Comisión Nacional de Investigación Científica y Tecnológica – CONICYT

FONDAP CENTERS OF RESEARCH PROGRAM

ANNUAL PROGRESS REPORT

Guidelines:

The report should be written following the format specified hereafter. Both a printed (report and excel spreadsheets) and an electronic version must be sent to the following address:

PROGRAMA CENTROS DE EXCELENCIA FONDAP
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Comisión Nacional de Investigación Científica y Tecnológica – CONICYT

I. PRESENTATION

PERIOD REPORTED: 1st Year ☐ 2nd Year ■ 3rd Year ☐ 4th Year ☐ 5th Year ☐

PERIOD COVERED: From: January 22/2014 To: January 19/2015

NAME OF THE CENTER		CODE
		15 11 00 09
DIRECTOR OF THE CENTER Laura Gallardo Klenner	E-MAIL laura@dgf.uchile.cl lgallard@u.uchile.cl	SIGNATURE Laura Gallardo K. Directora (CR)2
DEPUTY DIRECTOR René Garreaud Salazar	E-MAIL rgarreau@dgf.uchile.cl	SIGNATURE
SPONSORING INSTITUTION Universidad de Chile		
ASSOCIATED INSTITUTION(S) (if applicable) Universidad de Concepción Universidad Austral de Chile		
CENTER WEBSITE ADDRESS http://www.cr2.cl/		

Date: January/20/2015

Research Lines

º	Research Line	Objective	Principal Researcher	Associated Researcher(s)
	Biogeochemistry (BGC)	✓ Estimate emissions of climatically active tracers (CATs) ✓ Identify and quantify novel biogeochemical processes mediating CATs cycling in surface waters ✓ Characterize the regional interactions between urban areas and adjacent ecosystems	Laura Farías	(*Marcela Cornejo*) Beatriz Diez* Ricardo De Pol Roberto Rondanelli
	Climate Dynamics (CD)	✓ Analyze interdecadal climate variability in Chile ✓ Diagnose of contemporaneous climate trends ✓ Project hydrological response to climate change	René Garreaud	Duncan Christie Paulo Herrera* Patricio Moreno
	Human Dimensions (HD)	✓ Identify ways to build resilience for climate change ✓ Diagnose the institutional framework ✓ Perform economic evaluation of climate change in Chile ✓ Define adaptation measures ✓ Contribute to the strengthening of institutional capacities	Pilar Moraga	Paulina Aldunce Laura Nahuelhual (*Ana Lya Uriarte*)
	Ecosystem Services (ECO)	✓ Design optimal landscape arrays for the combined production of goods and services ✓ Define time frames, rates, and costs of the recovery of water provision as an ES from ecological restoration ✓ Assess reduced precipitation predicted by climate models for Central and Southern Chile on water provision as an ES from watersheds	Antonio Lara	Susana Gómez Mauro González Carlos Jara*
	Modeling and Observing Systems (MOS)	✓ Implement and develop modeling and observation platforms to assess climate change and variability and to define probable scenarios ✓ Establish a test-bed, and transference of Climate Services ✓ Develop integrated observing systems	Laura Gallardo	Melitta Fiebig* Axel Osses Maisa Rojas (*Gary Shaffer*)

NB. In parenthesis and italics: people who have resigned. The asterisk (*) indicated researchers who have become adjoint (other) researchers.

II. EXECUTIVE SUMMARY

Provide a brief overview of the vision, goals, plans and performance of the Center. Report on the progress made towards reaching the original goals of the Center and provide an overview of the most significant accomplishments during the reported period. Please indicate the research highlights. Describe any significant changes from the original proposal. (**Maximum length: 2 pages**).

The Center for Climate and Resilience Research (CR)2 aims at:

- Deepening our understanding of the climate system, processes, and impacts throughout Chile, in a holistic manner that confronts the complexities of socio-ecological systems
- Strengthening the emerging community of natural and social scientists in Earth System Science in Chile
- In collaboration with stakeholders, contributing to the definition of climate change adaptation and mitigation measures building societal resilience

A large fraction of our efforts during the first year of execution were devoted towards the installation of the center, while keeping the momentum of our researchers in terms of scientific output, capacity building and outreach. During the second year, the challenge has been to move towards interdisciplinary research by addressing a common question. Following our national and international panels' advice, we decided to sequentially approach the overarching themes already defined in our proposal, i.e., scarcity and variability of water resources, growing urbanization, and rapid land use changes. This implies focusing a significant part of our activities towards a common research question. Of course, this does not exclude pursuing other research questions but it emphasizes, over a period of ca. 18 months, a given integrating question leading to improved understanding, and also to impact on public policy. The question selected in early 2014 refers to the causes and consequences of the drought experienced during the last few years along Chile, which we called "mega drought". In addition to counting with direct observations of this phenomenon, it serves as an analogue of the probable future climate of Central and Southern Chile where the majority of the population lives. This question encompasses the theme of scarcity and variability of water resources and it has been coordinated by Dr. Garreaud. A work plan addressing various research questions was defined involving the participation of all groups in Concepción, Valdivia and Santiago (See Section IV, 1, B).

Significant advances have been shown regarding the understanding of climate variability at various time scales and its consequences. Also, substantial progress has been done with respect to the characterization of sinks and sources of greenhouse gases in the coastal ocean. An assessment of buffer effects of streamside native forests on water provision in watersheds dominated by exotic industrial forest plantations has been produced. Also, climate sensitivities of native forest have been identified, and of species in dry lands. Furthermore, landscape restoration post fire has been studied. A mapping approach to assess intangible cultural ecosystem services was developed, and it has been adapted to address the mega drought. The use of landscape ecology tools in the framework of ecosystem services has been reviewed. Climatologies of various atmospheric variables have been published. The theoretical approach for resilience has been further consolidated, and anthropologic and sociologic perspectives have been integrated(Urquiza, 2014; Urquiza and Cadenas, 2015). Legal frameworks for climate change have also been addressed. The scientific productivity so far is largely based

upon the outputs and leadership of well-established scientists in core research lines. However, we expect that the cross-cutting issues being developed will pave the way for increased productivity of emerging areas and individuals, and start reflecting interdisciplinary efforts. This expectation is supported by manuscripts in review and in preparation, as well as new ancillary projects recently obtained by these researchers. Also, the acquisition and installation of new instruments (wind profiler, wet deposition sampler, ocean buoy), and the establishment of data bases and computing facilities will certainly facilitate our research and that of the community. Moreover, we expect to enhance the productivity around themes and questions posed within the framework of our center. All in all, during 2014, CR2 has continued its progress having produced more than 30 peer-reviewed articles, many of them in high impact journals, 7 book chapters, in addition to over 100 presentations in conferences and symposia in Chile and abroad.

In addition to the research initiated this year with respect to the mega drought phenomenon, substantial progress has been achieved in terms of the study of short-lived climate pollutants regarding sources of aerosols and gases leading to radiative forcing and impacts over the Andean cryosphere. These advances refer to modeling and observational tools, as well as the framing of the problem both scientifically and in terms of its impact in policy making. Moreover, several concurrent projects have been granted to our researchers including 5 FONDECYT, 1 FONDEQUIP, 5 post-doctoral fellowships, adding significant resources (roughly a half million dollars) to the Center's activities. We also successfully proposed Dr. Guy Brasseur, member of our international panel for the Abate Molina prize. His presence during 4 months in 2015 will enhance the development of climate services.

During the second half of the year, we carried a thorough evaluation of individual and group performances regarding scientific productivity, formation of advanced human resources, team work, and outreach, resulting in changes in roles and dedications of associate researchers, allowing the reallocation of financial resources and increasing the number of adjoint and post-doctoral researchers during 2015. All in all, the conclusion is that we owe to enhance the support of younger and mid-career scientists, and to improve the collaboration between researchers in natural and social sciences.

Regarding capacity building and formation of advanced human resources, we have engaged 3 new post-doctoral fellows, and several adjoint researchers bringing new perspectives and expertise. Also, two PhD students, 7 MSc students, and 11 professionals have completed their degrees in 2014. Moreover, several students and young professionals have supported our research in various capacities, including short-term professional practices.

National and international collaboration networks have resulted in concrete products such as publications, co-guided theses, and in an increased recognition of the center. This is also reflected in media appearances, and the attraction of participants in our symposia and outreach activities. Our relation with stakeholders has been strengthen leading to agreements, and the participation in official delegations (e.g., Conference of the Parties for the Climate Convention), and the provision of opinion and expert advice (e.g., energy agenda, water management and legislation).

After two years, CR2 keeps progressing towards the establishment of a productive, well recognized center of excellence addressing the key and complex issues of climate variability and change, and societal resilience. Nevertheless, important challenges and new endeavors remain ahead regarding the growth in number and quality of our scientific results, the

development of climate services, and the consolidation of our exchange and collaboration with stakeholders to contribute to building societal resilience in a changing climate.

III. ADMINISTRATIVE ASPECTS

1. Budget execution

Describe and justify any budgetary modifications (itemized) of the original proposal.

Year 2	Income			Expenses			
Item	**CONICYT in MCLP**	**Universities in MCLP**	**Total in MCLP**	**CONICYT in MCLP**	**Universities in MCLP**	**Total in MCLP**	**Comments**
Personnel	$ 191.504		191.504	$178.884		$178.884	The difference arises from the resignation of two associated researches (Marcela Cornejo and Ana Lya Uriarte), This difference was reoriented to support travel expenses for the Conference of the Parties of the United Nations Climate Convention (COP) Lima
New Hires		$27.825	$27.825		$25.000	$25.000	The new associated researcher Nicolás Huneeus started in March not in January 2014. The difference from his salary was used to provide him a personal computer and peripherics reported under Capital Goods.
Post-doctoral fellows	$75.500		$75.500	$55.719		$55.719	Two of the postdoctoral fellows, D. Bozkurt (MOS) and M. Yévenes (BGC) were granted fellowships from FONDECYT starting in November 2014. Additionally C. Little (ECO), who was in the last year of the center postdoctoral fellowship got a permanent position in the public sector. The difference was re-assigned to research assistants. Additionally, the first 3 months of D. Bozkurt and F. Albrecht were paid under internationalization, since the contract with University of Chile was delayed.
Support Staff	$140.473	$8.500	$148.973	$155.260	$8.500	$163.760	This item considers student, technicians and other research assistants, as well as our computing and data base manager. The additional budget corresponds to the difference derived from post-doctoral fellows.
Traveling	$28.350		$28.350	$39.004		$39.004	International traveling exceeded the estimated budget. In particular, we had to cover our participation in the Chilean delegation before the IPCC in Copenhagen and in the COP Lima
Per-diem *Domestic* *International*	$ 12.000 $4.500 $7.500		$ 12.000 $4.500 $7.500	$15.583 $3.725 $11.858		$15.583 $ 3.725 $11.858	
Tickets *Domestic* *International*	$16.350 $ 4.350 $12.000		$16.350 $4.350 $12.000	$23.421 $3.478 $19.943		$23.421 $3.478 $19.943	
Internationalization	$20.000		$ 20.000	$22.778		$22.778	
Operational costs	$73.000		$73.000	$84.475		$84.475	New equipment purchased during the first and the second year's budget was declared as operational expenses, leading to an increase in the dedicated budget.

Capital goods	$ 150.000		$ 150.000	$ 165.852	$40.113	$205.965	Office space was optimized instead of building new spaces, producing a surplus in the infrastructure item. Such funds were relocated in Capital Goods. Also, computers for students and post docs were purchased. Weather stations for enhanced monitoring and further scientific equipment for a better operation of the wet deposition sampler were acquired.
Infrastructure	$5.000	$45.788	$50.788	$6.532	$8.500	$15.032	University contributions were reassigned to weather stations, and office and lab spaces were optimized.
General expenses	$25.000		$ 25.000	$13.436		$13.436	A 40% of the original budget in General expenses was moved to acquire personal workstation for the postdoctoral and students at the center
Administrative staff	$45.350		$45.350	$45.648		$45.648	
Publication and subscriptions	$1.000		$ 1.000	$2.475		$ 2.475	
Bank bonds	$ 1.000		$ 1.000	$1.310		$1.310	
Consulting services	$3.500		$3.500	$ 901		$901	
Adminitrative expenses (overhead)	$40.500		$40.500	$40.500		$40.500	
Unforeseen expenses	$12.597		$ 12.597			$	See notes above.
Total M$	**$ 812.774**	**$82.113**	**$ 894.887**	**$812.774**	**$82.113**	**$ 894.887**	

Overall, the budget was fully executed except for 55.417 M CLP, which will be expended at the latest by April 2015 in meteorological and oceanographic sensors for the buoy that is being acquired under the FONDEQUIP project granted in late 2014. The purchase of this equipment is already ongoing. There are 63.498 MCLP which were not formally declared, according to University of Chile rules and procedures in 2014 due to various administrative delayed (travels in late 2014, purchases of equipment, contracts of research assistants, etc.).

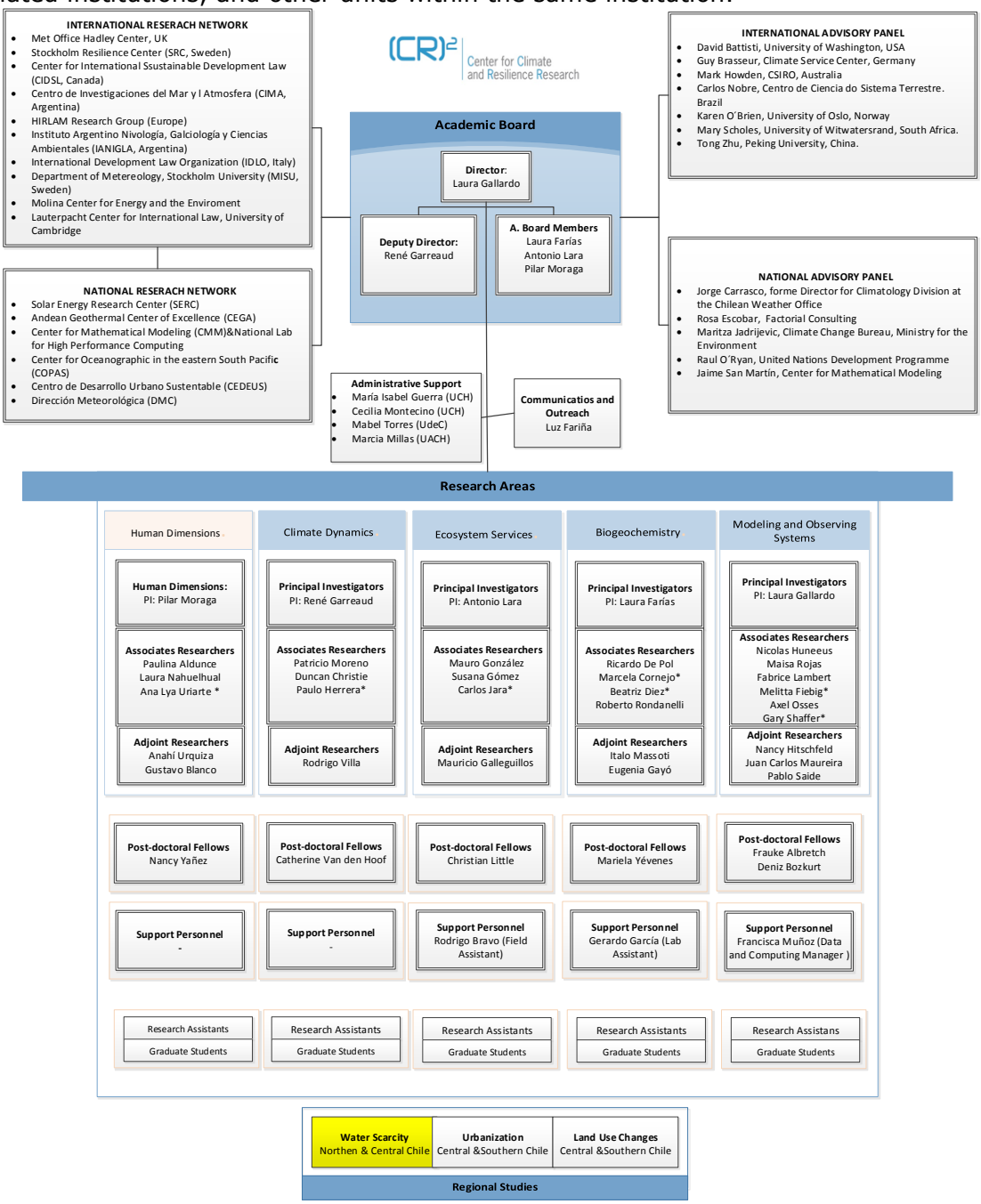
2. Accomplishment of institutional commitments

Describe any difficulty(ies) encountered regarding this aspect.

All institutions made their financial contributions on time. However, we experienced some delay in the report of expenses by Universidad de Concepción. Officially, we got their financial report only on Friday January 16th. We will be holding a meeting with the Research Director, Dr. Bernabé Rivas to sort out these difficulties.

3. Organizational Chart

Present an organizational chart of the Center depicting its main links to companies, associated institutions, and other units within the same institution.



4. Personnel

Provide a table indicating all personnel involved in the operation of the Center during the reported period, including names, position within the center (e.g. associate researcher, post doc, student, technician, etc.) and the number of hours committed to the Center. In addition, in no more than one page, provide a brief academic biography for each new researcher recruited by the Center.

A. Principal, associate, and adjoint researchers

Table III-1. Principal and associate researchers, indicating weekly dedication (hours per week), research area and institutional affiliation.

Name	Last Name	Category	Dedication	Research Area	Affiliation
Laura	Farías	Principal Researcher	26	BGC	UDEC
Laura	Gallardo	Principal Researcher	44	MOS	UCH
René	Garreaud	Principal Researcher	26	CD	UCH
Antonio	Lara	Principal Researcher	26	ECO	UACH
Pilar	Moraga	Principal Researcher	26	HD	UCH
Paulina	Aldunce	Associate Researcher	7	HD	UCH
Duncan	Christie	Associate Researcher	7	CD	UCH
Marcela	*Cornejo*	*Associate Researcher*	*7*	*BGC*	*UDEC*
Ricardo	De Pol	Associate Researcher	14	BGC	UDEC
Beatriz	Diez	Associate Researcher	7	BGC	PUC
Melitta	Fiebig	Associate Researcher	7	MOS	ULS
Susana	Gómez	Associate Researcher	7	ECO	UBB
Mauro	González	Associate Researcher	14	ECO	UACH
Paulo	Herrera	Associate Researcher	7	CD	UCH
Nicolás	Huneeus	Associate Researcher	10	MOS	UCH
Carlos	Jara	Associate Researcher	7	ECO	UACH
Fabrice	Lambert	Associate Researcher	44	MOS	UCH
Patricio	Moreno	Associate Researcher	14	CD	UCH
Laura	Nahuelhual	Associate Researcher	7	HD	UACH
Axel	Osses	Associate Researcher	7	MOS	UCH
Maisa	Rojas	Associate Researcher	9	MOS	UCH
Roberto	Rondanelli	Associate Researcher	7	BGC	UCH
Gary	*Shaffer**	*Associate Researcher*	*7*	*MOS*	*UDEC*
Ana Lya	*Uriarte*	*Associate Researcher*	*7*	*HD*	*UCH*

*Dr. Cornejo, Dr. Shaffer and Dr (C) Uriarte resigned from the center in March, December and July respectively. See Section III 5.

Table III-2. Adjoint researchers, i.e., researchers that supported specific research activities or guided theses in collaboration with CR2 associate researchers. In general, they receive monetary incentives.

Name	Last Name	Research Area	Affiliation	Activity
Gustavo	Blanco	HD	UACH	Resilience conceptualization, guiding of theses
Mauricio	Galleguillos	ECO	UCH	Changes in vegetation and evapotranspiration
Eugenia	Gayó	BGQ	UDEC	Analysis of water isotopes
Nancy	Hitschfeld*	MOS	UCH	Methods for characterizing urban canopy, guiding of thesis
Italo	Massoti	BGQ	UV	Ocean primary productivity and dimethyl sulfide fluxes
Juan Carlos	Maureira*	MOS	UCH	Assistance regarding installation of computing and data base system
Pablo	Saide	MOS	U. Iowa	Simulations of pyro aerosols in Central Chile
Anahí	Urquiza	HD	UCH	Vulnerability and water resources and markets
Rodrigo	Villa	CD	UMAG	Paleo environmental records of climate variability in Southern Patagonia

*Did not receive monetary incentives

Table III-3. Post-doctoral fellows, indicating weekly dedication **(hours per week)**, research area and institutional affiliation. When funded by CR2, all contracts are signed under Universidad de Chile.

Name	Last Name	Dedication	Research Area	Affiliation	Incorporation Date	Status	Sponsoring Researcher	Funding	Theme of research
Frauke	Albrecht	22	MOS	UDEC	September 2013	Active	G. Shaffer/ N. Huneeus	CR2	Downscaling and application of global mean sea-level rise to the coast of Chile using spatially-resolved models of ocean circulation and warming, (land ice) self-gravitation and isostactic adjustment, until December 2014. Thereafter she works on the analysis of decadal projections.
Paola	Arias	44	MOS	UCH	October 2014	Active	M. Rojas	FONDECYT	Variability of the South American monsoon circulation
Deniz	Bozkurt	44	MOS	UCH	November 2013	Active	M. Rojas/R. Garreaud	CR2	Dynamical downscaling of reanalyses and projections of stream flows for various climate scenarios Chile
Christian	Little	44	ECO	UACH	March 2013	Inactive	A. Lara	CR2	Multi-scale relationships for quality and quantity of water services in forest watersheds
Kristina	Pistone	44	MOS	UCH	March 2014	Inactive	L. Gallardo	Fulbright	Aerosol climatology for Santiago

Catherine	Van den Hoof*	44	CD	UCH	March 2013	Active	R. Garreaud	FONDECYT	Assessing the influence of precipitation on surface air temperature variability in South America and implications for climate change projection
Nancy	Yáñez	44	HD	UCH	July 2014	Active		CR2	Dogmatic analysis of water legislation in the framework of human rights
Mariela	Yévenes	44	BGC	UDEC	April 2013	Active	L. Farías	CR2	Integrating remote sensing and chemical appraisal to assess modern and historical thermal patterns, and reactive nitrogen dynamics in Southern Chilean rivers.

*Dr. Yévenes and Dr. Bozkurt got post-doctoral fellowships from CONICYT/FONDECYT starting in November 2014

B. Students

Table III-4. Current doctoral fellows (14), indicating thesis title, weekly dedication (in hours per week), research area and institutional affiliation.

Name	Last Name	Tutor(s)	Affiliation	Research Area	Dedication	Thesis Title/Subject
María Estrella	Alcamán	Beatriz Diez	PUC	BGQ	44	Effects of temperature on nitrogen metabolism in thermophilic cyanobacteria
Pilar	Aparicio	Italo Massoti	UV	BGQ	44	Impacts of the variability in phytoplankton functional groups in upwelling systems
Marco Aurelio	Cortés	Antonio Lara	UACH	ECO	44	Restauration ecology of Araucaria araucana relicts in the coastal Cordillera of Chile
Melisa	Díaz	Laura Dawidowski, Laura Gallardo	UBA	MOS	44	Aerosol dynamics in Buenos Aires
Ignacio	Díaz	Laura Nahuelhual	UACH	HD	44	Analysis and design of landscapes for ecosystem services provision: towards sustainable socio-ecosystems
Ignacio	Díaz Galvez	Laura Nahuelhual	UACH	HD	44	Analysis and design of landscapes for ecosystem services provision: towards sustainable socio-ecosystems
Sergio	Guajardo	Beatriz Diez	PUC	BGQ	44	Comunidades virales asociadas a cianobacterias termófilas en el sistema hidrotermal Porcelana
Carolina	Jara*	Carlos Jara	UACH	ECO	44	Effects of Eucaliptus globulus plantations on the dynamics of organic matter community structure of macrozoobenthos in fluvial ecosystems of en coastal Cordillera of Chile
Noémie	Kugler	Pilar Moraga	UCH/UA Marseille	HD	44	Climate damage legislation
Roy	Mackenzie*	Beatriz Diez	UAB	BGQ	44	Microbial diversity in extreme environments
Priscilla	Nowajewski	Maisa Rojas	UCH	MOS	44	Climate dynamics by obliquity forcing in planetary atmospheres
Oscar	Pesce	Patricio Moreno	UCH	CD	44	Westerly wind patterns between 40 and 52 S since the last glacial termination
Mario	Romero	Mauro González/Antonio Lara	UACH	ECO	44	Recovery of evergreen forest under different anthropic disturbances in the coastal Cordillera in Southern Chile
Gastón	Sotes	Susana Gómez	UDEC	ECO	44	Evaluando en la planta invasora Centaurea melitensis el efecto de los tricomas glandulares sobre la eficiencia en el uso de recursos, la competencia y la interferencia

*Their theses were defended in 2014.

Table III-5. Master fellows, indicating thesis title, weekly dedication, research area and institutional affiliation.

Name	Last Name	Tutor(s)	Research Area	Affiliation	Dedication	Thesis Title/Subject
Carlos	Ardissoni	Paulo Herrera	CD	UCH	44	Estudio de la interacción entre agua superficial y subterránea en la cuenca del río San José
Claudio	Bravo*	Maisa Rojas	MOS	UCH	44	Condiciones Climaticas y neoglaciación durante el holoceno medio en latitudes medias del hemisferio sur
Matías	Bravo	Nancy Hitschfeld/Laura Gallardo	MOS	UCH	44	Sistema de obtención de dosel urbano para simulaciones atmosféricas de alta resolución
Néstor	Burgos*	Laura Nahuelhual	HD	UACH	44	Mapeo de la vulnerabilidad socioecológica de servicios ecosistémicos. el caso de la madera de bosques nativos en la comuna de Ancud en la isla de Chiloé, sur de Chile
Cristina	Carrasco*	Laura Farías	BGQ	UDEC	44	El rol del Agua Intermedia Antártica (AAIW) en la distribución de gases (O2, N2O y CO2) en el Pacífico Sur Oriental y su influencia en la ventilación de la zona de mínima de oxígeno".
Susana	Correa*	Pilar Moraga	HD	UCH	44	Intellectual property rights and international technology transfer as a measure to address climate change
Cynthia	Escares	Laura Farías	BGQ	UDEC	44	Origen del óxido nitroso (N2O) en cultivos monoclonales de microalgas marinas: un estudio con picoeucariontes fotosintéticos".
Pilar	Fierro*	Mauro Gonzalez	ECO	UACH	44	Diversidad de insectos en bosques de Nothofagus afectados por la caída de ceniza volcánica de la erupción del Cordón Caulle en el Parque Nacional Puyehue
Richard	Fitzek*	Antonio Lara	ECO	UACH	44	Restauración Ecológica de Bosque Siempreverde Templado Andino, de Bosques de Fitzroya cupressoides y Pilgerodendron uviferum en Huinay, Región de los Lagos, Chile.
Mindy	Fuentes	Pilar Moraga	HD	UCH	44	Incorporación de la vulnerabilidad al cambio climático a la planificación territorial del borde costero
María	Gálvez	Laura Farías	BGQ	UDEC	44	Enzymatic adjustments of the TCA metabolism of heterotrophic bacteria in response to natural iron fertilization in the Southern Ocean (KEOPS2)
Sergio	González	René Garreaud	CD	UCH	44	Patrón de temperatura en la cordillera de Nahuelbuta
María	González	Laura Farías	BGQ	UDEC	44	Fijación de nitrógeno molecular en zonas HNLC y de surgencia costera: casos de estudio en Océano Austral y Pacifico Sur Oriental
Lucía	Gonzalorena	Patricio Moreno	CD	UCH	44	Historia postglacial de la vegetación de Lago Tarumán, en la zona centro-occidental de Isla Grande de Chiloé: inferencias paleoambientales a partir de un registro palinológico de alta resolución
Julio	Hasbún*	Paulina Aldunce/Roxana Borquez	HD	UCH	44	Análisis de discurso de medios de comunicación digitales en chile respecto del cambio climático y la resiliencia: propuesta para el diseño de política pública
William	Henríquez*	Patricio Moreno	CD	UCH	44	Variaciones de la vegetación y clima en Patagonia norte y centro desde la última terminación glacial
Adolfo	Henríquez*	Laura Gallardo/Axel Osses	MOS	UCH	44	Apoyo al desarrollo e implementación de un método variacional para optimizar redes de observación atmosférica
Katy	Indvik*	Paulina Aldunce/Roxana Borquez	HD	UCH	44	Una revisión sistemática de la conceptualización de la resiliencia en su aplicación al contexto del cambio climático
Amerinda	Jaramillo*	Laura Nahuelhual	ECO-HD	UACH	44	Modelling the ecosystem service of water supply and flow regulation under different land use scenarios

Dana	Jiménez	Laura Nahuelhual	HD	UACH	44	Evaluación de la distribución del agua en cuencas de la comuna de Río Bueno (región de Los Ríos) a través del concepto de huella hídrica
Ricardo	Konrad*	Beatriz Diez	BGQ	UCH	44	Caracterización de microorganismos reductores de sulfato y oxidantes de azufre y tiosulfato en tapetes microbianos de sistemas hidrotermales de Chile (X Región de Los Lagos)
Víctor	Merino Campos	Ricardo de Pol	BGQ	UDEC	44	Agua Profunda del Pacífico mediante el análisis de isótopos estables
Mauricio	Montiel*	Mauro Gonzalez	ECO	UACH	44	Efecto de disturbios catastróficos sobre el establecimiento y crecimiento radial de Nothofagus pumilio, Parque Nacional Puyehue
Carolina	Morano	Rodrigo Villa /Patricio Moreno	CD	UMAG	44	Desarrollo de registros paleoecologicos de alta resolución temporal durante los últimos 3000 años en Patagonia Sur
Cristián	Muñoz*	René Garreaud	CD	UCH	44	Precipitación Orografica en Chile Central
Pilar	Muñoz*	Anahí Urquiza	HD	UCH	44	Comunicación de la amenaza ambiental en la web 2.0: Observando las comunicaciones en twitter y facebook vinculadas a la protesta. El caso No Alto Maipo.
Romina	Novoa*	Mauro Gonzalez	ECO	UACH	44	Efecto de la caída de ceniza en bosques de Nothofagus pumilio, post erupción del Cordón Caulle
Andrea	Orfanoz	Laura Gallardo	MOS	UCH	44	Penachos Volcanicos y su evolución
Cristián	Parra	Carlos Jara	ECO	UACH	44	Respuesta de la comunidad bentonica a la dinamica del caudal en dos sistemas loticos sometidos a diferente uso de suelo, en la Reserva Costera Valdiviana, Chaihuin, Chile
Cristián	Pino	Paulo Herrera	CD	UCH	44	Aplicación del modelo HydroGeosphere en la cuenca del río San José, XV región de Arica y Parinacota, Chile
Fabián	Pinto*	Beatriz Diez	BGQ	UCH	44	Cianofagos del sistema hidrotermal Porcelana (X Región de los Lagos, Chile): diversidad, abundancia y asociación con la cianobacteria termófila CHP1 (Stigonematales)
Hugo	Pizana	Anahí Urquiza	HD	UCH	44	Transformaciones socioterritoriales en el espacio rural. Análisis desde una observación sistémica en el marco del Proyecto Ciudades Rurales Sustentables implementado en Chiapas, México
Pamela	Pizarro	Roberto Rondanelli	BGQ	UCH	44	Frecuencia de neblina y nubosidad baja en el valle central de Chile"
Alejandro	Rangel	Laura Farías	BGQ	UDEC	44	Respuestas del fitoplancton a la acidificación de los océanos y sus efectos sobre el reciclaje de gases de efecto invernadero: Un enfoque basado en experimentos de mesocosmos
Dharma	Reyes-Macaya	Ricardo de Pol	BGQ	UDEC	44	Geometría de masas de agua frente al margen continental chileno durante el pleistoceno tardío"
Joaquín	Rivera*	Laura Nahuelhual	HD-CD	UACH	44	Efectos de la variabilidad climática en la productividad de cereales y factores que han influido en la vulnerabilidad a eventos climáticos extremos: análisis regional en Chile para el período 1980 - 2012
Sandra	Sanhueza*	Laura Farías	BGQ	UDEC	44	Fijación biológica de N2 y N2O en los giros subtropicales del Pacífico Norte y Sur (35°N-30°S) así como en tres modelos biológicos para investigar su respuesta ante variaciones de sustrato".
Cynthia	Sanhueza	Beatriz Diez	BGQ	UCH	44	Composición de la comunidad bacteriana marina en sistemas polares
Rodrigo	Santander*	Laura Nahuelhual	HD-CD	UACH	44	Exposición a eventos climáticos y políticas públicas: un análisis espacial en la región de Los Ríos
Enzo	Simi	Patricio Moreno	CD	UCH	44	Vegetación, clima y paleofuegos en la región de Aysén desde la Última Terminación Glacial
Patricio	Velásquez	Laura Gallardo/Roberto Rondanelli	MOS	UCH	22	Ozone climatology from Cerro Tololo

Josefa	Verdugo	Laura Farias	BGQ	UDEC	44	Contenido e intercambio de gases de efecto invernadero en aguas del Bahía Chile, Antártica; el caso del CH4 y N2O y de los procesos biogeoquímicos que los consumen"
Javiera	Videla*	Patricio Moreno	CD	UCH	44	Cambios en la vegetación y clima a escalas multimilenial, milenial y centenal en la Región de Los Lagos chilena (41ºS), desde el Último Máximo Glacial hasta la actualidad.

*Their theses were defended in 2014.

Table III-6. Undergraduates who got their exams in 2015, indicating thesis title, weekly dedication, research area and institutional affiliation.

Name	Last Name	Tutor(s)	Research Area	Affiliation	Dedication	Thesis Title/Subject
Aníbal	Acevedo	Pilar Moraga	HD	UCH	44	"Marco institucional para la gestión integrada de cuencas hidrográficas
Yalia, Danilia Constanza	Aguad, Cáceres	Susana Gomez	ECO	UBB	44	Variabilidad inter- e intra-poblacional de los rasgos de las semillas de Helenium aromaticum (Hook.) H.L. Bailey (Asteraceae)
Gabriel	Araya	Pilar Moraga	HD	UCH	44	Análisis de la equidad en la Convención Marco de las Naciones Unidas sobre el Cambio Climático: Perspectivas para el futuro
Camila	Barrientos	Susana Gomez	ECO	UBB	44	¿Son las semillas de especies con fruto carnoso resistentes a la temperatura?
Valentina	Besoain Menares	Laura Farías	BGQ	PUCV	44	Variabilidad estacional e interanual de los hotspot de N2O en una zona de surgencia sobre la plataforma continental de Chile central (~36°)
Ignacio	Díaz Hormazabal	Mauro Gonzalez	ECO	UACH	44	Análisis espacio-temporal de incendios en la región del Maule
Victor	Elgueta	Mauro Gonzalez	ECO	UACH	44	Composición, estructura y dinámica de un bosque Roble-Raulí-Coigüe del Predio "El Retiro" Ciudad de Angol, Región de la Araucanía
Sebastian	Espinoza	Beatriz Diez	BGQ	PUC	44	Microdiversidad y caracterización de cianobacterias diazotróficas del grupo V aisladas del sistema hidrotermal de Porcelana
Patricia	González	Anahí Urquiza	HD	UCH	44	Minería del oro y agua segura en territorios fronterizos, etnobiodiversos y de alta vulnerabilidad geopolítica. Dinámicas socio institucionales de la implementación de agua segura en la zona norte de la Provincia de Esmeraldas, Ecuador.
Victor	Merino*	Ricardo de Pol	BGQ	UDEC	44	Agua Profunda del Pacífico mediante el análisis de isótopos estables

Pilar	Muñoz	Anahí Urquiza	HD	UCH	44	Comunicación de la amenaza ambiental en la web 2.0: Observando las comunicaciones en twitter y facebook vinculadas a la protesta. El caso No Alto Maipo.
Andres	Palma	Antonio Lara	ECO	UACH	44	Cambios en la Estructura del bosque adulto de Araucaria araucana y Nothofagus pumilio en la Reserva Privada Nasampulli, en la región de La Araucanía de Chile.
Daniela	Rodriguez Berger	Christian Little	ECO	UACH	44	Análisis de la oferta y demanda del servicio ecosistémico provisión de agua en la cuenca de Purapel en Nirivilo, centro-sur de Chile.
Lenin	San Martin	Laura Farías	BGQ	UDEC	44	Procesos y micro-organismos involucrados en la producción de metano en la capa superficial del océano
Ignacio	Vera Esquivel*	Carlos Jara	ECO	UACH	44	Efecto de la erupción del Cordón Caulle en comunidades de macroinvertebrados bentónicos de ecosistemas fluviales en el Parque Nacional Puyehue,

*They are now starting their MSc programs.

Thus all in all, there were 2 PhD theses, 17 MSc theses and 15 professional exams produced within the research framework of CR2 in 2014.

C. Support personnel

Table III-7. Support personnel of CR2. T corresponds to transversal to all. Dedication is in hours per week.

Name	Last Name	Role	Research Area	Affiliation	Dedication
Rodrigo	Bravo	Field Assistant	ECO	UACH	44
Luz	Fariña	Journalist	T	UCH	44
Gerardo	García	Laboratory Assistant	BGC	UDEC	44
María Isabel	Guerra	General Coordinator/Manager	T	UCH	44
Marcia	Millas	Secretary/Accountant	T	UACH	11
Cecilia	Montecino	Secretary/Accountant	T	UCH	44
Francisca	Muñoz	Data and computing manager	MOS	UCH	44
Mabel	Torres	Secretary/Accountant	T	UDEC	11

In addition to this personnel, the Department of Geophysics, University of Chile contracted Aldo Vizcarra (Geophysicist) to support the maintenance of all instruments associated to Atmospheric Science, including part of the CR2 instruments.

5. Changes in research personnel

Describe any changes in the principal and associate researchers relative to the original project.

D. Principal researchers

There are no changes to report regarding principal researchers.

E. Associate researchers

Regarding associate researchers, several changes occurred:

- **Nicolás Huneeus** (Modeling and Observing Systems) joined the team in January 2014 while still working in France, and moved to Chile in March. He took the position of assistant professor at the Department of Geophysics Universidad de Chile which corresponds to a contribution from our sponsoring institution to CR2. He is associated to Modeling and Observing Systems area. He has successfully integrated in various research and outreach as shown in the following sections of this report.
- **Marcela Cornejo** (Biogeochemistry) asked for a change of status from associate researcher to adjoint researcher due to differing views with the Principal Investigator for Biogeochemistry. Given the nature of the disagreements, this change of status was not accepted by the board members and she resigned from her position. So far, she has been replaced by two adjoint researchers in biogeochemistry, Dr. Gayó and Dr. Massoti.
- **Gary Shaffer** (Modeling and Observing Systems), a senior scientist with a deep expertise on climate modeling, submitted his resignation in October being effective as from January 2015. He did not accept the offer of remaining as an adjoint researcher. In spite of being a distinguished scholar, his profile does not correspond to one of a team player who could participate fruitfully in the framework of interdisciplinary research.
- **Ana Lya Uriarte** (Human Dimensions) resigned in July 2014 due to personal reasons. Ana Lya Uriarte acted as Minister for the Environment of President Michelle Bachelet in her previous period. Nowadays Ana Lya acts as Chief of Staff of President Michelle Bachelet in her current administration.

In addition to these changes, after the second year evaluation carried out by the center's Director and the board, the roles and dedications of all associate researchers have been modified. In fact, all dedications were put at a minimum of 12 hours per week starting in January 2015, which implies and increase in the dedication of researchers. Also we decided to streamline the team of associates keeping in that category those who contribute the most in terms of scientific and educational output while being team players in terms of their interactions, and research themes. Thus, the following researchers changed their status from associate to adjoint:

- **Beatriz Diez** (Biogeochemistry) is a molecular biologist contributing to the study of various specific processes associated with biogenic emissions of climatically active tracers. This work is key but very specific. Her adjoint position allows continuing the initiated work.
- **Melitta Fiebig** (Modeling and Observing Systems) is an applied mathematician who has contributed to the development and application of statistical downscaling techniques for climate scenarios. She is now retiring and we considered appropriate to reduce her formal commitment to the Center.
- **Carlos Jara** (Ecosystem Services) is a zoologist who has contributed to the understanding of impacts of changes in runoff in rivers. Carlos is also retiring and we considered appropriate to reduce his formal commitment to the Center.
- **Paulo Herrera** (Climate Dynamics) is a modeler with expertise on ground water systems, which is a pretty unique expertise in Chile. He is an assistant professor at the Civil Engineering Department, Universidad de Chile, and has multiple commitments that are difficult to reconcile with the required dedication under CR2 in 2015. Nevertheless, he keeps his collaboration as an adjoint researcher.

In late December, while preparing this report, **Dr. Fabrice Lambert** got a permanent position at the Department of Geography at the Catholic University in Chile. In this manner, CR2 has effectively enhanced the number of experts in climate change in Chile. Fabrice keeps his position as associate researcher at CR2 but he will reduce his dedication from 44 to 12 hours per week starting in March 2015. Also, during the first half of the year, Fabrice had a transversal position with respect to the research lines. This did not show very pragmatic so we decided to incorporate him to Modeling and Observing Systems.

Thus, all in all, from a total of 19 associate researchers in January 2014 with a typical dedication of 7 hours per week, we streamlined the team to a group of 12 researchers with a dedication of 12 hours per week in January 2015. Also, this allowed an increase in resources for adjoint researchers and a new post-doctoral fellowship for the third year.

F. Adjoint researchers

In addition to Gustavo Blanco (HD, Universidad Austral), Nancy Hitschfeld (MOS, Universidad de Chile), and Juan C. Maureira (MOS, Universidad de Chile), who continued their collaboration, new researchers started collaborating with us (See details in Table 4-2):

- **Mauricio Galleguillos** (Ecosystem Services, Universidad de Chile)
- **Eugenia Gayó** (Biogeochemistry, Universidad de Concepción)
- **Ítalo Massoti** (Biogeochemistry, Universidad de Valparaíso)
- **Pablo Saide** (Modeling and Observing Systems, University of Iowa)
- **Anahí Urquiza** (Human Dimensions, Universidad de Chile)

Also, collaboration has been initiated with **Dr. Rodrigo Arriagada** (Human Dimensions, Catholic University) to address evidence-based environmental policy in the 21st century.

G. Post-doctoral fellows

The number of post-doctoral fellows associated to CR2 grew in 2014, and it will be further increased in 2015 by the inclusion of fellows funded by the post-doctoral program of CONICYT. Also, we expect to fill 5 new positions opened by CR2 by March 2015. The new fellows funded by CONICYT are:

- **Catalina Aguirre**: She has a PhD in Fluid Dynamics (University of Chile) and strong background in oceanography. She will work on the coupling of atmospheric and oceanic regional models. She is sponsored by Dr. Maisa Rojas.
- **Juan Pablo Boisier**: He has a PhD in Atmospheric Science (U. of Paris) and works on land-atmosphere coupled modeling. He is sponsored by Dr. Roberto Rondanelli.

Also, Dr. **Deniz Bozkurt** (sponsored by René Garreaud), and **Mariela Yévenes** (sponsored by Laura Farías) remain associated to CR2 but they are being funded by CONICYT since November 2014.

In 2013 **Dr. Paola Arias** started working with Dr. Maisa Rojas on the variability of the South American monsoon system. Given the relevance of her research she has been invited to participate in the Center. She has a FONDECYT grant and a PhD from the University of Texas.

In October 2014, Dr. **Christian Little** took a position at the National Institute for Forestry (In Spanish, Instituto Nacional Forestal, INFOR, http://www.infor.cl/) where he continues his research work. This enables an important collaboration between CR2 and INFOR.

Between March and October 2014, we had the opportunity to host at the Center **Dr. Kristina Pistone**, a Fullbright fellow with a PhD in Atmospheric Science from the SCRIPPS institution in California. She prepared a proposal for FONDECYT but it was unfortunately not granted and she took a position in the United States. Nevertheless, she is developing, in collaboration with CR2 researchers, an aerosol climatology for Santiago. She will visit CR2 in fall to finish the paper.

Dr. Nancy Yáñez, a doctor of law recently graduated at University of Chile, started a post-doctoral fellowship in mid-2014 addressing the dogmatic analysis of water legislation in the framework of human rights. During 2015 she will continue her collaboration but as an adjoint researcher. Personal reasons make it very difficult for her to complete the post-doctoral work.

6. Advisory committee

Describe its tasks, the frequency of meetings, and usefulness of the advice provided to the Center. Also, report on the availability of the committee to assist the Center.

The International Scientific Panel provides guidance to our leading team of principal investigators, to promote collaboration between $(CR)^2$ and other centers around the world, and participates in our annual meetings and in activities involving students and stakeholders. The members of our committee are:

- Dr. David Battisti, Tamaki Chair and Professor of Atmospheric Sciences, University of Washington, USA.
- Dr. Guy Brasseur, Director of the Climate Service Center, Germany
- Dr. Mark Howden, Theme Leader - Adaptive Primary Industries, Enterprises and Communities, CSIRO, Australia.
- Dr. Carlos Nobre, Instituto Nacional de Pesquisas Espaciais, Centro de Ciência do Sistema Terrestre (CST), Brazil
- Dr. Karen O'Brien, Professor at the Department of Sociology and Human Geography at the University of Oslo, Norway
- Dr. Mary Scholes, Professor in the School of Animal, Plant and Environmental Sciences and Assistant Dean for Postgraduate Studies in the Faculty of Science, University of the Witwatersrand, South Africa.
- Dr. Tong Zhu, Chair Professor of Environmental Sciences, Cheung Kong Scholar Program at Peking University, China.

The first in situ meeting took place in Villa Alegre, Chile, between January 11 and 15, 2014. In that opportunity Professors Battisti, Brasseur and Scholes attended. They provided extremely useful comments regarding the various aspects of CR2. These comments were enclosed in the previous report.

Dr. Mark Howden visited Chile in May 2014 and in addition to a seminar, he held a meeting with the Human Dimensions team providing insightful comments and recommendations attached to this report (See Annex 5).

The in situ review by CONICYT of the international panel will possibly take place in May 2015: we expect to hold a meeting with our international and national panels in that opportunity.

Also, during 2015, Prof. Guy Brasseur will visit Chile for an extended period of 4 months in total. This is possible since he was awarded the Abate Molina Prize. In addition to seminars, he will use and further develop a system that uses available surface emissions, satellite observations and surface measurements of atmospheric chemical compounds, their integration in a regional chemical transport model (WRF-Chem) to assess the fate of short-lived climate forcers, ozone and black carbon in particular. This work is functional to various field studies being developed by the Center for Climate and Resilience Research, as well as international initiatives that aim at addressing impacts of such tracers on the Andean cryosphere (http://www.mce2.org/activities/pisacsouth-american-cryosphere).

In addition to the International Scientific Panel, we established a National Advisory Panel to promote the connection with various institutions and sectors. We invited individuals and institutions. The current members are:

- Jorge Carrasco, former Director of the Climatology Division at the Chilean Weather Office (DMC, Dirección Meteorológica de Chile). He was designated by the Director of DMC Mr. Guillermo Navarro.
- Rosa Escobar, private consultant with expertise in environmental studies for the mining industry. She acted also as director for the regional office of the National Commission for the Environment (Now Ministry for the Environment).
- Maritza Jadrijevic, Officer at the Ministry for the Environment, Climate Change Bureau, Ministry for the Environment.
- Raúl O'Ryan, former Officer at the United Nations Development Program in Santiago and now Director for Innovation and Energy, Universidad Adolfo Ibáñez
- Jaime San Martín, Researcher and former Director for the Center for Mathematical Modeling

Jorge Carrasco, Rosa Escobar, and Raúl O'Ryan actively participated in the Villa Alegre meeting in January 2014 providing comments and insights. Also, Dr. O'Ryan collaborated with Dr. Herrera and our coordinator, María Isabel Guerra in the formulation of a project for integrated management of groundwater in the Azapa valley in Northern Chile. Unfortunately, this project was not selected. In the upcoming scientific symposium to be held in Roca Negra, Chile, Dr. Carrasco, Mrs. Jadrijevic, and Dr. San Martín will participate.

Of the original group only Mrs. Karen Poniachick has not been able to participate.

IV. OBJECTIVES AND RESULTS ATTAINED (Maximum 20 pages)

1. RESULTS OBTAINED RELATIVE TO CENTER OBJECTIVES

a. *Organize your report describing the most significant outcomes for the following aspects:*
   - *i. Main research findings*
   - *ii. Synergy and collaboration among research lines*
   - *iii. Formation of advanced human capital directly related to the Center´s objectives*
   - *iv. Collaborative networks both at the national and international level*
   - *v. Dissemination and exploitation of results*
   - *vi. Outreach to society*
   - *vii. Contribution to public policies*

Refer also to those objectives that have not been accomplished, justifying the reasons.

b. *Describe unexpected difficulties encountered and indicate how they were dealt with.*

A. Main research findings

Significant advances have been shown regarding the understanding of climate variability at various time scales and its consequences (Caniupán et al., 2014; Jacques-Coper and Garreaud, 2014; Lamy et al., 2014; Lara et al., 2014; Mohtadi et al., 2014; Moreno et al., 2014; Muñoz et al., 2014). Also, substantial progress has been done with respect to the characterization of sinks and sources of greenhouse gases in the coastal ocean (Cornejo et al., 2014; Farías et al., 2014; Galán et al., 2014; González et al., 2014; Pérez et al., 2014). Also, climatologies of various atmospheric variables have been published (Garreaud et al., 2014; Rahn and Garreaud, 2014; Rondanelli et al., 2014; Viale and Garreaud, 2014).

An assessment of buffer effects of streamside native forests on water provision in watersheds dominated by exotic industrial forest plantations has been produced (Little et al., 2014). Also, climate sensitivities of native forest have been identified (Urrutia-Jalabert et al., 2015), and of species in dry lands (Ulrich et al., 2014). Further, landscape restoration post fire has been reviewed (González, 2014).

A mapping approach to assess intangible cultural ecosystem services was developed (Nahuelhual et al., 2014a), and it has been adapted to address the mega drought. The use of landscape ecology tools in the framework of ecosystem services has been reviewed (Iverson et al., 2014).

The theoretical approach for resilience has been further consolidated (Aldunce et al., 2014; Aldunce et al., 2015), and anthropologic and sociologic perspectives have been integrated (Urquiza, 2014; Urquiza and Cadenas, 2015). Legal frameworks for climate change have also been addressed (Maljean-Dubois and Moraga, 2014; Moraga,

2015). Moreover, human settlements in northern Chile have been studied combining archeology and carbon dating (Gayó et al., 2014).

In addition to the research initiated this year with respect to the mega drought phenomenon, substantial progress has been achieved in terms of the study of short-lived climate pollutants regarding aerosol and gases radiative impacts and over the Andean cryosphere. These are steps forward regarding the integration and interdisciplinary research.

It is worth noticing the number of concurrent projects granted to our researchers, which allow enhancing our activities (See VI 10). For instance, a FONDEQUIP project with resources of roughly 400 kUSD was granted, allowing the purchase of a buoy to be deployed in 2015 in the coastal area of Concepción. Instruments already in used are illustrated here by.

B. Synergy and collaboration among research lines

Achieving interdisciplinary research is a long term process that our team has initiated. Therefore, during 2013, we discussed in various meetings a common question that, on the one hand, could help integrating different disciplines leading to improved understanding, and on the other hand have an impact on policy making. The question selected in early 2014 refers to the causes and consequences of the drought experienced during the last few years along Chile, which we called "mega drought". In addition to counting with direct observations of this pressing phenomenon, it serves as an analogue of the probable future climate of Central and Southern Chile where the majority of the population lives. This question encompasses the theme of scarcity and variability of water resources and it has been coordinated by Dr. Garreaud.

To enable the mega drought research theme, Dr. Garreaud met with all research lines holding meetings in Concepción, Santiago and Valdivia. Also, researchers were asked to define research activities that would contribute to determining causes and

consequences of the mega drought under a common format. Many of our researchers provided proposals. These proposals were integrated by Dr. Garreaud and the board. The consolidated research questions can be summarized in the following expected results:

- Hydro climatic characterization of the current drought, and contextualization in the framework of paleo records;
- Assessment of impacts on river runoff, ground water levels, vegetation, and snow coverage;
- Evaluation of forecasting capabilities, projections and recurrence time of droughts based on climate models;
- Assessment of impacts on water provision and fire occurrence in areas with extensive substitution of native forest by exotic plantations;
- Characterization of impacts on primary productivity in coastal ecosystems as a consequence of changes in nutrient loading and stream flow;
- Analysis of societal and institutional responses and vulnerability mapping tools.

A summary of these activities was sent as a letter to multiple policy makers, and meetings have been held with some of them to engage them at an early stage. In the annual meeting held near Concepción (Roca Negra) in January 2015, 15 papers were presented, which shows advances on the mega drought research (See Annex 1). Also, a subset of these results has been presented in national and international symposia. Preliminary results indicate that:

- The current drought is unprecedented in terms of duration and geographical when put in the framework of historical and paleo-records (last 1000 years). Also, while the negative phases of El Niño Southern Oscillation and the Pacific Decadal Oscillation have contributed to its maintenance, neither of those natural modes can fully explain its extent, strongly suggesting a partial role of climate change mediated by changes in atmospheric circulation.
- The length of the drought has a long-standing impact on many physical systems such as snow-cover, ground-water, natural vegetation, and coastal areas. This is connected to the fact that these systems have memories that lead to coping strategies in the short-term, which seem not resilient in face of multi-year drought events.
- The current governance of water resources is not able to cope with extended droughts. The majority of measures are designed for short-term responses, with little coordination among different stakeholders.

The board and the general coordinator met in six occasions in 2014. Only one meeting was held outside Santiago, namely in Valdivia. Even though meeting outside Santiago is typically more expensive, it has the advantage of allowing a closer communication with researchers and students. During 2015, we intend to hold at least half of the meetings elsewhere than Santiago. These in situ meetings are also complemented by video conferences, and colloquia broadcasted by videoconference

and internet streaming, which we started organizing in October 2014. These closed colloquia were held to stimulate cross-pollination among research areas.

As indicated earlier, a mini symposium was held in Roca Negra near Concepción the first week of January where the majority of our researchers and post-doctoral fellows, and a few students participated. In addition to the January meeting, we will hold a second meeting in connection with the visit of the evaluation panel, possibly in June 2015. We will also take the opportunity to organize thematic colloquia.

In late November CONICYT organized a meeting among centers of excellence in which the question of interdisciplinary research was discussed in length. In particular the metrics used to show interdisciplinary research were a subject of debate. In fact, every research line within CR2 can argue in favor of discipline crossing collaboration, and the mere line label does not ensure an actual interdisciplinary effort. One distinct effort was led by Dr. Moreno, resulting in a high profile publication involving biogeochemistry, climate dynamics and modeling and observing system researchers. Beyond metrics, we expect to consolidate a first genuine interdisciplinary output in 2015 as a result of the mega drought studies. A similar development may occur subsequently with respect to short-lived climate pollutants.

Photos from Roca Negra. Scientific symposium, January 7 and 8 2014.

C. Formation of advanced human capital directly related to the Center´s objectives

We have been successful in involving early career scientists in post-doctoral positions, counting today 5 active fellows (Albrecht, Arias, Bozkurt, Van den Hoof and Yévenes). In early 2015 we will incorporate two fellows (Boisier and Aguirre), and hopefully by March, 5 more depending on the selection of candidates to be sanctioned by late January. Yáñez will continue her collaboration in the role of adjoint researcher.

Two doctoral theses were completed the second year. Also, our records show 17 master theses defended in 2014 and 11 undergraduate exams.

Another source of advanced human capital corresponds to foreign students that visit us for a few months, during which they gain experience and we benefit from their research support. This year we had Ilona Jördis Jäkel a master student from Postdam, Germany, and Geidy Rodríguez from Universidad Nacional de México (UNAM). Ilona stayed for 3 months, and Geidy for one month. Also, we have hired trainees from our own institutions for brief periods. This is a way to engage early on good students.

D. Collaborative networks both at the national and international level

At the national level we have collaborated with centers and institutions including governmental agencies as presented in Subsection G. Nationally, we highlight:

- Chilean Weather Office (http://www.meteochile.gob.cl/): We signed an agreement to access and analyze data, develop climate services, and train personnel.
- Solar Energy Research Center (SERC, FONDAP Nº15110019): we participated in the discussion of the Energy Agenda of the Ministry of Energy (See subsection G). In addition to this, it must be pointed out that Dr. Pilar Moraga is Principal Investigator for CR2 and associate researcher at SERC.
- Center for Sustainable Urban Development (CEDEUS, FONDAP N°15110020): co-organized meetings and events.
- Non-Governmental Organization ADAPT (http://www.adapt-chile.org/): co-organized meetings and events
- Center for Mathematical Modeling (CMM): we used part of their computational infrastructure. In addition to this, it must be pointed out that Dr. Axel Osses is an associate researcher both in CR2 and CMM.
- We submitted a joint outreach proposal with the Andean Geothermal Center of Excellence (CEGA, FONDAP N°15090013).

Internationally, we highlight the leading role of CR2 researchers in the organization of conferences:

- Paulina Aldunce had a prominent role in the organization of the third climate change adaptation conference held in Fortaleza, Brazil in May 2014 (http://adaptationfutures2014.ccst.inpe.br/). Several CR2 students and research assistants attended the conference.
- Laura Gallardo acted as convener of the 13th quadrennial iCACGP symposium and 13th IGAC science conference held in Natal Brazil in September 2014 (http://igac-icacgp2014.org/). Students and researchers attended the conference. A stand with the institutional video, brochures and other graphic material was maintained at the conference.
- The area of Ecosystem Services had an important participation in the annual conference of the Ecosystem Services Partnership held in Costa Rica in September (http://www.espconference.org/ESP_Conference), including a keynote presentation by Antonio Lara.

The international network of climate change governance and resilience (REDES 130066) developed successfully their work plan allowing the extended visits of CR2

researchers and student in recognized foreign research centers, and of foreign researchers in Chile. In addition to symposia, the collaboration led to joint publications and co-guided theses.

The Pollution and its Impact on the South American Cryosphere (PISAC, http://www.mce2.org/activities/pisac) initiative produced a white paper to be submitted in February 2015, and held two writing meetings in La Paz in May and July 2014. Several presentations in international conferences were also held, and two complementary 3-year projects have been granted to CR2 researchers (Huneeus, Lambert).

Laura Gallardo was invited as Coordinating Lead Author (CLA) of the first (framing) chapter of the ongoing assessment on short-lived climate pollutants for the Latin America and Caribbean region. Dr. Huneeus has been convened as a lead author of Chapter 4 on emissions and observations. This initiative is chaired by Dr. Paulo Artaxo (Brazil) and Dr. Graciela Raga (Mexico), and carried out under the auspices of the United Nations Environment Programme, and the Climate and Clean Air Coalition (CCAC) to reduce short-lived climate pollutants (http://www.ccacoalition.org/).

In 2014, CR2 researchers (Gallardo, Garreaud, and Uriarte) contributed in different capacities to an international initiative on public health and climate change under the leadership of Prof. Kyle Steenland from the Emory Institution for Public Health, Georgia University.

New initiatives:

- In March 2014, CR2 partially funded the visit of Drs. Justin Minder (University of New York at Albany) and Bart Gerts (University of Wyoming), experts in mesoscale dynamics, aerosols and meteorology, respectively. In addition to their seminars, they worked with R. Garreaud (Climate Dynamics) and other colleagues, developing a plan for a major field experiment on orographic precipitation in the Nahuelbuta Mountains in Southern Chile. The plan evolved in a full research proposal named CCOPE (Chilean Coastal Orographyc Precipitation Experiment) submitted to NSF (EAGER program) by Minder, Gerts, Garreaud (CR2), Montecinos (U. of Concepcion, Chile) and Kingsmill (University of Colorado). The proposal is under review and, if funded, will include a field campaign in the austral winter 2015 that will bring an unprecedented array of meteorological platforms to understand how the frontal systems are modified by the prominent topography of southern Chile.
- Dr. Nicolás Huneeus was granted a project (ECOS/CONICYT) for collaborating with the team lead by Prof. Olivier Boucher at the Pierre Simon Laplace Institute in France. The topic is remote sensing and inversion methods of aerosol sources at the regional scale.
- CR2 has committed to organize the 11th version of the International Conference on Southern Hemisphere Meteorology and Oceanography (ICSHMO) to be held in Santiago, Chile, from 5-11 October 2015. ICSHMO is a topical conference of the American Meteorological Society that every three years provides a unique and interdisciplinary forum to ocean and atmosphere sciences that are specific to the Southern Hemisphere (http://www.icshmo-2015.com/). We expect about 300

scientists from all over the world, so that ICSHMO will provide a major, international showcase for our center, specially our work in climate dynamics, modeling and observations and biogeochemistry.

E. Dissemination and exploitation of results

In addition to numerous (>100) standard presentations for the national and international communities in seminars and conferences, we were keen to take part in multiple meetings and seminars oriented to the general public and stakeholders. We highlight the following instances:

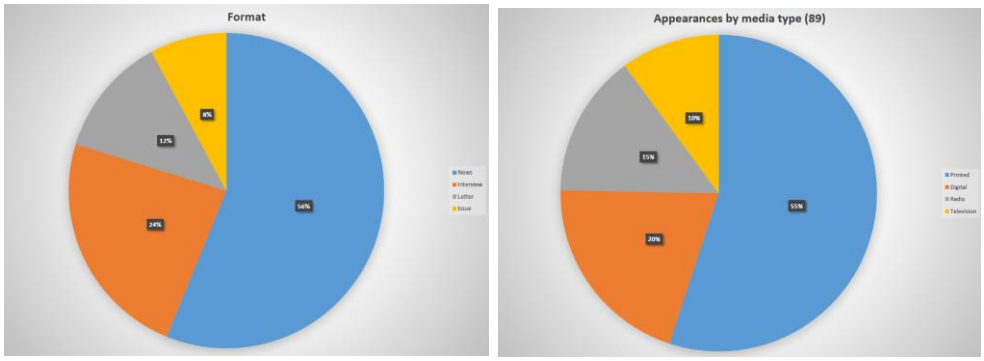
- *Adaptación al cambio climático: una urgencia pendiente.* This was an international symposium co-organized with academics from the University of Melbourne, and in which participated representatives from the Ministry for the Environment. It was organized by Paulina Aldunce and the Human Dimensions team in May 2014.
- "*Desafíos para la Incorporación de la Restauración Ecológica en las Políticas Públicas*". There were more than 100 attendees, many of which represented the public and private sectors. This seminar was held partly in Valdivia and partly in Santiago in June 2014. Antonio Lara and the Ecosystem Services team organized this event.
- "*VII Jornadas de Derecho Ambiental -Reflexiones sobre un nuevo paradigma de la regulación del agua en Chile*". This symposium discussed the different legal doctrine approaches to regulate water resources, which is very timely since Constitutional reforms and legal frameworks for water management are being discussed in the Parliament. It was organized by Pilar Moraga and the Human Dimensions team.

F. Outreach to society

During 2014 our communication strategy continued in national media press, achieving 89 original press publications (excluding secondary media and institutional websites). We had three landmarks: 1) Conference of the parties held in Lima, Peru (COP20) in December 2014, with press management previous, during, and after the international meeting, which included interviews, opinion articles, press videos and brochures, adding 16 appearances. CR2 researchers (Laura Gallardo, Laura Nahuelhual, and Pilar Moraga), journalist (Luz Fariña) and students (Gabriel Araya, Noémie Klugger) integrated the official Chilean delegation, and participated in side events; 2) In connection with the 40th meeting of the Intergovernmental Panel for Climate Change (IPCC), held in Copenhagen, Denmark, 24 - 31 October 2014, where CR2 researchers, Laura Gallardo and Maisa Rojas, actively participated in the discussions as part of the Chilean delegation, accompanying Mrs. Maritza Jadrijevic (head of delegation) lead to several interviews, opinion articles and outreach material which delivered in the national press; and 3)Last but not least, a third relevant landmark has been the press kit, blog post, opinion articles, and other material developed around the mega drought theme.

There are 48 records in written press in major newspapers (La Tercera, El Mercurio and La Segunda); followed by radio and television interviews. Also, we increased our presence in digital press (18). We count 49 appearances in the news, and 21 interviews, plus 11 opinion articles. The institutional website (www.cr2.cl) had a monthly average of 4500 visits, the fan page in Facebook had a 914 likes, and the twitter holds 747 followers. We participated in the Science and Engineering Festival (Universidad de Chile) and the week of science organized by CONICYT (October 2014) with a stand, a workshop, live experiments and other activities.

In addition to this, we submitted several outreach proposals (EXPLORA) involving researchers within CR2, and also from other centers and institutions. Also, in December we organized a tale writing competition in a school attended by vulnerable teenagers in Santiago (Claudio Matte School). They wrote about "Tragedies on global warming" organized by (CR) 2 together with teachers of Language Department. The goal of this activity was to link the origins of Greek tragedy with what's happening in Chile regarding climate change and the mega drought. In August, our researches in Biogeochemistry (University of Concepción) invited vulnerable students, mostly girls, from a school in Talcahuano that participed in a "Science Workshop", and in an altitudinal transect from the coast to the Cordillera de Los Andes, sampling water and snow from the Itata River, which afterwards they analyzed in the laboratory together CR2 researchers.



For details see Annex 4 "In the media", and attached summary brochure.

G. Contribution to public policies

- We collaborated with the Center for Energy (CE) at the University of Chile and the Solar Energy Research Center (SERC, FONDAP Nº15110019) support the discussion of the Energy Agenda required to University of Chile by the Ministry of Energy. The discussions resulted in a document to which Pilar Moraga, Ana Lya Uriarte and Laura Gallardo contributed. Our views regarding territorial management, participation of communities, clean fuels, etc. were finally adopted by the government. These activities took place in May and June 2014.
- Dr. Lara and his team co-organized two important meetings in which stakeholders had an important role. Firstly, a symposium on forest restoration held both in Santiago and Valdivia, and secondly, a workshop on fire ecology in Valparaíso.

- A document discussing gender and climate change was prepared by Laura Gallardo and Laura Nahuelhual as requested by the Ministry for Foreign Affairs of Chile as a contribution to the speech of President Michelle Bachelet during the Climate Summit organized by the United Nations and in New York in September 2014.
- Together with the Center for Sustainable Urban Development (CEDEUS, FONDAP N°15110020), and the Non-Governmental Organization ADAPT (http://www.adapt-chile.org/), we participated in the meeting of Chilean Majors against Climate Change (http://www.redmunicc.cl/foro_de_alcaldes_conclusiones.htm). The media coverage of this event was run by CR2 in November 2014. These discussions are central to face adaptation and resilience at the local scale.
- In November 2014, Nancy Yáñez made a solicited presentation to the Senate for the Special Commission on water resources, desertification and drought. The discussion at hand is the revision of the water legal framework, including constitutional ammendments.
- Laura Gallardo was invited in December 2014 to participate in the Scientific Advisory Committee for Air Quality recently created by the Ministry for the Environment.
- Anahí Urquiza, Laura Nahuelhual, and Alejandra Carmona (Human Dimensions) together with María Isabel Guerra (coordinator), submitted an applied project (FONDEF) to extend and develop vulnerability maps. This project is sponsored by the Ministry for the Environment.
- Maisa Rojas and Laura Gallardo participated as members of the Chilean delegation, led by Mrs. Maritza Jadrijevic from the Climate Change Bureau of the Ministry for the Environment in 40th meeting of the IPCC held in Copenhagen, Denmark. In this meeting the Summary for Policy Makers was revised and adopted line by line by all governments.
- A pre proposal to address the legal and institutional framework for climate change in Chile has been approved by the Latin American Regional Prosperity Fund of the British Embassy in Chile. The proposal was selected among 100 applications, and it counts with the support of the Ministry for the Environment. The leader for this initiative is Dr. Pilar Moraga and it involves the non-governmental organization ADAPT Chile.

2. RESULTS ACHIEVED PER RESEARCH LINE

Briefly describe the main results per research line achieved during the period.

A. Biogeochemistry

Within the framework of the "mega drought" referred to earlier, a significant effort of our team has been oriented toward the environmental monitoring of rivers, and coastal zones of the Central-South area of Chile (30°-45 °S). This is a region where changes in the hydrological cycle (reduced precipitation, rising temperatures, melting glaciers) constitute a key driver of various environmental changes. We have worked on assessing the impact of riverine nutrient and particle transport on the coastal zone (i.e. from the expansion of river plumes, chlorophyll biomass index and nutrient loading (Figure 1). Satellite retrievals have shown that river plumes of major rivers in Central Chile have reduced their areas of influence and chlorophyll levels have declined over the last 10 years, which follows from declining river discharge during fall and winter. A study of the interannual variability of dissolved inorganic nitrogen (DIN) in the Biobío River, South-Central Chile was performed, finding enhanced levels of DIN in wet years, and enhanced consumption of DIN in dry years. Also, preliminary results suggest that primary biophysical factors such as soil hydrological group, precipitation and land use, are controlling water quality at the watershed scale (Yevenes et al., submitted).

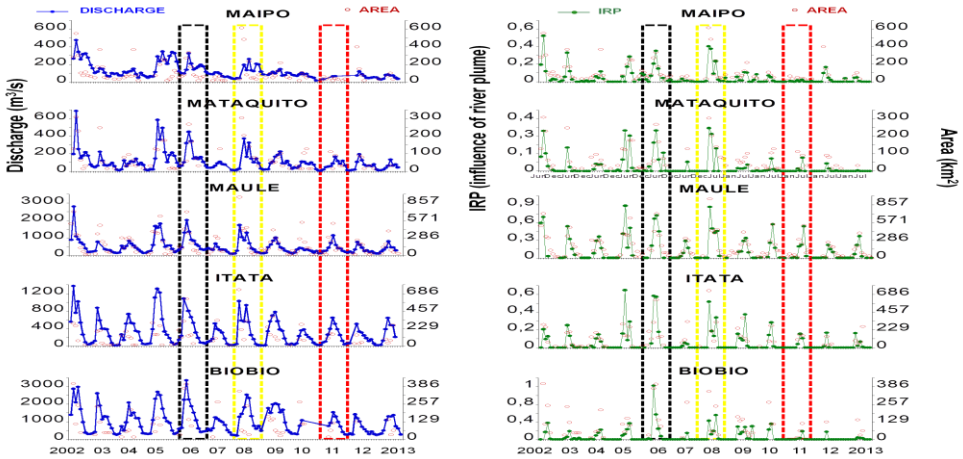


Figure 1. Time series of river discharge of main river located in Central Chile (from north to south: Maipo, Mataquito, Maule, Itata and Biobio) along with area of influence of river plume and index of biomass in the plumes. Years with high and low stream flow are highlighted. Massoti et al (in preparation).

We have continued the work on isotopic analyses, which have been made possible by the acquisition in the first year of the Picarro L2130-i Analyzer. Preliminary results of deuterium and oxygen isotopes (δ2H and δ18O) in water have been obtained, achieving the first meteoric curve with samples of different origin (fresh- and coastal waters for the Central-South Chile region (De Pol et al, forthcoming) (Figure 2).

Over the coming years, we will continue to collect water from different sources (i.e. glaciers, groundwater, others) in order to study the different sources of fresh water continental reservoirs as well as their physical transformation processes (i.e., evaporation and condensation). This will also be functional to study other physical processes such as stratosphere-troposphere exchange (Galewsky and Samuels-Crow, 2014) and its impacts on tropospheric ozone in the Chilean Global Atmospheric Watch stations of Easter Island and Tololo (Gallardo et al, forthcoming). Moreover, in 2014 we acquired a wet-only deposition sampler to be located at the University of Concepción campus in early 2015. This, in addition to providing ionic composition of interest for assessing sulfur and nitrogen biogeochemical cycles, it will allow further studies of water isotopes.

A record of atmospheric radiocarbon (^{14}C) in *Fitzroya cupressoides* (larch, *Alerce* in Spanish) tree rings grown during the anthropocene (1850-201) has been obtained (De Pol, pers. communication). Additionally, we have estimated the age of the shallow marine reservoir located throughout Chile by measuring the radiocarbon content of molluscs from museum collections. This information is vital for future paleo-oceanographic research which relies completely on firmly establishing age model for sedimentary sequences dated by radiocarbon on surface dwelling carbonaceous organisms like foraminifera. Furthermore, it provides a database of radiocarbon dates for the western slope of the Central Andes between 16° and 21° S. Through analysis of time series it is possible to verify the capability and accuracy of this dataset to reconstruct the demographic patterns of pre-Hispanic societies during the last 15,000 years. Thus, the results obtained indicate that the time series analysis established through these methods are key to determining the sensitivity of societies that inhabit arid areas to changes in the regional and global hydrological cycle (Gayó et al., 2014).

We have also studied the distribution of solar radiation on the planet's surface (Rondanelli et al., 2014). It is established that the Atacama Desert in northern Chile, in particular the area of the Domeyko mountain range and the Chajnantor plain are areas where solar radiation reaches the global maximum of 310±15 W/m^2. Regional climate dynamics control the maximum surface solar radiation and simultaneously may control the decline in the subtropical anticyclone, the position of the subtropical jet stream, and cloud distribution associated with the plateau during winter and the relative lack of attenuation by aerosols. In addition to an improved understanding of dynamical processes, this study is functional to the work being developed by the Solar Energy Research Center (SERC, http://www.sercchile.cl).

We have continued the work regarding biogeochemical processes affecting sources and sinks of nitrous oxide (N_2O) and methane (CH_4) in the coastal ocean in Central Chile. In particular, a new process has been reported, i.e., chemolithotrophic denitrification, which is able to generate N_2O in the hypoxic waters of coastal upwelling (Galán et al., 2014). We have also elaborated upon greenhouse gas distribution studies in the Chile and other remote regions of the Pacific Ocean (Galán et al., 2014). These results show that mesoscale structures, such as the polar front, concentrate a high accumulation of methane which is previously unreported for these latitudes (Galán et al., 2014). Also, an unaccounted N_2O sink has been identified (Cornejo et al.,

2015). Finally, molecular and functional characterization of bacteria living in extreme environment was performed (Alcamán et al., in revision).

B. Climate Dynamics

During the second year of our center, research in Climate Dynamics has focused on the drought event that has afflicted central Chile since ~2010. While droughts are not uncommon in the semiarid part of our country, the longevity (a continuous sequence of up to 5 years), spatial extent (30-40S) and intensity (annual precipitation deficits ≥30%) make the current event as one of the most dramatic drought in the last century (referred to as "mega drought").

In first place, we assembled a large dataset of precipitation, temperature and river flow from the networks managed by the National Weather Service (DMC) and National Water Authority (DGA). The more than 800 time series of precipitation allowed us to define the spatial extent of the Mega drought and estimate its recurrence in time. As an example, Figure 2 shows the precipitation deficits for the major droughts during the second part of the XX century emphasizing that, unlike previous events, the current drought has encompassed from the semi-arid northern Chile well down to the south where more rainy conditions prevail. Indeed, rainfall deficits as the present one have a return period between 3-6 years in the north but up to 30 years in south-central Chile. Moreover, stations around Concepcion (38S) have experienced for the first time in their record 4 years with deficits larger than 30%. Work is underway to characterize the mega drought from a hydrological perspective.

Only a few stations have records that begin at or before 1900. The team lead by Dr. Christie has compiled those records forming a unique century-long precipitation record for central Chile from where we found a weak drying trend and substantial inter-decadal variability. This low-frequency variability seems well related to the Pacific Decadal Oscillation (PDO), such that periods with a negative (positive) polarity of the PDO index tends to have less (more) precipitation than average in central Chile (Jacques-Coper and Garreaud, 2014). While most of the last decade has featured negative values of the PDO index, the intensity of the current drought is substantially more marked than that observed in other periods with similar PDO characteristics (e.g., the cold period from 1960 to 1975). On the other hand, individual dry years are most often associated with the development cold anomalies in the equatorial Pacific. Only one of the previous dry years feature well defined La Niña conditions, the others being neutral or even El Niño like. Altogether, the previous analysis suggests that the current mega drought may contain some signal from the ongoing anthropogenic climate change. We plan to address this issue next year using results from climate change numerical experiments (the CMIP-5 Historical and Future simulations).

One key element linking climate change with central Chile droughts is the maintenance of cold sea surface temperatures (SST) off the western coast of Subtropical South America. Indeed, a cooling SST trend has been observed in that region during the last three decades, in sharp contrast with the warming trend of about 0.2°/decade observed inland(Falvey and Garreaud, 2009). To test the physical link between eastern Pacific SST anomalies and central Chile rainfall, we are performing a

series of regional simulations for selected years with observed and altered SST.The cooling trend off South America is relevant in its own (e.g., impacts on fisheries) and may provide a negative dynamical feedback on climate change provided that its intensity is related with the expansion of the Hadley cell (a trade mark of the Climate Change) is being investigated.

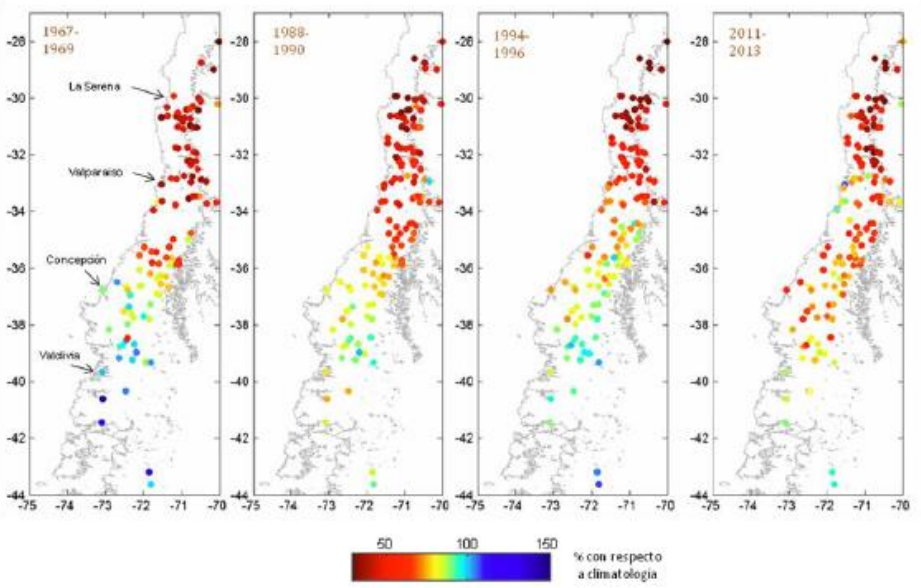


Figure 2. Extended droughts (3 years) in central Chile during the historical period. The specific years are shown at the top of each panel. The colors indicate, for each weather station, the average rainfall deficit or excess (in %) relative to the long-term mean climatology

Other topics of research in our group include the spatial heterogeneity in the projected changes in diurnal temperature range (DTR) during the rest of the 21st century (under several emission scenarios) and its relation with the projected precipitation changes. DTR is a suitable index of climate variability and change and several studies have highlighted the existence of a negative correlation with both the cloud cover and the precipitation rate over land throughout last century. Whether or not these processes are captured in the current generation of global and regional models is matter of current research.

A thesis guided by Dr. Paulo Herrera, aims at the modeling of the underground water in northern Chile under climate changes scenarios for the rest of the 21st century. We also published two papers describing the nature of summertime extreme events in the subtropical Andes, including its potential change in the future climate (Viale and Garreaud, 2014), and a novel paper on the lighting activity in western Patagonia (Garreaud et al., 2014).

Looking at past climates, Dr. Christie and his team continue his quest for the hydroclimate conditions over the South American Altiplano. Using tree-ring and ice-cores they were able to reconstruct the level of Lake Titicaca, that contain an ENSO-like signal at several time-scales. From the 1930's onward there is a persistent drying

trend which appears unprecedented in the context of the last 700 years, suggesting again a role of climate change mediated by changes in the atmospheric circulation. Christie et al. also used their century-long precipitation record and tree-ring chronology to develop a reconstruction of rainfall over central Chile from 1000AD to present day that provide an outstanding context for analyzing current and future precipitation anomalies.

The team lead by Dr. Moreno has advanced in their documentation and understanding of the low-frequency ranges of natural climate and environmental variability (multidecadal to centennial) over the last three millennia over Patagonia, providing an adequate context for assessing the instrumental changes recorded during the Anthropocene. This multi-disciplinary effort resulted in a joint publication in a highly ranked journal this year (Moreno et al., 2014). This line of work continues through the work of Carolina Morano, a MSc. student guided by Moreno and Villa-Martinez, using high resolution pollen and sediment records at Lago Calvario (Parque Nacional Torres del Paine).

C. Ecosystem Services

Research during 2014 in ecosystem services has addressed the objectives of this research line regarding I) the design of landscapes for the combined production of timber and water provision as an ecosystem service, II) Restoration and its potential for the recovery of ecosystem services. This includes the study of disturbance regimes as well as the resilience of ecosystems to natural and human disturbances as the basis for their restoration. We have also contributed to the topic of the effect of the "mega drought" on water provision as an ecosystem service and on fire occurrence.

Regarding the first objective, we have analyzed the effects of vegetation on water provision as an ecosystem service and timber production as well as the trade-offs between both in landscapes dominated by exotic commercial plantations (mainly pines and eucalypts) (Little et al., 2014). For this purpose we selected two contrasting watersheds in the Maule Region (35° 30' S Agua Fría and Nirivilo with an area of 2309 ha and 2033, respectively). Exotic pine commercial plantations cover 85% of the area in Agua Fría and 55% in Nirivilo. The reminder is covered by shrub lands, mixed exotic and native formations and native forests (3.5% in Agua Fría and 6,1% in Nirivilo). Projected Timber production for the next 25 years to optimize net economic benefits (net present value) from exotic commercial plantations that is the criterion followed by the land owners, competes with water provision and determines a high expected inter-annual variability in this ecosystem service due to variable runoff associated to harvest and reforestation of the plantation stands as they reach rotation age to maximize timber economic value. The projected increase in water provision in Agua Fría where younger plantations dominate at present is associated to the increase in harvested area starting in 2028 when a large proportion of plantations reach rotation age. The predicted water provision accumulated in the 2014-2039 period for Nirivilo is higher compared to Agua Fría, due to smaller percentage of plantation cover in the former watershed. Nevertheless, after 2034 the predicted slope of accumulated water provision for Agua Fría is steeper than for Nirivilo. This as an indication that a better

combination of stands of different ages of plantations is reducing evapotranspiration and increasing runoff as compared to the initial condition dominated by older stands with high evapotranspiration rates and low runoff. This study in progress is an innovative approach since it considers the changes projected for the next 25 years built from the aggregation of a detailed analysis of individual forest stands in contrast with broader available analysis that use a coarser scale and a static approach considering the present situation or other determined condition.

On the second objective, research done by students as part of their theses under M. González supervision. They have established the resilience of the Valdivian broadleaved evergreen rainforests after disturbance by clear-cuts and human set fires. Master students supervised by M. González finished their theses on the resilience of forest ecosystems to volcanic eruptions, using the Caulle volcano (Puyehue National Park 41°S) that erupted in June 2011 as a research model. Impact of tephra fall on the structure and composition, tree growth as well as composition and species richness of the Coleoptera community of *Nothofagus pumilio* forest stands were addressed.A Lara supervised Reinhard Fitzek on his Master thesis on the design and implementation of a restoration project of long-lived *Fitzroya cupressoides* and other forests in the Huinay Reserve (43^{o} S).

In the research of disturbance regimes and their drivers, we have investigated the relative importance of lightning strikes and land cover in fire occurrence in central Chile. Preliminary results indicate that lightning are less frequent in Chile tan in other ecosystems in Mediterranean climates worldwide. In Chile, only a small number of fires can be attributed to lightning as an ignition source, whereas land cover in a more relevant factor. There is some interaction between the influence of lightning and land cover in fire occurrence. This interaction is driven by the positive association of forest cover (including native forests and exotic plantations) and lightning with fire occurrence.

We also studied the long-term stream flow variability for the Baker river in Northern Patagonia (45^{o} S), that is relevant to climate dynamics and also to the understanding of the long-term variability of recreation and tourism opportunities as ecosystem services provided by this river (Lara et al., in revision). The Baker river has the highest mean discharge of those draining both slopes of the Andes South of 20°S and it is among the six rivers with the highest mean stream flow in the Pacific domain of South America (1,100 m3 s-1 at its outlet). It drains an international basin of 29,000 km^{2} shared by Chile and Argentina and has a high ecologic and economic value including conservation, tourism, recreational fishing, and projected hydropower. We reconstructed the summer–early fall Baker stream flow using *Nothofagus pumilio* tree rings for the period 1765-2004 (Lara et al., 2014). The regression model for the period (1961-2004) explains 54% of the variance of the Baker river stream flow. This reconstruction is relevant for planning, policy design and decision-making regarding water resources in the Baker basin. The most significant temporal pattern in the record is the sustained decline since the 1980s, which is unprecedented since 1765. The decreasing trend in the Baker discharge might be explained by the decrease in precipitation due to the rise of the Southern Annular Mode (SAM). The Correlation of the Baker stream flow with the November-April observed SAM is significant. The Baker

record is also correlated with the available SAM tree-ring reconstruction that is completely independent from this reconstruction when both series are filtered with a 25-year spline, emphasizing SAM as the main climatic forcing of the Baker stream flow.

Within the topic of mega drought, we have analyzed the changes in the exceedance probabilities of rainfall and water provision (indicated by stream flow) as an ecosystem service in two large watersheds in the Coastal Range under a pluvial regime (Purapel and Cauquenes) and compare them with two watersheds in the Andean Range (Longaví and Diguillín) under a mixed pluvial-nival regime. Preliminary results indicate lower stream flow in the watersheds under a rainfall regime in the 2009-2014 period in most months for the watersheds located in the Coastal Range compared to previous periods as opposed to Longaví and Diguillín under where this period is not exceptional in the record starting in 1960, that can be attribute by the snowmelt contribution to stream flow (Figure 3).

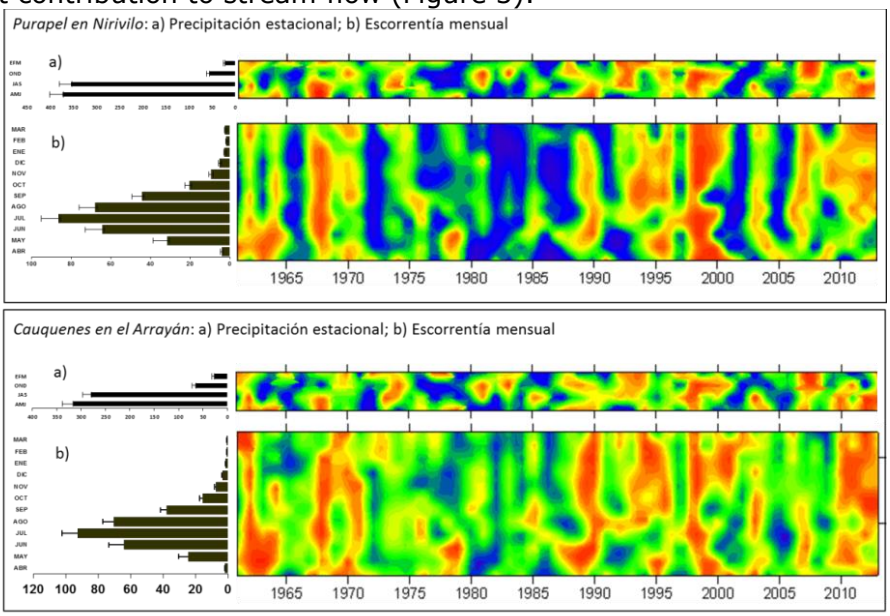


Figure 3. Changes in the excedence proabilities in monthly precipitation and runoff for two large watersheds in the Coastal Range in the Maule Region in the 1960-2012 period. Blue colors represent pluvials with low excedence probabilities that only occur in certain years and red represent low precipitation and streamflow values with a high excedence probability.

Also in the research of the mega drought, we are analyzing the effect of the 2010-2014 drought on fire regimes in Central and South-Central Chile (33°– 40°S). Preliminary results indicate an increase in number of fires and area burned in some regions (e.g. Maule) in the context of the 1985-2009 period, whereas no trends are exhibited in other regions of the country.

D. Human Dimensions

The group oriented a significant part of its research towards the analysis of the mega drought. We analyzed from a historic perspective the legal and administrative

framework for water management. Also, we identified the response of the Chilean State in connection with the ongoing drought and its effectiveness in view of water equity. Also the consequences of governmental measures at local and community scales are being analyzed. Preliminary results indicate that this response has a place in an emergency context and therefore is not sufficient for a permanent phenomenon. In this perspective we will analyze the solutions adopted by others countries facing similar problems as those occurred in Chile.

We have worked on the mapping of vulnerability with respect to climate variability and change, with emphasis on precipitation changes. This work is based upon previous work (Barrena et al., 2014; Nahuelhual et al., 2014a; Nahuelhual et al., 2014b)Changes in regional climatic patterns can adversely affect the provision of ecosystem services (SE). To assess its effects, a protocol for mapping socio-ecological vulnerability (VS) to climate change was developed and applied in the Maule Region. The VS was estimated based on three factors: exposure (EXP) to climate stress (measure as return probability of extreme drought), the susceptibility of socio-ecosystem to the loss of SE (SEN) and adaptive capacity (CA) SEN was calculated as the change in ecosystem service benefits caused by a given stressor; SEN indicator includes variables such as flow, capture (which is related to the spatial distribution of ecosystem services benefits received by population), and social value (degree of welfare and benefit sharing). CA, also is a composite indicator, where variables are grouped under the concepts of robustness, coupled and adapt. This protocol seeks explain vulnerability characteristic and its spatial distribution, for helping planners; also it's also accompanied by a set of spatial assessment tools that make it transferable to other institutions. Protocol works mainly with provision ecosystem services, especially provision of food for local circuits and water supply. See Figure 4.

Following the work initiated last year regarding the conceptualization of resilience (Aldunce et al, in revision), we addressed the incorporation of this concept to the vulnerability protocol described above by comparing vulnerability variables with key attributes of resilience in order to integrate the merged information into the vulnerability maps.

Coastal areas of Chile have been identified as vulnerable to changes in sediment transport, erosion of beaches, and wave height affecting port infrastructures (Magrin et al., 2014). Fuentes et al (in preparation) have assessed the treatment of vulnerability in the law with respect to impacts of climate change in coastal areas in Chile, identifying short-comings and potential solutions.

The Chilean model for water management is a unique example of neoliberal policies in which water is merely considered as an economic good to be ruled by the market (Bauer, 2005; Hearne and Donoso, 2005). This model is considered to have achieved technical and economic efficiency in its use of water but many problems have also been identified (Hearne and William Easter, 1997; Briscoe et al., 1998; Bauer, 2004; Budds, 2010; Mundial, 2011). Yáñez proposes a new framework emerging the perspective of human rights. The market approach is best implemented in Limarí basin in the semi-arid region of Coquimbo in Chile (~30°S). Urquiza has extensively studied social vulnerability in this basin. She shows that the free market model appears unable to cope under the water stress conditions observed over the past years. The current

government has launched several initiatives to deal with water resources. There is a presidential delegate in charge of coordinating an effort to define administrative and legal changes to water management. Also, a constitutional reform regarding water resources has been announced and it is being discussed in the Parliament. There, Dr. Yáñez made a presentation in which she emphasized the role of the State, and the need of highlighting the perspective human rights.

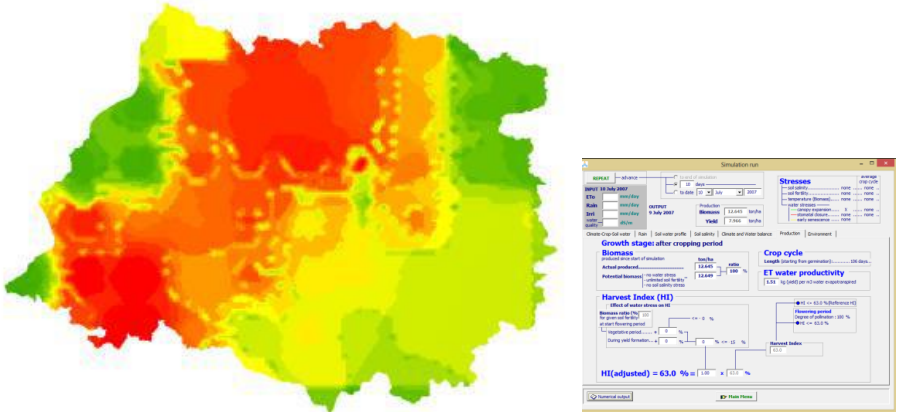


Figure 4. Example of vulnerability map outputs, and software interface.

The conceptualization of resilience developed in 2013 (Aldunce et al, in revision) was validated within the framework of a participative process with stakeholders and CR2 scientists. Workshops were organized with local stakeholders and CR2 researchers and students in Concepción, Santiago and Valdivia (75 participants). A synthesis of this work is ongoing. Main findings of this research refer to. Firstly, an "action-research" process is suitable, which is a relevant contribution in our country because these kind of approaches are rarely used in Chile. Secondly, key determinants of resilience to drought were identified in a participatory process. For the social systems these are information, preparation, adaptive capacity, technology and auto-organization. For the ecological systems these are diversity, connectivity, adaptation, and diversification. The information emerged from this analysis is now been integrated into the evaluations of practices and responses to drought. Also, the use of the resilience concept in public policy was analyzed using a bibliometric approach. Apparently, the concept is adopted loosely as an equivalent of adaptability and resistance. We analyzed the framing of climate change in the Chilean media. The Chilean media present climate change as a governmental issue linked to international agreements, relevant for the future and no so for the present, and with an emphasis for interest for the silvo-agricultural sector.

Other topics of research address the analyses of international negotiations of United Nations Framework Convention on Climate Change (UNFCC). The application of the principle of common but differentiated responsibilities has been analyzed, identifying difficulties. Justice, equity and common but differentiated responsibilities can be claimed by all Parties, sometimes with diametrically-opposed goals. Since the adoption of the Framework Convention (1992) and the Kyoto Protocol (1997), the structure of global carbon emissions has changed considerably, in particular as a result

of increased emissions from China. The principle, used as a shield by some and as a foil by others, is currently referred to frequently in difficult « post-2012 » and « post 2020 » negotiations, and its role is gradually changing (Maljean-Dubois and Moraga, 2014). Under the auspices of the Ministry for the Environment, we are now in the process of assessing the pros and cons of adopting a climate law and as well as alternative approaches.

The definition of climate damage within the framework of international law is being addressed. In fact, the growing severity of climate change impacts, the development of a clear definition of the concept of "climate damage" becomes essential in particular to determine whether it could trigger State liability in international law.

Climate finance is key in the international framework of climate change negotiations as recognized in the recent Conference of the Parties in Lima 2014. We analyzed this issue with respect to the Chilean energy sector (Araya et al). This work has been carried out in collaboration with Grupo de Financiamiento Climático para América Latina y el Caribe (GFLAC, http://www.gflac.org/), a group with whom we have signed an agreement.

E. Modeling and Observing Systems

We carry out research on methods for evaluating and developing integrated observing systems, ways to develop and improve integrated models, detection and attribution methodologies, etc.. Also, we support the establishment of data bases and computing systems.

In the previous year we reported on a statistical methodology for the quality – in terms of representativity and specificity- and evolution of monitoring networks (Osses et al., 2013). During 2014 we completed the development of a similar tool based on a variational approach (Henríquez et al, 2014 in review). In collaboration with personnel of the Chilean Weather Office we are now initiating the analysis of representativity and specificity of the precipitation and temperature networks.

To assess, quantify and provide a basis for predicting these changes, the World Meteorological Organization (WMO) has established the Global Atmospheric Watch program (GAW). Three stations were installed in Chile under the auspices of GAW and the Chilean Weather Office (DMC) by the mid 1990's. Namely, an O_3 sounding device on Easter Island (27ºS, 109ºW, 51 m.a.s.l.); a surface O_3 monitor, meteorological and radiation sensors at Cerro Tololo (30ºS, 70ºW, 2200 m.a.s.l.); and a multiband radiometer at Valdivia (39.8ºS, 73ºW, 10 m.a.s.l.). Unfortunately, the Valdivia station was destroyed in a fire in the mid-2000. Only a fraction of these data have been reported in the peer-reviewed literature. We have signed an agreement with the Chilean Weather Office to carry out analyses and make these data available for the international community via peer-reviewed publications. First we have analyzed 16 years of ozone soundings at Rapa Nui (Easter Island) producing a climatology and insights regarding dynamical and atmospheric chemistry processes relevant in this remote site of the Pacific (Henríquez, 2014). A similar analysis is now being performed for Cerro Tololo.

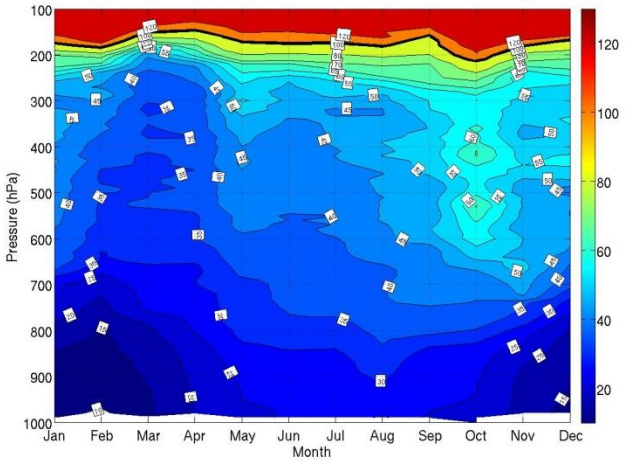


Figure 5. Standard climatology of tropospheric ozone soundings at Rapa Nui for the period 1994-2010. Ozone values are in ppbv and isolines are drawn every 5 ppbv from 10 to 80 ppbv, and every 20 ppbv after 80 ppbv. Vertical levels are indicated in pressure (hPa). The dark line corresponds to 100 ppbv ozone, i.e., the chemical tropopause level. Gallardo et al (in preparation).

A thorough analysis and validation of air quality data in collaboration with the Ministry for the Environment has been initiated. Our interest is to produce a benchmark dataset that will be proposed for future model development and validation and to characterize and examine the dispersion patterns of various key pollutants in Santiago. Furthermore, these dataset will serve to produce a climatology of urban aerosols using concurrent satellite retrievals and available sunphotometer data to estimate the evolution of aerosol forcing over Santiago. This makes use of ancillary data regarding aerosol composition and size distribution obtained in campaigns and by means of modeling (Escribano et al., 2014). In addition to this, we have started the implementation and evaluation of state-of-the-art modeling tools. The objective is to simulate and characterize the dispersion of urban pollutants in order to assess their impact on air quality, water resources, radiative balance, etc. These models are valuable tools in the assessment of the efficiency of policies aiming to improve air quality and/or reduce impact on climate.

The referred modeling tools will also be functional to assess the potential impacts of carbonaceous aerosols, particularly black carbon on the Andean cryosphere. A white paper has been prepared during 2014 addressing this issue under the international umbrella of the **P**ollution and its **I**mpact on the **S**outh **A**merican **C**ryosphere initiative (PISAC, http://www.mce2.org/activities/pisac). According to this review, even though changes in temperature and precipitation are major drivers for the observed glacier retreat and changes in snow coverage, available but scarce observations along the Andes as well as scientific evidence collected in other mountain ranges suggest an accelerating effect of black carbon. Also, new projects to assess specific aspects of the PISAC initiative have been granted and they will be initiated in 2015. Huneeus and co-workers will estimate the contribution of anthropogenic and open burning BC to the degradation of air quality in Santiago and Talca, and their characteristic dispersion

patterns, as well as their downwind transport on glaciers and snow covered areas of the Andean mountain range. To this end a combined modeling and observing approach will be used. Lambert and co-workers will analyze time series of elemental composition, as well as elemental, organic carbon and black carbon records in Santiago in the past two decades. Also, shallow ice-cores will be drilled on the Olivares/Juncal Sur glacier complex, where evidence of diesel and open burning have been found (Jenk et al., 2013). These analyses will be complemented by isotopic and chemical analyses of tree samples between the city of Santiago and the Olivares/Juncal Sur glaciers. In addition to this, we are in the process of implementing a system to characterize pyro aerosols and their evolution (Saide et al., 2014). We are using the fires observed in the summer of 2014 as case study. In combination to the previous, researchers from CR2 have started an international collaboration to estimate the biomass burning emissions in South America from a top down approach and explore the impact of model resolution on the estimate.

The capabilities being implemented to serve our process understanding, will also offer an opportunity to support the development of the new attainment plan for the Santiago metropolitan region and those of Southern Chile where wood and diesel burning represent important sources of aerosols with detrimental health impacts and possibly regionally relevant climatic forcing (Mena-Carrasco et al., 2014). Furthermore, CR2 researchers are participating in the upcoming report on short-lived climate pollutants for the Latin America and the Caribbean that is coordinated by the United Nations Environmental Programme (UNEP).

Previously we reported on the exploration of existing urbanization approaches in models at use, and methods to generate the needed urban canopy data, which are needed to describe the complex exchanges between urban areas and surrounding ecosystems. A software based on the footprint approach, using data provided by Google Maps and/or OpenStreetMap is being implemented for Santiago.

During 2014, a simple modeling system to produce useful projections of future sea level rise along the Chilean coast was further developed (Shaffer, 2014). The regionalization of the model outputs is pending (Albrecht, in preparation).

Climate variability and its impacts on the hydrological cycle along Chile and in South America are being analyzed using global and regional simulations as well as available observations. The shortening of the North and South American monsoon seasons has been studied (Arias et al, in review). Similarly, temporal changes in rainfall in Western Patagonia and the El Niño Southern Oscillation driven desertification of the semi-arid Atacama's Southern edge are being investigated (Rojas et al, Ortega et al, in preparation).

As a contribution to the mega drought studies, we have assessed the impact of projected increases in temperatures and decreased precipitation on the runoff of a number of representative river basins on the western side of the southern Andes (~30-40S) (Bozkurt et al, in preparation). We have used daily precipitation and temperatures from the CMIP5 ensemble simulations run under the RCP8.5 scenario throughout the 21st century to drive a hydrological model (the VIC model). The hydrological model simulations foresee that total annual runoff will decrease in the future (40-45% by the end of the century). Moreover, peak runoff timing tends to shift

to earlier days (3-5 weeks by the end of the century). Differences are found between pluvial and mixed pluvial-snow regime watersheds. Furthermore, the capabilities to predict surface temperature on decadal timescales over Chile and Southeast Pacific from a suite of climate simulations conducted within the Coupled Model Intercomparison Project Phase 5 (CMIP5) are being examined (Albrecht and Huneeus, in preparation). Future work will also consider precipitation projections.

In collaboration with CR2 scientists, data bases on temperature, precipitation, air quality data and model simulations have been compiled. To this end a storage and data server system has been installed (Annex 2). Also, the sunphotometer acquired in 2013 has been operational as part of the **AE**rosol **RO**botic **NET**work (http://aeronet.gsfc.nasa.gov/new_web/photo_db/Santiago_Beauchef.html). The Department of Geophysics, University of Chile supports a technician to maintain this instrumentation. This instrument, in addition the the wet deposition sampler and the wind profiler acquired this year, as well as the analytical platforms installed in the first year, and the buoy to be acquired soon have significantly enhanced the observational basis of our institutions and Chile in general.

V. SUGGESTIONS FROM PREVIOUS EVALUATION

Describe how the suggestions provided by the evaluation panel and the FONDECYT Council in its previous evaluation report were taken into account by the Center.

The first year evaluation provided by two anonymous reviewers were very positive. Their suggestions were very consistent with those provided by our national and international panels, and our own evaluation. In particular, the need for focusing on few but central and integrating questions; and the need to improve our outreach platforms were emphasized. Both actions were carried out during the second year. However, we still have to improve with respect to integrated research, public policy impact, and offering a nurturing environment for emerging scientists and students.

This year, a significant fraction of the scientific publications have a clear CR2 imprint; nevertheless, the majority of papers, particularly those of high impact, continue to be associated to a few researchers. The mega drought research initiated in 2014 should culminate in a substantial scientific output, with impact on policy making, and a clear CR2 branding. Also, the work on short-lived climate pollutants should provide a good stand point to strengthen the center's impact.

Outreach activities have continued at a very good pace in 2014 in spite of not having high profile events such as those of the first year. This reflects the recognition of the center as a reference in climate and resilience research, particularly among Chilean stakeholders and media. Next year we must clearly strengthen our regional and international outreach, including the production of more contents in English.

VI. PRODUCTS GENERATED BY THE PROJECT

In what follows, complete the attached Excel spreadsheets taking into account the following:

REPORT ONLY PUBLISHED MATERIAL INCLUDING THOSE WITH AN OFFICIAL DOI POINTER (e.g., with EARLY ONLINE ACCESS).

EXCEPT FOR BOOKS, ALL BACKUP DOCUMENTS MUST BE PRESENTED IN DIGITAL FORMAT. DO NOT SEND PRINTED COPIES.

ONLY PUBLICATIONS THAT ACKNOWLEDGE THE FONDAP PROGRAM WILL BE CONSIDERED.

1. ISI Publications

- ✓ *For each publication, if applicable, the principal author and the corresponding author must be indicated using the following terminology:*
  - *[1] For principal author (example: Toro[1], J.)*
  - *[2] For the corresponding author (example: Toro[2], J.)*
  - *[3] For principal and corresponding author (example: Toro[3], J.)*
- ✓ *Include a digital copy of each **PUBLISHED** paper.*

1. Aldunce, P., Handmer, J., Beilin, R., Howden, M.,2014. Is climate change framed as a 'business as ususal' or as a challenging isue? The practioners dilema. *Environment and Planning C*
2. Aldunce, P., Beilin, R., Howden, M. and Handmer, J. 2015. Resilience for disaster risk management in a changing climate: Practitioners' frames and practices. *Global Environmental Change* **30**, 1-11.
3. Barría, E. M., Santos, S., Jara, C. G. and Butler, C. J. Sexual dimorphism in the cephalothorax of freshwater crabs of genus Aegla Leach from Chile (Decapoda, Anomura, Aeglidae): an interspecific approach based on distance variables. *Zoomorphology*, 1-11.
4. Bozkurt, D., O.L. Sen and S. Hagemann, 2015. Projected river discharge in the Euphrates-Tigris Basin from a hydrological discharge model forced with RCM and GCM outputs. *Climate. Researche*. 62:131-147, doi:10.3354/cr01268.
5. Cornejo, M., Murillo, A. A. and Farías, L. 2015 Unaccounted N2O sink in the surface water of the Eastern Subtropical South Pacific: Physical Versus Biological Mechanisms. *Progress in Oceanography*.
6. Farías, L., Florez-Leiva, L., Besoain, V., Sarthou, G. and Fernández, C. 2014. Dissolved greenhouse gases (nitrous oxide and methane) associated with the naturally iron-fertilized Kerguelen region (KEOPS 2 cruise) in the Southern Ocean 2. *Biogeosciences Discussions*.

7. Flores, F., Garreaud, R. and Muñoz, R. C. 2014. OpenFOAM applied to the CFD simulation of turbulent buoyant atmospheric flows and pollutant dispersion inside large open pit mines under intense insolation. *Computers & Fluids* **90**, 72-87.
8. Galán, A., Faúndez, J., Thamdrup, B., Santibáñez, J. F. and Farías, L. 2014. Temporal dynamics of nitrogen loss in the coastal upwelling ecosystem off central Chile: Evidence of autotrophic denitrification through sulfide oxidation. *Limnology and Oceanography* **59**, 1865-1878.
9. Garreaud, R. D., Gabriela Nicora, M., Bürgesser, R. E. and Ávila, E. E. 2014. Lightning in Western Patagonia. *Journal of Geophysical Research: Atmospheres* **119**, 4471-4485.
10. Gayó, E. M., Latorre, C. and Santoro, C. M. 2014. Timing of occupation and regional settlement patterns revealed by time-series analyses of an archaeological radiocarbon database for the South-Central Andes (16°–25° S). *Quaternary International*,**356**, 4-14.
11. Jacques-Coper, M. and Garreaud, R. D. 2014. Characterization of the 1970s climate shift in South America. *International Journal of Climatology*.
12. Huneeus, N., Boucher, O., Alterskjær, K., Cole, J. N., Curry, C. L. and co-authors 2014. Forcings and feedbacks in the GeoMIP ensemble for a reduction in solar irradiance and increase in CO2. *Journal of Geophysical Research: Atmospheres*.
13. Iverson, L., Echeverria, C., Nahuelhual, L. and Luque, S. 2014. Ecosystem services in changing landscapes: An introduction. *Landscape Ecology* **29**, 181-186.
14. Jara, I. A. and Moreno, P. I. 2014. Climatic and disturbance influences on the temperate rainforests of northwestern Patagonia (40° S) since~ 14,500 cal yr BP. *Quaternary Science Reviews* **90**, 217-228.
15. Kerber, F., Querel, R., Rondanelli, R., Hanuschik, R., van den Ancker, M. and co-authors 2014. An episode of extremely low precipitable water vapour over Paranal observatory. *Monthly Notices of the Royal Astronomical Society*, stt2404.
16. Lamy, F., Gersonde, R., Winckler, G., Esper, O., Jaeschke, A. and co-authors 2014. Increased dust deposition in the Pacific Southern Ocean during glacial periods. *Science* **343**, 403-407.
17. Lara, A., Bahamondez, A., González-Reyes, A., Muñoz, A. A., Cuq, E. and co-authors 2014. Reconstructing streamflow variation of the Baker River from tree-rings in Northern Patagonia since 1765. *Journal of Hydrology*.
18. Little, C., Cuevas, J. G., Lara, A., Pino, M. and Schoenholtz, S. 2014. Buffer effects of streamside native forests on water provision in watersheds dominated by exotic forest plantations. Ecohydrology.
19. Mechoso, C., Wood, R., Weller, R., Bretherton, C., Clarke, A. and co-authors 2014. Ocean-cloud-atmosphere-land interactions in the Southeastern Pacific: The VOCALS Program. *Bulletin of the American Meteorological Society* **95**, 357-375.

20. Mohtadi, M., Prange, M., Oppo, D. W., De Pol-Holz, R., Merkel, U. and co-authors 2014. North Atlantic forcing of tropical Indian Ocean climate. *Nature* **509**, 76-80.
21. Moreno, P. I., Vilanova, I., Villa-Martínez, R., Garreaud, R., Rojas, M. and co-authors 2014. Southern Annular Mode-like changes in southwestern Patagonia at centennial timescales over the last three millennia. Nature communications 5.
22. Muñoz, A. A., Barichivich, J., Christie, D. A., Dorigo, W., Sauchyn, D. and co-authors 2014. Patterns and drivers of Araucaria araucana forest growth along a biophysical gradient in the northern Patagonian Andes: Linking tree rings with satellite observations of soil moisture. Austral Ecology 39, 158-169.
23. Nahuelhual, L., Carmona, A., Laterra, P., Barrena, J. and Aguayo, M.. 2014. A mapping approach to assess intangible cultural ecosystem services: the case of agriculture heritage in southern Chile.. *Ecological Indicators* **40**, 90-101.
24. Pesce, O. and Moreno, P. 2014. Vegetation, fire and climate change in central-east Isla Grande de Chiloé (43° S) since the Last Glacial Maximum, northwestern Patagonia. *Quaternary Science Reviews* **90**, 143-157.
25. Rahn, D. A. and Garreaud, R. D. 2014. A synoptic climatology of the near-surface wind along the west coast of South America. International Journal of Climatology 34, 780-792.
26. Romero-Mieres M, González M., Lara A.2014. Recuperación natural del bosque siempreverde afectado por tala rasa y quema en la Reserva Costera Valdiviana, Chile. *Bosque*, **35**, 257-267
27. Rondanelli, R., Molina, A. and Falvey, M. 2014. The Atacama Surface Solar Maximum. Bulletin of the American Meteorological Society.
28. Shaffer, G. 2014. Formulation, calibration and validation of the DAIS model (version 1), a simple Antarctic Ice Sheet model sensitive to variations of sea level and ocean subsurface temperature. Geoscientific Model Development Discussions 7, 1791-1827.
29. Ulrich, W., Soliveres, S., Maestre, F. T., Gotelli, N. J., Quero, J. L. and co-authors 2014. Climate and soil attributes determine plant species turnover in global drylands. Journal of Biogeography.
30. Urrutia-Jalabert, R., Rossi, S., Deslauriers, A., Malhi, Y. and Lara, A. 2015. Environmental correlates of stem radius change in the endangered Fitzroya cupressoides forests of southern Chile. Agricultural and Forest Meteorology 200, 209-221.
31. Viale, M. and Garreaud, R. 2014. Summer Precipitation Events over the Western Slope of the Subtropical Andes. Monthly Weather Review 142, 1074-1092.

2. Non ISI Publications

- ✓ *For each publication, if applicable, the principal author and the corresponding author must be indicated using the following terminology:*
  - *[1] For principal author (example: Toro[1], J.)*
  - *[2] For the corresponding author (example: Toro[2], J.)*
  - *[3] For principal and corresponding author (example: Toro[3], J.)*
- ✓ *Include a digital copy of each **PUBLISHED** paper.*

1. Garreaud R., and M. Viale, 2014: Anlisis de los fenmenos meteorológicos y climáticos que afectan la cuenca del río Maipo. Aquae Papers, 5, 17-29.
2. Maljean-Dubois, S. and Moraga, P. 2014. Le principe des responsabilités communes mais différenciées dans le régime international du climat. *Les Cahiers de droit* **55**.
3. Urquiza, A. and Cadenas, H. 2015. Sistemas socio-ecológicos: Elementos teóricos y conceptuales para la discusión en torno a vulnerabilidad hídrica. *L'Ordinaire des Amériques*.

3. Books and book chapters

- ✓ *Include a hard copy of every **PUBLISHED** book.*
- ✓ *Include a digital copy of the front page of the chapter in the case of a book chapter.*

1. Adler, C. E., Aldunce, P., Indvik, K., Alegría, D., Bórquez, R. and co-authors 2015. Climate resilience: taking stock, moving forward. In: *Research Handbook on Climate Governance* (ed. Lövbrand, K. B. E.). Edward Elgar.
2. Benedetti, A., Baldasano, J. M., Basart, S., Benincasa, F., Boucher, O. and co-authors 2014. Operational Dust Prediction. In: *Mineral Dust*. Springer, 223-265.
3. Díez, B. and Ininbergs, K. Ecological importance of cyanobacteria. *Cyanobacteria: An Economic Perspective*, 41-63.
4. González, M. E. 2014. Post-fire passive restoration of Andean *Araucaria–Nothofagus* forests. In: *THE STATE OF THE WORLD'S FOREST GENETIC RESOURCES –THEMATIC STUDY, GENETIC CONSIDERATIONS IN ECOSYSTEM RESTORATION USING NATIVE TREE SPECIES* (ed. Michele Bozzano, R. J., Evert Thomas,David Boshier,Leonardo Gallo,Stephen Cavers,Sándor Bordács,Paul Smith and Judy Loo). FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS and Bioversity International, Rome, Italy.
5. McPhee, J., Cortés, G., Rojas, M., Garcia, L., Descalzi, A. and co-authors 2014. Downscaling Climate Changes for Santiago: What Effects can be Expected? In: *Climate Adaptation Santiago*. Springer, 19-41.
6. Moraga, P. 2015. Regards sur certaines conventions environnementales en droit chilien : une contribution au développement d'une économie « bas-carbone ». In: *Contrat et environement* (ed. Bouttonet, M.), Paris.

7. Urquiza, A. 2014. Resiliencia y adaptación en sistemas organizacionales. In: *La Organización de las Organizaciones. Aplicaciones desde perspectivas sistémica*. RIL Editores, Santiago.

4. Patents

✓ *Include all patents generated by the FONDAP Center.*

5. Congress presentations

✓ *Include abstracts of all presentations. Attach a digital copy of the front page of the congress/workshop book.*

See excel tables.

6. Organization of Scientific Meetings

✓ *List all congresses, courses, conferences, symposia, or workshops organized by the FONDAP Center.*

✓ *Include abstracts of all presentations. Attach a digital copy of the front page of the congress/workshop book.*

See excel tables.

7. Collaborative Activities

✓ *List the scientific visits of Center members to international institutions*

✓ *List the scientific visits of foreign researchers to the Center in Chile.*

See excel tables.

8. Postdoctoral Fellows

✓ *List postdoctoral fellows working in the Center during the reported period regardless of their funding sources.*

✓ *Provide current affiliation and positions held by former postdoctoral fellows that left the Center during the reported period*

See excel tables.

9. Students

✓ *List titles of theses framed in the project completed during the reported period. Attach an abstract and the subject index.*

✓ *List titles of theses in progress, framed in the project, during the reported period. Include digital copies of the corresponding thesis registrations.*

- ✓ *Provide current affiliation and positions held by former students that graduated during the reported period*

See excel tables.

10. Funding Sources

- ✓ *List all funding sources including FONDAP.*

See excel tables.

VII. OTHER ACCOMPLISHMENTS

Report articles or notes published in the media (provide URL links, if available), awards, prizes, etc.

The engagement of our researchers is shown in the significant number of concurrent projects they have submitted during 2014 to competitive calls, the majority of which have been granted. Some of the projects are in collaboration with other institutions both in Chile and abroad.

Table VII-1. Projects submitted by CR2 researchers during 2014.

Project Title	Principal Investigator	Participants/Sponsor	Research area	Funding source	Country	Status
Coupled ocean-atmosphere interaction off central Chile	Aguirre, Catalina	Rojas, Maisa	MOS	Fondecyt-Postdoc 2014	Chile	Granted
Estrategias de adaptación local y su evaluación en Chile central	Aldunce, Paulina		HD	Fondecyt-Iniciación 2015	Chile	Granted
Dynamical mechanism of the projected drying trend in Chile	Boisier, Juan Pablo	Rondanelli, Roberto	BGC	Fondecyt-Postdoc 2014	Chile	Granted
Non-Enso Rainfall variability in Chile	Bozkurt, Deniz	Garreaud, René	CD	Fondecyt-Postdoc 2014	Chile	Granted
Black carbon in the Andean cryosphere	Cordero, Raúl	Huneeus, Nicolás, Rondanelli, Roberto, Lambert, Fabrice	MOS/BGC	Anillo en Ciencia y Tecnología	Chile	In review
N2O biological fixation	Diez, Beatriz		BGC	Fondecyt-Regular 2015	Chile	Granted
Plataforma integrada de observación costera y sus cuencas hidrográficas	Farías, Laura		BGC	Concurso CORFO-INOVA Bienes Publicos, Región del Bio Bio	Chile	Not granted
Julieta en la tierra de las Niñas	Otero, Sofía	Fariña, Luz	T	Explora, XIX Concurso, 2014	Chile	In review
Norte Claro, Sur Oscuro: Explicaciones populares a fenómenos meteorológicos	Zamora, Rosa	Gallardo, Laura	T	Explora, XIX Concurso, 2014	Chile	In review
La ruta del agua: Aprendizaje local para aplicación global	Bertín, Ariana	Eugenia Gayó, Fariña, Luz	T	Explora, XIX Concurso, 2014	Chile	In review
Plataforma de observación océano-atmósfera	Garreaud, René	Farías, Laura	CD/BGC	FONDEQUIP 2014	Chile	Granted
Orographic Precipitation in the Nahuelbuta Mountains (Southern Chile)	Garreaud, René		CD	EAGER, NSF, USA	USA	In review

Sendero Ambiental: Caminando hacia la restauración de los bosques	González, Mauro		T/ECO	Explora, XIX Concurso, 2014	Chile	In review
Nuevos mercados en el norte de Chile por mayor disponibilidad de agua producto de recarga artificial de acuíferos	Herrera, Paulo	O'Ryan, Raúl, Guerra, María Isabel	CD	Concurso CORFO-INOVA Bienes Publicos	Chile	Not granted
Dispersion modeling study of urban and rural black carbon in central Chile and its deposition to the Andean Cryosphere	Huneeus, Nicolás	Gallardo, Laura	MOS	Fondecyt-Regular 2015	Chile	Granted
Bici-aire: Mediciones ciudadana de calida del aire en Bicicleta	Huneeus, Nicolás	Fariña, Luz	T/MOS	Explora, XIX Concurso, 2014	Chile	In review
Top down estimates of biomass burning emissions in South America	Huneeus, Nicolás	Osses, Axel	MOS	ECOS-Conicyt	Chile-France	Granted
Climatic effects of dust aerosols	Lambert, Fabrice		MOS	Redes PCI	Chile-France-USA	Not granted
Santiago Pollution in Andean Mountains	Lambert, Fabrice	Muñoz, Ariel, Fernandoy, Francisco	MOS	Fondecyt-Regular 2015	Chile	Granted
Proposal for a legal framework to address climate change in Chile	Moraga, Pilar		HD	UK regional Prosperty Fund for Latin American	United Kingdom	In review
Legal frameworks for wáter resources	Moraga, Pilar		HD	Redes PCI	Chile-USA	Not granted
Sistema de evaluación de intangibles socio-ecológicos y servicios ecosistémicos	Nahuelhual, Laura		HD	Fondecyt-Regular 2015	Chile	Granted
Inverse Problems in Physical Sciences and Engineering	Osses, Axel		MOS	Fondecyt-Regular 2015	Chile	Granted
Origin, distribution and regional climate forcing of absorbing aerosols in Central Chile	Pistone, Kristina	Gallardo, Laura	MOS		Chile	Not granted
Coastal clouds in northern Chile	Rondanelli, Roberto	Rutllant, José	BGC	Fondecyt-Regular 2015	Chile	Not granted
Plataforma de Evaluación de Vulnerabilidad al cambio climatico y su integracion a la gestión ambiental	Urquiza, Anahí	Nahuelhual, Laura, Carmona, Alejandra, Aldunce, Paulina, Guerra, María Isabel	HD	Programa IDeA FONDEF 2014	Chile	In review
Ciclo del nitrato en ríos del centro sur de Chile	Yévenes, Mariela	Farías, Laura	BGC	Fondecyt-Postdoc 2014	Chile	Granted

We also successfully proposed Dr. Guy Brasseur, member of our international panel, for the Abate Molina prize. His presence during 4 months in 2015 will enhance the development of climate services.

There are also publications produced by our researchers that do not acknowledge the center, nevertheless, they are relevant to it:

1. Caniupán, M., Lamy, F., Lange, C. B., Kaiser, J., Kilian, R. and co-authors 2014. Holocene sea-surface temperature variability in the Chilean fjord region. *Quaternary Research*.
2. Mujica, M. I., Latorre, C., Maldonado, A., González-Silvestre, L., Pinto, R. and co-authors 2015. Late Quaternary climate change, relict populations and present-day refugia in the northern Atacama Desert: a case study from Quebrada La Higuera (18° S). *Journal of Biogeography* **42**, 76-88.
3. Pérez, G., Farías, L., Fernandez, C., Conde, D. and Piccini, C. 2014. Incidence of phytoplankton and environmental conditions on the bacterial ammonium uptake in a subtropical coastal lagoon. *Journal of Limnology* **73**.
4. Romero-Lankao, P., Hughes, S., Qin, H., Hardoy, J., Rosas-Huerta, A. and co-authors 2014. Scale, urban risk and adaptation capacity in neighborhoods of Latin American cities. *Habitat International* **42**, 224-235.

Also, several publications are being reviewed in international journals.

Within the framework of the Conference of the Parties of the United Nations Climate Convention (COP) held in Lima, Peru, Dr. Pilar Moraga and colleagues at the Center for Environmental law, Universidad de Chile, and Luz Fariña at our Center produced 8 numbers of a bilingual monthly bulletin oriented towards policy makers, and law practitioners. The following articles were published as monthly interviews and distributed to stakeholders in Chile and elsewhere during the COP at Lima.

1. Pirazolli, A. The challenges at COP 20. Bulletin 1, March 2014.
2. Zaccai, E. The role of the state in adaptation to climate change. Bulletin 2, April, 2014
3. Guzmán, S. and Fuentes, P. Climate finance. Bulletin 3, May, 2014
4. Neyret, L. Liability for Climate Change. Bulletin 4, June, 2014.
5. Salzman, J. The incompatibility between "green policies" and international trade in the new climate regime. Bulletin 5, August, 2014
6. Gehring, M.. International trade law and climate change. Bulletin 6, September 2014
7. Gallardo, L. and Nahuelhual, L. Gender and climate change. Bulletin 7, October, 2014
8. Boutonnet, M., Contract: an instrument in the battle against climate change. Bulletin 8, November, 2014.

Regarding collaboration among our research associates, we see a slight progression between 2013 and 2014 as sketched in Figure 6.

	Individual productivity	In Collaboration	Research area	L Gallardo	N. Huneeus	A. Osses	M. Rojas	G. Shaffer	F. Lambert	M. Fiebig	R Garreaud	P Moreno	D Christie	P Herrera	R Villa	L Farias	M Yevenes	M Cornejo	R DePol	B. Diez	R Rondanelli	A Lara	C Little	S Gomez	M Gonzalez	C Jara	P Moraga	P Aldunce	L Nahuelhual	A Carmona	R. Bórquez
L Gallardo	2	50%		1,0		0,5															0,5									
N. Huneeus	1	100%			1,0																									
A. Osses	1	50%		0,5		0,5																								
M. Rojas	2	100%					0,7				0,7	0,2		0,2				0,2												
G. Shaffer	2	100%						2,0																						
F. Lambert	1	100%							1,0																					
M. Fiebig	0	NA	7,2							0,0																				
R Garreaud	12	11%				0,7					10,7	0,2		0,2				0,2												
P Moreno	7	19%				0,2					0,2	5,7		0,7				0,2												
D Christie	4	17%											3,3									0,3		0,3						
P Herrera	0	NA												0,0																
R Villa	2	65%	22,6			0,2					0,2	0,7		0,7				0,2												
L Farias	5	10%													4,5		0,5													
M Yevenes	0	NA														0,0														
M Cornejo	1	50%													0,5		0,5													
R DePol	7	11%				0,2					0,2	0,2		0,2				6,2												
B. Diez	0	NA																	0,0											
R Rondanelli	3	17%	14,7	0,5																2,5										
A Lara	3	39%											0,3								1,8	0,5		0,3						
C Little	1	50%																			0,5	0,5								
S Gomez	0	NA																					0,0							
M Gonzalez	1	67%											0,3								0,3			0,3						
C Jara	1	0%	5,3																						1,0					
P Moraga	1	0%																								1,0				
P Aldunce	2	0%																									2,0			
L Nahuelhual	2	25%																										1,5	0,5	
A Carmona	1	50%																										0,5	0,5	
R. Bórquez	1	0%	7,0																											1,0
																														51,0

Figure 6. Sketch of individual and collaborative productivity in terms of indexed papers by CR2 researchers between 2013 and 2014. The individual contribution to one paper is pondered by the number of authors. The figure was suggested by Dr. Carlos Saavedra.

VIII. SUGGESTIONS

What recommendations would you make to the FONDAP Program Office to improve the performance of the Center and the review process? Please describe.

During the first year we indicated the need of being able to generate proper contracts for the support personnel. This is now possible and we initiated in late 2014 the corresponding calls according to hiring rules for public servants.

Again, we repeat the need for establishing better indicator than those included in the annexed tables to evaluate to what extent there is interdisciplinary and transdisciplinary research. This is particularly relevant as our center and others are expected to have an impact in public and private policies. Evaluating this is not straightforward, and there is a need to find ways to better assess such achievements. This has been discussed at length in previous meetings. Perhaps, one should consider consultancies from experts in the field, which is per se a growing area of research. The facilitation of meetings and gatherings by CONICYT with stakeholders would be very valuable for centers as CR2.

A common standardized, on-line platform for accounting purposes would be much appreciated. We are aware of development in centers like ours but it appears more suitable to have a platform under CONICYT similar to that used by the FONDECYT program. Also, to coordinate in a central platform the submission of post-doctoral proposal would be useful.

A final suggestion is to promote inter center meetings not only among principal investigators but also, at least every two years, among researchers and post-doctoral fellows. Perhaps, a fair would provide a meeting place for exchange and a good way to highlight the achievements of the program.

ANNEXES

Annex 1. List of papers submitted to the scientific symposium held in Roca Negra

A. Mega drought abstracts

Los impactos de cambios en la disponibilidad de recursos hídricos a través de la vertiente occidental de los Andes centrales (16°-25°S): una perspectiva histórica / (E Gayó)

Nitrato en Ríos / (M Yévenes)

Rivers discharge and their influence on phytoplankton biomass during drought period in central coastal areas of Chile / (I Masotti, P Aparicio, R Garreaud, L Farías)

Centennial- and Millennial-Scale Changes of the Southern Westerly Winds Since 15 Ka in Southwestern Patagonia / (P Moreno, I Vilanova, R Villa-Martínez,R De Pol-Holz, R Garreaud, M Rojas)

Hydrological Changes in the Semiarid Andes / (D Christie, C LeQuesne, M Morales, M Vuille, R Villalba, M Masiokas, R Garreaud, B Francou)

Identifying role of subtropical southeast Pacific SST anomalies on precipitation dynamics in central Chile / (D Bozkurt, R Garreaud)

La Mega Sequía 2009-2014 en Chile Central: Causas y Consecuencias / (R Garreaud)

Análisis de cambio de cobertura de uso de suelo entre el año 2001 y 2015 y su relación con la cartografía de evapotranspiración real en las cuencas de Purapel y Cauquenes, región del Maule. / (M Galleguillos, B Sotomayor, A Bravo, E Cruz, C Little, A Lara)

Combined production of timber and water provision as an ecosystem service as a function of land use and vegetation cover in two contrasting watersheds in the Maule Region. / (E Cruz, A Lara, C Little, C Pérez)

Comprensión del efecto de la megasequía en el régimen de fuego de la región central de Chile / (M Gonzalez, A Lara, I Díaz, C Little, S Gómez, R Garreaud)

Reconstructing streamflow variation of the Baker River from tree-rings in Northern Patagonia since 1765 / (A Lara, A Bahamondez, A González-Reyes, A Muñoz, E Cuq, C Ruiz-Gómez)

Evaluación de la Distribución del Agua en Cuencas de la Comuna de Río Bueno (Región de los Ríos) a través del Concepto de Huella Hídrica / (D Mella, L Nahuelhual, A Carmona)

La Respuesta Del Estado Frente A La Sequía En Chile / (P Moraga)

Los problemas de equidad y sustentabilidad del modelo chileno de aguas desde la perspectiva de los derechos fundamentales y lineamientos para una reforma al régimen de aguas / (N Yáñez)

Respuestas y prácticas para combatir la mega sequía en Chile / (P Aldunce, G Lillo, C Carrasco, M Vidal, R Garreaud)

Variabilidad climática y agricultura en Chile: Evidencias del efecto negativo de la sequía sobre la productividad de trigo en la zona central de Chile. / (J Rivera, L Nahuelhual)

Vulnerabilidad Hídrica en la Cuenca del Limarí. Un análisis de las condiciones socioculturales del modelo de gestión de aguas / (A Urquiza)
Near-term temperature predictability over Chile / (F Albrecht, N Huneeus)
Proyecciones de Cambio climático en la zona centro-sur de Chile para el siglo XXI / (M Rojas, D Bozkurt, J Valdivieso)

B. Other abstracts

El concepto de mitigación de emisiones de gases de efecto invernadero en ecosistemas naturales e intervenidos / (L Farías)
The Atacama Surface Solar Maximum / (R Rondanelli, A Molina, M Falvey)
Assessing the Influence of Precipitation on Diurnal Temperature Range Changes: Implications for Climate Change Projections / (C Van den Hoof, R Garreaud)
Modelación numérica de los efectos de la variabilidad climática sobre la utilización sustentable del acuífero de la cuenca del río San José, Arica / (I Balic, R Garreaud, P Herrera)
Influencia de Disturbios Antrópicos en la Respuesta del Bosque Siempreverde en la Cordillera de la Costa Valdiviana / (M Romero-Mieres, M González, A Lara)
Influencia de la caída de tefra en los patrones de crecimiento de los bosques subandinos durante los últimos 200 años en el Parque Nacional Puyehue / (M Montiel, M González, D Christie, A Lara)
Parámetros de metabolismo ecosistémico como indicadores de la resiliencia de ambientes lóticos. / (C Jara; J Nimpstch; I Esquivel y C Becerra)
Quince años de restauración de Araucaria araucana en la cordillera de la costa de Chile / (M Cortés, A Lara)
Análisis De Discurso A Medios De Comunicación Digitales En Chile Respecto Al Cambio Climático: Encuadres Para La Construcción De Las Agendas Pública Y Política / (J Hasbún, P Aldunce, G Blanco, R Browne, R Bórquez)
Efectividad del Principio de Participación en el Proceso de Definición de los Planes de Adaptación en Chile / (P Moraga, G Araya)
El Financiamiento Del Cambio Climático, Análisis Del Sector Energético Chileno / (G Araya)
El Principio de las Responsabilidades Comunes y Diferenciadas en el Contexto de las Actuales Negociaciones Internacionales de Cambio Climático, en Miras a 2015 / (P Moraga)
Evaluación de los componentes de vulnerabilidad al cambio climático basado en el servicio ecosistémicos de provisión de alimentos. / (A Carmona, L Nahuelhual)
Evidence-based environmental policy in the 21st century / (R Arriagada)
Exposición a eventos climáticos y políticas públicas: un análisis espacial en la región de Los Ríos / (R Santander, L Nahuelhual, A Carmona, R Garreaud)
Interface ciencia-política en el contexto de la resiliencia al cambio climático / (A Alegría, P Aldunce, R Bórquez, P Moraga)
La Incorporación de la Vulnerabilidad a los Impactos del Cambio Climatico al Marco Normativo de la Planificación Territorial que Regula las Zonas Costeras en Chile / (M Fuentes)
La Necesidad De Una Ley De Cambio Climático Para Chile / (P Moraga)

The problematic absence of a definition for "climate damage" / (N Kugler)
Analysis and optimal design of air quality monitoring networks using a variational approach / (A Henríquez, A Osses, L Gallardo, M Diaz)
Bases de Datos y Recursos Computacionales CR2 / (F Munoz, M Bravo)
Estratificación vertical y trasporte viento abajo de contaminantes urbanos en Santiago / (A Orfanoz, L Gallardo, N Huneeus)
Obliquity effects over the meridional heat transport / (P Nowajewski, M Rojas, R Rondanelli, P Rojo)
Ozone in Rapa Nui: 16 years of data / (L Gallardo, A Henríquez, P Velasquez, R Rondanelli)
Ozono y otras trazas en Cerro Tololo / (P Velasquez)
Pollution and its Impacts on the South American Cryosphere (PISAC) / (L Gallardo, A Molina, F Lambert, N Huneeus, R Garreaud)
Santiago Pollution in Andean Mountains / (F Lambert)
Sistema de obtención de dosel urbano para modelos atmosféricos de alta resolución / (M Bravo, N Hitschfeld, L Gallardo)
Urban pollution, air quality and climate / (N Huneeus)

Annex 2. Data bases and computational infrastructure

During 2014, the unit of Data and Computing Resources was implemented. Among its goals, is to maintain and make available in scientific format, various databases of interest to the Center. Depending on its soundness and privacy levels, these databases can be obtained publicly from the internet or internally through the storage server. It also aims to manage and provide to the Center of high performance computing environments, as well as large storage capacity, for the performance of climatic simulations through earth system models.

The data available has been gathered from various national or international sources, through websites or ftp transferences. We have access to institution's public and internal observations databases, like DMC (Dirección Meteorológica de Chile), DGA (Dirección General de Aguas), MMA (Ministerio del Medio Ambiente), gridded results of regional model runs, as well as local copies of global gridded data. A summary of these data is presented here.

A. OBSERVATIONAL DATA

i. Chilean Weather Office (DMC)

- From the website of DMC, we download daily values for Precipitation, Maximum, Minimum and Mean Temperature. For Precipitation, accumulated values every 6 hours are also available. For Maximum and Minimum Temperature, the time of occurrence is available. These stations are the most stable ones, mainly present at airports.

- From the University of Chile project, "ACT 19", we obtained daily values for Precipitation, Maximum, Minimum Temperature, in excel format. This data complemented the one downloaded from the website in many cases.

- From DMC's internal Saclim database, we are weekly fed 12 hourly meteorological variables and indicators through ftp transference. These include: Wind Direction, Wind Speed, Humidity, Atmospheric Pressure, 6 hours accumulated Precipitation, Daily Maximum and Minimum Temperature, Temperature.

- From other DMC sources, they collected in excel files the accumulated daily Precipitation, for 69 stations (other than those described above), different from the ones available publicly.

ii. Water Management Authority (DGA)

- From the website of DGA, we download daily values for Precipitation, Maximum, Minimum and Mean Temperature, as well as River Flow and drainage area for each station location when available.

iii. Ministry for the Environment (MMA)

- From MMA's internal database system, based on swedish software Airviro, we can access hourly and daily values for Air Quality related data (PM10, PM2.5, CO, CH4, SO2, NO, NO2, NOx, Ozone) and meteorological related (wind, temperature, precipitation, humidity, radiation). The regional data is being subject of revision, since the instrument operators are external from MMA.
- From MMA's internal database system, based on Swedish software Airviro, we can access reference data of 5, 15 and 30 minutes, as well as hourly and daily values for Air Quality related data, Particulate Matter and Gases (PM10, PM2.5, CO, CH4, SO2, NO, NO2, NOx, Ozone) and meteorological related (wind, temperature, precipitation, humidity, radiation). This data is being subject of revision, since there are some inconsistencies and probable mismatch in the assigned time values between different variable observations.
- MMA handled an excel file with Black Carbon data, from 1 Station in the Metropolitan Region, including 7 measuring length waves, measured every 5 minutes. An analysis report was submitted back to MMA.

B. Model outputs

i. Regional model outputs

- Precis-ECHAM from project Anillos SOC28:- Regional Grids, 1950-2100. Data obtained from PRECIS simulations, over various regions in Chile using global ECHAM5-A1B model as boundary condition and 25km resolution.
- PRECIS Precis from project Precis-CONAMA and Anillos ACT-19:- Regional Grids, 2071-2100. Data obtained PRECIS simulations, over various regions in Chile using HadCM3 model as lateral boundary condition and 25km resolution.
- PRECIS Precis from ERA-40 Fondecyt:- Regional Grids, 2071-2100. Data obtained PRECIS simulations, over various regions in Chile using era40 as boundary condition

ii. Global model outputs

- CMIP5-CMIP3 Earth System Grid FederationGlobal Grids, Various Experiments and Variables. From the data available in the Earth System Grid Federation website, we have downloaded 9Terabytes of data. The subset includes models and variables for the following Experiments: Historical, Decadal, RPC (26, 85), PiControl, MidHolocene, Lgm, Past1000. These files are available from the Computing Server Camanchaca, and the Data Server Qhawayra for all researchers of CR2.

C. Computing system

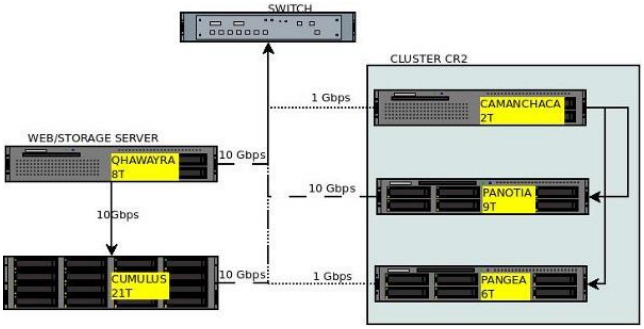
Our initial intention was to perform our model simulations in the High Performance Computing (HPC) system run by the Center for Mathematical Model and the HPC laboratory. At this lab we have run shorter, less demanding simulations.

However, the installation of the new system and the lack of an appropriate storage system for our data intensive simulations, we decided to establish a distributed computing cluster (Rocks operative system based on Centos) and two computing nodes. Also a storage device is available, with 21 Terabytes capacity, as well as a Storage and Web Server.

In sum, the milestones of the years were:

- ✓ Signature of an Agreement of Cooperation and Information Transfer with DMC
- ✓ Data Download from DMC and DGA (Temperature, Precipitation and River Flow) from up to 800 stations in Chile
- ✓ Revision of Temperature and Precipitation data compiled from DMC and DGA sources mainly. Generation of a compiled data set in scientific format, that has made publicly available, and counts up to 140 downloads (precipitation is the most downloaded variable with 140 hits, followed by river flow with 90, and temperature with 60-70)
- ✓ MMA Data Access: 5, 15, 30 minutes as well as hourly and daily Air Quality and Meteorological variables for the Metropolitan Region, hourly and daily data for the rest of the country
- ✓ Global data (CMIP3 and CMIP5) from the Modeling and Observations System area, has been organised, and increased the amount of downloaded data from 6Terabytes to 9 Terabytes. Regarding regional gridded data, the results from PRECIS regional simulations are available locally, and are detailed on a structured inventory.
- ✓ Preparation of the Terms and Conditions for implementing a Climate Explorer (computerised visualisation system that allows geographical navigation as well as display and extract time series of interest.

The summary of the in house computing capacity can be seen in the following scheme.



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Annex 4. In the media

Date	Medium	Format	Type	Title	Who	Theme	Link
07-01-2014	La Tercera	Papel	Noticia	CDEC-SIC proyecta año seco para 2014 y expertos ven alza en costo de energía	Garreaud	Sequia	http://www.latercera.com/noticia/negocios/2014/01/655-559526-9-cdecsic-proyecta-ano-seco-para-2014-y-expertos-ven-alza-en-costo-de-energia.shtml
07-01-2014	LUN	Papel	Noticia	Satélite de la NASA captó todos los incendios que afectan al país	Garreaud	Incendios Forestales	http://www.lun.com/pages/detail-view.htm?enviar=%2FPages%2FNewsDetail.aspx%3Fdt%3D2014-01-07%26NewsID%3D251927%26BodyID%3D0%26PaginaId%3D6%26SupplementID%3D0
06-01-2014	La Tercera	Papel	Carta al Director	Plantaciones forestales e incendios	González	Incendios Forestales	http://www.latercera.com/noticia/opinion/correos-de-los-lectores/2014/01/896-559314-9-plantaciones-forestales-e-incendios.shtml
07-01-2014	El Mostrador	Digital	Columna de Opinión	Plantaciones forestales, incendios y restauración ecológica	González	Incendios Forestales	http://www.elmostrador.cl/opinion/2014/01/07/plantaciones-forestales-incendios-y-restauracion-ecologica/
10-01-2014	El Dinamo.cl	Digital	Columna de Opinión	Causas y efectos de los incendios en el centro-sur de Chile	Gómez	Incendios Forestales	http://www.eldinamo.cl/blog/causas-y-efectos-de-los-incendios-en-el-centro-sur-de-chile/
10-01-2014	TVN	TV	Entrevista	Entrevista a L.Gallardo sobre tormenta eléctrica y ola de calor en Argentina	Gallardo	Eventos extremos	TVN
10-01-2014	ElDesconcierto.cl	Digital	Columna de Opinión (Análisis)	Incendios forestales, calidad del aire y temperaturas extremas	Garreaud	Incendios Forestales	http://eldesconcierto.cl/incendios-forestales-calidad-del-aire-y-temperaturas-extremas/
22-01-2014	Bnamerica.cl	Digital	Entrevista	Cambio climático es una realidad en regiones de centro y sur de Chile, según experta	Gallardo	Cambio climático Chile	http://www.bnamericas.com/news/aguasyresiduos/cambio-climatico-es-una-realidad-en-regiones-de-centro-y-sur-de-chile-segun-experta
27-01-2014	Radio Universidad de Chile	Radio	Entrevista	Entrevista en el programa Milenio, en sintonía con la ciencia	Aldunce	Resiliencia	http://radio.uchile.cl/programas/milenio/milenio-85
10-02-2014	Radio Universidad de Chile	Radio	Entrevista	Entrevista en el programa Milenio, en sintonía con la ciencia	Rojas	Paleoclima	http://radio.uchile.cl/programas/milenio/milenio-83
04-02-2014	Radio BioBio	Radio	Entrevista	Entrevista a R. Rondanelli sobre clima en Chile	Rondanelli	Clima	
24-02-2014	Radio Futuro	Radio	Entrevista	Entrevista a Maisa Rojas sobre sequia	Rojas	Sequia	
07-03-2014	El Dinamo.cl	Digital	Columna	Mujeres y Cambio Climático	Aldunce	Género	http://www.eldinamo.cl/blog/mujeres-y-cambio-climatico/
11-03-2014	El Mostrador	Digital	Columna	Los gametos más grandes (les) hacen	Gallardo	Género	http://www.elmostrador.cl/opinion/2014/03/11/los-gametos-mas-grandes-le-

				bien (a) la ciencia y la tecnología			hacen-bien-a-la-ciencia-y-la-tecnologia/
15-03-2014	La Tercera	Papel	Noticia	Los acelerados escépticos del cambio climático	Garreaud/ Rojas	Cambio climático	http://www.latercera.com/noticia/tendencias/2014/03/659-569759-9-los-acelerados-escepticos-del-cambio-climatico.shtml
19-03-2014	La Tercera	Papel	Noticia	Cambio climático: informe de la ONU alerta que afectará economía mundial	Aldunce/Rojas	IPCC	http://www.latercera.com/noticia/tendencias/2014/03/659-570317-9-cambio-climatico-informe-de-la-onu-alerta-que-afectara-economia-mundial.shtml
19-03-2014	Canal13	TV	Entrevista	El fenómeno de El Niño	Garreaud	El Niño	
31-03-2014	El Dinamo.cl	Digital	Noticia	Cambio climático en Chile: Expertas apuntan disminución del agua y cambios en temperaturas	IPCC	Aldunce	http://www.eldinamo.cl/2014/03/31/cambio-climatico-en-chile-expertas-apuntan-disminucion-del-agua-y-cambios-en-temperaturas/
01-04-2014	La Tercera	Papel	Noticia	Menor disponibilidad de agua, principal impacto del cambio climático en Chile	IPCC	Aldunce	http://www.latercera.com/noticia/tendencias/2014/04/659-572077-9-menor-disponibilidad-de-agua-principal-impacto-del-cambio-climatico-en-chile.shtml
02-04-2014	Radio.Uchile.cl	Digital	Noticia	Informe ONU vincula cambio climático al aumento de pobreza y enfermedades	IPCC	Aldunce	http://radio.uchile.cl/2014/04/02/informe-onu-sobre-cambio-climatico-advierte-consecuencias-en-pobreza-salud-y-territorio
01-04-2014	El Mercurio	Papel	Noticia	El cambio climático aumenta los riesgos de conflictos y hambrunas en el mundo	IPCC	Aldunce	http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2014-04-01&NewsID=216553&dtB=01-04-2014+0%3A00%3A00&BodyID=1&PaginaId=10
04-04-2014	Radio Universidad de Chile	Radio	Entrevista	IPCC	IPCC	Aldunce	http://radio.uchile.cl/wp-content/uploads/2014/04/semaforo-04-04-14-sergio-rodriguez-venezuela-tono-freire-cultura.mp3
25-04-2014	El Mercurio	Papel	Noticia	Fenómeno "El Niño" previsto para el invierno no sería tan intenso como se ha evidenciado	Garreaud	El Niño	http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2014-04-25&NewsID=222542&dtB=25-04-2014+0%3A00%3A00&BodyID=1&PaginaId=10
03-05-2014	LUN	Papel	Noticia	La Nasa Captó Sistema Frontal que está sobre Chile	Rondanelli	El Niño	http://www.lun.com/Pages/NewsDetail.aspx?dt=2014-05-03&NewsID=271466&BodyID=0&PaginaId=2
05-05-2014	La Tercera	Papel	Noticia	Dirección Meteorológica: 2003-2013 es la década más seca de los últimos 150 años	Garreaud	Sequía/El Niño	http://www.latercera.com/noticia/tendencias/2014/05/659-576562-9-direccion-meteorologica-20032013-es-la-decada-mas-seca-de-los-ultimos-150-anos.shtml
30-04-2014	La Segunda	Papel	Noticia	La Apuesta del (Cr)2 por influir en las Políticas Ambientales	Gallardo	Cr2	http://www.la2da.cl/Pages/NewsDetail.aspx?dt=2014-04-30&PaginaId=8&SupplementId=4&bodyid=0

30-04-2014	La Segunda	Papel	Noticia	Llega El Niño: El Regreso de los paraguas?	Garreaud	Sequiía	http://www.la2da.cl/Pages/NewsDetail.aspx?dt=2014-04-30&PaginaId=4&SupplementId=4&BodyId=0
18-04-2014	El Dínamo	Digital	Columna de Opinión	Crónica de un desastre esperado en Valparaíso	Gomez	Incendios Forestales	http://www.eldinamo.cl/blog/cronica-de-un-desastre-esperado-en-valparaiso/
30-04-2014	Radio Universidad de Chile	Radio	Entrevista	Expertos vinculan cambio climático con alza de desastres naturales en EEUU			http://radio.uchile.cl/2014/04/30/expertos-advierten-aumento-de-desastres-naturales-y-conflictos-sociales
13-05-2014	La Tercera	Papel	Noticia	¿Por qué no llueve en Santiago?	Garreaud	El Nino	http://www.latercera.com/noticia/tendencias/2014/05/659-577843-9-por-que-no-llueve-en-santiago.shtml
19-05-2014	El Mostrador	Digital	Reportaje	La deuda pendiente de Bachelet con los glaciares chilenos	Borquez	Glaciares	http://www.elmostrador.cl/2014/05/19/la-deuda-pendiente-de-bachelet-con-los-glaciares-chilenos/
09-05-2014	LUN	Papel	Noticia	El Niño sí se está acercando	Rondanelli	El Nino	http://www.lun.com/Pages/NewsDetail.aspx?dt=2014-05-09&NewsID=271937&BodyID=0&PaginaId=10
06-06-2014	La Segunda	Papel	Noticia	Cambio Climático: Enemigo al Acecho	Garreaud	Clima	http://www.cr2.cl/wp-content/uploads/2014/06/La-Segunda-Digital_5-de-junio.pdf http://www.cr2.cl/wp-content/uploads/2014/06/La-Segunda-Digital_5junio2.pdf
21-05-2014	HispanTv.cl	Audivisual	Reportaje	La Gran Historia - Chile: Contaminación ambiental	Gallardo	Contaminación	http://t.co/1Eni0E9Dvf
22-06-2014	El Mercurio	Papel	Reportaje	Por qué no todos creen en el cambio climático	Rojas/Rondanelli	Ipcc	http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2014-06-21&PaginaId=4&BodyId=9
07-07-2014	Radio Universidad de Chile	Radio	Entrevista	Pronóstico Meteorológicos	Rondanelli	Meteorología	http://radio.uchile.cl/programas/milenio/vicky-quevedo-conversa-con-liliana-iturriaga-y-peter-kennedy-sobre-el-trabajo-que-realizan-y-la-nueva-version-del-curso-biodiversidad-y-conservacion-de-humedales-en-la-region-metropolitana-ademas-r
01-06-2014	Revista Beauchef	Papel	Entrevista	Último informe del IPCC: Evidencias del calentamiento global	Rojas	Ipcc	http://ingenieria.uchile.cl/publicaciones/101342/edicion-1er-semestre-2014-la-nueva-mineria-chilena
09-06-2014	LUN	Papel	Noticia	Tres Meteorólogos analizan el nuevo frente: Es Potente	Rondanelli	Meteorología	http://www.lun.com/lunmobile//pages/NewsDetailMobile.aspx?IsNPHR=1&dt=2014-06-09&NewsID=0&BodyId=0&PaginaID=25&Name=25&PagNum=2&SupplementId=0&Anchor=20140609_25_0_0
14-07-2014	El Mercurio	Papel	Noticia	La Patagonia también tuvo períodos de clima más cálido en el pasado remoto	Moreno/Garreud	Paleoclima	http://webcache.googleusercontent.com/search?q=cache:RT2JSPcuwYcJ:impresa.elmercurio.com/mermobile/HomePage.aspx%3Fqs%3D2%26dt%3D2014-07-10+&cd=2&hl=es-419&ct=clnk&client=safari

23-07-2014	UCV TV	TV	Entrevista	Clima	Rojas	Cambio Climático	
25-07-2014	Canal13	TV	Entrevista	Cambio Climático y Biodiversidad	Aldunce	Biodiversidad	
18-08-2014	La Tercera	Papel	Noticia	Santiago registró ayer la temperatura más alta de agosto en los últimos 41 años	Rondanelli	Clima	http://diario.latercera.com/2014/08/18/01/contenido/pais/31-171148-9-santiago-registro-ayer-la-temperatura-mas-alta-de-agosto-en-los-ultimos-41-anos.shtml
19-08-2014	La Tercera	Papel	Noticia	Meteorólogos corrigen pronóstico y advierten que éste será un año seco	Rondanelli	Meteorología	http://www.latercera.com/noticia/nacional/2014/08/680-591925-9-meteorologos-corrigen-pronostico-y-advierten-que-este-sera-un-ano-seco.shtml
06-10-2014	El Mercurio	Papel	Noticia	Largas Sequías Como la Actual se podrían duplicar en los Próximos Años	Garreaud	Sequia	http://impresa.elmercurio.com/mermobileiphone//HomeSlide.aspx?qs=2&dt=2014-10-06#pagina-10
13-10-2014	Radio	Radio FM Tiempo	Entrevista	Programa Chilesustentable de radio	Garreaud	Glaciares	
02-10-2014	La Tercera	Papel	Carta al Director	Megasequía	Garreaud	Sequía	http://www.latercera.com/noticia/opinion/correos-de-los-lectores/2014/10/896-598306-9-megasequia.shtml
25-09-2014	Radio Universidad de Chile	Radio	Entrevista	Cumbre ONU sobre cambio climático NY	Rojas	IPCC	
22-09-2014	Diario Universidad de Chile	Digital	Nota	Calentamiento Global: Solo el compromiso político salvará al planeta	Moraga	IPCC	http://radio.uchile.cl/2014/09/22/calentamiento-global-solo-el-compromiso-politico-salvara-al-planeta
22-09-2014	Radio Universidad de Chile	Radio	Entrevista	Cumbre ONU sobre cambio climático NY/Acuerdo Internacional	Moraga	IPCC	
22-10-2014	El Dinamo.cl	Digital	Nota de prensa	(CR)2 investiga abordo de crucero cambio climático y sus consecuencias en ciclo hidrológico	Sanhueza	Cimar	http://www.eldinamo.cl/2014/10/22/cr2-investiga-abordo-de-crucero-cambio-climatico-y-consecuencias-en-ciclo-hidrologico/
23-09-2014	Radio Concierto	Radio	Entrevista	Entrevista a Paulina Aldunce "Mañana será otro día"	Aldunce		
23-09-2014	Santiago Times	Digital	Nota	Bachelet attends landmark climate summit	Rojas		http://santiagotimes.cl/bachelet-attends-landmark-climate-summit/
03-11-2014	El Dinamo.cl	Digital	Columna de Opinión	Preparándose para tomar decisiones sobre nuestra influencia	Gallardo	IPCC	http://www.eldinamo.cl/blog/preparandose-para-tomar-decisiones-sobre-nuestra-influencia-climatica/

				climática, Por Laura Gallardo			
02-11-2014	ElDesconcierto.cl	Digital	Columna de Opinión	Avanzando hacia un acuerdo en cambio climático, por Maisa Rojas	Rojas	IPCC	http://eldesconcierto.cl/avanzando-hacia-un-acuerdo-en-cambio-climatico/
21-10-2014	El Mercurio	Papel	Reportaje	El buque científico "Cabo de Hornos" les tomó el pulso a los canales del extremo sur	Sanhueza	Biogeoquímica	http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2014-10-29&PaginaId=13&BodyId=1
13-11-2014	El Mercurio	Papel	Noticia	Histórico acuerdo entre China y EE.UU. para reducir sus emisiones	Gallardo	Negociaciones	http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2014-11-13&dtB=13-11-2014%200:00:00&PaginaId=11&bodyid=1
13-11-2014	La Tercera	Papel	Noticia	Histórico acuerdo contra el cambio climático	Gallardo	Negociaciones	http://diario.latercera.com/2014/11/13/01/contenido/tendencias/16-177440-9-historico-acuerdo-contra-el-cambio-climatico.shtml
23-11-2014	El Mercurio	Papel	Noticia	¿El hombre tendrá que conquistar el espacio?	Rondanelli	Cambio climático Chile	
25-11-2014	La Tercera	Papel	Noticia	China presiona a los Ricos	Araya	COP	http://diario.latercera.com/2014/11/26/01/contenido/tendencias/16-178364-9-china-presiona-a-los-ricos.shtml
02-12-2014	La Tercera	Papel	Noticia	Chile lanza plan para adaptarse al cambio Climático	Aldunce	Plan Adaptacion	http://diario.latercera.com/2014/12/02/01/contenido/tendencias/16-178796-9-chile-lanza-plan-para-adaptarse-al-cambio-climatico.shtml
02-12-2014	El Mercurio	Papel	Noticia	Chile ya tiene plan de adaptación al Cambio Climático	Aldunce	Plan Adaptacion	http://impresa.elmercurio.com/pages/LUNHomepage.aspx?BodyID=1&dtB=02-12-2014
01-12-2014	Radio Futuro	Radio	entrevista	Cop y Plan de adaptación	Aldunce	COP20	
02-12-2014	La Segunda	Papel	Reportaje	CUMBRE DE LIMA recibe a delegaciones optimistas por alcanzar un nuevo acuerdo climático	Gallardo/ Moraga	COP	http://www.lasegunda.com/Noticias/CienciaTecnologia/2014/12/978964/CUMBRE-DE-LIMA-recibe-a-delegaciones-optimistas-por-alcanzar-un-nuevo-acuerdo-climatico
04-12-2014	Mega	TV	Noticia	Entrevista a Roberto Rondanelli "2014 el año más caluroso"	Rondanelli	Meteorología	http://www.ahoranoticias.cl/noticiario/edicion-central/cientificos-aseguran-que-el-2014-es-el-ao-mas-caluroso-en-la-historia-de-la-humanidad.html
04-12-2014	TVN	TV	Noticia	Entrevista a René Garreaud "2014 el año más caluroso"	Garreaud	Meteorología	
03-12-2014	Canal 24H	TV	Entrevista	Entrevista a Pilar Moraga sobre COP20	Moraga	COP	
02-11-2014	TVN	TV	Noticia	Laura Gallardo	Gallardo	Cambio Climático	
11-12-2014	La Tercera	Papel	Carta al Director	El rol de Chile en la cumbre de Lima	Moraga	COP20	http://diario.latercera.com/2014/12/11/01/contenido/opinion/11-179365-9-el-rol-de-chile-en-la-cumbre-de-lima.shtml

12-12-2014	La Tercera	Papel	Noticia	Chile, el segundo país que más emisiones per cápita genera en Latinoamérica	Gallardo/Farias	COP20	http://www.latercera.com/noticia/tendencias/2014/12/659-608350-9-chile-el-segundo-pais-que-mas-emisiones-per-capita-genera-en-latinoamerica.shtml
09-12-2014	Radio Universidad de Chile	Digital	Notcia	Organizaciones buscan instalar debate sobre efectos sociales del Cambio Climático	Aldunce	COP20	http://radio.uchile.cl/2014/12/09/organizaciones-buscan-instalar-debate-sobre-efectos-sociales-del-cambio-climatico
02-12-2014	El Mercurio	Papel	Noticia	Chile ya tiene un plan de adaptación al cambio climático	Aldunce	COP20	http://impresa.elmercurio.com/pages/LUNHomepage.aspx?BodyID=1&dtB=02-12-2014
02-12-2014	La Tercera	Papel	Noticia	Chile lanza plan para adaptarse al cambio climático	Aldunce	COP20	http://diario.latercera.com/2014/12/02/01/contenido/tendencias/16-178796-9-chile-lanza-plan-para-adaptarse-al-cambio-climatico.shtml
09-10-2014	ElDesconcierto.cl	Digital	Reportaje	Centro de Ciencia del Clima: "El Comportamiento del Clima Actual no tiene Precedentes"	Garreaud/ Aldunce	Cambio Climático	http://eldesconcierto.cl/centro-de-ciencia-del-clima-el-comportamiento-del-clima-actual-tiene-precedentes/
22-09-2014	La Tercera	Papel	Noticia	¿Qué ha hecho Chile contra el Cambio Climático?	Aldunce	Cambio climático Chile	http://www.latercera.com/noticia/tendencias/2014/09/659-596812-9-que-ha-hecho-chile-contra-el-cambio-climatico.shtml
12-05-2014	Radio Universidad de Chile	Digital	Entrevista	Llaman a autoridades a tomar medidas urgentes para enfrentar sequía y cambio climático	Garreaud	Sequia	http://radio.uchile.cl/2014/05/10/llaman-a-autoridades-a-tomar-medidas-urgentes-para-enfrentar-sequia-y-cambio-climatico
12-05-2014	Radio Universidad de Chile	Radio	Entrevista	Llaman a autoridades a tomar medidas urgentes para enfrentar sequía y cambio climático	Garreaud	Sequia	http://radio.uchile.cl/2014/05/10/llaman-a-autoridades-a-tomar-medidas-urgentes-para-enfrentar-sequia-y-cambio-climatico
07-04-2014	La Tercera	Papel	Noticia	Los chilenos tras el informe de cambio climático de la ONU	Rojas/Aldunce	IPCC	http://diario.latercera.com/2014/04/06/01/contenido/tendencias/16-161614-9-los-chilenos-tras-el-informe-de-cambio-climatico-de-la-onu.shtml
12-10-2014	El Mercurio de Calama	Papel	Reportaje	Calama: Calentamiento Global Causará Problemas en la Provincia	Garreaud	Cambio climático Chile	http://www.mercuriocalama.cl/impresa/2014/10/12/full/2/
12-09-2014	La Tercera	Papel	Noticia	Estudio registra por primera vez recuperación de capa de ozono	Gallardo	Capa de Ozono	http://diario.latercera.com/2014/09/12/01/contenido/tendencias/16-173012-9-estudio-registra-por-primera-vez-recuperacion-de-capa-de-ozono.shtml
28-08-2014	La Tercera	Papel	Noticia	EEUU busca acuerdo político que reemplace Protocolo de Kioto	Moraga	Convención Marco	http://www.latercera.com/noticia/tendencias/2014/08/659-593288-9-eeuu-busca-acuerdo-politico-que-reemplace-protocolo-de-kioto.shtml
12-05-2014	La Tercera	Papel	Noticia	Estudio revela que el 55% de los ecosistemas en Chile está amenazado	Little	Biodiversidad	http://www.latercera.com/noticia/nacional/2014/05/680-577687-9-estudio-revela-que-el-55-de-los-ecosistemas-en-chile-esta-amenazado.shtml

05-05-2014	La Tercera	Papel	Noticia	Dirección Meteorológica: 2003-2013 es la década más seca de los últimos 150 años	Garreaud	Sequia	http://www.latercera.com/noticia/tendencias/2014/05/659-576562-9-direccion-meteorologica-20032013-es-la-decada-mas-seca-de-los-ultimos-150-anos.shtml
17-03-2014	La Tercera	Papel	Noticia	Proyecto recupera árboles nativos para conservar el agua de los bosques	Little	Servicios Ecosistémicos	http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2014-01-21&PaginaId=14&BodyID=1
16-12-2014	La Tercera	Papel	Noticia	Las dudas que deja la COP	Moraga	COP20	http://www.latercera.com/noticia/tendencias/2014/12/659-608828-9-las-dudas-que-deja-la-cop-20.shtml
16-12-2014	El Mercurio	Papel	Noticia	Se necesitan 30 años para saber si aumentará o no el nivel del mar	Rojas	Paleoclima	http://impresa.elmercurio.com/pages/detail-view.htm?enviar=%2FPages%2FNewsDetail.aspx%3Fdt%3D16-12-2014%200%3A00%3A00%26PaginaId%3D14%26SupplementId%3D0%26bodyid%3D1
17-12-2014	Diario Financiero	Papel	Noticia	Chile comienza a dar los primeros pasos para enfrentar efectos del cambio climático	Moraga	Energía	https://www.df.cl/noticias/empresas/innovacion-y-sustentabilidad/chile-comienza-a-dar-los-primeros-pasos-para-enfrentar-efectos-del-cambio-climatico/2014-12-16/165019.html
02-12-2014	La Segunda	Papel	Noticia	Cumbre de Lima recibe a delegaciones optimistas por alcanzar un nuevo acuerdo climático	Gallardo/ Moraga	COP20	http://www.lasegunda.com/Noticias/CienciaTecnologia/2014/12/978964/CUMBRE-DE-LIMA-recibe-a-delegaciones-optimistas-por-alcanzar-un-nuevo-acuerdo-climatico
16-11-2014	El Mercurio	Papel	Noticia	La comida occidental tampoco es saludable para el planeta”	Rojas	Cambio Climático	http://buscador.emol.com//redirect.php?url=http%3A%2F%2Fdiario.elmercurio.com%2Fdetalle%2Findex.asp%3Fid%3D%7B896d14d3-20a7-41e7-b926-4f394c4dc5b9%7D
12-12-2014	La Tercera	Papel	Noticia	Chile, el segundo país que más emisiones per cápita genera en Latinoamérica	Farias/gallardo	Cambio Climático	http://www.latercera.com/noticia/tendencias/2014/12/659-608350-9-chile-el-segundo-pais-que-mas-emisiones-per-capita-genera-en-latinoamerica.shtml

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