

Final Evaluation Report

Your Details	
Full Name	Paulina Fernanda Puchi González
Project Title	Using wood-anatomical traits to clarify Araucaria araucana decline in Northern Patagonia
Application ID	23677-1
Grant Amount	Small Grant
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Date of this Report	03/05/2021

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Fieldwork				In January 2019 with Argentinian researchers from National Agricultural Technology Institute (INTA-Argentina) Alejandro Martinez-Meier, Anne-Sophie Sergent and Chilean research Cristián Frêne from Institute of Ecology and Biodiversity (IEB) and coordinator of the Chilean Long-Term Socio-Ecological Research Network (LTSER-Chile), we went to field trip for sampling <i>Araucaria araucana</i> in Chile and Argentina, including Marco Carrer (supervisor) and Julio Camarero (co-supervisor, Instituto Pirenaico de Ecología - Spanish Nat Res Council). This multidisciplinary network collaborated to the research project.
Project dissemination in local newspaper				I conducted an interview for University Austral of Chile (Valdivia-Chile), in which they asked me about my scientific research and talked about the project financed by Rufford Small Grant to clarify the causes of mortality of the <i>Araucaria araucana</i> . Full interview: https://diario.uach.cl/paulina-puchi-exalumna-de-la-uach-el-planeta-necesita-con-urgencia-personas-preocupadas-por-la-conservacion-de-los-recursos-naturales/ *views 1778
Scientific paper <i>“Wood anatomy and tree-ring isotopes reveal long-lasting hydraulic deterioration as the main cause of Araucaria araucana drought-induced dieback in southern America”</i>				We were able to elucidate the causes of decline in <i>Araucaria araucana</i> in Chile and Argentina using wood anatomical features and stable isotopes. The results it will be published in the journal <i>Global Change Biology</i> that has an impact factor of 8.5. This journal promotes new understanding of the interface between biological systems and all aspects of environmental change that affects a substantial part of the globe.

International conference			Oral presentation of the results in the virtual conference “Tree Rings in Archaeology, Climatology and Ecology” (TRACE). It will be held in June 2021 (last year it was cancelled due to Covid-19 pandemic). https://trace-2021.com/
Workshop and seminars			<p>The workshop was carried out virtually (via zoom), therefore I categorise it as moderately achieved, because I think it would have been much more fruitful to have done it in person, however, Covid-19 pandemic, it was the only way to achieve these goals.</p> <p>However, this talk was recorded and many people in the audience requested the recording of the presentation as educational material, and for dissemination for people who could not be present.</p> <p>In addition, managers of national parks who work in the national forestry corporation of Chile and Argentina asked me for a poster for educational material and dissemination of the most relevant results of the project.</p>

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.

One of the main difficulties and constraints was the Covid-19 pandemic, since I had delays, at a scientific level (during my doctoral thesis period), and the dissemination activities of the results in Chile. These activities could not be carried out in person, however, the presentation of the results was performed via Zoom (recorded presentation).

3. Briefly describe the three most important outcomes of your project.

- Scientific paper
 Puchi, P.F., J.J., Camarero., G., Battipaglia., M., Carrer. (2021). Wood anatomy and tree-ring isotopes reveal long lasting hydraulic deterioration as the main cause of *Araucaria araucana* drought-induced dieback in southern America. *Global Change Biology* (submitted). This is a high Impact factor journal (8.5).
- Presentation of the results in the congress Tree Rings in Archaeology, Climatology and Ecology (TRACE), virtual conference held in June 2021 (last year it was cancelled due to Covid-19 pandemic). I will perform an oral presentation with the research “Wood anatomy and tree-ring isotopes reveal

hydraulic deterioration as the main cause of Araucaria araucana dieback in southern America”.

- Dissemination of the results (via Zoom) to local communities, native people, scientific community, and managers of national parks in Chile and Argentina where *Araucaria araucana* population are present. We to establish a network for the conservation of *Araucaria araucana* in Chile and Argentina. In addition, the managers of national parks in the two countries and agents of Mapuches in Argentina will collaborate in the distribution of my presentation and poster (dissemination of the results).

4. Briefly describe the involvement of local communities and how they have benefitted from the project.

The local communities, universities and public institutions that participated and were interested in the results of the project:

- Marcelo Antilef, Sergio Lefiche and Ernestina Lefiche, *Mapuche*-native agents of Argentina.
- Pilar Contreras (Environmental Engineer), she is the president of “*Mulchen Consciente*” it is an Environmental social movement, whose main objective is to educate, protect and conserve the environment, located in Mulchen city at Bio-Bio Region in Chile (*Mapuche-Territory*).
- Dámaris Rodríguez, Agent of the pewence zonal council (*Pehuenche-Mapuche*).
- National Institute of Agricultural Technology (INTA-Bariloche-Argentina).
- National Council for Scientific and Technical Research of Argentina.
- National Forestry Corporation of Chile and Argentina.
- National Parks administration of Chile and Argentina.
- Scientific community from Chile, Argentina, Mexico, Uruguay and France.
- Austral University of Chile.
- University of La Republica, Uruguay.
- National University of Comahue San Martín de los Andes (Argentina).

Through the results obtained in the project, I was able to generate innovative results to determine the causes of the drought-induced dieback of the *Araucaria araucana* in Chile and Argentina through anatomical traits (all the results were exposed in the recorded presentation via Zoom). The most relevant results were the long-lasting hydraulic deterioration of declining trees started more than 200 years.

Finally, in the presentation (video attached) I made conservation proposals where I indicated the relevance of covering the problem of the decline phenomenon of the *Araucaria* forest through a multidisciplinary approach, where I declared that it is essential to integrate the ancestral knowledge of the *Mapuche* communities that have coexisted with the species a 1,000 years ago.

5. Are there any plans to continue this work?

Yes, I still have a lot of work to do. I'm the only researcher in Chile and Argentina who is working to combine the novel methodologies dendro-anatomy and stable isotopes. During the analysis of the results appeared new scientific questions to solve, and elucidate this new gap of information it will be very important to scientific community, stakeholders, and indigenous communities to improve the knowledge to understand the decline and tree mortality causes of *Araucaria araucana*.

Nowadays, in Chile, the regulations for the conservation of native forests and, in particular, the *Araucaria araucana* monument tree continues very scarcely without control and inspection, in relation to forest fires, illegal firewood extraction, and new pathogens attack (fungus). Unfortunately, this is happening due to the extractivist economy model of my country (Chile), and therefore it is very important to continue this project for the conservation of native forests to preserve *Araucaria araucana* and its aborigines, "Los Mapuche".

6. How do you plan to share the results of your work with others?

- Scientific paper.
- Oral presentation in international conference.
- Open workshop (recorded video) to show the results of the project to universities, national forestry corporation, scientific communities (in South America) local communities in Chile and Argentina.
- Poster with the most relevant results, requested by the directorate of protected wild areas in the national parks where the *Araucaria* populations are present (Chile and Argentina).

7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?

The project was executed over 2 years, however, do to the Covid-19 pandemic, I asked an extension of 4 months to be able to finish all the activities proposed in the project.

8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Accommodation	500	1053	+553	This budget was expended for 10 days field-trip accommodation for the team (4 persons). The difference was afforded by my supervisor Marco Carrer (University of Padova).
Increment bores & Lab materials	1300	3035	+1735	The difference of budget was used to pay stable isotopes analyses supplies, to determine water use efficiency. * Stable isotopes supply
Car Rental & toll	800	1118	+318	The car was rented for 10 days to perform the field-trip sampling of Araucaria in Chile and Argentina.
Food	400	400		This budget was expended for 10 days of field trip food for part of the team (me and Cristian Frêne Conget). The expenditure was 20 £ per day a person. <i>*My supervisors they paid their food (as it was indicated in the project budget).</i>
Fuel	500	178	-322	This budget was expended for 10 days of car rental field trip. During the fieldtrip we drove approximately. 2000 kilometres to reach the study sites for sampling Araucaria in Chile and Argentina.
Flight tickets Public transport in Chile	1500	1718	+218	This item consists in 2 flight tickets, for the team (me, and 1 supervisor) to go to Chile for sampling.

Total amount	5000	7502	2502	*The amount of 2502 was paid by Marco Carrer (Supervisor - University of Padova, Italy).
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9. Looking ahead, what do you feel are the important next steps?

Continue working with the local and native communities, because they inhabit and protect the territory. In addition, I'm very motivated to carry on this project in the future, because in Chile there are not much research applied to local communities. In this context, I believe that if fundamental that science must be transmitted to society and indigenous communities in order to build a new model of science that integrate scientific knowledge with ancestral wisdom with the purpose to conserve natural resources in the long term scale.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

Yes, I used the Rufford Foundation logo. The logo was used for:

- PhD annual evaluations (oral presentation) to University of Padova, Italy (2019-2020-2021).
- Doctoral final evaluation (oral presentation) to get the degree of PhD at University of Padova, Italy (30/3/2021).
- Seminars for dissemination the results local and native communities (recorded presentation).
- International conference (TRACE Lund, June 2021).
- Acknowledgment in scientific paper "Wood anatomy and tree-ring isotopes reveal hydraulic deterioration as the main cause of *Araucaria araucana* dieback in southern America" submitted in the *Journal Global Change Biology*.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

Marco Carrer. He was my PhD supervisor. Expert in Forest Dynamics and Dendroecology. He studies the effects of climate on tree growth. He developed dendroanatomy: the analysis of time series of xylem anatomical traits to improve the knowledge on tree functioning and on climate/growth associations. He is one the most active researchers in this field in Europe. He participated on the fieldtrip to extract dendrochronological samples in Chile and Argentina. He is co-author of the scientific article.

Jesus Julio Camarero Martinez He was my PhD co-supervisor. He is the expert for tree die-off and mortality analysis. He collaborated in the fieldtrip campaign for sampling *Araucaria* in Chile and Argentina. He is co-author in the scientific paper.

Cristian Frêne Conget. Ph. D in Ecohydrology. He supported in field campaign for sampling *Araucaria* in Chile and Argentina. He also collaborated in the organization of the seminar for native communities in Chile.

Anne-Sophie Sargent. Researcher of the National Institute of Agricultural Technology (INTA-Bariloche-Argentina). She collaborated in field trip campaign for *Araucaria araucana* sampling. She also was the gestor of Scientific Permission to be able to be sampling an Endangered Species in Argentina. Finally, she collaborates in the dissemination of the results in Argentina (Lanin National Park).

Giovanna Battipaglia. Expert in stable isotopes in tree-rings. She performed the stable analysis of non-declining and declining trees at University of Campania 'L. Vanvitelli', Department of Environmental, Biological and Pharmaceutical Sciences and Technologies, Caserta-Italy. She is the co-author of the scientific article.

12. Any other comments?

I'm aware that the budget should be expend on field-base activities, but due to restrictions imposed by the Covid-19 pandemic, I was not able to carry out the dissemination of the results activities physically.

Even though all the constraints I managed to continue with the activities despite all the difficulties.

The differences on budget for "dissemination of the results" item was move to "lab materials", because to increase the impact of the results we include the stable isotope analysis to determine the water use efficiency to be able to understand the physiological mechanism of *Araucaria araucana* declining trees are using to withstand or survive under extreme drought in a long-term scale.