



**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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## I. PRESENTATION

**PERIOD REPORTED:** 1<sup>st</sup> Year ☒ 2<sup>nd</sup> Year ☐ 3<sup>rd</sup> Year ☐ 4<sup>th</sup> Year ☐ 5<sup>th</sup> Year ☐

**PERIOD COVERED:** From December 12, 2012 To December 7, 2013

<b>NAME OF THE CENTER</b> Center for Climate and Resilience Research Centro de Ciencia del Clima y la Resiliencia		<b>CODE</b>  15 11 00 09
<b>DIRECTOR OF THE CENTER</b>  Laura Gallardo Klenner	<b>E-MAIL</b>  laura@dgf.uchile.cl	<b>SIGNATURE</b>   Laura Gallardo K. Directora (CR2)
<b>DEPUTY DIRECTOR</b>  René Garreaud Salazar	<b>E-MAIL</b>  rgarreau@dgf.uchile.c I	<b>SIGNATURE</b>  
<b>SPONSORING INSTITUTION</b>  Universidad de Chile		
<b>ASSOCIATED INSTITUTION(S)</b> (if applicable)  Universidad de Concepción Universidad Austral de Chile		
<b>CENTER WEBSITE ADDRESS</b>  <a href="http://www.cr2.cl/">http://www.cr2.cl/</a>		

**DATE:** 20/01/2014

Research Lines

°	Research Line	Objective	Principal Researcher	Associated Researcher(s)
1	Biogeochemistry (BGC)	<ul style="list-style-type: none"> <li>Estimate emissions of climatically active tracers (CATs)</li> <li>Identify and quantify novel biogeochemical processes mediating CATs cycling in surface waters</li> <li>Characterize the regional interactions between urban areas and adjacent ecosystems</li> </ul>	Laura Fariás	Marcela Cornejo Beatriz Diez Ricardo De Pol Roberto Rondanelli
2	Climate Dynamics (CD)	<ul style="list-style-type: none"> <li>Analyze interdecadal climate variability in Chile</li> <li>Diagnose of contemporaneous climate trends</li> <li>Project hydrological response to climate change</li> </ul>	René Garreaud	Duncan Christie Paulo Herrera Patricio Moreno
3	Human Dimensions (HD)	<ul style="list-style-type: none"> <li>Identify ways to build resilience for climate change</li> <li>Diagnose the institutional framework</li> <li>Perform economic evaluation of climate change in Chile</li> <li>Define adaptation measures</li> <li>Contribute to the strengthening of institutional capacities</li> </ul>	Pilar Moraga	Paulina Aldunce Laura Nahuelhual Ana Lya Uriarte
4	Ecosystem Services (ECO)	<ul style="list-style-type: none"> <li>Design optimal landscape arrays for the combined production of goods and services</li> <li>Define time frames, rates, and costs of the recovery of water provision as an ES from ecological restoration</li> <li>Assess reduced precipitation predicted by climate models for Central and Southern Chile on water provision as an ES from watersheds</li> </ul>	Antonio Lara	Susana Gómez Mauro González Carlos Jara (Mario Pino)
5	Modeling and Observing Systems (MOS)	<ul style="list-style-type: none"> <li>Implement and develop modeling and observation platforms to assess climate change and variability and to define probable scenarios</li> <li>Establish a test-bed, and transference of Climate Services</li> <li>Develop integrated observing systems</li> </ul>	Laura Gallardo	Melitta Fiebig Axel Osses Maisa Rojas Gary Shaffer

## 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).**

We envision our Center for Climate and Resilience Research (CR)2 as a world-class research center focusing on Earth System Science, which, in an interdisciplinary manner and in close relation to stakeholders, improves our understanding of the Earth System and is functional to the enhancement of societal resilience in Chile. We aim to:

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

Our efforts during the first year of execution have been oriented towards: 1) Continuing research initiated prior to the center's creation, and also defining new research questions with an increasing degree of integration among different disciplines and individuals; 2) Integrating talented students, post-doctoral fellows, researchers and professionals into our team; 3) Positioning our center in the media, among our peers and, very importantly, among diverse stakeholders; and, last but not least, 4) Installing the center as an organization that manages a substantial amount of public resources, involving more than 100 individuals over the first year, including researchers, students, professionals, technicians and administrative staff from several universities and other institutions.

We have gained understanding regarding the biogeochemical processes leading to emission and removal of greenhouse gases in surface waters throughout Chile (Farías et al, 2013; Daniel et al, 2013; Florez et al, 2013), as well as in soils (Delgado-Boquerizo et al, 2013). We have furthered our description and understanding of air temperature trends observed in Chile and characterized by a sharp contrast between warming over land and cooling over ocean. At least part of this signal during the last three decades can be attributed to anthropogenic climate change. The Southern Annular Mode and El Niño variability over the past millennia (Moreno et al., 2013), and centuries (Li et al. 2013) as well as synoptic characterization of extreme events (Garreaud, 2013; Viale and Garreaud 2013) have been other foci of our research. Research on ecological restoration has been enhanced by including the study of fire regimes, ecosystem resilience and recovery after natural (e.g. volcanism) and human (e.g. human-set fires, logging) disturbances. Moreover, a body of knowledge on land-use change in watersheds in Latin America has been synthesized (Lara et al, 2013). New methods for assessing monitoring networks (Osses et al, 2013), and model validation for addressing sea level rise (Eby et al, 2013), and quantifying the forcing by urban aerosols (Escribano et al, 2013) have also been undertaken. We have also analyzed the institutional framework for Climate Change (Moraga, 2013), established a conceptual framework for resilience (Aldunce et al, 2014 in prep.), and are building a vulnerability mapping protocol (Nahuelhual et al, 2014 in prep.). We have engaged more than 40 students and research assistants in these research activities, as well as five post-doctoral fellows. Moreover, we have linked CR2 to new and complementary resources by means of proposals addressing specific research questions or facilitating international collaboration. In this respect it is worth noting the new Nucleus on Paleo-climate Research, and the Network on human dimensions studies, led by Dr. Rojas and Dr. Moraga, respectively.

Regarding integration among different areas, we have examined several overarching questions that require the concurrence of diverse expertise, and that are relevant for policy making. For instance, the extended drought event observed along Central and Southern Chile over the last few years offers a template of future climate and its impacts, and of adaptation strategies. Another example of integrative questions refers to the fate and impacts of short lived climate forcers, black carbon in particular, which allows for necessary integration between scales and processes in socio-ecological systems, and the addressing of issues relevant for policy making.

A consistent effort for positioning our center in the media, among our peers, and among stakeholders, has been carried out this year. We count ca. 100 appearances in national television, newspapers, radio, etc.. We also had a well-attended (more than 200 people) launching ceremony in October. Together with academics and authorities, many governmental representatives and other stakeholders representing several institutions were present at our ceremony. Moreover, we have established our National Advisory Panel including representatives from academia, government and private sectors, and we have participated in numerous formal and informal gatherings with stakeholders and the general public.

In December 2012, we initiated the search for administrative personnel and a journalist, and we made an international call for the new academic position in the Department of Geophysics contributed by Universidad de Chile. Hiring a public administrator proved to be difficult, in part due to the employment conditions linked to our FONDAP grant by which we can only offer positions on soft money with no provision of social benefits. In fact, we hired a Public Administrator in early January but he left after 10 days after receiving an offer for employment with a proper contract in a public institution. We were then forced to hire a second person who, despite having strong work capacity and excellent language skills, never got used to the way public administration works at Universidad de Chile. All this resulted in an overload of administrative work for the Director and Deputy Director of CR2, and a delay in the execution of funds. These problems were largely resolved in August and September when we hired, as originally stipulated in our proposal, a general coordinator/manager and a secretary with expertise in public and university administration, respectively. We modified our original proposal in the sense that we hired local administrative help at associated institutions. The establishment of formal agreements between sponsoring and associated institutions was uneventful contents-wise, but it was extremely lengthy in terms of the corresponding formal reviews and signatures required by the parties, including CONICYT. All in all, resources were transferred to the associated universities only in late September. This significantly delayed the purchase of part of needed equipment, and the realization of field work. In spite of these delays, CR2 researchers have continued to work enthusiastically. Maintaining the hiring of post-docs, assistants and students on a Central level compensated in part for the lack of fresh resources at the associated institutions.

The installation of CR2 refers not only to the administrative aspects described above, but also to the establishment of internal procedures and rules (governance). In this respect we have generally followed the scheme presented in our proposal, namely, regular meetings of an academic board made up of the director, deputy director and PIs, and which is responsible for strategic decisions of (CR)2. We met six times in different places: Catillo near Concepción (December 2012); Santiago (January 2013); El Añil outside Santiago (April 2013); Valdivia (June 2013); Concepción (August 2013); Santiago (October 2013). In addition to the five PIs, we invited the deputy PIs of each research line. The meetings held outside Santiago have also generally involved local researchers and students. The board also holds closed meetings when necessary.

All in all, CR2 has been successfully established and we have produced 34 peer-reviewed papers, three books and 16 book chapters, in addition to over 100 presentations in conferences and symposia in Chile and abroad. Moreover, we have engaged 5 post-doctoral fellows, 9 PhD students, 28 MSc students, and 14 professional exams, organized several symposia and established discussions with decision-makers. During our second year we expect to improve these indexes and, more importantly, to advance integration between our different research areas

### III. ADMINISTRATIVE ASPECTS

#### 1. Budget execution: Describe and justify any budgetary modifications (itemized) of the original proposal.

Year 1	Incomes			Expenses			Comments
Item	CONICYT in MCLP	Universities in MCLP	Total In MCLP	CONICYT in MCLP	Universities in MCLP	Total In MCLP	
<b>Personnel</b>	<b>\$ 334.740</b>	<b>\$ 73.613</b>	<b>\$ 408.353</b>	<b>\$ 299.591</b>	<b>\$ 14.370</b>	<b>\$ 313.961</b>	
Researchers	\$ 177.576	\$ -	\$ 177.576	\$ 149.722	\$ -	\$ 149.722	The difference with the original budget was the underutilization of the budget assigned to "Other researchers". The main idea was incorporate collaborators in specific areas of the researches lines, however during the first year the research team was in a consolidation process so only a few "other researchers" were hired. In total, this item reached 84% of the original budget. The difference was re-oriented to research assistants instead, who appear under support personnel.
New Hires	\$-	\$ 32.100	\$ 32.100	\$ -	\$ -	\$ -	In the original proposal, we considered hiring of full-time assistant professor and graduate scholarships for students. This process was initiated in December 2012 and completed in October. The selected candidate will start in January 2014. The institutional contribution for personnel was reassigned to fund three months of postdoctoral fellows, instruments, and support for participation in student congresses and operative expenses.
Post-doctoral fellows	\$ 54.360	\$ -	\$ 54.360	\$ 30.190	\$ 5.250	\$ 35.440	Originally, three post-doctoral fellows in ECO, HD, and MOS were considered. We decided instead to make an open call and, according to expertise and excellence, we hired post docs in BGC (Yévenes), CD (Van den Hoof) and ECO (Little). Later on, we re-oriented resources from support personnel in MOS to hire two postdocs for MOS (Albrecht & Bozkurt). The post doc budget appears under-executed because as an interim procedure we had to hire foreigners under "internationalization". Also, the last two post docs were funded in 2013 with the contribution of Universidad de Chile.
PhD students	\$ -	\$ 23.100	\$ 23.100	\$ -	\$ -	\$ -	
MSc students	\$ 43.272	\$ 17.413	\$ 60.685	\$ 21.608	\$ 8.120	\$ 29.728	During the first year CR2 defined the position of "research assistant". These support staff were mostly graduate students hired to contribute in a particular research line involved at different levels of the projects from searching for academic relevant literature to analysis of data and in certain levels conducting part of the research project. For that reason, the master and undergraduate students' budget was spent in almost 40% of the original budget, in favor of the support staff budget.

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Under-graduates	\$ 15.552	\$ 1.000	\$ 16.552	\$ 6.757	\$ 1.000	\$ 7.757	See above.
Support staff	\$ 43.980	\$ -	\$ 43.980	\$ 91.314	\$ -	\$ 91.314	In the original proposal we considered two engineers (MOS), field (ECO) and laboratory support (BGC). However, under this category we hired our journalist – originally assumed as a consultancy-as well as several research assistants, typically students who had recently finished their degrees that could work on specific tasks.
<b>Traveling</b>	<b>\$ 30.670</b>	<b>\$ -</b>	<b>\$ 30.670</b>	<b>\$ 42.969</b>	<b>\$ -</b>	<b>\$ 42.969</b>	This first year the center exceeded the budget in national travels because of the need to coordinate and acquaint our staff. Six CR2 meetings were carried out, two near Concepción, one in Valdivia and three near Santiago. We used double as much of the original budget in international travel expenses since the researchers and students attended several conferences abroad aiming at positioning CR2 and strengthening international collaborations.
<i>Per-diem</i>	<i>\$ 12.670</i>	<i>\$ -</i>	<i>\$ 12.670</i>	<i>\$ 22.472</i>	<i>\$ -</i>	<i>\$ 22.472</i>	
Domestic	\$ 4.200	\$ -	\$ 4.200	\$ 3.836	\$ -	\$ 3.836	
International	\$ 8.470	\$ -	\$ 8.470	\$ 18.636	\$ -	\$ 18.636	
<b>Tickets</b>	<b>\$ 18.000</b>	<b>\$ -</b>	<b>\$ 18.000</b>	<b>\$ 20.497</b>	<b>\$ -</b>	<b>\$ 20.497</b>	
Domestic	\$ 2.500	\$ -	\$ 2.500	\$ 7.595	\$ -	\$ 7.595	
International	\$ 15.500	\$ -	\$ 15.500	\$ 12.902	\$ -	\$ 12.902	
<b>Internation- alization</b>	<b>\$ 35.350</b>	<b>\$ -</b>	<b>\$ 35.350</b>	<b>\$ 48.961</b>	<b>\$ 1.000</b>	<b>\$ 49.961</b>	The center spent almost 40% more of the original budget, since under this item we had to fund foreigners. Moreover, several congress and symposia were co-organized by the CR2, with the participation of many foreign partners
<b>Operation costs</b>	<b>\$ 65.500</b>	<b>\$ -</b>	<b>\$ 65.500</b>	<b>\$ 65.500</b>	<b>\$ 386</b>	<b>\$ 65.886</b>	
<b>Capital goods</b>	<b>\$ 156.060</b>	<b>\$ -</b>	<b>\$ 156.060</b>	<b>\$ 178.513</b>	<b>\$ 18.994</b>	<b>\$ 197.507</b>	All planned equipment for the first year were acquired. But the overspending resulted because the wet deposition sampler cost was higher and the acquisition of storage to improve connection to the cluster was required. Another reason was the higher price of the dollar in the last months of budget execution.
<b>Infrastructure</b>	<b>\$ 27.000</b>	<b>\$ 8.500</b>	<b>\$ 35.500</b>	<b>\$ 28.561</b>	<b>\$ 47.363</b>	<b>\$ 75.924</b>	Part of the fund from personnel was re-oriented to build an extension of the building where the offices of researchers and director of the Center is located. The architectural design and the feasibility study are underway and are expected to begin construction in the first half of 2014.
<b>General expenses</b>	<b>\$ 25.000</b>	<b>\$ -</b>	<b>\$ 25.000</b>	<b>\$ 25.000</b>	<b>\$-</b>	<b>\$ 25.000</b>	



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Administrative staff	\$ 38.376	\$ -	\$ 38.376	\$ 25.529	\$ -	\$ 25.529	The general coordinator was hired in August, which explains the under execution of this budget. The exceeding resources were re-oriented towards research personnel.
Publications and sub- scriptions	\$ 1.000	\$ -	\$ 1.000	\$ 600	\$ -	\$ 600	
Bank bonds	\$ 2.000	\$ -	\$ 2.000	\$ 1.708	\$ -	\$ 1.708	
Consulting services	\$ 24.000	\$ -	\$ 24.000	\$ 22.905	\$ -	\$ 22.905	We hired assistance for graphic design, group dynamics, etc.
Administrative expenses (overhead)	\$ 40.500	\$ -	\$ 40.500	\$ 40.500	\$ -	\$ 40.500	
Unforeseen expenses	\$ 33.143	\$ -	\$ 33.143	\$ 33.143	\$ -	\$ 33.143	Part of the unforeseen expenses were used to fund operational expenses incurred by the need for installation of CR2 in the first year, and extra costs of instruments due to changes in foreign currency.
<b>Total M\$</b>	<b>\$ 813.339</b>	<b>\$ 82.113</b>	<b>\$ 895.452</b>	<b>\$ 813.479</b>	<b>\$ 82.113</b>	<b>\$ 895.592</b>	

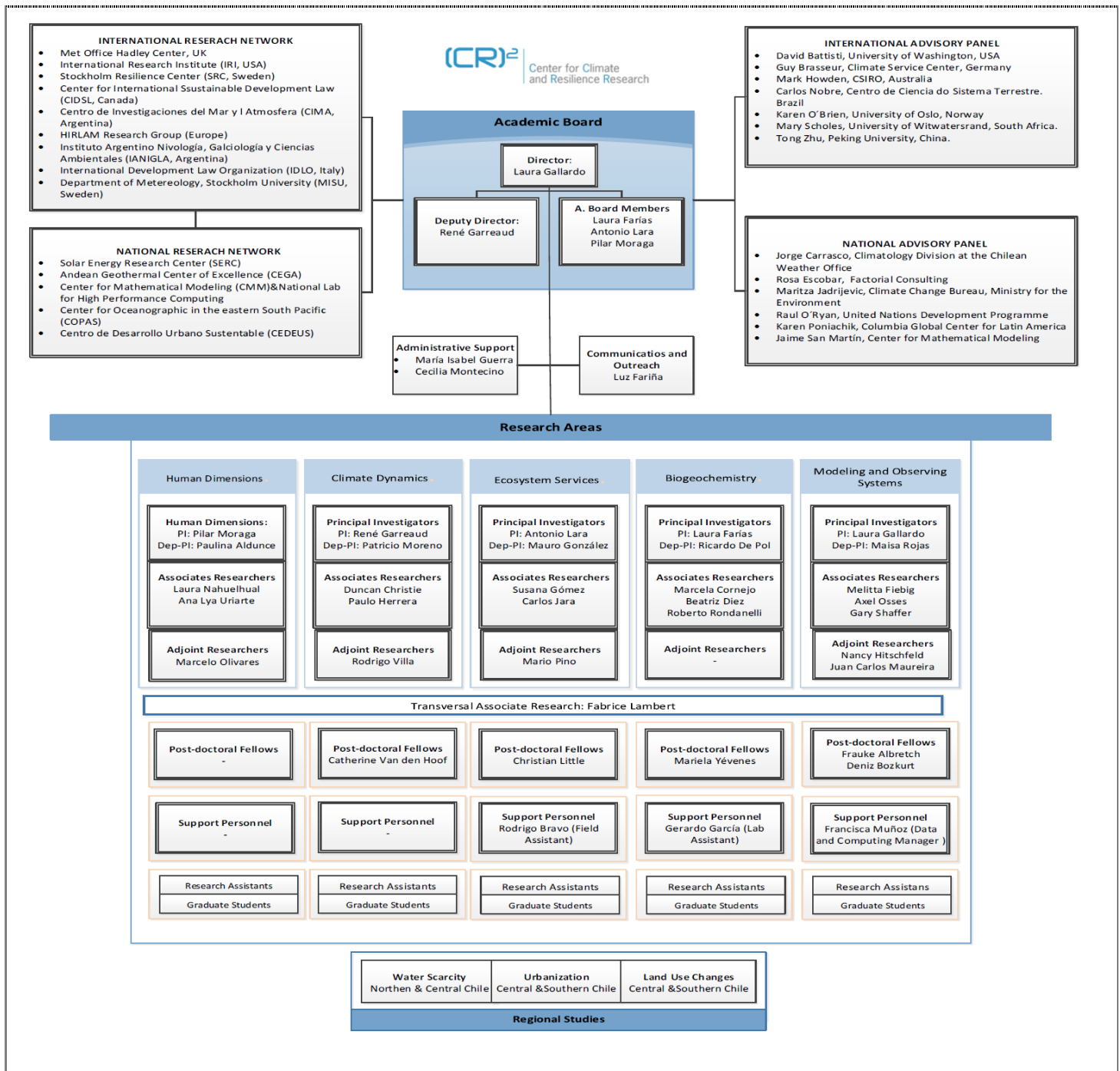
So far, we have officially declared 767.169 MCLP out of the 813.339 MCLP granted by FONDAP. The difference (ca. 46 millions) corresponds to pending payments for capital goods (wet deposition sampler), wages, and infrastructure costs. All these expenses will be liquidated by March 2014. Regarding the total budget including the FONDAP grant and the cash contribution from the sponsoring institutions, we are liquidating 793.034 MCLP. Pending resources correspond to: 1) 38.3 million for new infrastructure at the Geophysics Department, University of Chile, which is part of a larger investment under development; 2) 8.5 million for modifications to current laboratory infrastructure at the biogeochemistry laboratory, University of Concepción, which will be carried out during the summer break; and 3) hiring of students and research assistants at Universidad Austral.

**Accomplishment of institutional commitments:** describe any difficulty(ies) encountered regarding this aspect.

These commitments were completely accomplished. However, the delay in transferring resources to the associated universities made it necessary to differ from and change part of the expenses considered in the proposal.

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



2. **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.

**Table 3.1.** Principal and associate researchers, indicating weekly dedication, research area and institutional affiliation.

Name	Last Name	Category	Dedication (hours per week)	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	10	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	26	CD	UCH
Carlos	Jara	Associate Researcher	7	ECO	UACH
Fabrice	Lambert	Associate Researcher	44	T	UCH
Patricio	Moreno	Associate Researcher	14	CD	UCH
Laura	Nahuelhual	Associate Researcher	10	HD	UACH
Axel	Osses	Associate Researcher	7	MOS	UCH
Mario	Pino*	Associate Researcher	7	ECO	UACH
Maisa	Rojas	Associate Researcher	14	MOS	UCH
Roberto	Rondanelli	Associate Researcher	7	BGC	UCH
Gary	Shaffer	Associate Researcher	7	MOS	UDEC
Ana Lya	Uriarte	Associate Researcher	7	HD	UCH

\*Until June 2013. He was replaced as an associate researcher by Susana Gómez.

**Table 3.2.** Adjoint researchers, i.e., researchers that received incentives for occasionally supporting specific research activities.

Name	Last Name	Research Area	Affiliation	Activity
Marcelo	Olivares	HD	UCH	Operational research for quantifying heat waves impacts on industrial productivity
Nancy	Hitschfeld	MOS	UCH	Review of methods for characterizing urban canopy
Juan Carlos	Maureira	MOS	UCH	Review of database managers for climate services
Mario	Pino	ECO	UACH	Paleo-archeology and fire records
Rodrigo	Villa	CD	CEQUA/UMAG	Paleo-environmental research in Southern Patagonia

**Table 3.3.** Post-doctoral fellows, indicating weekly dedication, research area and institutional affiliation. All contracts are signed under Universidad de Chile.

Name	Last Name	Dedication (hours per week)	Research Area	Affiliation	Theme of research
Frauke	Albrecht	22	MOS	UDEC	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 isostatic adjustment
Deniz	Bozkurt	44	MOS	UCH	Dynamical downscaling of reanalyses and projections for various climate scenarios Chile
Christian	Little	44	ECO	UACH	Multi-scale relationships for quality and quantity of water services in forest watersheds
Catherine	Van den Hoof*	44	CD	UCH	Assessing the influence of precipitation on surface air temperature variability in South America and implications for climate change projection
Mariela	Yévenes	44	BGC	UDEC	Integrating remote sensing and chemical appraisal to assess modern and historical thermal patterns, and reactive nitrogen dynamics in Southern Chilean rivers.

\*Dr. Van den Hoof has since November 2013 a post-doctoral fellowship from FONDECYT.

In addition to the above named post-doctoral fellows, Dr. Francisca Guzmán has been working on “Clouds Clouds under very warm climates” under the guidance of Dr. Roberto Rondanelli. She received CR2 travel support to attend the “Euclipse summer School on clouds and climate”, between June 24<sup>th</sup> and July 5<sup>th</sup> 2013 in Les Heuchès, France.

**Table 3.4.** Doctoral fellows (9), indicating thesis title, weekly dedication, research area and institutional affiliation. All these students receive funding from other resources.

Name	Last Name	Tutor(s)	Affiliation	Research Area	Dedication (Hours per week)	Thesis Title/Subject
Mónica	Bello	René Garreaud	UCH	CD	44	Circulación Oceanica en Bahía de Coquimbo (30S)
Marco Aurelio	Cortés	Antonio Lara	UACH	ECO	44	Ecología de la Restauración de los relictos Araucaria araucana en la Cordillera de la Costa de Chile
Melisa	Díaz	Laura Dawidowski, Laura Gallardo	UBA	MOS	44	Dinámica de los aerosoles atmosféricos en el Área Metropolitana de Buenos Aires
Ignacio	Díaz Galvez	Laura Nahuelhual	UACH	HD	44	Análisis y diseño de paisajes de provisión de servicios ecosistémicos: en búsqueda de socio-ecosistemas sostenibles
Cecilia	Farías*	Roberto Rondanelli	UCH	MOS	44	Estudio de la dinámica de la formación de capas residuales en la cuenca de Santiago
Federico	Flores	René Garreaud/ Ricardo Muñoz	UCH	CD	44	Modelación de Flujos en geometría compleja (Rajos Mineros)
Priscilla	Nowajewski	Maisa Rojas	UCH	MOS	44	Climate dynamics by obliquity forcing in planetary atmospheres
Oscar	Pesce	Patricio Moreno	UCH	CD	44	Comportamiento de los Vientos del Oeste entre los 40° S y 52°S desde la Última Terminación Glacial.
Mario	Romero	Antonio Lara	UACH	ECO	44	Recuperación del bosque siempreverde bajo distintas intervenciones antrópicas en la Cordillera de la Costa de la región de Los Ríos

\*By the beginning of 2013, Laura Gallardo acted as her advisor and Roberto Rondanelli acted as co-advisor. Now, this role has been taken by Dr. Rondanelli.

Cecilia Farías and Priscilla Nowajewski received CR2 support to partially fund their participation in international courses during 2013. Cecilia Farías attended the European Research Course on Atmospheres organized by Université Joseph Fourier of Grenoble and CNRS in January 2013. Priscilla Nowajewski attended the Urbino Summer School in Paleoclimatology in July 2013.

**Table 4.5.** Master fellows (28), indicating thesis title, weekly dedication, research area and institutional affiliation.

Name	Last Name	Tutor(s)	Research Area	Affiliation	Dedication (Hours per week)	Thesis Title/Subject
Denis	Alegría	Paulina Aldunce/Roxana Bórquez	HD	UCH	44	Análisis bibliométrico del concepto de "resiliencia" en la literatura científica en el contexto del cambio climático y su actual aplicación en políticas públicas
Carlos	Ardisoni	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 Climáticas y neoglaciación durante el holoceno medio en latitudes medias del hemisferio sur
Néstor	Burgos	Antonio Lara	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	BGC	UDEC	44	El rol del Agua Intermedia Antártica (AAIW) en la distribución de gases (O <sub>2</sub> , N <sub>2</sub> O y CO <sub>2</sub> ) en el Pacífico Sur Oriental y su influencia en la ventilación de la zona de mínima de oxígeno".
Inger	Daniel	Laura Farías	BGC	UDEC	44	Intercambio de gases invernadero hacia la atmósfera versus acumulación de carbono y nitrógeno en los sedimentos del estuario/humedal Tubul-Raqui
Cynthia	Escares	Laura Farías	BGC	UDEC	44	Origen del óxido nitroso (N <sub>2</sub> O) en cultivos monoclonales de microalgas marinas: un estudio con piceocuariontes fotosintéticos".
Pilar	Fierro	Mauro González	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
Mindy	Fuentes	Pilar Moraga	HD	UCH	44	Incorporación de la vulnerabilidad al cambio climático a la planificación territorial del borde costero
Lucía	Gonzaloren	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 Bórquez	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	22	Herramientas matemáticas para el análisis de sistemas de observación atmosféricos

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Katherine	Indvik	Paulina Aldunce/Roxana Bórquez	HD	UCH	44	Una revisión sistemática de la conceptualización de la resiliencia en su aplicación al contexto del cambio climático
Amerindia	Jaramillo	Laura Nahuelhual	HD	UACH	44	Modeling the ecosystem service of water supply and flow regulation under different land use scenarios
Dana	Jimenez	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
Carolina	Morano	Rodrigo Villa /Patricio Moreno	CD	UMAG	44	Desarrollo de registros paleoecológicos de alta resolución temporal durante los últimos 3000 años en Patagonia Sur
Cristian	Muñoz	René Garreaud	CD	UCH	44	Precipitación Orográfica en Chile Central
Romina	Novoa	Mauro González	ECO	UACH	44	Efecto de la caída de ceniza en bosques de Nothofagus pumilio, post erupción del Cordón Caulle
Andrea	Orfanos	Laura Gallardo/Rol and Von Glasow	MOS	UCH	44	Penachos Volcanicos y su evolución
Pamela	Pizarro	Roberto Rondanelli	BGC	UCH	44	Frecuencia de neblina y nubosidad baja en el valle central de Chile"
Dharma	Reyes	Ricardo De Pol	BGC	UDEC	44	Geometría de masas de agua frente al margen continental chileno durante el pleistoceno tardío"
Joaquín	Rivera	Laura Nahuelhual/ René Garreaud	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 periodo 1980 - 2012
Sandra	Sanhueza	Laura Farías	BGC	UDEC	44	Fijación biológica de N <sub>2</sub> y N <sub>2</sub> O 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".
Rodrigo	Santander	Laura Nahuelhual / René Garreaud	HD/CD	UACH	44	Exposición a eventos climáticos y políticas públicas: un análisis espacial en la región de Los Ríos
Patricio	Velázquez★	TBD	MOS	UCH	22	TBD
Josefa	Verdugo	Laura Farías	BGC	UDEC	44	Contenido e intercambio de gases de efecto invernadero en aguas del Bahía Chile, Antártica; el caso del CH <sub>4</sub> y N <sub>2</sub> O 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 (41°S), desde el Último Máximo Glacial hasta la actualidad.

★ Velázquez is a meteorologist at the Chilean Weather office.

**Table 3.6.** Professional exams (15), indicating weekly dedication, research area and institutional affiliation.

Name	Last Name	Tutor(s)	Research Area	Affiliation	Dedication (Hours per week)	Thesis title/subject
Valentina	Besaoin	Laura Fariás	BGC	PUCV	44	Variabilidad estacional e interanual de los hotspot de N <sub>2</sub> O en una zona de surgencia sobre la plataforma continental de Chile central (~36°)
Gustavo	Conteras	Marcela Cornejo	BGC	UDEC	44	Efecto de la disminución de oxígeno disuelto sobre la ecofisiología de Acartiatonsa y Euphausia mucronata, por medio de la incorporación neta y bruta de nitrógeno utilizando técnicas isotópicas
Ignacio	Díaz Hormazabal	Mauro González	ECO	UACH	44	Análisis espacio-temporal de incendios en la región del Maule
Gonzalo	Duarte	Duncan Christie	CD	UACH	44	Patrones multicentenarios de crecimiento de Nothofagus pumilio a través de un gradiente altitudinal en los Andes valdivianos
Víctor	Elgueta	Mauro González	ECO	UACH	44	Composición, estructura y dinámica de un bosque Roble-Raúl-Coigüe del Predio "El Retiro" Ciudad de Angol, Región de la Araucanía
Karla	Leal	Mauro González	ECO	UACH	44	Restauración de bosques siempreverdes en la cordillera de la costa
Pia	Leiva	Christian Little	ECO	UACH	44	Análisis de la oferta y demanda del servicio ecosistémico provisión de agua en la cuenca de Cauquenes en Arrayán, centro-sur de Chile
Víctor	Merino	Ricardo De Pol	BGC	UDEC	44	Agua Profunda del Pacífico mediante el análisis de isótopos estables
Paulina	Montoroy	Duncan Christie	CD	UACH	44	Cambios multicentenarios en el crecimiento de bosques de Nothofagus dombeyi en los Andes valdivianos
Mauricio	Montiel	Mauro González	ECO	UACH	44	Efecto de disturbios catastróficos sobre el establecimiento y crecimiento radial de Nothofagus pumilio, Parque Nacional Puyehue
Miguel	Pelayo	Pilar Moraga	HD	UCH	44	Influencias de la discusión sobre Equidad en el Acceso al Desarrollo Sostenible en conceptos y principios del derecho ambiental internacional: Nuestro presente común
Daniela	Rodríguez	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 Marín	Laura Fariás	BGC	UDEC	44	Procesos y micro-organismos involucrados en la producción de metano en la capa superficial del océano
Cynthia	Sanhueza	Beatriz Diez	BGC	PUC	44	Composición de la comunidad bacteriana marina en sistemas polares
Ignacio	Vera	Carlos Jara / Mauro González	ECO	UACH	44	Efecto de la erupción del Cordon Caulle en comunidades de macroinvertebrados bentónicos de ecosistemas fluviales en el Parque Nacional Puyehue,



**Table 3.7.** Research assistants (15), engineers, technicians, indicating weekly dedication, research area and institutional affiliation.

Name	Last Name	Contract (in months)	Dedication (hours per week)	Research Area	Affiliation	Tutor(s)	Support theme
Enrique	Cruz	12	44	ECO	UACH	Antonio Lara	Field work support
Gabriel	Araya	8	44	HD	UCH	Pilar Moraga	Legal framework of climate change
Camilo	Barahona	2	11	CD	UCH	René Garreaud	Cutt-off lows climatology
José	Barrena	12	44	HD	UACH	Laura Nahuelhual	Economics of ecosystem services
Roxana	Bórquez	12	44	HD	UCH	Paulina Aldunce	Meta-analysis of resilience
Matías	Bravo	1	11	MOS	UCH	Laura Gallardo, Nancy Hitschfeld	Urban canopy representation
Alejandra	Carmona	12	44	HD	UACH	Laura Nahuelhual	Vulnerability maps
Jerónimo	Escribano	7	44	MOS	UCH	Laura Gallardo, Roberto Rondanelli	Aerosol forcing quantification
Tania	Faúndez	2	22	MOS	UCH	Melitta Fiebig	Statistical downscaling of climate scenarios
Gerardo	García	12	44	BGC	UDEC	Laura Farías	Laboratory support
Adolfo	Henríquez	2	22	MOS	UCH	Laura Gallardo, Axel Osses	Variational methods for optimal network design
Andrea	Iturra	6	44	BGC	UDEC	Ricardo De Pol	Laboratory support
Cristián	Rivera	4	44	MOS	UCH	Laura Gallardo, Juan Carlos Maureira	Data bases and climate services
Claudia	Villarroel	2	11	CD	UCH	René Garreaud	Heat waves and freezing events in central Chile
Solange	Villarroel	4	44	HD	UCH	Pilar Moraga	Legal framework of climate change

**Table 3.8.** Other support personnel, indicating weekly dedication and institutional affiliation.

Name	Last Name	Contract (in months)	Dedication (hours per week)	Tesis Title/Subject
Luz	Fariña	11	44	Outreach and communications
Andrea	Obaid	2	22	Organization of launching ceremony and media support
María	Ogaz	6	11	Graphic design
Valentina	Ortega	2	11	Work space design
Ricardo	Stein	3	22	Building architecture
Julieta	Vivar	1	11	Group dynamics
Julio	Yoma	3	22	Building calculation

**Table 3.9.** National and Foreign trainees. Foreign trainees receive ca. 300 kCLP per month.

Name	Last Name	Country	Contract (in months)	Dedication (hours per week)	Research Area	Theme
Lisa	Caridis	Australia	6	44	HD	Iterational framework for Adaptation; Review of legal standards for ecosystem services
Noemi	Krugler	France	6	44	HD	Climate change governance in Chile
Nicolás	Molina	Chile	1	44	MOS	Data assimilation and attribution: Implementation of a simple column model with convective adjustment

**Table 3.10.** Administrative personnel, indicating weekly dedication and institutional affiliation.

Name	Last Name	Contract (in months)	Dedication (hours per week)	Affiliation	Specific Role
Belkys	Castillo	8	44	UCH	Secretary and administrator
Mauricio	Castro	12	11	UACH	Accountant
María Isabel	Guerra	4	44	UCH	General Coordinator
Cecilia	Montecino	3	44	UCH	Secretary and administrator
Mabel	Torres	12	11	UDEC	Accountant
Pamela	Villouta	1	11	UCH	Accountant

**3. Changes in research personnel:** Describe any changes in the principal and associate researchers relative to the original project.

There are no changes to report regarding principal researchers. With respect to associate researchers there have been changes in dedication, the replacement of a researcher, and the addition of new researchers. Additionally, members of CR2 have competed and obtained new complementary resources in the area of paleo-climate research, which may have consequences for their nominal dedication to CR2 starting in March or April 2014.

***Changes in dedication***

In the area of Human Dimensions, Laura Nahuelhual and Paulina Aldunce shared the position of deputy principal investigator (PI), i.e., both appear with a dedication of 10 hours per week as a consequence of Paulina Aldunce's residence during the first half of the year. She was finishing her PhD in Melbourne, Australia. Even though Paulina Aldunce worked for the Center, and visited Chile over that period, it appeared practical to have Laura Nahuelhual to act as deputy PI. Now that Paulina Aldunce is back in Chile, her dedication will be of 14 hours and that of Laura Nahuelhual of 7 hours as originally planned.

In the area of Biogeochemistry, Ricardo De Pol took the position as deputy PI, replacing Marcela Cornejo. This follows from the fact that Ricardo De Pol has a permanent position at University of Concepción, whereas at the time Marcela Cornejo only had post-doctoral position. Now, Marcela Cornejo has found a permanent position at the Pontificia Universidad de Valparaíso. She will keep her current research position at CR2 with a dedication of 7 hours per week.

Under the leadership of Dr. Maisa Rojas, deputy PI for Modeling and Observing Systems (MOS), a nucleus proposal was submitted to the Milenium Initiative in Chile by late 2012. This proposal was granted in late 2013 (NC120066). The nucleus deals with paleo climate studies for the Southern Hemisphere, which complements the studies developed at CR2. Also, it provides support to field and modeling work. In addition to Maisa Rojas (MOS), the nucleus also involves as investigators other CR2 researchers, namely: Patricio Moreno (CD), Ricardo De Pol (BGC), and Gary Shaffer (MOS). At this point we have deemed it necessary to reduce the commitment of Dr. Rojas from 14 to 7 hours per week, starting in March 2014. In her role as deputy PI, we have proposed her replacement by Dr. Nicolás Huneeus (See next "new researchers"), the new Faculty hired by the Universidad de Chile. We may later in 2014 reconsider the dedications of Dr. De Pol and Moreno. Nevertheless, it must be pointed out that this nucleus is considered to be a good match and not a competition for CR2.

***Replacement of a researcher***

Prof. Mario Pino, who has a long trajectory in paleo-archeology and sedimentology, was an associate researcher with a dedication of 7 hours per week in the area of Ecosystem Services. He resigned from this position in May 2013 as he looked for new funding opportunities for specific research areas of interest. He keeps a position as an adjoint researcher providing occasional support to the group led by Dr. Lara (ECO). Dr. Pino was replaced by Dr. Susana Gómez, who is a young but experienced scientist with a background in fire ecology. This area of expertise is key to our research. This proposition has been authorized by CONICYT's council.

***New researchers***

Our sponsoring institution, i.e., Universidad de Chile, contributed to the CR2 with a new faculty position at the Department of Geophysics, where the leadership for CR2 resides. A national and international call was made in late December 2012 by the University. By April 30 – closing date of the call- more than 14 applications were received. In addition to the standard selection procedure followed by the University, the opinion of Prof. Guy Brasseur (Climate Service Center in Germany, and part of our International Advisory Scientific Committee) and of

Prof. Carolina Vera (University of Buenos Aires, part of our international network) were consulted. By mid-October 2013, the position was sanctioned and offered to Dr. Nicolás Huneus, who proposed to develop research on the role that aerosol forcing may play in explaining the interdecadal variability using state-of-the-art regional climate models. Dr. Huneus is the lead author in various publications addressing aerosol climatic forcing by means of advanced modeling tools including inverse modeling and data assimilation. He has now been proposed to CONICYT to become an associate researcher at CR2 under the area of Modeling and Observing Systems. He is expected to start his work for CR2 in January 2013.

According to the recommendations made by CONICYT's council, we were urged to appoint before the end of the second year of CR2 "a recognized international scientist, residing in Chile, with expertise in climate change". In connection with the call for a faculty position, we established contact with Dr. Fabrice Lambert. Dr. Lambert, who graduated in Bern in 2007 under the direction of Prof. Thomas Stocker (Current IPCC chairman), has a strong record of publications on the use dust records collected in Antarctica to understand climate change and variability, and the polar amplification of climate change. He was keen to move to Chile and to work at CR2 because of the opportunities to better understand the underlying processes to dust export and impacts. Also, he appreciates our interdisciplinary approach and the connection with other disciplines. We have offered him a position as an associate researcher at CR2 for the remaining period of the center. We have submitted the corresponding proposal to CONICYT's council.

4. **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)<sup>2</sup> 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 will take place in Villa Alegre, Chile, between January 11 and 15, 2014. In this opportunity, we will count with the attendance of Professors Battisti, Brasseur, and Scholes. Prof. Howden, O'Brien and Zhu had concurrent commitments in early January in connection with IPCC's group two meetings. Prof. Nobre could not attend for personal reasons. Dr. Howden will visit us later in 2014 or in connection with the international review panel in early 2015. In addition to visiting us and giving seminars, our panel has helped review this annual report. Also, as stated earlier, Prof. Brasseur provided an independent evaluation of the short list of researchers who applied for a Faculty position at Universidad de Chile.

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, 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. She was designated as the institutional representative by Mrs. María Ignacia Benítez, head of the Ministry for the Environment.
- Raúl O’Ryan, Officer at the United Nations Development Program in Santiago
- Karen Poniachick, Director, Columbia Global Centers for Latin America in Santiago. She also acted as head of the Ministry for Energy
- Jaime San Martín, Researcher and former Director for the Center for Mathematical Modeling

We held a first meeting with the National Advisory Panel in Concepción, last August, in connection with one of our extended board meetings. The attendees were: Mrs. Escobar, Mrs. Jadrijevic, Mr. O’ Ryan and Mr. San Martín. They listened to brief presentations by the board and provided comments on our activities, and ways to establish a fruitful communication and connection with different sectors, particularly but not exclusively the public sector. They advised us on defining a few deliverables: climatic data including quality indicators, recurrent meetings dedicated to relevant topics (e.g., water resources), etc. The difficulties involved in adopting an interdisciplinary approach were also extensively discussed.

Dr. O’Ryan is leaving his position at UNDP and Dr. Carrasco is retiring. Thus it will be necessary to assess their participation in the Committee later 2014. Also, a new government will come into office next year, which may lead to other changes. In the Villa Alegre meeting we will count with the participation of Jorge Carrasco, Rosa Escobar, and Raúl O’Ryan.

In Annex 3, we have added short reviews provided by the national and international advisory panels, including recommendations.

#### IV. OBJECTIVES AND RESULTS ATTAINED (Maximum 20 pages)

##### 1. RESULTS OBTAINED RELATIVE TO CENTER OBJECTIVES

a. Considering the objectives established in the project. Refer also to those objectives that have not been accomplished, justifying the reasons. 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

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

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a. Our center's overarching goal is to foster the development of Earth System Science in Chile. To this end, we have adopted a systemic and interdisciplinary approach combining five broad areas of research, in alphabetical order: biogeochemistry (BGC), climate dynamics (CD), ecosystem services (ECO), human dimensions (HD), and modeling and observing systems (MOS), which together and interactively should be functional, if worked out in collaboration with stakeholders, in defining sound, medium and long term adaptation, and mitigation strategies for enhancing social resilience. To ensure interactions among different disciplines and stakeholders (scientists, decision makers, public, etc.) we envision, in addition to providing national perspectives, integrative regional studies at three geopolitical regions of Chile dealing with:

- Scarcity and variability of water resources in Central and Northern Chile, where an improved characterization of the hydrological cycle and climate variability is required for management strategies to satisfy increasing and often conflicting demands.
- Growing urbanization in Central and Southern Chile requiring integrated and intersectoral management in order to maximize control of pollution and climate driver sources.
- Rapid land use changes in Central and Southern Chile leading to sectoral, territorial and cultural conflicts that require the design of adequate landscape arrays to provide multiple market goods and services, as well as ecological restoration for the recovery of ecosystem services and new conflict resolution approaches.

During the first year, in addition to the establishment of the Center itself, we have advanced in our science in a way that largely reflects the natural extension of the previous efforts that began before the center's creation and have resulted in 34 indexed publications with explicit recognition to CR2 in 20 of them, 2 books and 16 book chapters, and 106 presentation in congresses and symposia in Chile and abroad. Also, we have successfully engaged new researchers (3), post-doctoral fellows (5), research assistants (15), doctoral (9) and master (28) fellows, undergraduate students (14), and trainees (4). Moreover, we have established contact with stakeholders including governmental agencies, private companies, non-governmental organizations (NGOs), etc. We have contributed to the revision of Adaptation Plans (Biodiversity) and strategies presented by the Ministry for the Environment. In addition to numerous media appearances (~100 until December 7 2013), we have hosted and co-hosted 10 congresses and symposia (national and international), and held multiple seminars for scientists and also for the general public and in schools. Our researchers have been successful in bringing new and complementary projects to further the Center's research, and its international linkages. Some of these achievements are highlighted in the next paragraphs. Also, we briefly discuss upcoming

steps for the consolidation of joint research activities to foster integrative and interdisciplinary research.

*(i) Main research findings*

We have gained understanding in a variety of subjects and processes including biogeochemical cycles of climatically active gases in the coastal ocean and riverine systems, urban aerosol forcing, characterization of extreme precipitation events, low frequency climate variability, hydrological cycle, etc.. Also, the legal framework for climate change and its principles have been analyzed. The concept of resilience has been systematically reviewed, and a mapping protocol to visualize socio-ecological vulnerability to climate change has been developed. Progress has been made regarding mapping of forest and vegetation cover and land-use change in watersheds in Central Chile, as well as with respect to ecological restoration. Research advances are briefly described under the results of each research line.

It must be pointed out that our research capabilities will be greatly improved by the acquisition of new instruments including isotopic analyzers for water and nitrogen isotopes, a sunphotometer, a wet only deposition sampler, and a windendo. Also, we acquired storage and fast connections to access computing clusters.

*(ii) Synergy and collaboration among research lines*

Achieving interdisciplinary research is a long term process that our team has initiated. To do so we have met on several occasions to discuss and formulate common research questions.

First, in April 2013 we held a two-day meeting in the mountains close to Santiago with the majority of researchers, students and staff to promote a common vision, discuss the mission of our center and to exercise ways to surpass the language barriers found among the different disciplines and academic cultures represented at CR2 (This meeting was mediated by an external consultant with expertise in science communication.)

Principal (PI) and deputy investigators met in June in Valdivia to discuss disciplinary vs. interdisciplinary research, and to formulate research objectives that could involve and would require of an interdisciplinary approach. We organized an exercise in which people proposed several integrative research themes that might lead to a high impact journal ("nature like") and at the same time be relevant for policy making. A vivid discussion took place at the time.

In August, we held a meeting in Concepción with PIs and deputy PIs, and we reviewed three potential themes for interdisciplinary research, namely: 1) Extended drought, natural variability or climate change? (R. Garreaud); 2) Vulnerability map and resilience potential: more than environmental management? (P. Moraga & L. Nahuelhual); and 3) Black carbon as an integrative theme (L. Gallardo). The discussion was organized in small groups, including members of our National Advisory Panel, and all themes were deemed to be plausible as relevant for developing interdisciplinary research. A decision was made to define an area of study that would provide a common scenario in which different scientific questions could be addressed. For logistical considerations, the area between 35S and 38S was considered most appropriate to develop common research initiatives. We will start 2014 by discussing these issues accompanied by members of our National and International Advisory panels in a meeting in that region, namely at Villa Alegre (35°40'S; 71°45'W), including a visit to an experimental plantation run by our ECO colleagues.

In terms of numbers, there are just a couple of papers involving different research lines. We recognize that we must make an effort to increase those numbers. Nevertheless, achieving integration and moving towards interdisciplinary research is a process, thus we look forward to an increased integration during 2014.



*(iii) Formation of advanced human capital directly related to the Center's objectives*

As in the case of scientific findings, so far a significant fraction of graduate students have developed mostly disciplinary work that follows from activities initiated prior to the Center's creation, which in spite of their relevance to our current research were not conceived ab initio as contributions to CR2. Theses and exams recently initiated are more in accordance with the science fostered under CR2. On the other hand, the selection of post-doctoral fellows was made strictly according to research questions related to CR2 objectives.

In addition to students and technical staff, we have included the category of research assistants. Typically, their profiles correspond to advanced students or graduated students that are in transition from one degree or from one job to another. We have hired them to assist in specific laboratory or field work, or to expand the research initiated earlier for periods of time that only exceptionally exceed six months. Of this group of collaborators, some have or are about to migrate to other countries to pursue doctoral studies (See Table 4.7).

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 (See Table 4.9). Also, we have hired trainees from our own institutions for periods of up to six months. This is a way to engage early on good students.

*(iv) Collaborative networks both at the national and international level*

At the national level we have collaborated with centers and institutions that supported our proposal in 2012, and also with new research centers:

- The Center for Mathematical Modeling has provided computational support, and his former director, Dr. Jaime San Martín participates in our National Advisory Panel.
- We collaborated with the Center for Energy (CE) at the University of Chile and the Solar Energy Research Center (SERC, FONDAF N°15110019) to support the discussion of regional climate scenarios for the recently finalized report for the "*Mitigation Action Plans & Scenarios (MAPS)*", led by the Ministry for the Environment and coordinated by CE and SERC. Our researchers Maisa Rojas and Pilar Moraga actively participated in the MAPS project. Moreover, we co-organized an international symposium on Climate Change and Sustainability, held in October 2013.
- We participated in invited talks at a symposium organized by the Center for Sustainable Urban Development (CEDEUS, FONDAF N°15110020). Also, one of our research assistants, Roxana Bórquez, collaborated in a project on sustainable practices in municipalities in Santiago led by the NGO Adapt Chile, for which CR2 and CEDEUS contributed with invited talks and discussions.
- We are collaborating with the Chilean Weather Office in several ways. They designated a representative to our National Advisory Panel, namely Dr. Jorge Carrasco. We have provided a fellowship for meteorologist Patricio Velázquez to take part in the master's program in Climatology and Meteorology at the University of Chile. Also, we are exploring ways to establish a formal collaboration agreement regarding climate services, data access, and observational platforms.

In addition to this, we co-organized two national/international conferences held in Chile. The "*3er Congreso de Oceanografía Física, Meteorología y Clima del Pacífico Sur Oriental*" was held in Santiago in mid October 2013, and the "*Congreso Internacional del Bosque y el Agua: Generando puentes entre la ciencia y la Sociedad*" was held in Valdivia in early December 2013. The former was co-organized with the Department of Geophysics, University of Chile, the Chilean Weather Office, the Meteorological Office of the Chilean Navy, and the National Committee for Oceanography. The latter was co-organized with Universidad Austral de Chile,



foundation FORECOS and project Innova Cuencas (<http://www.innovacuencasapr.cl/>). It was also supported by the international networks LANES and VESPLAN.

Last April 2013, we also collaborated with the Ministry for the Environment and for Foreign Affairs to organize a meeting on “Climate Justice” among regional negotiators from Latin America and the Caribbean at the Climate Change Convention, as well as prominent stakeholders, including former Chilean president Ricardo Lagos. Invited talks were given by Prof. Solange Teles da Silva, Sao Paulo University, Brazil, and by Prof. Marie Claire Cordonier, Cambridge University and International Development Law Organization (IDLO).

Internationally, we have strengthened our collaboration with our partners abroad by co-organizing symposia and congresses, submitting joint proposals, co-guiding students, short-courses, etc..

#### *Congresses and symposia*

The following events were co-organized by CR2 and foreign partners:

- Tercer Congreso de los Servicios Ecosistémicos en los Neotrópicos: Estado del Arte y Perspectivas, in Medellín, Colombia in early October 2013. This congress convened ca. 250 participants, including CR2 researchers and students from ECO and HD research lines.
- Workshop on Black Carbon in the Andes (October 10-11, Santiago). This meeting convened ca. 30 experts from all Andean countries, as well as North American and European researchers. The meeting was co-organized by CR2, the Molina Center for Energy and Environment (MCE2, <http://mce2.org/>) Universidad Andrés Bello, the International Cryosphere Climate Initiative (ICCI, <http://iccinet.org/>), and the international Commission for Atmospheric Chemistry and Global Pollution (iCACGP, <http://www.icacgp.org/>). During this meeting a white paper was outlined, including CR2 researchers in all research lines (Further information can be found in <http://mce2.org/en/activities/pisacsouth-american-cryosphere>).

In addition to this, CR2 researchers have been invited to participate in the scientific and organizing committees of or as invited speakers to three major conferences in 2014, namely:

- 13th Quadrennial iCACGP Symposium and 13th IGAC Open Science Conference “Changing Chemistry in a Changing World” to be held from the 22nd-26th September, 2014, in the city of Natal, in northeastern Brazil. Laura Gallardo is a co-convenor of the session on Atmospheric chemistry and urbanization: from local to the global scales (<http://www.igac-icacgp2014.org/>).
- Third International Climate Change Adaptation Conference to be held in Fortaleza Ceará – Brazil, between 12 and 16 may 2014. Paulina Aldunce is part of the International Executive Organizing Committee. <http://adaptationfutures2014.ccst.inpe.br/>
- WCRP Conference for Latin America and the Caribbean: Developing, linking and applying climate knowledge, to be held in Montevideo Uruguay. René Garreaud is in the scientific steering committee and Laura Gallardo is an invited speaker. <http://www.cima.fcen.uba.ar/WCRP/>

#### *Joint proposals*

- The Human Dimension Research Area of CR2 was awarded the CONICYT 2013 “Support of international networking between research centers” grant (REDES130066). The objective of this grant program is to support the formation of networks to strengthen international links, in all areas of knowledge between national scientific and technological research centers and other centers located in certain countries, as indicated in the call for applications. Of all the applications submitted, CR2’s was ranked first. As a result, three CR2 research assistants will undertake internships at the following locations: the Institute for Environmental Decisions (IED), Switzerland, Goethe Universität Frankfurt am Main, Germany, and the

Lauterpacht Center for International Law, University of Cambridge in the United Kingdom. Moreover, CR2 will have the opportunity to host the following visiting academics: Marie Claire Cordonnier from the Center for Sustainable Development Law, Canada, Sandrine Dubois Maljean from the *Centre d' Etudes et de Recherches Internationales et communautaires*, The Aix Marseille Université, France, Carolina Adler from the Institute for Environmental Decisions, Switzerland, and Victor Galaz from the Stockholm Resilience Center, Sweden. Finally this grant will enable three principal CR2 investigators to travel to the *Centre d' Etudes et de Recherches Internationales et communautaires*, the Institute for Environmental Decisions, and the Stockholm Resilience Center, respectively. The outputs of these activities will be disseminated to the community through publications in national and international journals, and seminars and workshops intended to further the research undertaken. And finally, these activities will also help establish methodological definitions for the work of CR2 in the future.

- Our colleagues at the International Research Institute for Climate and Society (IRI) at the Earth Institute from Columbia University, under the leadership of IRI's director Dr. Lisa Goddard submitted a proposal on Water Sustainability and Climate to the National Science Foundation (NSF) in the United States. The proposal was entitled: "Understanding the interaction of hydroclimate variability and institutions: do water markets foster sustainability or increase volatility?" (NSF solicitation 13-535). We acted as a counterpart in Chile for this proposal. Unfortunately, it was not granted. We look forward to re-submitting this proposal or part of it during 2014.
- Emory University investigators, under the leadership of Prof. Kyle Steenland, submitted a proposal to the Global Health Research and Research Training eCapacity Initiative (R25) from the National Institute for Health in the United States for transferring knowledge from the US to Chile, regarding new techniques and software which pertain particularly to the areas of exposure measurement, epidemiology, and geospatial technology tools for addressing health impacts. We acted as a third party in collaboration with the School of Public Health at the University of Chile, with focus on the use of remote sensing for assessing health impacts of aerosols. This proposal was not granted.
- In California, there is an initiative studying various aspects regarding coastal fog. Given the similarities between the fogs occurring along California and Central and Northern Chile, we were invited to participate in meetings (over the internet), and to attend workshops in the USA to discuss various questions, and to eventually submit joint proposals. In this context we have initiated collaboration with Dr. Peter Weiss-Penzias from University of California-Santa Cruz. Dr. Weiss-Penzias got an NSF grant aimed at exploring the cycling of mercury in coastal California, and to compare that with what occurs along Chile. The site at Fray Jorge National Park on the coast of Chile is ideally suited to collecting marine fog in the austral spring and summer. This work is led by Dr. Rondanelli.
- Prof. Rodney Keenan and Ruth Beilin from the University of Melbourne in Australia visited us shortly in mid-March. We discussed the possibility of co-organizing a side workshop southern climate science and adaptation during the Adaptation conference in Brazil (<http://adaptationfutures2014.ccst.inpe.br/>). The purpose is to hold a workshop for partnership development involving scholars from University of Melbourne, University of Sao Paulo, and CR2. Dr. Aldunce (HD) is the coordinator for this activity. This proposal was granted.

#### *Co-guiding students*

- Andrea Orfanos (MOS) is starting her MSc thesis work on the evolution and radiative forcing of volcanic plumes from degassing Andean volcanoes under the guidance of Laura Gallardo and Roland von Glasow at the Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia (UEA). She will visit UEA in 2014.



- Katherine Indvik (HD) has developed her MSc thesis on the conceptualization of resilience for climate change under the guidance in Chile of Paulina Aldunce and Roxana Bórquez. Prof. Carolina Adler from Institute for Environmental Decisions (IED, <http://www.ied.ethz.ch>) acts as her co-advisor, and Prof. Victor Galaz from the Stockholm Resilience Centre in Sweden will act as external reviewer of her thesis.
- Joaquin Rivera and Rodrigo Santander are two MSc students at Universidad Austral working under the supervision of Laura Nahuelhual (HD). Given the interdisciplinary character of their work (impact of climate variability on crops and social vulnerability) their thesis committee is composed by Ana Lya Uriarte (HD) and René Garreaud (CD).

#### *Short courses*

- Boundary layer processes and modeling. Professor Alexander Baklanov from the Danish Meteorological Institute visited CR2 in mid-October 2013. He gave the invited lecture at our launching ceremony on October 15<sup>th</sup>. Also, he gave an invited talk at the Meteorology and Oceanography Congress. In addition to this, he gave a short primer on boundary layer meteorology and modeling, with emphasis on urban processes and parameterizations at the Geophysics Department. We had graduate students from our programs in Computer Science, Fluid Dynamics and Climatology and Meteorology, and CR2 researchers (MOS), with an overall attendance of about 10 participants.
- During the last week of November 2013, Dr. María Victoria Cachorro and Dr. Yasmine Bennouna from the group of Atmospheric Optics at the University of Valladolid in Spain, visited CR2 in Santiago after their. This group is responsible for the calibration of the European network of sunphotometers under the European project Aerosol Cloud and TRace gas InfraStructure (ACTRIS, <http://www.actris.net/>). They helped us with the installation of our sunphotometer, which is expected to become a part of the Aerosol Robotic Network (AERONET, <http://aeronet.gsfc.nasa.gov/>). They also gave a hands-on primer on photometry for CR2 students, and also for two physics students from Universidad de Santiago. During 2014 we expect to establish further collaboration with Prof. Cachorro's group.

#### *(v) Dissemination and exploitation of results*

In addition to the standard dissemination of scientific results within the national and international communities –as reflected in over 100 seminars and conference contributions–, we were keen to take part in multiple meetings and seminars oriented to the general public and stakeholders. In these seminars or informal talks, we took the opportunity to present and position our center, attempting to identify possibilities for collaboration. We highlight the following instances:

- Invited lecture by Laura Gallardo in the inaugural ceremony for the Climate Justice Dialogue – Mobilising Bold Action, Sub-Regional in early April 2013, an event co-organized with Ministry for the Environment and the Ministry for Foreign Affairs, as well as the Mary Robinson Foundation, the World Resources Institute, with the collaboration of the United Nations Development Programme, Energieia-Alliances for Sustainable Developments, CDKN- Alianza Clima y Desarrollo. In addition to the many Chilean stakeholders who attended, including the Minister for the Environment, Mrs. María Ignacia Benítez, and Ambassador José Manuel Balmaceda from the Ministry for Foreign Affairs.
- The ECO team, under the leadership of Antonio Lara and Christian Little, organized the International Congress on Forests and Water: Establishing Bridges between Science and Society that took place in Valdivia between December 4 and 6. There were more than 200 participants. This gathering provided a new opportunity to exchange perspectives and knowledge with timber companies, government agencies, NGOs and other organizations. Through such dialogue we expect to build policy recommendations to achieve large-scale

restoration, contributing measures to be incorporated in the National Strategy for Adaptation to Climate Change for the forestry sector in Chile.

- One of our research assistants, Roxana Bórquez, participated in a project on sustainable practices in municipalities, integrating such practices for adapting to Climate Change in the Metropolitan Area of Santiago led by the NGO Adapt Chile, and funded by the British Embassy and held in collaboration with the Metropolitan Secretariat for the Ministry for the Environment.
- A course on Ecological Restoration and its applications was co-organized by the ECO team, under the leadership of Mauro González, with Forestal Mininco, and Universidad Austral de Chile. The course was held in Angol, Chile and it had more than 40 attendees, the majority of them practitioners.
- René Garreaud (PI in CD) was among the three lecturers of the short course "*1era Escuela Internacional de Variabilidad y Cambio Climático en los Andes*" organized by UNESCO and project ACCION (University of Albany, US State Department, U. de Chile, IGP). The course was held in Lima, Peru, with the participation of 21 young scientists from Latin America, including one CR2 fellow (Claudio Bravo).

#### (vi) Outreach to society

The outreach goal of the first year was to position (CR2) among peers, stakeholders and the media. A communication strategy was developed around four lines: institutional image; internal communication; database building; and training in science communication.

A corporate image including logo, presentation brochure, and business cards for staff and researchers were designed. Also, a bilingual web page was launched: <http://www.cr2.cl/>. Similarly, institutional twitter (@cr2\_uchile) and Facebook (Center for Climate and Resilience Research) accounts were created.



A bimonthly newsletter is distributed by e-mail among researchers, students, and staff at CR2. It contains a summary of all activities passed and upcoming, and media appearances.

Science communication is one of the pillars of CR2. Therefore, during the first year emphasis was put on training communication skills among scientists and students. To that end, in April 2013 we held a two-day meeting in the mountains close to Santiago with the majority of researchers, students and staff to promote a common vision, discuss the mission of our center and to surpass the language barriers found among the different disciplines and academic cultures represented at CR2. This meeting was mediated by an external consultant with expertise in science communication. As our team counts with a former minister for the Environment (Ana Lya Uriarte), we had a splendid chance to discuss the gaps in communication between scientists and policy-makers. A detailed report of this meeting is available in our intranet. Also, in connection with our board meetings in Valdivia and Concepción, our journalist held half day workshops for students and researchers introducing basic knowledge and training on media and communicating with the media, including tips for better communication.

An extended database of stakeholders in academia, policy, parliament members, governmental officials, journalists, etc. was created. This list already includes more than 600 individuals and their corresponding contact information.



We had 106 media appearances between March and December 2013, of which 57 corresponded to digital media other than CR2, 31 articles and notes in newspapers and magazines, 11 radio interview, and 7 appearances in regional and national television. Of these, roughly 70% are categorized as news, letters and opinion columns add 14%, and interviews represent 12% of all media appearances. Over time, these appearances peak in connection with our launching ceremony, and the publication of the IPCC report in late November. For details see Annex 2 "In the media".



Our launching ceremony took place at the Palacio de la Moneda Cultural Center on October 15 2013. We had more than 200 attendees, including university authorities from all involved institutions, scientists, governmental officials, general public, etc.. We had 42 media



appearances in conventional and digital press, as well as interviews on national radio and television.

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

Even though the number of peer-reviewed papers produced by our researchers and students is 34, only 20 of these explicitly recognize CR2 as FONDAP 15110009, and this results in our incompleteness of the quota for papers indicated by our proposal. As stated elsewhere, many of these publications were initiated before CR2 but are relevant to our current research. Some of them correspond to large international efforts involving many scientists and institutions, which makes it impractical to include a lengthy list of acknowledgements. In some cases, the lack of affiliation and acknowledgement simply results from author's overlook. We have insisted on strictly following the acknowledgement rules in current manuscripts.

A similar story can be told regarding the themes of the post graduate theses already defended. They are relevant but they were initiated prior to the Center's start. Therefore, we expect to increase the number theses during the second year, and the number of theses co-guided by researchers in different areas and institutions.

We had an average of less than one citation per paper. This is not surprising since the vast majority of our articles were accepted in early or mid-2013. In fact, it was an error from our side to put 13 as the expected value, which is extremely difficult to achieve after one year.

## RESULTS ACHIEVED PER RESEARCH LINE

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

### ***Biogeochemistry (BGC)***

This research area aims at: 1) Identifying and quantifying novel biogeochemical processes mediating the cycling of climatically active tracers (CATs) in surface waters, nitrous oxide ( $\text{N}_2\text{O}$ ), methane ( $\text{CH}_4$ ), and dimethyl sulfide (DMS) in particular; 2) Assess CAT emission fluxes in selected natural environments (coastal ocean, volcanoes) and from anthropogenic sources (mining, energy production and aquaculture); 3) Characterizing the regional interactions between urban areas and adjacent ecosystems.

#### *Biogeochemical processes*

Fariás et al. (2013) have shown biological  $\text{N}_2\text{O}$  fixation is an alternative and novel pathway capable of directly transforming this gas into particulate organic nitrogen (PON) in the subtropical and tropical waters of the South Pacific Ocean. This pathway also constitutes a  $\text{N}_2\text{O}$  loss other than canonical denitrification. This provides evidence that diazotrophic microorganisms use  $\text{N}_2\text{O}$  as a substrate with a non-selective nitrogenase enzyme complex. It is remarkable that this process seems to be active over a wide range of environmental conditions (e.g. light and dark; surface and deep waters). Our evidence draws attention to the importance of this pathway for regional and even global  $\text{N}_2\text{O}$  removal, preventing part of its potential efflux toward the atmosphere, but also contributing to new biological production throughout the entire water column. Thus,  $\text{N}_2\text{O}$  represents a new form of fixed N that could change our vision and understanding of the nitrogen cycle.

Regarding the cycling of  $\text{CH}_4$ , DMS and other methylated compounds, we have collected six-months of a (monthly)  $\text{CH}_4$  time series, along with measurements of photo- and chemosynthetic activities. This offers glimpses into the origin of  $\text{CH}_4$  in surface waters—often referred to as the “methane paradox”. These data are providing new insights into the synergisms between phototrophs and methyltrophs, and how they mediate  $\text{CH}_4$  cycling in surface water. Florez et al (2013) reported the participation of DMS in  $\text{CH}_4$  formation in surface waters.

#### *Sources and sinks of CATs*

We have put special attention to  $\text{N}_2\text{O}$  and  $\text{CH}_4$  sources and sinks in connection with cultivated microalgae in ponds and lab cultures. This is of particular interest given the global rise in massive algae cultures for biodiesel and aquaculture purposes, considered so far as a new green revolution. Also we have measured high emissions for  $\text{CO}_2$  and  $\text{CH}_4$ , and a sink for  $\text{N}_2\text{O}$  from the Tubul-Raqui estuary, a coastal system off central Chile at  $36^\circ\text{S}$  (Daniel et al, 2013). This system is adjacent to an active coastal upwelling area, which undergoes rapid changes associated with natural and anthropogenic perturbations. Distinctive temporal patterns were observed that respond not only hydrological and nutrient balances within the system but also by the influence of wind-driven upwelling processes. We analyzed the potential effects of changes in nutrient load and freshwater discharge on net ecosystem metabolism (i.e., autotrophy or heterotrophy) and therefore, on the production/removal of greenhouse gases in this system.

Within CR2, we have continued the time series studies  $\text{N}_2\text{O}$  (11 years) and  $\text{CH}_4$  (5 years) off Concepción ( $36^\circ\text{S}$ ,  $73^\circ\text{W}$ ). This sampling was initiated by a previous FONDAP grant, namely COPAS (<http://copas.udec.cl/>). CR2 is allowing an improvement of this prominent record by means of better analytical capabilities (PICARRO isotopic  $\text{N}_2\text{O}$  analyzer), and soon by increasing the vertical resolution of the sampling using continuous sensors (buoys). We are looking for new resources for supporting the logistical costs of this sampling effort. We have also launched a new monitoring program in the Itata and Bio Bio rivers, measuring particles, nutrient, greenhouse gases and their isotopes. This work is carried out by our post-doctoral fellow Dr. Mariela Yévenes in collaboration with Dr. Marcela Cornejo. The new acquired equipment PICARRO for ethylene

and  $\text{N}_2\text{O}$  will be used to measure nitrogenase activity in cultures of nitrogen-fixing cyanobacteria. These experiments will allow us to better understand their physiology and function under different environmental conditions in natural systems. Collaboration with the Faculty of Engineering of Pontificia Universidad Católica de Chile will allow the construction of a prototype that enables automatic measurements.

A new focus of our research is led by Dr. Ricardo De Pol who is using advanced isotopic analyses to study the impact of climate variability on the hydrological cycle. Water isotopic composition of water ( $\delta\text{D}$ ,  $\delta^{18}\text{O}$ ) can tell us a great deal about the sources and pathways of different water sources because water isotopes leave fingerprints for climate variability and hydrological cycle. Thus, we have installed new equipment (PICARRO) and implemented techniques to quantify isotopic composition of water in fresh and seawater, rainfall, among others. Now that the techniques are in place, we can initiate a stronger collaboration with CD and ECO to study the changes in the hydrological cycle along Chile.

Paleo-climate studies do also shade light on the current and future behavior of the climate system. Our team has continued to study changes in the vertical stratification (Martínez-Mendez et al, 2013) and age of Antarctic water masses in the Pacific (Siani et al, 2013). This research will continue under the recently awarded nucleus on paleo-climate studies for the Southern Hemisphere funded by the Millennium Initiative in Chile.

#### *Interactions between urban areas and adjacent ecosystems*

Interactions between the coastal ocean and urban areas are plentiful (von Glasow et al, 2013). During the first year we have focused on the characterization of boundary layer processes including vertical stratification and its evolution (Fariás et al, 2013; Gallardo et al, 2013), and also on the quantification of the aerosol forcing over the Santiago basin (Escribano et al, 2013).

The semi-permanent presence of the subtropical high over an area of complex terrain, and the passage of low-level lows frequently induce very stable conditions over the Santiago basin. Therefore, emissions of short-lived climate forcers and other pollutants are easily accumulated over Santiago, a phenomenon that is readily visible as haze and a heavy load of aerosols. Residual layers are also apparent. In collaboration with the Chilean Weather Office, officials from the Ministry for the Environment, and researchers from Universidad de Santiago, Dr. Roberto Rondanelli organized in August 2013 a short campaign to test various instruments, including an aethalometer mounted on a tethered balloon, radiometers at ground level, an elastic lidar (measuring at 355 nm), a ceilometer, and conventional soundings. During this campaign we collected interesting data confirming the presence of residual layers, substantial amounts of absorbing aerosols, and the development of a convective boundary layer. Also, we could test various inversion methods to better characterize aerosol's optical properties.

We are also exploring ways to establish a long-term monitoring station to quantify aerosol-cloud interactions close to the Fray Jorge reserve in Northern Chile ( $30^\circ\text{S}$ ). Dr. Rondanelli has submitted a FONDECYT project to study these processes. Also, collaboration with other institutions have been sought, i.e., Pacific Coastal Fog network, Centro de Tecnologías Ambientales, Universidad Federico Santa María, etc..

#### ***Climate Dynamics***

Research in climate dynamics (CD) at CR2 focuses in four major areas: (1) diagnosis and projections of the temperature trends along Chile, (2) extreme events in future climate, (3) depiction and diagnosis of the low frequency variability and (4) climate impacts on water resources.

#### *Diagnosis and projections of the temperature trends along Chile*

The temperature trends along north-central Chile during the last 3 decades exhibit a warming of about  $0.2^\circ/\text{decade}$  inland in sharp contrast with cooling of about  $-0.2^\circ/\text{decade}$  along



the coast and offshore (Falvey and Garreaud 2008), which is relevant for the biogeochemical process off Chile. The origin of the ocean cooling remains unknown and hardly represented in the historical GCM integrations in CMIP3 (Falvey and Garreaud 2008) and CMIP5. Actually, a few models in CMIP5 do capture the cooling opening the door for a diagnosis of its cause. We aim at addressing two related questions: what is the underlying physical mechanism of the coastal cooling? and is this cooling result of natural variability or anthropogenic climate change? Regarding the first question, we consider two hypotheses: (i) enhanced coastal upwelling and evaporative cooling due to the strengthening of the local (collocated) meridional winds, and (ii) changes in the coastal thermocline remotely forced by changes in the trades over the equatorial, central Pacific. We examined the observed (ERA-interim) and simulated (CMIP5) trends of surface winds and air temperature and found that the models that better capture the cooling are those with coastal wind enhancement but with an inconsistent signal in the tropical Pacific, favoring our first hypothesis. Regarding the origin of this ocean cooling (partially responsible for the "global-warming hiatus"; Trenberth and Fasullo 2013), it has often been linked to the negative phase of the Pacific Decadal Oscillation (PDO, internal variability), but its presence in several un-initialized GCMs indicates that at least part of this cooling can be attributed to the increase of Greenhouse gases concentrations.

#### *Extreme events in future climate*

During the first year of CR2 we have completed the synoptic characterization of two types of extreme events: warm winter rain-storms in central Chile (Garreaud 2013) and summer convective storms in the subtropical Andes (Viale and Garreaud 2013). Work in underway to characterize the conditions during freezing events in south-central Chile (Villarroel and Garreaud). While the diagnosis is based on current climate, it will allow us to explore changes in the occurrence of these extreme events in the future. The case of convective storms is particularly clear: GCMs (and even RCMs) can hardly resolve these events but they do resolve changes in circulation that favor (or suppress) their occurrence.

#### *Depiction and diagnosis of the low frequency variability*

In this area we aim at responding a key question: how large is climate-change signal with respect to the natural variability (interannual, interdecadal and longer timescales)? The relatively short instrumental record (typically less than 50 years in Chilean stations), however, hinders a comprehensive statistical analysis of the natural variability, so that here we rely on paleo-climate records properly calibrated. The research team in Valdivia (lead by D. Christie) focuses its efforts on yearly-resolving tree-rings during the last millennium. They have extended their collection of tree-rings in the semiarid central and subtropical Andes to reconstruct rainfall, snowpack and lake-levels during the last 300-1000 years. Once finished, these multiple reconstructions will be synthesized to describe the regional-scale hydroclimatic interdecadal variability as well as to compare with recently released 1K historical GCM simulations. Dr. Christie has also been involved in major efforts assessing El Niño variability over the past seven centuries (Li et al. 2013) and continental-scale temperature variability over the last two millennia (Ahmed et al. 2013) using world-wide tree-ring records.

Climate fluctuations on longer-time scales are addressed by P. Moreno and his team. During this year, the work has focused on interpreting a paleovegetation and paleofire record from Lago Cipreses (51°S), southwestern Patagonia, that reveals recurrent centennial-scale dry/warm phases over the last 3000 years (Moreno et al. 2013). The most recent of these phases started in the late 19<sup>th</sup> century and has persisted until the present, concomitant with positive anomalies of the SAM and widespread disturbance of southwestern Patagonian environments by Euro-Chilean settlers. We interpret these changes as secular SAM-like oscillations. The current pole-ward shift and intensification of the SH Westerly wind belt is unprecedented in the context of the last 3000 years and might reflect juxtaposition of natural and human-induced variability since the late 19<sup>th</sup> century. Master student C. Morano (under the

guidance of P. Moreno and P. Villa) is now extending this type of study to other lakes in Patagonia. An automatic weather station was also installed in Patagonia this year to support this line of research.

#### *Climate impacts on water resources*

While the impact of climate change/variability on surface water resources has been addressed in several studies (e.g., Vicuña et al. 2012) its counterpart on groundwater has been much less explored. On the other hand, groundwater is a key resource on semiarid Chile. During 2013, P. Herrera and his team has assembled a comprehensive dataset of underground water levels in northern Chile that will be combined with climatic data to assess the time-scale of the groundwater response to changes in precipitation (Jimenes et al. 2013), and eventually its numerical modeling.

#### ***Ecosystem Services (ECO)***

The first task of The Ecosystem Services (ECO) Research line during the first year was to develop a detailed plan to reach the objectives declared in the proposal, and the selection of specific study areas. These objectives are: 1) to design optimal landscape arrays for the combined production of goods and services (e.g. timber and water provision); 2) to define the time frames, rates, costs of the recovery of water provision as an ES from ecological restoration; 3) to assess the potential of ecological restoration as a mean for building resilience, adaptation and mitigation to climate change. The main integrative regional studies that are aimed to be addressed through the collaboration with the other research lines are: a) the scarcity and variability of water resources in Central and Southern Chile and b) rapid land use changes in Central and Southern Chile and its consequences for ecosystem services, sustainability and human welfare. The selected study areas were the Purapel and Cauquenes watersheds (25,000 and 70,000 ha, respectively) in the Maule Region in Central Chile (35° 36' S) under a mediterranean-type climate and Reserva Costera Valdiviana (RCV) in Los Ríos Region (50,000 ha) located at 40° 40' 30' S with a temperate rain climate. These study areas cover a wide climatic gradient from areas with a rainfall of 900-1000 mm/year to 3,000 – 4,000. This is superposed to a human disturbance gradient, extensively dominated by forest plantations and pulp mills in the northern portion, and with larger areas of native forests towards the south.

#### *Landscape design for a diversified production of goods and services*

We are progressing regarding the mapping of forest and vegetation cover and land-use change in the Purapel and Cauquenes watersheds including imagery analysis and ground truthing, updating and validation of stream-flow and precipitation records for the last 10 years in these watersheds, compilation of water rights allocated in the watersheds, their location and time series of their allocation on the watersheds, and the estimation of the balance between the allocation and the available water resources (Lara et al, 2013; Leiva et al; Rodríguez et al, in preparation). We are also experimenting with the software used by the timber companies to optimize timber production, to incorporate restrictions that introduce water provision as an ecosystem service in the optimization function to decide the management of the various forest stands or vegetation patches.

#### *Restoration of native forests*

Regarding this objective, we have continued the monitoring at RCV in watersheds where the exotic Eucalypt plantations have been clear-cut and planted with native trees in the largest ecological restoration experiment in Chile involving 150 ha that was established in 2006. This was done under an agreement with The Nature Conservancy that owns the Reserve. Monitoring of 40 plots indicate that species richness that grew in the understory of the Eucalypt plantations have been maintained after the clear-cut due to sprouting and natural regeneration of native

tree species and other life-forms. Monitoring of stream flow indicate a large increase in stream flow after the clear-cut and establishment of the native plantation.

Research on ecological restoration has been enhanced by including the study of fire regimes, ecosystem resilience and recovery after natural (e.g. volcanism, Swanson et al, 2013) and human disturbances (e.g. human-set fires, logging).

We have also started studies of the taxonomic structure and functional organization of the benthic macro-invertebrate communities in the streams of watersheds dominated by plantations compared to those covered by native forests. We are conducting field and laboratory analysis to assess the resilience of these communities to reduced stream flows, with higher seasonal and interannual variability and increase of sediment loads typical of exotic pine and eucalypt watersheds compared to those covered by native forests. This work is aimed at the development of an index of the integrity and productivity of the benthic invertebrate community that can be associated to the forest cover and disturbance along a gradient from native forests to exotic plantations.

Other objectives, namely, assessment of the potential of ecological restoration as an adaptation ecological restoration as a mean for building resilience, adaptation and mitigation to climate change will start to be developed in year 2.

### ***Human Dimensions***

HD is a cross-cutting area of research that gathers expertise on law, economics and sociology. Aims of this area consider: diagnosing the institutional framework of climate change; providing economic valuations of climate change in Chile; contributing to the definition of adaptation measures, allowing in the long run strengthening institutional capacities and contributing to building resilience to climate change in Chile. During the first year, research has been carried out to analyze the institutional framework, establish a conceptual framework for resilience, and building a vulnerability mapping protocol.

#### ***Institutional framework***

During the first year, our legal team has undertaken an analysis of some aspects of the international climate change negotiations, specifically in relation to the legal principles underpinning the evolution of international legal framework for climate change: common but differently responsibilities and equity, for instance, from the perspective of developing countries (Moraga et al, 2014). This area is also analyzing the international legal framework for climate change adaptation with as a contribution to a "Vulnerability Mapping Protocol", discussed below.

Domestic legal issues are also being studied by conducting a review and evaluation of climate change governance (defined as the set of rules and institutions that govern climate change) in Chile. The purpose of this inquiry is to determine whether the existing governance arrangements are sufficient to confront the challenges of climate change in Chile. The preliminary results show the existence of inadequacies in the institutional order, including temporal instability, insufficient delimitation of powers and the absence of tools to assess the coherence of the measures proposed or taken to address climate change in with shaft resilience. The findings of this research can be found in an internal working paper. In this context, a master's thesis is being written on the topic "Coastal land use planning and climate change". Up to now, the domestic literature has scarcely addressed the development of law relevant to climate change. The work of the Centre's legal researchers to systematically advance and address the role of climate change law in Chile directly contributes to the creation of new capacities in Chile while working in close relationship with decision-makers.

#### ***Conceptual framework***

A systematic review of climate change resilience literature has been completed and is in its final stage of analysis. This review has made possible the de-construction of resilience definitions and their tendencies, and the development of a working definition of resilience in the

face of climate change. The team has also produced a “Resilience Wheel” – a framework identifying key resilience determinants, the various attributes of these determinants, and existing indicators for the evaluation of resilience – to support resilience building within investigative and applied contexts. A bibliometric analysis and analysis of associated climate change policies for reviewed resilience literature is well underway; strong trends can already be observed and are guiding continuing investigation. A discourse analysis of resilience and climate change within the Chilean media is in process.

The prevailing view of resilience in the economic literature is narrow: referring to the capacity of the economy and consumer spending to return to their historical levels of growth, usually measured by GDP. Our theoretical framework relies on the concept of ecosystem services which accounts for the different components of human welfare, unlike GDP which merely reflects material wellbeing, disregarding other components of human needs, equity and sustainability issues. Thus, by means of a thorough literature review, we have found that resilience lacks any sort of formal theoretical foundation in economics and as consequence the word is used in very different ways.

Glossaries of climate change and resilience in English and Spanish derived from IPCC definition have been developed built and published on the CR2 webpage ([http://www.cr2.cl/?page\\_id=2570](http://www.cr2.cl/?page_id=2570)).

#### *Vulnerability mapping protocol*

A mapping protocol to visualize socio-ecological vulnerability to climate change has been developed. This protocol considers: exposure to climatic stressors (e.g., drought); sensitivity of a socio-ecosystem to losses in ecosystem services; and the adaptative capacity to that loss. The mapping protocol needs to go through a validation process by experts within CR2 and from other institutions. A preliminary version of the protocol has already been applied at the regional scale, taking as a case study three municipalities of the Los Ríos Region. Once validated, the protocol will be applied to the entire country to obtain vulnerability maps for the three macrozones considered in the CR2 project.

#### ***Modeling and Observing Systems (MOS)***

This purpose of this area is two-fold. On the one hand, it provides support to other research areas by implementing modeling and observation platforms intended to generate and validate climate scenarios, and by establishing a test-bed for Climate Services to be transferred to authorities. On the other hand, 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.. During the reported period we have worked on several of these themes.

#### *Evaluation and development of integrated observing systems*

We have developed methods for assessing the quality – in terms of representativity and specificity- and evolution of monitoring networks using both statistical (Osses et al, 2013), and variational analysis tools (Henríquez, 2014). The applications shown in these publications refer to air quality data but they can be extended to temperature and precipitation networks, and this is considered in our second year work. Also, self-organizing maps (SOMs) and other statistical tools have been applied to the analysis of 15 years of ozone soundings at Rapa Nui (Easter Island, Henríquez, 2014).

Escribano et al (2013) implemented a simple model based on empirical data to evaluate satellite retrievals of aerosol optical depth over Santiago, with emphasis on the role of stratification and surface reflectance. Further they implemented methods to retrieve extinction and dispersion coefficients of aerosols based on concurrent measurements using a ceilometer and an elastic LIDAR. Also, Farías et al (2013) implemented several methods to estimate the depth of the boundary layer using LIDAR data.

To address the complex exchanges between urban areas and surrounding ecosystems, it is necessary to run meso-scale atmospheric models at very high resolution (~a few hundred meters). This requires in turn a detailed and accurate description of the interactions between the city and the atmospheric flow, where many interactions occur modifying the air circulation, mixing and the microclimate. We have explored existing urbanization approaches in models at use, and methods to generate the needed urban canopy data (Bravo, 2013).

#### *Model development and climate scenarios*

Over the years, one of our associate researchers, Dr. Gary Shaffer has developed the Danish Center for Earth System Science (DCESS) model. This model was included in three recent international intercomparison projects for Earth System Models of Intermediate Complexity (Zickfeld et al, 2013; Eby et al, 2013; Joos et al, 2013). The DCESS model results compare well with those from other, more complex models, including comparisons of steric sea level rise projections. This lends confidence to its application to assess sea-level rise along Chile. For this it will be used in combination with simple ice sheet and mountain glacier models recently developed by Dr. Shaffer, models of isostatic adjustment and output from spatially-resolved models of ocean circulation and warming. This work is being carried out in collaboration with Dr. Frauke Albrecht, a CR2 post-doc at Universidad de Concepción since early October 2013.

The World Climate Research Project (WRCP) initiated in 2008 the Coupled Model Intercomparison Project Phase 5, known as CMIP5. This project provided the climate simulations and projections recently reported by the Inter-Governmental Panel for Climate Change (IPCC). This extraordinary and complex database will be used at CR2 to generate new climate scenarios for Chile at the regional scale. This requires on the one hand the implementation of downscaling tools, both statistical and numerical, and on the other hand, performing a thorough analysis and evaluation of the global scenarios, including comparisons with available observations for past and current climate. Of particular interest is to address the ability to capture interdecadal and interannual variability signals. Dr. Deniz Bozkurt is a post-doctoral fellow at CR2 whose work focuses on the analysis of CMIP data and the use of the British Met Office regional modeling system (PRECIS) for generating new climate change scenarios for Chile. This work is done in collaboration with the Met Office. Our associate researcher Dr. Melitta Fiebig is applying a stochastic weather generator (LARS-WG) to provide statistical downscaling of climate scenarios for the Elqui basin.

CMIP5 data has been used to assess climate change impact on southern Andes watersheds (Rojas and Falvey, 2013). This work is a step forward regarding the coupling of atmospheric and hydrological models.

Other exploratory work refers to implementation of faster numerical algorithms (Fiebig-Wittmark et al, 2011) for PRECIS, the use of data assimilation techniques for addressing detection and attribution problems (Nicolás Molina, Mathematical Engineering trainee).

#### *Data bases and computational platforms*

We hired an engineer to design and implement a pilot system able to handle different types of data including climate model outputs, time series, maps, etc., as well as different types of users and to access the data over the internet either pre-processed or to be handled by the user with different software (e.g., IDV, Phython o Matlab). He reviewed systems at use in several climate centers, and one jointly developed by the International Research Institute for Climate and Society (Columbia) and UNESCO in Chile, and already implemented for UNESCO in Chile. He suggested the use of a so-called Live Access Server (LAS) developed by the National Oceanographic and Atmospheric Administration (NOAA) in the United States. This system was implemented on a server at the Center for Mathematical Modeling, and tested for CMIP5 data and a time series of nitrous oxide (N<sub>2</sub>O) record. The LAS system is optimal for handling model outputs but it requires further development for times series at a given place. This work is going to be revised and expanded starting in January 2014.



## 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 panel evaluation panel provided in general very positive comments that qualified and ranked our proposal as best among five. However, there were a few points to be noted:

- The panel showed some concern regarding the lack of “glacial dimension” to address hydrological responses. In fact, we recognized that at the time of the proposal we were not able to engage one of the few glaciologists in Chile since they were already committed to other projects. We have now hired Dr. Fabrice Lambert as an associate researcher; he has an extensive background in glaciology.
- There were other comments related to specific methodological approaches (aerosol-cloud interactions, upwelling and primary production, etc. In fact, the proposal was restricted to 20 pages and we omitted a number of details. Others are being defined along with the progress of the work, and according to collaboration and funding opportunities. For instance, we may very well install a fog detector in Northern Chile depending on the success of a FONDECYT project proposed this year by Dr. Rondanelli.
- The panel also criticized the way in which we loosely used the concepts of mitigation, adaptation and resilience. It may be very well the case but such confusion is still present in the literature, and more so in praxis. Therefore, a first task for the HD team was to prepare a working glossary that adopted IPCC definitions, and to provide a review of the concept of resilience and construct a definition for our center.
- Other concerns referred to the leadership of the Director given her relatively short record of publications. This has not proven to be a problem, and on the contrary her background and experience working in the public sector as a senior consultant for the National Commission for the Environment as well as her trajectory in international bodies have provided the necessary skills for establishing a strong connection with stakeholders.

CONICYT’s council also provided a positive review; nevertheless, they pointed out some concerns:

- They wondered to what extent the geopolitical approach proposed was scientifically novel. Indeed, the geopolitical approach was not intended as a novel scientific approach; rather as a matter of fact description of the climate related problems affecting Chile.
- The definitions of adaptation and resilience seemed also unclear to this panel. Again, both in the literature and in praxis, there is some confusion and we have taken steps to solve it, at least for operational purposes in the framework CR2.
- Another issue refers to the distinction between scientific and social outputs of CR2. We are very much aware that this is a center of excellence. Hence we expect CR2 to produce a substantial amount of peer reviewed papers, conference presentations, advanced capital human, etc., i.e., the standard indexes used in the scientific community. But differently from purely scientific research centers, we include law and social science, which have different approaches to peer-review. And more importantly, we do also expect to have an impact in decision making, particularly public policies related to Climate Change. The question remains however as to how evaluate this in a non-trivial manner. This is an open question for CR2 and other centers that have a similar nature to ours, and it has been a matter of discussion with the Council. So is the case, for standard indexes that are nowadays subject to discussion and debate. In spite of these difficulties, we are keen to make a difference in terms of connecting with stakeholders.

What seemed to us a puzzling condition imposed by CONICYT’s council for the approval of our proposal was to hire an “a recognized international scientist, residing in Chile, with expertise

in climate change” within the first two years of CR2. It was not clear to us what type of expertise or background was required. We have proposed Dr. Fabrice Lambert. He is a Swiss national with a strong background in climate dynamics, glaciology and aerosol forcing (See section III 5).

## 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:
  - <sup>1</sup> For principal author (example: Toro<sup>1</sup>, J.)
  - <sup>2</sup> For the corresponding author (example: Toro<sup>2</sup>, J.)
  - <sup>3</sup> For principal and corresponding author (example: Toro<sup>3</sup>, J.)
- ✓ Include a digital copy of each PUBLISHED paper.

### 2. Non ISI Publications

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

### 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.

### 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.

### 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.

## **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.

## **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

## **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

## **10. Funding Sources**

- ✓ List all funding sources including FONDAP.



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## VII. OTHER ACCOMPLISHMENTS

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



## 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.

It appears essential to allow centers approved during the fourth call to be able to hire professionals with proper work contracts, in a similar manner to other centers approved before and after that call. The rule applied to us is in contradiction with the rules applicable to our institutions. It is also contradictory to have administrative personnel responsible for managing and accounting large amounts of public resources without the possibility of investigating or sanctioning any administrative mistake or action in discordance with administrative rules and the law. Our administrative personnel at Universidad de Chile cannot obtain the needed training (restricted to public servants) or access the public market tools (*Mercado Público*). Moreover, the lack of proper contracts makes it generally less appealing for people to work with us.

CR2 is a center of excellence for which standard publication metrics are applicable. However, as it is the case for other centers, there is the expectation of having 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. The facilitation of meetings and gatherings by CONICYT with stakeholders would be very valuable for centers as CR2.

Finally, media outreach could be facilitated and better coordinated by CONICYT promoting a stronger link among the different centers, and with stakeholders and the public in general.

## Annex 1. Publications and research metrics

The following table shows the publications produced by CR2 researchers during the first year (in italics those that do not explicitly acknowledge CR2). Statistics are based on the 2012 version of Journal Citation Reports®. Thereafter we list books and book chapters.

Publication	Sub-category	Rank	J. per category	Cita-tions	Impact Factor	Quartile
Li, J., Xie, S., Cook, E.R., Morales, M.S., Christie, D.A., Johnson, N.C., Chen, F., D'Arrigo, R., Fowler, A.M., Gou, X. & Fang, K. 2013 . El Niño modulations over the past seven centuries Nature Climate Change 3 , 822–826	Atmospheric	1	74	2	14,4	Q1
Rutllant, J., Muñoz, R., Garreaud, R. 2013 . Meteorological observations in the northern Chilean coast during VOCALS-REx. Atmospheric Chemistry and Physics. VOCALS-REx Special Issue. 13 , 3409-3422	Atmospheric	3	77	0	5,5	Q1
Escribano J., Gallardo L., Rondanelli R. and Choi, Y-S. 2013 . Satellite retrievals of aerosol optical depth over a subtropical urban area: the role of stratification and surface reflectance Aerosol and Air Quality Research (In press) ,	Enviroment	43	205	0	2,8	Q1
I. Daniela, M. De Grandpre, L.Farias2 2013 . Greenhouse gas emissions from the Tubul-Raqui estuary (central Chile 36°S) Estuarine, Coastal and Shelf Science. 134 , 31–44	Marine	22	100	0	2,3	Q1
L.Florez-Leiva, E. Damm, L.Farias2 2013 . Methane production induced by dimethylsulfide in surface water of an upwelling ecosystem Progress in Oceanography.112-113 , 38–48	Ocean	3	60	0	3,7	Q1
Farias L3, Faúndez J, Fernández C, Cornejo M, Sanhueza S, et al. 2013 . Biological N2O Fixation in the Eastern South Pacific Ocean and Marine Cyanobacterial Cultures PLoS ONE8(5) , e63956	Ocean	7	56	0	3,7	Q1
A.Osses, L. Gallardo, T. Faundez 2013 . Analysis and evolution of air quality monitoring networks using combined statistical information indexes Tellus B 65 , 19822	Atmospheric	16	74	0	3,2	Q1
G. Martínez-Méndez, D. Hebbeln, M. Mohtadi, F. Lamy, R. De Pol-Holz, D. Reyes-Macaya , T. Freudenthal 2013 . Changes in the advection of Antarctic Intermediate Water to the northern Chilean coast during the last 970 kyr Paleoclimatology (In press)N/A , N/A	Ocean	5	60	0	3,3	Q1
Giuseppe Siani, Elisabeth Michel, Ricardo De Pol-Holz, Tim DeVries, Frank Lamy, Mélanie Carel, Gulay Isguder, Fabien Dewilde & Anna Laurantou 2013 . Carbon isotope records reveal precise timing of enhanced Southern Ocean upwelling during the last deglaciation Nature Communications 4 , Article number: 2758	Multidisciplin	3	56	0	10	Q1
Garreaud, R. 2013 . Warm winter storms in Central Chile J. of Hydrometeorology14 , 1515-1534	Atmospheric	14	74	0	3,3	Q1
Rahn, D., and R. Garreaud 2013 . A synoptic climatology of the near-surface wind along the west coast of South America Int. Journal of Climatology (In press)N/A , N/A	Atmospheric	18	74	0	2,9	Q1
Aguirre, C., R. Garreaud and J. Rutllant 2013 . Surface ocean response to synoptic-scale variability in wind stress and heat fluxes off south-central Chile Dynamics of Atmospheres and Oceans (In press)N/A , N/A	Ocean	28	60	0	1,7	Q2
Muñoz A., J. Barichivich, D.A. Christie, W. Dorigo, D. Sauchyn, Á. González-Reyes, R. Villalba, A. Lara, M. E. González 2013 . 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 (In press)N/A , N/A	Ecology	74	136	0	1,7	Q2
Aldunce, P., Beilin, R., Handmer, J., Howden, M. 2014 . Framing disaster resilience: the implications of the diverse conceptualisations of 'bouncing back' Disaster Prevention and Management (In press)23	Managemen t	164	174	0	0,2	Q3

Ahmed, M., Anchukaitis, K.J., Asrat, A., Borgaonkar, H.P., Braid, M., Buckley, B.M., Buntgen, U., Chase, B.M., Christie, D.A., Cook, E.R., Curran, M.A.J., Diaz, H.F., Esper, J., Fan, Z., Gaire, N.P., Ge, Q., Lara, A., Leziné, A., Ljungqvist, F.C., Lorrey, A.M., Luterbacher, J., Masson-Delmotte, V., McCarroll, D., McConnell, J.R., McKay, N.P., Morales, M.S., Moy, A.D., Mulvaney, R., Mundo, I.A., Nakatsuka, T., Nash, D.J., Neukom, R., Nicholson, S.E., Oerter, H., Palmduncaner, J.G., Phipps, S.J., Prieto, M.R., Rivera, A., Sano, M., Severi, M., Shanahan, T., Shao, X., Shi, F., Sigl, M., Smerdon, J.E., Solomina, O.N., Steig, E.J., Stenni, B., Thamban, M., Trouet, V., Turney, C.S.M., Umer, M., van Ommen, T., Verschuren, D., Viau, A.E., Villalba, R., Vinther, B.M., von Gunten, L., Wagner, S., Wahl, E.R., Wanner, H., Werner, J.P., White, J.W.C., Yasue, K. & Zorita, E. 2013 . Continental-scale temperature variability during the last two millennia Nature Geoscience 6 , 339-346	Geoscience	1	172	5	12,4	Q1
Galbraith E., M. Kienast., A. L. Albuquerque, M. A. Altabet , F. Batista , D. Bianchi, S. E. Calvert, S. Contreras-Quintana, X. Crosta, R. De Pol-Holz , N. Dubois, J. Etourneau, R. Francois , T.-C. Hsu, T. Ivanochko, S. Jaccard, S.-J. Kao, T. Kiefer, S. Kienast, M. F. Lehmann, P. Martinez, M. McCarthy, A. N. Meckler, A. Mix, J. Möbius, T. F. Pedersen, L. Pichevin, T. M. Quan, R. S. Robinson, E. Ryabenko, A. Schmittner, R. Schneider , A. Schneider-Mor, M. Shigemitsu , D. Sinclair, C. Somes, A. S. Studer, J.-E. Tesdal, R. Thunell and J.-Y. Yang, 2013 . The acceleration of oceanic denitrification during deglacial warming Nature geoscience6 , 579-584	Geoscience	1	172	2	12,4	Q1
Seguel, R., Mancilla, C., Rondanelli, R., Leiva, M., Morales, R. 2013 . Ozone distribution in the lower troposphere over complex terrain in Central Chile Journal of Geophysical Research AtmospheresVOL. 118, 1-15	Geoscience	23	172	0	3,2	Q1
Romero-Lankao, P., Hughes, S., Rosa-Huerta, A., Borquez, R., Gnat, D.M. 2013 . Institutional capacity for climate change responses: An examination of construction and pathways in Mexico City and Santiago Environment and Planning C: Government and Policy31 , 758-805	Pub Admin	15	47	1	1	Q2
L. Nahuelhual, A. Carmona, M. Aguayo, C. Echeverria 2013 . Land use change and ecosystem services provision: a case study of recreation and ecotourism opportunities in southern Chile. Landscape Ecology (In press)DOI 10.1007/s10980-013-9958-x	Pub Admin	31	172	0	2,9	Q1
Mastrangelo, M.E., F. Weyland, S.H. Villarin, M.P. Barral, L. Nahuelhual, P. Laterra 2013 . Concepts and methods for landscape multifunctionality and a unifying framework based on ecosystem services Landscape Ecology (In press)DOI 10.1007/s10980-013-9959-9 , N/A	Pub Admin	31	172	0	2,9	Q1
Flores, F., R. Garreaud, and R. Muñoz, 2013. CFD simulations of turbulent bouyant atmospheric flows over complex geometry: Solver development in OpenFOAM. Computer & Fluids82 , 1-13.	Mechanical	47	135	0	1,5	Q2
Garreaud, R., P. Lopez, M. Minvielle and M. Rojas 2013 . Large Scale Control on the Patagonia Climate. J. of Climate26 , 215-230	Meteorology	5	74	8	4,4	Q1
Swanson F., J. Jones, C. Crisafulli, A. Lara 2013. Effects of volcanic and hydrologic processes on forest vegetation: Chaitén Volcano, Chile Andean Geology 40 (2), 359-391.	Geology	19	47		1,4	Q2
Molina-Montenegro, M.A., Ricote-Martínez, N., Muñoz-Ramírez, C., Gómez-González, S., Torres-Díaz, C., Salgado-Luarte, C. & Gianoli E 2013 . Positive interactions between the lichen Usnea antarctica (Parmeliaceae) and the native flora in Maritime Antarctica Journal of Vegetation Science 24 , 463-472.	Forestry	3	62	1	2,8	Q1
Delgado-Baquerizo, M., F. T. Maestre, A. Gallardo, M. A. Bowker, M. Wallenstein, J. L. Quero, S. Soliveres, V. Ochoa, B. Gozalo, M. García-Gómez, P. García-Palacios, M. Berdugo, E. Valencia, C. Escolar, A. Escudero, J. A. Carreira, T. Arredondo, C. Barraza-Zepeda, D. Bran, M. Chaleb, A. A. Concelção, J. Contreras, M. Derak, D. J. Eldridge, C. I. Espinosa, A. Florentino, J. Gaitán, W. Ghiloufi, S. Gómez-González, J. R. Gutiérrez, E. Hepper, R. M. Hernández, E. Huber-Sannwald, M. Jankju, J. Liu, R. L. Mau, M. Miriti, J. Moneris, E. Morici, M. Muchane, K. Naseri, A. Ospina, V. Polo, E. Pucheta, L. Quevedo-Robledo, E. Ramírez, D. A. Ramírez-Collantes, R. Romão, M. Tighe, D. Torres, C. Torres-Díaz, E. D. Ungar, J. Val, W. Wamiti, D. Wang & E. Zaady 2013 . Decoupling of soil nutrient cycles as a function of aridity in global drylands Nature 502 , 672-676	Multidisciplin	1	56	1	38,6	

Pino, M.; Chavez, M., Navarro, X., Labarca, R. 2013 . The late Pleistocene Pilauco site, south central Chile Quaternary International 299 , 03 12	Geoscience	58	72	1	2	Q2
Labarca, R.; Pino, M.; Recabarren, O. (en prensa) 2013 . Los Lamini (Cetartiodactyla: Camelidae) extintos del yacimiento de Pilauco (Norpatagonia chilena): aspectos taxonómicos y tafonómicos preliminares. Estudios Geológicos ,						
Eby, M., A. J. Weaver, K. Alexander, K. Zickfeld, A. Abe-Ouchi, A. A. Cimatoribus, E. Crespín, S. S. Drijfhout, N. R. Edwards, A. V. Eliseev, G. Feulner, T. Fichefet, C. E. Forest, H. Goosse, P. B. Holden, F. Joos, M. Kawamiya, D. Kicklighter, H. Kienert, K. Matsumoto, I. I. Mokhov, E. Monier, S. M. Olsen, J. O. P. Pedersen, M. Perrette, G. Philippon-Berthier, A. Ridgwell, A. Schlosser, T. Schneider von Deimling, G. Shaffer, R. S. Smith, R. Spahni, A. P. Sokolov, M. Steinacher, K. Tachiiri, K. Tokos, M. Yoshimori, N. Zeng, and F. Zhao 2013 . Historical and idealized climate model experiments: an intercomparison of Earth system models of intermediate complexity Climate of the Past9 , 1111-1140	Geoscience	16	72	7	3,6	Q1
Joos, F., Roth, R., Fuglestad, J. S., Peters, G. P., Enting, I. G., von Bloh, W., Brovkin, V., Burke, E. J., Eby, M., Edwards, N. R., Friedrich, T., Frölicher, T. L., Halloran, P. R., Holden, P. B., Jones, C., Kleinen, T., Mackenzie, F. T., Matsumoto, K., Meinshausen, M., Plattner, G.-K., Reisinger, A., Segschneider, J., Shaffer, G., Steinacher, M., Strassmann, K., Tanaka, K., Timmermann, A., and Weaver, A. J 2013 . Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics: a multi-model analysis Atmos. Chem. Phys. 13 , 2793-2825	Atmospheric	3	77	5	5,5	Q1
Rojas, M. 2013 . Sensitivity of Southern Hemisphere circulation to LGM and 4xCO2 climates. GRL 40 (5) , 965-970	Geoscience	11	172	0	4	Q1
Rojas M., L. Li, M. Kanakidou, N. Hatzianastassiou, G. Seze, H. Le Treut 2013 . Winter weather regimes over the Mediterranean region, their links to clouds and surface climate: evaluation and Climate Change simulation of an Ocean-Atmosphere Regional Climate Model Climate Dynamics 41 , 551-571	Meteorology	6	74	0	4,2	Q1
Von Glasow, R. Jickells, T., Baklanov, A., Carmichael, G., Church, T. M., Gallardo, L., Hughes, C., Kanakidou, M., Liss, P. S., Mee, L., Raine, R., Ramachandran, P., Ramesh, R., Sundseth, K., Tsunogai, U., Uematsu, M., and Zhu, T. 2013 . Megacities and Large Urban Agglomerations in the Coastal Zone: Interactions Between Atmosphere, Land, and Marine Ecosystems Ambio 42 (1) , 13-28	Environment	75	210	1	2,3	Q2
K. Zickfeld, M. Eby, K. Alexander, A. J. Weaver, E. Crespín, T. Fichefet, H. Goosse, G. Philippon-Berthier, N. R. Edwards, P. B. Holden, A. V. Eliseev, I. I. Mokhov, G. Feulner, H. Kienert, M. Perrette, T. Schneider Von Deimling, C. E. Forest, P. Friedlingstein, F. Joos, R. Spahni, M. Steinacher, M. Kawamiya, K. Tachiiri, D. Kicklighter, E. Monier, A. Schlosser, A. Sokolov, K. Matsumoto, K. S. Tokos, S. M. Olsen, J. O. P. Pedersen, A. Ridgwell, G. Shaffer, M. Yoshimori, N. Zeng, and F. Zhao 2013 . Long-term Climate Change Commitment and Reversibility: An EMIC Intercomparison. Journal of Climate 26 (16) , 5782-5809	Meteorology	5	74	8	4,4	Q1
Power, M.J. , Mayle, F.E., Bartlein, P.J., Marlon, J.R., Anderson, R.S., Behling, H., Brown, K.J., Carcaillet, C., Colombaroli, D., Gavin, D.G., Hallett, D.J., Horn, S.P., Kennedy, L.M.I, Lane, C.S., Long, C.J., Moreno, P.I., Paitre, C., Robinson, G., Taylor, Z., Walsh, M.K. 2013 . Climatic control of the biomass-burning decline in the Americas after ad 1500 Holocene 23(1) , 3 13	Geoscience	22	172	5	3,2	Q1

### ***Books***

- Donoso, C., González, M.E., Lara, A. (eds). (In press). Ecología Forestal: Bases para un manejo sustentable de los Bosques Nativos. Marisa Cuneo Editores. Valdivia. 610 p.
- Lara, A., Laterra, P., Manson, R., and Barrantes, G., 2013. Servicios Ecosistémicos hídricos: estudios de caso en América Latina y el Caribe. Valdivia, Chile. Red ProAgua CYTED. Imprenta América. 312 p.
- Moraga, P. 2013 a. Energía, Cambio Climático y Sustentabilidad: Una Mirada desde el Derecho (Editora). Centro de Derecho Ambiental. Facultad de Derecho, Universidad de Chile. Editorial Legalpublishing Thomson Reuters, 266 páginas. ISBN 9789563463613.

### ***Book chapters***

- Aldunce, P., Levín, V and León, A., 2013. Disaster risk reduction informing climate change adaptation: Social Capital in Aguita de la Perdiz, n. 29. in: A Changing Environment for Human Security: Transformative Approaches to Research, Policy and Action L. Sygna; K. O'Brien; J. Wolf(Eds). 336-346, E. Routledge, Taylor and Francis Group
- Cárcamo M., A. Lara, L. Palma, M. Lavado, D. Roco, R. Bravo, 2013. Proyecto Innova Cuencas APR; Una oportunidad para generar condiciones habilitantes para el desarrollo de comunidades rurales: Hacia la construcción de un modelo de gestión de cuencas en la región de Los Ríos, Chile in: Servicios ecosistémicos hídricos: estudios de caso en América Latina y el Caribe. Lara A., P Laterra, R Manson, G Barrantes (eds.) 169-185, Red ProAgua CYTED. Valdivia, Chile. Imprenta América.
- González M.E., M. Amoroso, A. Lara, T. T. Veblen, C. Donoso, T. Kitzberger, I. Mundo, A. Holz, A. Casteller, J. Paritsis, A. Muñoz, M. L. Suarez, A. Promis., En prensa. Ecología de disturbios y su influencia en los ecosistemas forestales templados de Chile y Argentina in: Ecología Forestal: Bases para un manejo sustentable de los Bosques Nativos Donoso, C., González, M., Lara, A. (eds.) , Marisa Cuneo Editores. Valdivia
- Lara A, Little C, Cortés M, Cruz E, González M, Echeverría C, Suarez J, Bahamondez A, Coopman R. , En prensa. Restauración de ecosistemas forestales in: Ecología Forestal: Bases para un manejo sustentable de los Bosques Nativos Donoso, C., M. González, A. Lara, (eds.) , Marisa Cuneo Editores. Valdivia.
- Lara A., C. Little, M.E. González, D. Lobos., 2013. Restauración de bosques nativos para aumentar la provisión de agua como un servicio ecosistémico en el centro-sur de Chile: desde las pequeñas cuencas a la escala de paisaje in: Servicios ecosistémicos hídricos: estudios de caso en América Latina y el Caribe. Lara A., P Laterra, R Manson, G Barrantes. 2013 (eds.) 57-78, Red ProAgua CYTED. Valdivia, Chile. Imprenta América.
- Lara A., M. Amoroso, J. Bannister, C. Donoso, M.E. González, G. R. Vargas; C. Smith-Ramírez; G. Arellano, A. G. Gutiérrez, En prensa. Sucesión y Dinámica de Bosques Templados en Chile. in: Ecología Forestal: Bases para un manejo sustentable de los Bosques Nativos Donoso, C., González, M., Lara, A. (eds.) , Marisa Cuneo Editores. Valdivia.
- Little C., A. Lara. , En prensa. Ecología Forestal: Bases para un manejo sustentable de los Bosques Nativos in: Servicios ecosistémicos de los bosques nativos del centro sur de Chile. Donoso, C., M. González, A. Lara (eds.) , Marisa Cuneo Editores. Valdivia.
- Little, C, A. Lara, M.E. González, 2013. Temperate Rainforest Restoration in Chile (Virtual Field



- Trip) in: Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. A. Clewell and J. Aronson (eds) 190-196, Society of Ecological Restoration, 2nd Edition, Island Press, San Diego, USA.
- Masson-Delmotte, V., M. Schulz, M. Rojas, y otros, 2013. Information from Paleoclimate Archives. in: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Stocker, T. F., D. Qin, y otros , Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
- Moraga, P, 2013. Energía, desarrollo sustentable y derecho internacional. in: Energía, Cambio Climático y Sustentabilidad: Una Mirada desde el Derecho Moraga, P (Editora) 255-266, Editorial Thomson Reuters.
- Stocker, T. F., D. Qin, M. Rojas, y otros, 2013. Technical Summary in: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Stocker, T. F., D. Qin, y otros , Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, in press
- Villarroel, S., 2013. Gestión estratégica de stakeholders en un proyecto de energías renovables no convencionales: Lecciones del caso del proyecto eólico Chiloé. in: Energía, Cambio Climático y Sustentabilidad: Una Mirada desde el Derecho Moraga, P (Editora) 125-150, Editorial Thomson Reuters.

## Annex 2. In the media

As stated earlier the outreach goal of the first year was to position (CR2) among peers, stakeholders and the media. A communication strategy was developed around four lines: institutional image; internal communication; database building; and training in science communication.

Science communication is one of the pillars of CR2. Therefore, during the first year emphasis was put on training communication skills among scientists and students. To that end, in April 2013 we held a two-day meeting in the mountains close to Santiago with the majority of researchers, students and staff to promote a common vision, discuss the mission of our center and to surpass the language barriers found among the different disciplines and academic cultures represented at CR2. This meeting was mediated by an external consultant with expertise in science communication. As our team counts with a former minister for the Environment (Ana Lya Uriarte), we had a splendid chance to discuss the gaps in communication between scientists and policy-makers. A detailed report of this meeting is available in our intranet. Also, in connection with our board meetings in Valdivia and Concepción, our journalist held half day workshops for students and researchers introducing basic knowledge and training on media and communicating with the media, including tips for better communication.

An extended database of stakeholders in academia, policy, parliament members, governmental officials, journalists, etc. was created. This list already includes more than 600 individuals and their corresponding contact information.

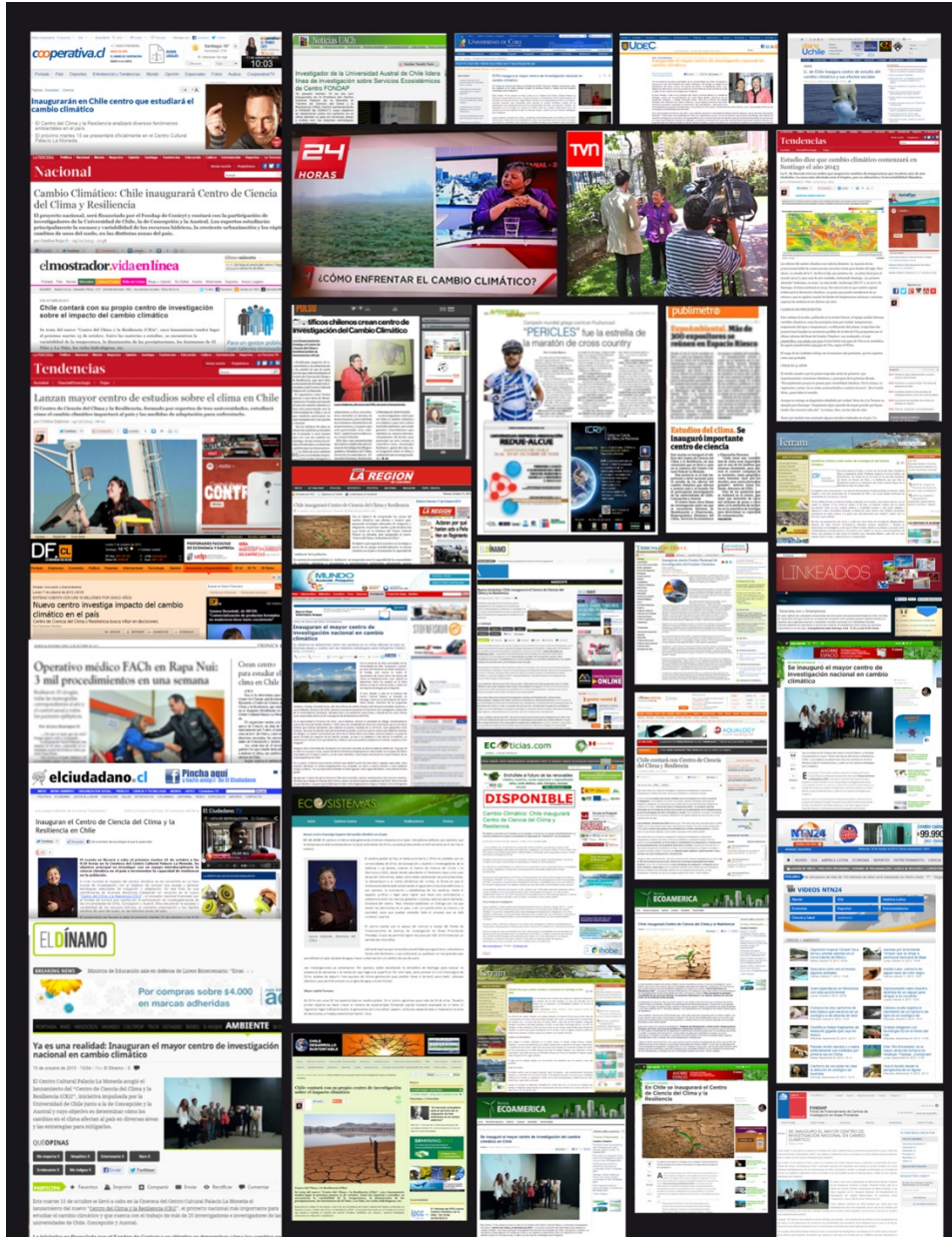
We had 106 media appearances between March and December 2013, of which 57 corresponded to digital media other than CR2, 31 articles and notes in newspapers and magazines, 11 radio interview, and 7 appearances in regional and national television. Of these, roughly 70% are categorized as news, letters and opinion columns add 14%, and interviews represent 12% of all media appearances. Over time, these appearances peak in connection with our launching ceremony, and the publication of the IPCC report in late November. For details see Annex 2 “In the media”.



Our launching ceremony took place at the Palacio de la Moneda Cultural Center on October 15 2013. We had more than 200 attendees, including university authorities from all involved

## Comisión Nacional de Investigación Científica y Tecnológica - CONICYT

institutions, scientists, governmental officials, general public, etc.. We had 42 media appearances in conventional and digital press, as well as interviews on national radio and television.





### **Annex 3. CR2 after one year, the meeting in Villa Alegre (35° 40'S;71° 45'W)**

Between January 12 and 15 2014, we convened a plenary meeting with our national and international advisory panels. The vast majority of researchers, students and support personnel participated in this event held in Villa Alegre, in the region where we have decided to pursue integrative studies. The purposes of the meeting were:

- Review our first year of activities identifying achievements, problems and needed actions.
- Provide/receive guidance regarding achieving scientific excellence, internationalization, impact on decision making, science communication, etc.
- Explore ways to achieve interdisciplinary studies



To this end, we organized the meeting around oral presentations and posters showing the different scientific activities, followed by a guided visit to a native forest and a restoration plantation field close by (A collaborative effort between Universidad Austral and Forestal Minico). In addition to this, the panels held meeting with students, research assistants and post-doctoral fellows, and associate researchers separately to get their impressions and suggestions. The students provided very good suggestions regarding joint research and communications within CR2.



After the visit, we organized group dynamics to promote interdisciplinary work. Six groups of people randomly chosen were to define around two questions and drawings a management plan for sustainability regarding water resources and fire protection for the area visited. They had to exchange the different approaches, and modify the plans accordingly. These plans were presented in plenary the next day. On the 15<sup>th</sup> both panels gave feedback and recommendations. These recommendations follow.

## Five Recommendations from the International Panel of the Center for Climate and Resilience Research (CR)2

Mary Scholes, David Battisti, Guy Brasseur. Villa Allegrre, Chile, 15 January 2014.

The Panel is [very impressed](#) by the development of the CR2 Project, the commitment of its members and the quality of the work. During the first year of its existence, the project has established itself, and important steps have been taken to start joint activities. The Program is in a good way to become the recognized expert in climate and resilience issues with good visibility on the national and international scenes. The constant efforts by the Director Dr. Laura Gaillard and her Deputy Director Dr. René Garreaud to bring together a team of excellent Chilean and foreign scientists, and develop a real interdisciplinary culture around problems of societal relevance must be highlighted. The Panel would like to congratulate the leaders of the CR2 Project and of its different research areas (Human Dimensions, Climate Dynamics, Ecosystem Services, Biogeochemistry, Modeling and Observing Systems). It was also impressed by the commitment and enthusiasm of the junior scientists and students. The Panel would like to make five recommendations.

1. A dedicated effort for clearly [defining a few key interdisciplinary problems/themes](#) in the context of the already developed resilience framework, and a process to define the related research activities (questions, objectives, teams involved, milestones, deliveries) needs to be urgently established.
2. In order to facilitate interdisciplinary studies, the Panel suggests that each year an [interdisciplinary theme](#) be identified, and that a study involving all groups in CR2 be conducted around the chosen theme. The topics identified in the original CR2 proposal (water availability/scarcity, rapid land-use change and urbanization) or the topics and approaches used for the excursion in the reforested areas are good examples of such themes. These studies could lead to a white paper, a review paper or other products that would provide the scientific basis for sound decision-making processes. The organization of summer schools would offer additional opportunities to develop interdisciplinary approaches.
3. In spite of the fact that the project focuses on interdisciplinary questions, there should remain [space for more disciplinary studies](#). A process to integrate results from such studies needs, however to be developed, so that the disciplinary input feeds to the overall goals of the Project.
4. There is not yet a fully clear expectation regarding individual and collaborative contributions of the participants of the project. We recommend that all participants in CR2 work together to [clarify the role of and expectations from each partner](#). In particular, efforts to improve communication between within each team and between the different teams and campuses should be made.
5. The Project should develop a process to [interact with stakeholders](#). A first step may be to map key stakeholders for different sectors (public administration and corporate world). CR2 with its university participants should develop a structured dialogue with some of them. In particular, stakeholders should be invited to [contribute to the definition and scope of research themes/questions](#) and could directly be involved in the development and implementation of some of the projects. This type of dialogue could provide interesting possibilities for the future career of the students involved in CR2.

15 de Enero, 2014

A: Laura Gallardo

De: Panel Asesor Nacional

**REF: Sugerencias del PAN para CR2**

En reunión anual del CR2 los días 13 al 15 de Enero del 2014, se presentaron los avances de las diversas áreas de trabajo. El Panel Asesor Nacional se reunió durante el último día para analizar lo presentado y a continuación se entrega un resumen de las sugerencias para el trabajo futuro del Centro. Estas se resumen en dos grandes categorías, una primera referida a prioridades para fortalecer el Centro y la segunda referida a como lograr ser un Centro relevante para los stakeholders.

A. Prioridades para fortalecer el CR2:

- Precisar stakeholders (hacer un mapa de sh); acercarse a ellos. Identificar preguntas relevantes a ser trabajadas con éstos.
- Definir a qué escala espacial y temporal se pretende trabajar: global, país, regional, local? Pueden ser varias. Lo mismo con la escala temporal: se trabajará a 5, 10 o 50 años? Pero se debe evitar la tensión que puede generarse al trabajar a diferentes escalas, por ejemplo nacional vs local, ya que cada grupo encuentra que su escala es la relevante.
- Si bien focalizarse en adaptación permite definir un nicho más preciso para el Centro, debe considerarse que la mitigación es un ámbito que empezará a requerir respuestas de política pública e inversiones privadas en el corto plazo (a diferencia de la adaptación que puede ser de más largo plazo), por lo que se debe revisitar la decisión de concentrarse solo en adaptación.
- Definir mejor el nicho propio del CR2. Diferenciarse de centros existentes (por ej CCG UC). Mirar otros modelos institucionales internacionales; a quien se quieren parecer?
- Definir productos claves del Centro. Modelos, información sistemática, estudios, etc. Se nota una tensión aquí entre productos académicos (papers publicables de alto nivel vs trabajo en terreno). Hay que diferenciar productos: (1) escritos: académicos (papers), position papers (más de política pública) , libros (difusión), notas de prensa, ...por ejemplo comentar sobre último informe IPCC...; (2) Outreach: seminarios, charlas...; (3) Modelos...generales, específicos; (4) Estudios...; Información y datos sistemáticos.
- Precisar modelo de negocios del Centro futuro. Qué líneas se trabajarán y con qué recursos humanos, financieros e institucionales? Pensar porqué en 5 años mas debieran renovarles el grant? Qué harán si éste se termina? Definir cuales son sus "caballitos de batalla"...productos emblemáticos...reconocidos por el medio externo no necesariamente académico; precisar la relación entre el Centro y las Universidades. Este ha sido fuente de conflictos en otros proyectos.
- Priorizar ámbitos de acción y focalizar: agua, urbanización y uso de suelo parecen ser temas relevantes. Quizás también se puede agregar energía. Precisar mejor estos ámbitos, por ejemplo envez de urbanización podría ser ciudades sustentables.
- Dentro de los ámbitos buscar casos demostrativos que cumplan con ciertas características: ser complejos, ser replicables, que permitan la interdisciplina.

Con ello los casos servirán de ejemplo o modelo para muchas otras aplicaciones, nacionales e internacionales.

- Documentar los procesos de los casos que se desarrollen. Es clave entender qué se hizo, como se hizo, lecciones aprendidas, etc. Esto no se hace al final si no durante toda el desarrollo de cada caso. Documentar es clave para replicar.
- Evaluar las intervenciones que se hagan...lo que parte por definir una línea base.
- Trabajar metodológicamente la interdisciplina, por ejemplo una jornada de trabajo de los Pis, con stakeholders relevantes(mapa de sh?)...parecido al ejercicio liderado por Mary Scholls.
- Transformar en fortaleza el ser tres centros separados geográficamente: por ejemplo para aplicar en tres zonas diferentes los conceptos que se desarrollan.
- Definir alcances del concepto “resiliencia social”...a la brevedad para definir a qué usuario se llegará.

B. Qué se espera del CR2 por parte de los stakeholders tanto públicos como privados, que lo haría necesario para éstos?

- Alto nivel científico.
- Independencia y credibilidad.
- Ser World Class. Da respaldo para que empresas accedan a financiamientos y a las entidades públicas en el desarrollo de políticas públicas de largo plazo.
- Redes internacionales operacionales y concretas.
- Generar información de base confiable, continúa con metodologías validadas.
- Modelos validados, de clase mundial.
- Opinión seria sobre temas contingentes y de futuro: Es cierto lo que dice el IPCC para Chile? Como nos afectará lo que hoy día se sabe?
- Tener respuesta a preguntas gracias a la interdisciplinariedad. Debe ser un “Google” de alto nivel...para Chile.
- Si se trabaja a nivel local, apoyar el desarrollo de capacidades a escala local. Se debe definir a qué nivel se hará esto.
- Apoyar la evaluación multidisciplinaria y por tanto aceptabilidad de propuestas frente a problemas complejos.
- Informar Qué decisiones/inversiones/prácticas actuales y de corto plazo deben modificarse dados los cambios esperados y sus incertidumbres...generar opinión, apoyar el proceso político



Santiago, 20 de enero de 2014

Para: Laura Gallardo K.  
Directora del Centro de Ciencia del Clima y la Resiliencia (CR2).

De: Rosa Escobar  
Ingeniero Químico. Comité Asesor Nacional.

Ref: Comentarios y Sugerencias. Reunión Plenaria, Villa Alegre 13 al 15 de Enero 2014.

Estimada Laura:

Junto con agradecerle por la valiosa oportunidad de compartir con el equipo de CR2 y los miembros de los comités internacional y nacional en la reunión Plenaria Anual, en primer lugar te pido hagas extensivas mis felicitaciones al equipo de trabajo por los significativos logros y avances alcanzados en este primer año.

Si bien como panel nacional elaboramos con Jorge y Raúl un documento conjunto, como me solicitaras, te hago llegar los comentarios y sugerencias que quisiera destacar por mi parte luego de las jornadas de trabajo. No hay nada nuevo, pero creo que puede ser útil. He agrupado estos comentarios y sugerencias en 3 grandes áreas: trabajo interdisciplinario, vinculación con stakeholders y posicionamiento.

**Trabajo interdisciplinario:** luego de un primer año de puesta en marcha, en donde ha sido puesta mucha energía en aspectos de administración, coordinación interna, arrastre de proyectos previos y generación de un lenguaje común, parece recomendable avanzar hacia el fortalecimiento del trabajo interdisciplinario a través de la integración de las líneas de trabajo en torno a 2 o 3 temas o preguntas “emblemáticas” tan concretas como sea posible (por ejemplo, uno en cada una de las áreas de estudio: agua y su gestión en condiciones de escasez, megaciudades y planificación urbana; cambio de uso de suelo).

Esta integración permitiría focalizar recursos, potenciar el trabajo desde la disciplina y construir una “respuesta” holística a esas preguntas o temas claves para el país. Creo que la opción entre “disciplina o interdisciplina” se supera en una buena elección de un tema emblemático: el aporte de los investigadores puede ser encauzado de manera de proveer conocimiento desde lo disciplinar (y en consecuencia, potenciar su desarrollo profesional) en la generación de respuestas interdisciplinarias. No digo que sea fácil; probablemente este el desafío más complejo de alcanzar.

Los avances de este primer año me parecen notables, pero aun hay un “espacio” entre los grupos de trabajo que desde afuera los hace aparecer mas independientes que integrados. Se trata de conseguir que CR2 sea más que la suma de los trabajos de 5 líneas de investigación por separado. Esto permitiría responder porqué la existencia del CR2 es un aporte al país y se debería asegurar su permanencia en el tiempo.

**Relación con stakeholders:** en el período que viene es recomendable identificar y caracterizar claramente quienes serán los stakeholders para el CR2. Es una decisión estratégica y tremendamente relevante porque desde el diálogo del equipo CR2 con los stakeholders nacen las preguntas cruciales, los temas que son relevantes para el país. Si bien es posible imaginar un amplio espectro de stakeholders interesados en el trabajo del CR2, apuntar a un número reducido pero relevante me parece lo recomendable en esta etapa.

Obviamente el sector público es la contraparte más importante: pero cuáles son los organismos “blancos” para el CR2 en esta etapa? Aquellos que no pueden faltar? Sugeriría avanzar en esta dirección y construir los espacios de diálogo con ellos en el corto plazo.

Otro grupo de stakeholders esta constituido por las organizaciones de la sociedad civil y las estructuras de gobierno local (Municipal básicamente, pero podría ser incluso de una escala menor).

Respecto del sector privado, entendiendo que es un tema también estratégico para el CR2 que puede ser delicado, la vinculación con organizaciones representativas de industrias (CORMA, Juntas de Usuarios de Agua, SONAMI, CORPESCA por mencionar algunas) tal vez sea un mejor primer paso antes de vincularse con empresas privadas derechamente.

De estos dos últimos grupos de stakeholders sugeriría también focalizarse en dos o tres, idealmente integrándolos en un tema en que además se convoque a actores del sector público (en experiencias piloto de adaptación, por ejemplo).

**Posicionamiento:** como manifesté en la reunión, el CR2 tiene mucho que decir en temas que son de largo plazo y a la vez contingentes: en muchos casos, la decisión que se deba tomar ahora define lo que se puede esperar en el largo plazo y en esos temas CR2 puede gradualmente avanzar a posicionarse como un referente independiente, científicamente sólido y proactivo. El CR2 puede poner temas en la agenda chilena del cambio climático. Tiene la gran ventaja de estar “distribuido” en el espacio y, en consecuencia, es hábil para captar las sensibilidades geográficas que modelan las particularidades de la adaptación y la resiliencia. No hay otro centro con estas características y me parece que hay que mostrarlo.

Recibe mis más cordiales saludos.

Rosa Escobar  
Ingeniero Químico – Consultor Ambiental

Dra. Laura Gallardo Keller  
Directora Centro del Clima y la Resiliencia (CR2)  
Presente:

Santiago, 20 de enero de 2014

#### INFORME DE REVISION Y RECOMENDACIONES AL PROYECTO CR2

Luego de la lectura del Informe del Primer Año, las presentaciones realizadas por los Investigadores Principales (IP) de las 5 líneas de investigación, las presentaciones de algunos investigadores asociados (IA) y una conversación con los estudiantes de investigación y los IAs; se puede concluir que el proyecto en su primer año presenta un importante avance en su implementación y puesta en marcha. En este primer año se han concluido algunas investigaciones que ya venían en un estado de avance significativo, pero que el proyecto permitió su finalización, de allí el listado de publicaciones asociados al CR2. Reciban todas(os) mis felicitaciones por lo realizado en el primer año. Sin embargo, permítanme algunas recomendaciones surgidas por las actividades realizadas en el Encuentro de Villa Alegre:

1.- Se requiere una mayor integración entre las líneas de investigación. Se sugiere que al menos 2 de ellas puedan elaborar un objetivo común, una problemática científica que los integre. El proyecto en sí plantea las siguientes temáticas: *escases de agua, urbanización y cambios de uso de suelo*. Es necesario que en el segundo año estas temáticas aparezcan con más claridad en el desarrollo de las investigaciones.

2.- Se requiere una mayor claridad de objetivos para los estudiantes de investigación. Algo que ellos plantearon. Se sugiere mayor interacción tanto vertical (top – down) como horizontal entre ellos. Un encuentro sólo para estudiantes pudiera ser interesante.

3.- El primer año muestra un esfuerzo tremendo en difusión, sin embargo, este debe ser permanente. El CR2 tiene la oportunidad y debiera alzarse como el principal referente en temas de cambio climático y temas relacionados. Esto debe tomarse como un desafío. Se sugiere aprovechar las instancias que muchas veces la propia naturaleza entrega con eventos que hacen noticia, y que da el hecho que este año aparecen los informes de IPCC. Si bien el del grupo 1 fueron dadas a conocer el septiembre de 2013, en febrero estará disponible el Informe completo, luego vendrán los Informes de los grupos 2 y 3.

4.- El proyecto propone el desarrollo y mejoramiento de productos y servicios climáticos. Se requiere una definición clara de los stakeholders, quienes son, qué papel juegan, son usuarios intermedios o finales, etc. Se sugiere que en transcurso del segundo año los stakeholders queden definidos así como también tener claridad de si éstos tienen la capacidad humana y técnica para recibir los productos y servicios climáticos. Se sugiere realizar talleres con los stakeholders.

5.- Poco o nada se discutió acerca de la mitigación, algo que se menciona en el proyecto. Se sugiere desarrollar esta temática o definir como se incorpora.

Sin otro particular, saluda atentamente a Ud.



Dr. Jorge Carrasco Cerda