation of a soil specialist to attribute the fertility "rating".

Technical requirements

No special software is needed to run the model because the 3PG is already implemented in the standsSIM simulator, freely available from http://www.isa.ulisboa.pt/cef/forchange/fctools and the ability to simulate defoliation and the chemical treatments will be added to the existing tool.

The data collection and processing can be undertaken by the stakeholders themselves (provided that they have information on climatic and physiological data). To obtain the data related to the soil (texture, maximum water storage and fertility index), technicians with good knowledge are needed, especially the "fertility rating" for which a soil specialist is needed.

Priorities identified for successful implementation of the tool (political, technical, human, financial…)

For successful implementation of the tool for defoliation simulation it is necessary to collect the data needed for the model (stand and environmental variables). Therefore, cooperation between all parties involved is necessary to achieve a robust database which can be used to run the model.

Challenges or risk factors (legal, financial, safety…) expected during the implementation and solutions proposed

Related to the previous point, the main challenge is to ensure coordination between the administrations in charge of forest management, companies in the sector and private owners in their capture and sharing of data so this can be used to obtain reliable defoliation estimation data for

different degrees of attack as well as for different phenological stages and climatic conditions.
Additional and non-formal experiences to help the implementation of good practice The transmission of information between all the stakeholders involved in *Gonipterus platensis* management is an essential issue to improve the tool in question and to implement it in the ordinary workflow of the people in charge of the pest management. For this reason it is important to promote workspaces where research centers and companies can share their knowledge and goals with the other stakeholders and transmit the wide range of possibilities that the 3PG Model tools can offer in the fight against *Gonipterus platensis* .

SWOT analysis

Strengths	**Weaknesses**
- The model is simple and easy to use, and not too demanding on input data - May be available in the web and be used through a user-friendly interface – standsSIM – also available online - Is well documented - Is fully dynamic and can be adapted for a range of species - The model has been used successfully in other simulations (e.g. impact of climate change, effect of irrigation, impact of fertilization, etc.) - The resulting graphs of defoliation simulation are very easy to interpret - The model provides management-related outputs	- Results of defoliation impact have not yet been validated. It is still in the testing phase (need to establish field trials / experiments) - Need of validation of 3PG simulations with real data (company inventory data) - It is assumed that after defoliation the allocation of biomass maintains, without being sure of it - The 3PG model considers the crown as a whole, without differentiating the photosynthetic capacity of the leaves located in different parts of the crown, whereas the weevil preferentially "attacks" the upper part of the crown. Does this simplification impact the quality of results? - The monthly pattern of leaf consumption by the insect was estimated by "expert judgment" - It becomes necessary the exclusion of insects in some trees and measurement of the intercepted light in comparison with trees "attacked", for clarification of the allocation
Opportunities	**Threats**
- The 3PG Model, based on physiological processes and environmental variables, is an important decision tool in forest planning and management. It is already incorporated in simulation platforms and it is an opportunity to add the ability to simulate the impact of defoliation. For having the advantage of being able to predict pest effects it constitutes an interesting tool in Eucalyptus stands to simulate the impact of defoliation caused by *G. platensis* as well as the impact of treatments.	- Climate may alter the behavior pattern of *Gonipterus platensis*, making it difficult to make future predictions of the damage it will cause.

Lessons learnt

Evaluation process, if exists (internal or external) Within the GT3 task of the PLURIFOR Project, a process of evaluation of the tool will be carried out.
Assessment of results (quantitative and qualitative) and comparison with main goals As the module to simulate the impact of defoliation is in experimental phase, validation of 3PG simulations with real data is needed.
Negative aspects identified N.A., the tool is still undergoing experimental testing.

Access to complete tool

Files	Methodology and results.pdf
Web links	https://plurifor.efi.int/wp-content/uploads/WP2/tools/Gonipterus-platensis-tool-3_3.pdf