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Científica y Tecnológica - CONICYT



COMISIÓN NACIONAL DE INVESTIGACION CIENTÍFICA Y TECNOLÓGICA

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<b>N° PROYECTO :</b> 3140161	<b>DURACIÓN :</b> 3 años	<b>AÑO ETAPA :</b> 2016
<b>TÍTULO PROYECTO :</b> WATER AVAILABILITY, WATER USE, AND WATER QUALITY EVALUATION IN RURAL CHILEAN WATERSHEDS, THROUGH COMMUNITY PARTICIPATION AND FIELD RESEARCH.		
<b>DISCIPLINA PRINCIPAL :</b> Geografía Física		
<b>GRUPO DE ESTUDIO :</b> GEOGRAFIA Y URBANISM		
<b>INVESTIGADOR(A) RESPONSABLE :</b> YESSICA ANDREA RIVAS TISNAO		
<b>DIRECCIÓN :</b>		
<b>COMUNA :</b>		
<b>CIUDAD :</b> Chillán		
<b>REGIÓN :</b> VIII REGION		

**FONDO NACIONAL DE DESARROLLO CIENTIFICO Y TECNOLOGICO (FONDECYT)**

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# INFORME FINAL

## PROYECTO FONDECYT POSTDOCTORADO

### OBJETIVOS

Cumplimiento de los Objetivos planteados en la etapa final, o pendientes de cumplir. Recuerde que en esta sección debe referirse a objetivos desarrollados, NO listar actividades desarrolladas.

N°	OBJETIVOS	CUMPLIMIENTO	FUNDAMENTO
1	1) To generate a participatory baseline inspection and mapping in study area.	TOTAL	A classification of the land use soil of the Arauco and Curanilahue communes was also carried out; in addition a classification, which fieldwork , of the Rio Raquí basin and the micro-watershed. The geology was also studied. Regarding, to different land uses classified, exotic tree plantations currently represent more than 63% of the study area, contrasted with native forest (17.6%) and native shrubland (6%), and agricultural and pasture land represent the 9.7%. All of this takes into account of the high vulnerability of coastal ecosystems.
2	2) To quantify the water use and availability inside households.	TOTAL	About the domestic water consumption, this last year was measuring the amount of water consumption as total, unclassified by the different uses within the house. The people were informed in relation to their monthly consumption per capita. In relation to water availability, The Brocca model has been calibrated and validated for the different measuring stations soil humidity of Arauco watershed. The results obtained for the watershed Arauco show that the model correctly simulates the evolution of the humidity content of soil superficial layer, from data about rainfall and temperature. For calibration and validation, values of indicator to quantify the adjustment goodness -of- fit are satisfactory, but only for rainy season. In the wet season, the model did not calibrate efficiently.

3	3) To analyze water quality in the different households in a local watershed.	TOTAL	Regarding water quality, physical and chemical parameters: total iron, total manganese and turbidity and microbiological: total and faecal coliforms do not meet the requirements according to the Chilean norms for potable water (NCh 1333 from 1987 and Organización Mundial de Salud (OMS, 2000). Complete water analysis procedure were performed for three years in the same season of the year. Furthermore, seasonal sampling of iron, nitrite and faecal coliforms were realized. One water quality index was calculated according to the community perception for the studied area.
4	4) To examine and compared the isotopic abundance of fractionation of $^{18}O$ , $^2H$ in waters and to evaluate the soil enzyme activity responses to changes in vegetation type.	TOTAL	In this objective we achieved to quantify isotope water abundance of the groundwater, upstream and downstream in the micro- watershed. We also achieved to quantify Isotope water abundance in all household of this stage. Rainwater samples were taken for a year, with this data Local Meteoric Water Line (LWL) was built, the $^{18}O$ and $^2H$ measured in precipitation shows an empirical linear relationship, described by LWL. Complementary to before, other complementary analyzes are currently under way to reinforce the previous data and allow the generation of a possible publication (Water from bulk soil and xylem are extracted from their respective matrix using the cryogenic vacuum distillation). Relative to soil enzyme activity, we achieved measure soil enzyme activity in each season year (we measure one more than initially proposed). In each land use, we also achieved soil DNA quantify relative to the richness of fungi and bacteria.
5	5) Evaluation of results with the community and local decision makers on management alternatives	TOTAL	Workshops with the community and schools were already. Two muppet shows were created and presented for kinder garden and for elementary school. About final workshops it was developed. The current land management impacts on water quality and use were discussed, and alternative methods to improve management were proposed. Riparian vegetation was emphasized as playing a key role to keep and improve water quality and quantity in their lands along the watershed and as wide as possible. Recommended better management practices included water re-use, rooftop water harvesting and the promotion of biogas. Two Individual sewage treatment pilot were constructed, as a decentralized treatment strategy.

Otro(s) aspecto(s) que Ud. considere importante(s) en la evaluación del cumplimiento de objetivos planteados en la propuesta

original o en las modificaciones autorizadas por los Consejos.

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## **FINAL SUMMARY:**

Describe in a clear and precise manner the main project objectives, goals and achieved results. Highlight the possible scientific, technological and / or economic implications of your results and the potential benefits they may have for society. Indicate also whether the scope and / or research results were in some way diffused in society. **The maximum length of this section is 1 page (font size 10, Arial or Verdana).**

Water availability, use and quality in Dispersed rural communities in a rural watershed of the Coastal Range of Chile were investigated through participatory research involving local community, so called citizen science. Research included the quantification of water use at the household level, monitoring water quality of river and some of its tributaries (streams), community water intakes and household faucets; and the determination of land use and water quality interactions, when was possible. The children of three local rural elementary schools and mainly women were involved mainly aspects of the research, design to implementation and remediation options. Rural communities in the Coastal Range of Chile have been experiencing a severe water shortage during the last years, as well as intense land-use changes. Afforestation after deforestation using fast growing exotic species is creating major land use changes throughout Chile and the world. Commercial forest plantations have increased in Chile by replacing natural forest, being *Eucalyptus globulus* Labill one of the most planted. Globalized agribusiness corporations have been expanding through the region driving land use changes, while the local traditional agriculture has experienced a sustained decline.

The territory receives considerable (mean =  $1,150 \pm 239$  mm/year the last 37 years), but highly variable, rainfall, and the hydrogeological setting does not offer enough inter-annual natural storage (50 % of rainfall) to cope with increasing demand and variable water viability. To supply drinking water, local governments are using tank trucks, which are a costly and unsustainable manner to tackle the problem. In relation to water quality in the area, the chemical quality of the water is good, except for the high concentration of iron and manganese in both households and stream water of natural origin. From the microbiological point of view the water is of poor quality. All analysed water samples have a high concentration of total and / or faecal coliforms. This could be related to the lack of maintenance of water collection systems, non-maintenance of septic tanks, animal traffic and low coverage of associated riparian vegetation. We also studied the microbiological characteristics associated to the different uses of soil, following questions: does land use practice (native forest vs monoculture eucalyptus plantations) influence the bacterial and fungal diversity and community composition in this area? What are the biotic and abiotic predictors associated with land use that best explain this influence? This questions were developed on native forest and unmanaged plantations where exotic trees are mixed with native species. Both traditional method of soil enzyme assays and advanced molecular PCR-DGGE techniques were used to investigate the impacts of land use change, after replacing native forests species by fast- growing exotic species. PCA was used as a tool of exploratory data analysis and for making predictive models of amount of soil microbial communities, enzymatic activities and physical and chemical parameters. Soil microbial communities and enzyme activities evaluated were sensitive indicators of the biochemical changes generated by soil use change. Land use change alters the structure and function of soil microbial communities, driven by shifts in understory coverage and soil resource availability. Leaving remnants of the original forest should be considered to help improve the metabolic function of soil microbial communities and decrease of impacted soil. Small changes in the great forestry industry of the country could improve productivity and sustainability of not only resources but also of the nearby communities. The approach involving specially children in research stimulated improved management of both land and water resources, and could be applied in small rural watersheds in developed or under-developing countries. Citizen Science approach can create new data and knowledge and could facilitate sustainable development activities, particularly in rural communities in central-southern of Chile.

<b>Estadías de perfeccionamiento.</b>					
institución	ubicación	financiamiento	objetivo	inicio	término
Universidad Austral de Chile	Valdivia/Chile	Fondecyt # 3140161	Extracción de DNA en el suelo, DGGE y Bioinformática.	01/03/2016	01/05/2016
Universidad del Bio Bio	Chillán/Chile	Fondecyt # 3140161	Extracción de DNA en muestras de agua, DGGE y evaluación antimicrobiana de aceites esenciales de Mentha aquatica y Foeniculum vulgare y su utilización como fitorremediadoras de aguas de bebida y residuales domiciliarias	Diciembre 2017	Enero 2017

## EVALUATION REPORT FROM POSTDOCTORAL RESEARCHER SPONSOR

SPONSOR NAME: Dr Diego Rivera Salazar

During the third year, Dr Rivas has carried out an intensive fieldwork on social issues, building bridges between scientists and communities. This action has led to a strong knowledge transfer, but also have improved Yessica's skills on social research.

Yessica has done an impressive work on bringing together data from different sources. She has framed her research in terms of the hidrosocial cycle, i.e. the links and interplay among physical geography, communities and institutional landscape.

Based on the examination of results and my own assessment of her work, I would like to support without reservations the quality, extend and impacts of Dr Rivas' postdoctoral work. We have been closely working on academic publications, developing new methods for data analysis and how to translate sound scientific knowledge for community empowerment. I am impressed by her creativity and generosity to share their knowledge. Her new ideas on hidrosocial aspects have the potential to become a breakthrough in terms of policy-making. Yessica is very active on our group discussion, by providing both theoretical and operational insights on our ongoing projects. Also, she has played a key role in establishing and implementing the research areas of my group. He has proved that at his young age, she has engineering, sustainability and ecosystem assessment expertise. She showed plasticity and ability to integrate knowledge from different disciplines, as well as strong skills to work in multi- and transdisciplinary teams.

Based on the examination of results and my own assessment of her work, I would like to support without reservations the quality, extend and impacts of Dr Rivas' postdoctoral work.

  
Dr D Rivera  
Chillán, 23 May 2017

# PRODUCTOS

## ARTÍCULOS

Para trabajos en Prensa/ Aceptados/Enviados adjunte copia de carta de aceptación o de recepción.

**N° :** 1  
**Autor (a)(es/as) :** Rivas, Y. ; Canseco, M.I.; Knicker, H.; Etcheverría, P.; Godoy,R.; Matus, F.; Valenzuela, E.; & Gallardo, R.  
**Nombre Completo de la Revista :** Revista Bosque  
**Título (Idioma original) :** Variación en el contenido de glomalina relacionada a las proteínas > del suelo, después de un incendio forestal en un Andisol en bosques de > Araucaria araucana del centro-sur de Chile.  
**Indexación :** ISI  
**ISSN :**  
**Año :** 2016  
**Vol. :** 37  
**N° :** 2  
**Páginas :**  
**Estado de la publicación a la fecha :** En Prensa  
**Otras Fuentes de financiamiento, si las hay :**

**Envía documento en papel :** no  
**Archivo(s) Asociado(s) al artículo :**  
Manuscrito\_Glomalina\_en\_Bosques\_de\_Araucaría12-04.pdf  
[https://servicios.conicyt.cl/sial/index.php/investigador/f4\\_articulos/descarga/13210102/3140161/2016/100193/1/](https://servicios.conicyt.cl/sial/index.php/investigador/f4_articulos/descarga/13210102/3140161/2016/100193/1/)

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**N° :** 2  
**Autor (a)(es/as) :** Rivas, Y.; Knicker, H., Matus, F.,; Godoy, R.; Rumpel, C.  
**Nombre Completo de la Revista :** Soil Biology and Biochemistry  
**Título (Idioma original) :** Neutral sugar content and composition as sensitive indicators of fire severity in Andisols of Araucaria- Nothofagus forest in southern Chile.  
**Indexación :** ISI  
**ISSN :** 0038-0717  
**Año :**  
**Vol. :**  
**N° :**  
**Páginas :**  
**Estado de la publicación a la fecha :** Enviada  
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**Envía documento en papel :** no  
**Archivo(s) Asociado(s) al artículo :**  
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[https://servicios.conicyt.cl/sial/index.php/investigador/f4\\_articulos/descarga/13210102/3140161/2016/100194/1/](https://servicios.conicyt.cl/sial/index.php/investigador/f4_articulos/descarga/13210102/3140161/2016/100194/1/)



**Nº :** 3  
**Autor (a)(es/as) :** Rivera, D.; Godoy, A.; Rivas Y.  
**Nombre Completo de la Revista :** Journal of Earth System Science  
**Título (Idioma original) :** Uncertainty in a monthly water balance model using the generalized likelihood uncertainty estimation methodology  
**Indexación :** ISI  
**ISSN :** doi:10.1007/s12040-0  
**Año :** 2015  
**Vol. :** 49  
**Nº :** 124  
**Páginas :** 49-59  
**Estado de la publicación a la fecha :** Aceptada  
**Otras Fuentes de financiamiento, si las hay :**

**Envía documento en papel :** no

**Archivo(s) Asociado(s) al artículo :**

Uncertainty\_in\_a\_monthly\_water\_balance\_model.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f4\\_articulos/descarga/13210102/3140161/2016/100195/1/](https://servicios.conicyt.cl/sial/index.php/investigador/f4_articulos/descarga/13210102/3140161/2016/100195/1/)

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## OTRAS PUBLICACIONES / PRODUCTOS

*Sin información ingresada.*

## CONGRESOS

**Nº :** 1  
**Autor (a)(es/as) :** Rivas, Y.; Martínez O.; Rivera, D.; Encina, C.; Werner, E.  
**Título (Idioma original) :** Soil enzymatic activities and microbial community composition in adjacent native and plantation forest of central South of Chile  
**Nombre del Congreso :** Tercer Taller Latinoamericano de Bacterias Promotoras del Crecimiento PGPR  
**País :** CHILE  
**Ciudad :** Pucón  
**Fecha Inicio :** 28/11/2016  
**Fecha Término :** 02/12/2016  
**Nombre Publicación :**  
**Año :**  
**Vol. :**  
**Nº :**

**Páginas :**

**Envía documento en papel :** no

**Archivo Asociado :**

congreso\_Pucon\_20161.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f4\\_congresos/descarga/13210102/3140161/2016/159166/1/](https://servicios.conicyt.cl/sial/index.php/investigador/f4_congresos/descarga/13210102/3140161/2016/159166/1/)

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**Nº :** 2

**Autor (a)(es/as) :** Rivas, Y.; Etcheverría, P.; Paulino, L.; Godoy, R.; Matus, F.; Valenzuela, E.

**Título (Idioma original) :** Change in total glomalin content related to soil proteins after a wildfire in an Andisol of Araucaria araucana forests of south-central Chile.

**Nombre del Congreso :** International Workshop, Micorrhizal Symbiosis America.

**País :** CHILE

**Ciudad :** Valdivia

**Fecha Inicio :** 06/03/2017

**Fecha Término :** 09/03/2017

**Nombre Publicación :**

**Año :**

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**Páginas :**

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**Archivo Asociado :**

Congreso\_International\_Mycorrhizal\_symbiosis\_in\_the\_southern\_cone\_of\_south\_America\_\_rivas\_\_paulino\_.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f4\\_congresos/descarga/13210102/3140161/2016/159172/1/](https://servicios.conicyt.cl/sial/index.php/investigador/f4_congresos/descarga/13210102/3140161/2016/159172/1/)

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**Nº :** 3

**Autor (a)(es/as) :** Paulino, L.; Rivas, Y.; Godoy, R.

**Título (Idioma original) :** Arbuscular mycorrhizal fungi in fire-altered Araucaria araucana forests and their relationship with biogeochemical patterns.

**Nombre del Congreso :** International Workshop, Micorrhizal Symbiosis America.

**País :** CHILE

**Ciudad :** Valdivia

**Fecha Inicio :** 06/03/2017

**Fecha Término :** 09/03/2017

**Nombre Publicación :**

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**Vol. :**

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**Páginas :**

**Envía documento en papel :** no

**Archivo Asociado :**

Mycorrhizal\_symbiosis\_in\_the\_southern\_cone\_of\_south\_America\_\_Paulino\_\_Rivas\_.pdf

## ANEXOS

**N° :** 1

**Archivo Asociado :** Informe\_Seguimiento\_Etico\_Bioetico\_N\_\_3140161.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f5\\_anexos/descarga/13210102/3140161/2016/76219/](https://servicios.conicyt.cl/sial/index.php/investigador/f5_anexos/descarga/13210102/3140161/2016/76219/)

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**N° :** 2

**Archivo Asociado :** Docencia.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f5\\_anexos/descarga/13210102/3140161/2016/76691/](https://servicios.conicyt.cl/sial/index.php/investigador/f5_anexos/descarga/13210102/3140161/2016/76691/)

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**N° :** 3

**Archivo Asociado :** FORMULARIOpostulacion\_explora.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f5\\_anexos/descarga/13210102/3140161/2016/76692/](https://servicios.conicyt.cl/sial/index.php/investigador/f5_anexos/descarga/13210102/3140161/2016/76692/)

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**N° :** 4

**Archivo Asociado :** Manuscrito1\_Biologico.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f5\\_anexos/descarga/13210102/3140161/2016/76710/](https://servicios.conicyt.cl/sial/index.php/investigador/f5_anexos/descarga/13210102/3140161/2016/76710/)

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**N° :** 5

**Archivo Asociado :** Citizen\_Science\_approach\_in\_rural\_communities\_primera\_correccion\_mayo\_2017\_\_\_Fondecyt\_.pdf

[https://servicios.conicyt.cl/sial/index.php/investigador/f5\\_anexos/descarga/13210102/3140161/2016/76711/](https://servicios.conicyt.cl/sial/index.php/investigador/f5_anexos/descarga/13210102/3140161/2016/76711/)

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A continuación se detallan los anexos físicos/papel que no se incluyen en el informe en formato PDF.

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