VACEA Final Technical Report
IRIACC Program

Section A: **Program Information**

1. Identification			
IDRC File Number 106372-008, 009	Title: VULNARABILITY AND ADAPTATION TO CLIMATE EXTREMES IN THE AMERICAS		
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Section B: **Synthesis**

2. Provide a one-page summary that describes the work conducted during the reporting period as it relates to the goals of the IRIACC competition (e.g., advancing research, influencing policies and practices, training and network development). As noted above, given the comparative nature of the research, please ensure that the report accurately reflects the work undertaken at each site.
The work completed on the VACEA project relates to advancing understanding of climate change vulnerability in the six river basins in five countries, and to training and network development. This work has produced a body of knowledge and deliverables that will influence climate adaptation policy and practices at least regionally if not nationally. The current reporting period included an annual project meeting held in southwestern Saskatchewan in mid September 2015 where actions were taken to reinforce integration of our research findings and to engage external partners and local stakeholders. This AGM set the stage for the months of project integration and dissemination, with an emphasis on translating the research results for the purpose of community-based adaption planning and the governance institutions with responsibilities in the project study areas. ARGENTINA During the 2015- 2016 period the Argentina team concentrated its efforts, time and resources to make progress towards the last phase of the project (item 3: Integrated Analysis Results). This required that we develop a basis from which to work. (The index RACE, originally proposed by VACEA as the tool for integration had demonstrated some limitations.) The three disciplinary teams of Argentina (hydro-meteorology, agro-physiology and socio-political) held numerous meetings to complete the integration. The results of this analysis were discussed with the members of the Advisory Committee. This served to reinforce and improve the findings. The analysis was presented at the AGM in Canada in 2015 and was adopted as a general methodology for all countries. Doctoral fellows continued their training from different courses at universities and training centers. During this last stage, the results were presented at national conferences and international symposiums. It was also a time of dissemination of results in different formats including scientific journals and media. Finally, joint publications were produced with team members from Canada and Colombia. CHILE During the fifth year the following end products were consolidated: 1. Final edition of the CLIMATE CHANGE ATLAS OF THE AMERICAS. This book contains a complete cartography describing the climatic baseline of the whole American territory (from Canada to Magellan region). This includes extreme temperatures, precipitation, degree days, freezing temperatures, chilling hours, dry and humid period, number of hot days, water surplus, water deficit, human comfort index. The same variables are represented in two future scenarios corresponding to the years 2050 and 2070. This information provides an overview of the main changes that climate may experience in the next decades and its possible impacts on human activities. This Atlas also includes the impacts of climate change on the three main crops: wheat, maize and rice, and the impacts on the main biomes of the

continent. This last information could be extremely useful in identifying hotspots for biodiversity conservation programs. This study attracted the interest of the environmental chapter of the Pacific Alliance who invited the VACEA team to develop a workshop to be held in Santiago in June 2016, to train persons charged with designing and implementing biodiversity protection programs in Mexico, Colombia, Peru and Chile.

2. Elaboration of a summary document containing the relevant result obtained by the five working groups (Canada, Chile, Argentina, Colombia and Brazil). This document also includes the six case studies corresponding to the six pilot areas and the proposed matrix of climate change adaptations including the diagnosis of threats, recommendations, and requirements to implement an effective strategy of climate change adaptation.
3. Final version of the VACEA manual of technical procedures to assess climate change scenarios, impacts, exposure and vulnerability. This book includes examples from Chile, but procedures are completely replicable in other regions of the continent.
4. Final edition of the VACEA compendium of educational materials for primary and secondary education, including multimedia material, experiments and demonstration, and learning roads for teachers.
5. Preparation of three scientific papers (Agricultural and Forest Meteorology, International Journal of Biometeorology and a contribution to the Global Conference of Ecological Modelling to be held in May 2016 in USA)
6. Dissemination activities as Press communications, participation in Seminars and Technical meetings.

BRAZIL

During 2015-2016, the Brazilian Team reported findings for its watershed region (Araranguá River Basin). One assistant professor (Marina Hirota) and a postdoctoral fellow (Nathan S. Debortoli) delivered 8 products according to the VACEA's template, which included: a watershed data compilation of environmental, socioeconomic and climatic indicators, interviews with stakeholders and governance analysis, the development of local maps including climate change scenarios and other physical and social aspects, and the participation in local conferences and networking within Santa Catarina state authorities (local stakeholders in the watershed committee, farmers and researchers from the state's rural extension and agricultural company - EPAGRI). Three undergraduate students (Ana Paula Veira, Arthur Müller and Tayara Tavares) and a MSc researcher (Mari Machado) also participated in the data analysis and fieldwork. At this point the Team is working on delivering handbooks and booklets to disseminate the project results, and to create focus groups within the local community, inserting key aspects and findings from VACEA to foster new adaptation strategies and reduce local and regional vulnerability. Also, together with Leandro Cara from the Argentinian team, we are working on the calculation of the exposure indicators to compute the RACE index.

CANADA

During 2015-2016 reporting period, the Canadian researchers were focused on completing all VACEA-related research and disseminating the key findings for both scientific and public audiences, and in particular sharing the research results with local stakeholders and our external partners. The Canadian team organized and hosted the VACEA AGM held in the Cypress Hills in southwestern Saskatchewan, near the upper reaches of the Swift Current Creek watershed, one of our two Canadian case study river basins. The one-week of meetings include two days spent with local agricultural producers and community decision makers. One day in a meeting room and one day on a field tour gave us the opportunity to share

research results but also obtain important feedback and advice from the stakeholders. Research activities included 1) documenting and interpreting the results of the community vulnerability and governance assessments, 2) applying a suite of scenarios of future climate change, and 3) evaluating RACE (Rural Adaptation to Climate Extremes) indices of exposure, sensitivity and adaptive capacity. We also have various opportunities to present the results of VACEA research at conferences and public events. Late in the reporting period our focus was on compiling all research results under a vulnerability node, integrating framework and also for a plain language summary for stakeholders.

COLOMBIA

University of Antioquia: During the last year, the sensitivities of peasants and farming entrepreneurs to diverse climatic extremes were assessed. To that aim, interviews were developed with 14 coffee farms and small peasant farms managed by families. The new information, added to that gathered in the previous years, was used as a primer for the first chapter of the doctoral thesis of Cristina Erika Acevedo. This chapter focuses on the sensitivity of the coffee growers to El Niño and La Niña. Multidimensional Poverty Indicators were insufficient to evaluate sensitivity. It would be wrong to say that the coffee grower who has exceeded the poverty line is resilient against extreme weather events. It was necessary to know first-hand the production processes and labor organization to identify the strengths and weaknesses of agribusiness and family farming. The farm visits and in-depth interviews provided an opportunity to clarify the effects of El Niño and La Niña. Sensitivity depends on the variety of coffee being grown. This information constitutes the first step to propose Differentiated Power Adaptation measures. This means designing adaptation strategies that take into account the economic rationale and the culture of coffee growers.

The Colombian team also worked on the analysis of governance processes associated with the planning and management of the Chinchiná River basin, where the farmers studied are located. Results were submitted as an article entitled “Governance and Climate Variability in Chinchiná River, Colombia” to the Journal of Climate Change Strategies and Management, which has been accepted for publication. This paper has resulted from the collaboration of researchers from Canada and Colombia. Another article is aimed at discussing the usefulness of indicators to assess vulnerability to extreme weather events among rural people of Colombia and Argentina. A poster presented at the Second National Congress of Environmental Sciences, held in Pereira (Colombia) discussed the vulnerabilities and adaptation to extreme weather events in the coffee region of the Chinchiná river basin.

University of Caldas: Our assessment of vulnerability to extreme weather events of the rural population of the Chinchiná River basin was focused on the municipalities of Villamaría and Manizales. Analyses during the last year were consolidated from: (1) formal knowledge institutions on governance in the context of climate change and extreme weather events, (2) knowledge, organization and local practices, and (3) the definition of paradigmatic cases in the territorial reconfiguration of the River Basin Chinchiná, the impact on the management of governance and governance, considering the peri-urban gentrification, environmental shifting and the declaration of the region as a Cultural Landscape World Heritage Site. We analyzed the relationship of each with the vulnerability and adaptation of agricultural production systems in each of the spatial units of analysis. We prepared a proposal for an interactive information platform of the project.

National University of Colombia (Medellin): Advances in the publication of VACEA results. We submitted the paper entitled "Interannual Hydro-Climatic Variability and the 2009-2011 Extreme ENSO Phases in Colombia - From Andean Glaciers To Caribbean Low-Lands", to the Journal of Hydrometeorology. This paper is a chapter of the Doctoral Thesis of Juan Mauricio Bedoya-Soto. It contains a regional analysis of the main

features of Climate Variability in Tropical South America at interannual timescales. The analysis made in this period shows that the most representative modes of variability at local scale in the Chinchiná and Recio Rivers are ENSO, TNA-TSA, Atlantic Niño and the Western Hemisphere Warm Pool (WHWP). Further results are being submitted to the Journal of Hydrologic Engineering. We also presented an oral presentation at the 2015 AGU Fall Meeting (San Francisco, CA, USA) entitled "Mountain Tropical Rainfall: Phase-Locking between the Diurnal, Annual and Interannual Cycles in the Andes of Colombia, dealing with variability of rainfall over the Andes of Colombia at diurnal, annual and interannual timescales. Finally, we collaborated on a conference paper with Prof. David Sauchyn in the Ninth Biennial Rosenberg International Forum on Water Policy - Managing Water and Biodiversity in Humid Areas, to assess the transversal effects of ENSO in Canada, Colombia and Chile.

Section C: Objectives & Research Problem

3. State the general and specific project objectives.

General Objectives:

The overall objective is to improve the understanding of the vulnerability of rural agricultural and indigenous communities to shifts in climate variability and to the frequency and intensity of extreme climate events, and to engage governance institutions in Canada, Argentina, Brazil, Chile and Colombia in enhancing their adaptive capacity to reduce rural community vulnerability.

Specific Objectives:

1. Advance our understanding of regional hydroclimatic variability and extreme events, in terms of the natural characteristics and drivers, and shifts in the frequency and intensity of inter-annual variability and extremes as a consequence of global climate change;
2. Advance our understanding of the past, current and future vulnerabilities of rural agricultural and indigenous populations to climate hazards and related stressors;
3. Determine the impacts of climate variability and extremes on agricultural productivity and environmental services that support the studied communities;
4. Evaluate and communicate adaptive management practices and governance policies that improve adaptive capacity and reduce climate-related risk;
5. Develop and implement a unified methodology, based on biophysical and socioeconomic indicators of vulnerability, to evaluate adaptation options for reducing vulnerability;
6. Promote sharing of knowledge, resources and expertise among research and governance institutions in order to inform policies and programs for reduced vulnerability and enhanced adaptive capacity;
7. Increase the capacity of research organizations and researchers in the five countries to undertake comparative and collaborative

interdisciplinary research on climate change impacts and adaptation; and

8. Enhance young researchers' expertise and skills in the interdisciplinary study of global environmental change.

4. Briefly describe the a) original rationale for the research program and its scientific importance, b) the rationale for site selection and comparative research design, and c) societal/technical relevance.

a) Original rationale for the research program and its scientific importance:

The **VACEA** project is a collaborative, comparative and interdisciplinary investigation of vulnerable rural agricultural and indigenous communities in Canada, Argentina, Brazil, Chile and Colombia. It addresses a major gap in knowledge and practice: the consequences of global climate change for a) regional climate variability and extremes and b) the associated vulnerabilities and adaptive strategies of rural communities. The most common and robust projections of future climate are climate model outputs averaged over decades and large areas. In turn, most assessments of climate change impacts and vulnerability have relied on these scenarios of shifts or trends in average climate. However, at local and regional scales the major climate hazards are extreme conditions rather than shifts or trends in the means. The analysis of current vulnerabilities in the context of projected shifts in climate variability and the frequency and intensity of extreme events will produce important insights into future risks and opportunities, informing the adoption of more appropriate local practices and adjustments to governance policies. The project is focused on rural populations that are highly vulnerable, either because they live on the social and economic margins of society or because the nature of their livelihoods makes them highly exposed and sensitive to climate variability and extremes.

The VACEA project encompasses natural and social science and engineering and an integration model that links the different perspectives and disciplinary approaches to research, knowledge translation and adaptive decision-making. Our interdisciplinary approach combines qualitative and quantitative methods, integrating various types of knowledge. The project aims to a) shape policy and inform practice, with a focus on local/sub-national scales, and b) improve understanding of the adaptation of social and natural systems to climate change, and the interrelated social, physical, political and structural drivers/constraints. In collaboration with our project partners, we will achieve heightened inter-jurisdictional awareness and exchange of practices and tools for adapting to climate, including vulnerability and risk assessment, interventions that respect traditional knowledge, and communication to enhance public understanding of climate change adaptation strategies and their benefits. We place a high priority on the networking of young and established scholars, and the active participation of graduate students. The project links initiatives across sectors and disciplines, involve partnership and collaboration with various non-academic partners, enhance collaboration between researchers from Canada and four Latin American countries, engage community-based and indigenous researchers, and work with multi-stakeholder groups to strengthen their commitment to achieving adaptation to climate change.

b) Rationale for site selection and comparative research design:

The research design and conceptual framework follow a vulnerability assessment model and its associated community-oriented, participatory methodologies. Vulnerability to climate change is a function of (1) exposure to climate hazards and their impacts; and (2) social conditions that determine sensitivity- the degree to which a system is affected by climate-related stimuli - and 3) adaptive capacity, the ability of a system to adjust to climate risks and opportunities by increasing its coping range. This vulnerability model, characterized as a "bottom-up" approach, offers a consistent framework for interdisciplinary and comparative research employing various methodologies, incorporating climate science, integrating structural institutional conditions and agency, and actively engaging stakeholders and decision makers. It directs all research activities towards evaluating past, current and future exposure, sensitivity and adaptive capacity, and applying knowledge of these determinants of vulnerability towards designing effective adaptation strategies. An emphasis on integration of project knowledge and activities is essential because the study of adaptation to climate change does not yield to the perspective and methods of single disciplines; each quickly reaches its limitations. Addressing complex issues such as climate change (often referred to as wicked problems) requires strong interdisciplinary approaches. Shared goals and objectives, and conceptual and operational frameworks are be the foundation for a continuous exchange of knowledge and experiences among the researchers in five countries and various disciplines, and among researchers, stakeholders and decisions-makers in the communities, and governance organizations. An integrated collaboration also will avoid duplication and fragmentation among project activities. The three core Research Themes are pursued in all watersheds using common methods and consistent methodologies; all research activities involve a) collection and analysis of secondary and contextual data, and b) knowledge translation and dissemination.

All of the study areas are rural and agricultural, and characterized by communities and economic activities that are sensitive to deviations in climate from normal conditions and to extreme events. Indigenous populations include the Kainai First Nation (on Canada's largest Indian Reserve) in southern Alberta, Guaranies in Brazil and Diaguitas in Chile. Four of the six rivers (Chinchiná, Mendoza, Choapa, Oldman) are fed primarily by snowmelt and rainfall runoff from mountainous headwaters. Droughts and floods are serious climate hazards in these basins, threatening water supply for human consumption and also for agricultural production and irrigation. The Araranguá River basin in southern Brazil has been recently repeatedly devastated by tropical storms, rarely experienced in the region prior to 2004. In Canada, Swift Current Creek sheds runoff from a prairie landscape where dryland agriculture is dependent on spring and summer rain, while the Oldman River heads in the Rocky Mountains and is used primarily for irrigation. Thus there are sufficient similarities and contrasts among the chosen river basins to enable a multi-national comparative study of the human and environmental dimensions of the impacts and adaptive responses to short-term climate variability and extreme events.

c) Societal/technical relevance:

Climate change, and especially projected shifts in variability and greater frequency of extreme events, will increasingly impact natural resources and the livelihoods of rural people and their social and economic activities (especially agriculture). Populations and sectors in rural areas are often disproportionately more vulnerable, given their dependency on natural resources, notably water, and their exposure to other stressors, such as globalization and restricted fiscal policies. There is a consensus that mitigation policies will not in the near future slow rates of climate change and its impacts and, accordingly, adaptation policies and practices are necessary. Current knowledge of vulnerabilities to climate variability and extremes is insufficient for a systematic evaluation of adaptive capacities and for anticipatory adaptation to climate change. Thus, expanding our knowledge of climate change impacts and vulnerabilities, and adaptive capacities is essential in order to improve policy, promote local awareness,

manage risks and opportunities, and guide local and regional decision-making.

The VACEA project has significant benefits to the participating countries, because the research has enabled us to:

- evaluate and inform practices and policies that hinder or facilitate adaptation processes in vulnerable rural agricultural and indigenous populations by developing a richer understanding of relevant stressors including those that engrain inequities within and between countries;
- establish networks that enhance the adaptive capacity of governments, industry and civil society;
- create new knowledge of regional climate variability and extremes and the impacts on rural livelihoods, ecological services and agriculture; c) existing sensitivities and adaptive capacity;
- assess governments' adaptive capacities to reduce the vulnerabilities of rural agricultural and indigenous communities;
- develop indicators of vulnerability and indices of risk that can be used by communities and governance institutions to better prepare for future change and uncertainty;
- test and improve assessment and governance tools and their dissemination, as well as determine their applicability in other countries; and
- initiate a government-community forum on adaptive strategies and a training program on climate change, vulnerability, and adaptive capacity.

Section D: **Program Results and Dissemination**

5. The Request for Applications identified potential 'Anticipated Results' across three domains 1) advancing knowledge, 2) shaping policy and informing practice, and 3) training and networking. Applicants were to design their research programs, including knowledge mobilization/translation strategies, to address some of the anticipated results listed in each domain (see Annex 4). Writing for a general audience, discuss your main results as they relate to each domain. Highlight notable examples and indicate who or what has benefited from your work. Additionally, indicate particular contributions made by your program to building the capacity of vulnerable communities / sectors?

ARGENTINA

***Advancing knowledge*:** in Argentina we were able to develop a methodological framework for the analysis of Vulnerability to Extreme Events in an integrated perspective. From this methodology we could build the basic guidelines and principles for Global Change Research in a interdisciplinary fashion. On this basis, the team also made a proposal to advance the research to other basins in the region of Mendoza (Tunuyan River Basin). The team continued fitting the models for defining scenarios of climate change in the basins and the development of a portfolio of adaptation practices resulting from studies of changes in crops (grape mainly) produced by events like El Niño, drought and heat waves.

Shaping policy and informing practice: During the entire project period, members of the VACEA team attended regionals seminars with producers and policy makers for the implementation of adaptation strategies. We worked with the following institutions: National Institute for

Agricultural Technology (INTA), Wine Cooperatives Association of Argentina (ACOVI) Argentina Wine Corporation (COVIAR).

Training and networking: it was a year of intense training for doctoral fellows. One of the project's research assistants (Julia Barrientos) was admitted to a PhD in Agricultural Social Studies and also obtained a scholarship from CONICET to continue her studies since April 2016 once the VACEA project is completed. Also, another project assistant (Leandro Cara) was admitted to Maestría en Aplicaciones de Información Espacial (Instituto de Altos Estudios Espaciales Mario Gulich and Facultad de Matemática, Astronomía y Física - Universidad Nacional de Córdoba). During the reporting period the team strengthened collaborative work with colleagues from other VACEA countries. These collaborations ended up in joint publications and submissions of new research proposals.

CHILE

Advancing knowledge

Climate extremes and plant stress and productivity
Important progress was made on modelling the effect of climate extremes on cultivated species and agricultural production. A doctorate thesis ended during march 2016, and 3 papers are being prepared on this subject. A complete model (RINDE and SIMPROC) to monitor plant stress due to climate extremes was constructed and tested. Daily monitoring of climatic variables and accumulated impact indices enable these models to detect stressing periods (intensity and duration) for cultivated plants affecting agricultural productivity. By mean of these models we map possible effects of climate change covering the whole continent (Canada to Magellan zone).

Climate Downscaling and "microscaling"
Important progress was made in the area of modelling and cartography of climate. Surface models to elaborate detailed cartography of extreme temperatures, precipitation, solar radiation and evapotranspiration were developed and used to create a complete a cartographic set covering the whole Chilean territory (an agro-climatic Atlas is under preparation). The system is based on mathematical equations having as input: latitude, altitude, distance to shoreline, specific topographic elements (barriers, valleys, topographic depressions) to calculate primary climatic variables (temperature, precipitation, air humidity, solar radiation and wind) using a geographical grid with a resolution of 1 x 1 Km. This procedure was named "microscaling" by the VACEA team.

Methodology to establish bioclimatic sensitivities of ecosystems
The VACEA Team developed a very innovative and promising technology to characterize the bioclimatic profile of any ecosystem. The system is based on the ecosystem's geographical distribution and bioclimatic surfaces, which are overlaid to define bioclimatic intervals of ecosystem distribution. On this basis, a set of histograms are established which describe ecosystem tolerances and sensitivities.

Modelling climate change at basin scale
Several applications of the Basin Climate Model were carried out in the Chilean pilot area. The results were used to improve the model in order to better assist policy makers in designing water management strategies. The system was equipped with a friendly interface and is now available to

be run in Windows.

Modelling climate change impact on farm production systems
The Farm model, developed in the previous years, was improved in order to better link expected changes of agricultural productivity and its economic dimension potentially affecting farmers. It was applied to real farms in the pilot area. These applications served to test the model applicability as an evaluation tool of the adaptation requirements to face climate change at the level of stakeholders.

***Shaping policy and informing practice**:*

- The National Commission on Irrigation (CNR) has developed an Internet platform to make VACEA results available to farmers and irrigation projects designers. This platform will be the only official support for projects that apply for official subsidies.
- The Ministry of Agriculture officially supported with funds the use of the VACEA methodology to map climate change scenarios, to extend its application to the whole Chilean territory. This is an initiative to elaborate an Atlas of Climate change during the next 18 months.
- The Pacific Alliance asked the VACEA team to organize a workshop addressing public administrators of biodiversity conservation programs in Mexico, Colombia, Peru and Chile. This workshop will be held in June in Santiago. This will be an excellent opportunity to shape public policies in biodiversity conservation in the four countries.

Training and networking:

The AGRIMED Center (UCH) trained two people from Colombia (Jonathan Burbano and Olga Ocampo) in the use of crop models to assess climate change impacts. Also we trained Jorge Albar from Spain in the use a protocol to assess vulnerability of rural communities to climate change. A workshop on mapping climate change scenarios was offered to professionals from the Direccion Meteorologica de Chile, which is the National entity charged with collecting and processing climate data in Chile.

CANADA

Advancing knowledge:

We characterized historical occurrence of growing season hydro-climatic extremes over the Oldman and Swift Current and compared an index of drought (the SPEI) to groundwater levels. Summer and water year (October to September) SPEI represent future changes to hydro-climatic extreme events. Results show considerable year-to-year variability and shifts from multi-year dry, warm conditions to persistent wet, cool periods and vice versa. In addition, there appears to be a slight increase in inter-annual variability since approximately 1990 over both watersheds especially the Oldman basin. The dominant atmospheric circulation patterns associated with both historical and future hydro-climatic extremes were identified and assessed for trends, changes, and variability. The most extreme summers (both drought and excessive wet) are influenced by distinct patterns that involved the dominance of a large-scale ridge centred over western Canada (for drought periods) and a large-scale trough pattern during excessive wet periods. Furthermore, there has been a significant increasing trend in the strong ridging pattern over the last ~60 years

and a slight decrease in the major trough pattern.

Projected future (2041 to 2010) changes in SPEI were also assessed using two Regional Climate Model projections; a warm, dry and a cooler, wetter future. Results showed that both locations experience a large mean decrease in SPEI values for the warm, dry scenario that directly translates into a higher frequency and severity of future drought. The warm, dry future is also associated with substantial increases in year-to-year variability. There is a greater range for the cool, wet projection including a smaller increase in droughts in the Oldman basin and relatively no change for the Swift Current watershed. The cool, wet scenario generally shows small decreases in inter-annual variability. These findings therefore suggest an uncertain future in drought/excessive moisture risk in the two basins ranging from considerably worse conditions involving a substantial increase in drought with a higher degree of year-to-year changes (that would cause adaptation challenges) to relatively no change from current conditions.

An economic model of a mixed farm was developed and tested for selected adaptations for livestock producers. This is a first of this type of model testing future climate extreme in the study regions. From the results of the Community Vulnerability Assessment, we derived a series of insights and recommendations concerning Economic and Social Sensitivity, Adaptation and Vulnerability to Environmental Stressors and Future Vulnerability. We observed that rural communities have adaptive capacity to deal with some extreme climate events within a certain range. The climate scenarios emphasize future intense and prolonged drought interspersed with more extreme precipitation events. Adaptive capacity in relation to drought exists in the study areas, but this is limited to a certain number of drought years (~3). In relation to intense precipitation, the study showed that communities in Saskatchewan (the Swift Current basin) have a very limited adaptive capacity. A more developed adaptive capacity to floods is found in Alberta because they have more experience (e.g., the extreme precipitation event of 1995) and because irrigation infrastructure can be used to manage flooding to some extent. Local water users' groups have also facilitated this higher adaptive capacity.

Shaping policy and informing practice: Two major initiatives were untaken in the final year of the VACEA project to share research results with decision makers at varous levels of governance. The RACE (Rural Adaptation to Climate Extremes) index was initiated by the Canadian researchers to translate VACEA project findings into a series of semi-quantitative indicators of exposure and sensitivity to climate change, and adaptive capacity. Once all countries have contributed to the evaluation of RACE indicators, we intend to present them at a workshop with policy makers. The second imitative in Canada within the past year was a workshop, held in conjunction with the VACEA AGM, where we presented research results and our recommendations to a group of local agricultural producers and officials from municipal, provincial and federal government agencies. Two days of interaction produced a series of recommendations endorsed by stakeholders.

Training and networking: The project supported four PhD students. In addition five students visited from Chile for a period of two months. Canada researchers are engaged in networking collaborating with colleagues in the four South American countries.

BRAZIL

***Advancing knowledge*:** in Brazil we were able to complete data compilation for the entire Araranguá River Basin region, including climatic data modeling scenarios, GIS material (maps and shapefiles), socioeconomic and aggregated data for municipalities within the Basin, and an update on

the local governance and policies. We have also detected gaps in local environmental and infrastructural policy.

***Shaping policy and informing practice*:** during the entire project period, members of the VACEA team that inhabit the region, like Chen Lin Sung, had an active role in the community, developing local forums to debate extreme weather events and discuss the importance of an integrative approach to deal with local issues concerning the watershed committee. Local 3D models of terrain and a participatory approach within the communities helped to determine flood risk areas within the Araranguá municipality and adjacent areas. We also developed an extreme event classification methodology that was incorporated in the local and regional civil defense policy.

***Training and networking*:** within focus groups and forums, many locals (farmers, civil defense and environmental stakeholders and members of the watershed committee) were able to receive the researchers' knowledge giving rise to new behaviours to cope with meteorological extremes, and environmental mismanagement. Moreover 5 undergraduate students and 1 PhD student were trained.

COLOMBIA

***Advancing knowledge*:**

Three paradigmatic socioeconomic dynamics have been identified in the study region (municipalities of Villamaría and Manizales in the Chinchiná River basin): (1) Peri-urban Gentrification in vereda (smallest political unit) La Florida, (2) Environmental Displacement of Human Population in veredas Nueva Primavera and Rio Claro, and (3) the declaratory of the region as UNESCO´s Landscape Cultural Heritage Site in veredas Llanitos and San Julian of the Chinchiná River Basin. Diverse strategies of inquiries and polls were developed, that allowed the assessment of vulnerability and adaptation of the peasants and small farmers and agricultural production systems to diverse climate change scenarios. The consolidated work allowed us to develop the conceptual and methodological work on vulnerability in the territory, and to identify the ways in which rural communities and population trigger a series of alliances and strategies for coping with situations of need or vulnerability.

Regarding the relationship between vulnerability to climate change and its territorial implications, we found a clear weakness between what the farmers refer to as "el tiempo que hace" (the current weather), and affectations on cultivated fields, river mining, and even on the vulnerability of the type of housing construction. There is a weak understanding among the rural communities about the effects of El Niño and La Niña beyond the traditional concept of wet and dry seasons. At this point, concepts such as cognitive justice must come to play a more obvious role, that is, that local knowledge is weighted not only to maintain what the communities posses, and the way they have lived their lives, but to suit the non-repetition and / or mitigation of the multidimensional effects brought about from climate variability and climate change. Among various coping strategies and/or adaptation measures are the creation of associations of farmers and small producers seeking to improve their income through vertical or horizontal integration, reduced production costs, and cancellation of marketing channels, and strength their organizational capabilities to interact with institutions of different types of which can obtain resources to finance common projects, etc. Due to the effects of climate variability, the inhabitants of the villages have reshaped their farming practices such as the development of greenhouses, crop diversification, increased use of agrochemicals, shaping social organizations, sustaining neighbourhood networks, among others, that allow them to sustain themselves in the territory that have never left despite the different effects brought about by the environmental phenomenon.

***Shaping policy and informing practice*:**

From the understanding of the reported problems, in relation to policy development and informed practices, progress was made in furthering meeting spaces, dissemination and sharing of the results of the investigation by our research group with local stakeholders in each of the villages in which we conducted investigative exercises. During each stage of fieldwork, our researchers participated in meetings with the populations to socialize the objectives of the VACEA project towards an understanding of the vulnerability and adaptation strategies and rural populations in each context. We interacted with the Community Action Boards, as well as with local committees, rural schools, and welfare spaces, through diverse forums and knowledge workshops, with academic and local and national researchers, which allowed to visualize the issues the problems in light of the paradigmatic cases, and the discussion in diverse levels (methodological, epistemological, and political) about the concepts which lead the analysis of the territorial and climate vulnerability in Chinchiná River Basin.

The vulnerability of the population of the Chinchiná River basin is not only due to climate change but also on the institutional capabilities of the rural communities to address specific situations. Therefore, the design and implementation of strategies for communities with governmental support to improve the degree of adaptability of rural people, is an imminent need identified. We found the Community Action Boards through which they are managing actions and projects aimed at achieving economic support through the municipal government, the various government ministries and even private equity, which allow to solve social problems and physical infrastructure that most afflict the communities. They have been developing agro-tourism and agro-ecological projects aimed at constructing alternative to traditional production processes and addressing such volatility in coffee prices as a monoculture.
In 2016 and 2017, work will be oriented to dissemination of results among public officials, researchers and community leaders of the Chinchiná River Basin

***Training and networking*:**

During the reporting period the Colombian team pursued collaborative work with colleagues from other VACEA countries. These collaborations produced joint publications and submissions of new research proposals. Similarly, through participation in national and international academic events, we developed an interesting dissemination and discussion of our research products In turn, progress was made in the development of different platforms, tools and broadcast formats such as the production of scientific articles, papers, reports, workshops, forums, conferences, and virtual platforms. As for the latter, the VACEA interactive platform is under construction, to comprise all the documents resulting from the Colombian research team; including a GIS interactive mapping, videos, pictures and audios associated with the investigation. The platform will be of free public access.

We have trained three PhD students Juan M. Bedoya, Olga Lucía Ocampo, and Erika Cristina Acevedo, working under the supervision of Professors Germán Poveda, Jorge Julián Vélez and Sandra Turbay, respectively. Finally, the education and human capacity building processes were strengthened by the participation of an undergraduate Anthropology student and a Young Professional Researcher in Veterinary Medicine, who framed their research around the general objectives of the VACEA project.

Section E: Implementation and Management

6. How were non-academic partners (e.g., research users, community organizations, businesses) involved in the implementation of your Team's research program? For example, how did partner organizations contribute (in cash and/or in-kind and/or intellectual leadership) to research activities, support implementation, or provide feedback on research results?

ARGENTINA

The participation of members of the Advisory Committee was relevant in building bridges with technical associations, wine cooperatives and other institutions of the productive sector. Also, during the reported period, as throughout the entire project, meetings with the Advisory Committee were crucial to receive feedback on the results and the research process.

CHILE

The Ministry of the Environment provided funds and logistic support to prepare an integrative analysis of climate change impacts, vulnerabilities and exposure in the zone around the VACEA pilot area in Chile. This initiative lead to the creation of an "Atlas of climate change in the arid and semiarid region of Chile". The Ministry of the Environment also provided funds and information to apply the VACEA methodology to assess climate change threats on ecosystem conservation. This action leaded to an extensive application of the VACEA methodology to calculate bioclimatic stress on ecosystems covering the whole Chilean territory. This diagnosis was adopted officially to design a National Strategy on Ecosystem Conservation. The same methodology was applied by the VACEA team to the whole continent from Canada to the Magellan zone in the extreme austral America. The Ministry of Agriculture provided funds and logistic capacity to prepare, on the basis of the VACEA database, a complete cartography of climate variables influencing water requirements of the agricultural sector in Chile. This cartographic set is being used as the official reference to design projects that apply for funds in the context of the law 18450 on Water for Irrigation (Ley de Fomento al Riego).

BRAZIL

The local and regional civil defense agencies were very proactive with supporting the implementation of a local agenda on climate extreme forums, and farmers helped to disseminate information while participating in the follow up of watershed conflicts in the local community. Local networking from local stakeholders was crucial to contact leaders and fully comprehend the region's main challenges towards adaptation to weather phenomena, and the lack of participation in local policies.

CANADA

The Swift Current Creek Watershed Stewards, an active watershed council in southwestern Saskatchewan, was instrumental in organizing the VACEA AGM last September, and in particular the 2-day component that involved agricultural producers and local and regional government officials. This stakeholder workshop was the source of important feedback for the VACEA research team. Our external partners also have been very helpful with the review of a series of fact sheets summarizing research findings.

COLOMBIA

VACEA researchers interacted with Community Action Boards, as well as with local committees, rural schools, and welfare spaces, through diverse forums and knowledge workshops, with academic and local and national researchers, which allowed to visualize the issues the problems in light of the paradigmatic cases, and the discussion in diverse levels (methodological, epistemological, and political) about the concepts which lead the analysis of the territorial and climate vulnerability in Chinchiná River Basin.

7. Thinking about the opportunity to collaborate with team members across boundaries (e.g., disciplinary, organizational, and country), critically assess whether the design of your collaboration and the competition has added value to your efforts to advance knowledge, shape policy and inform practice.

The VACEA project has enabled us to understand the difficulties in harmonizing the views of different national teams, having different strengths, focus and interests. This has to be considered as a challenge and adversity that we have to live with. The end results of the project likely will not reflect the same degree of development in all participating countries. Some teams will be more able than others to integrate and apply research results. This is not seen as a failure, but as the natural difficulties of a project with such a diversity of participants, backgrounds and situations. What is important is the possibility of sharing experiences, developing integrated models and applying them in different situations. Even if we won't be able to reach a complete integration of methodologies, the rich exchange of experiences and views will clearly improve the capacities of each national team to support future tasks related to climate change adaptation and designing public policies to face climate change.

Argentinean (Paula Musseta), Colombian (Dr. Sandra Turbay, Erika Cristina Acevedo Mejía) and Canadian team members (Amber Fletcher, Harry Diaz, Margot Hulbert, Greg Marchildon) have been jointly working on vulnerability and governance. They have been writing an article that compares the theoretical and methodological difficulties that each team met building social indicators for the Rural Adaptability to Climate Extremes (RACE) Index. Recently we collaborated on a series of presentations at the World Symposium on Climate Change Adaption (WSCCA-2015), 2-4 September 2015, Manchester, United Kingdom. One of these presentations by Drs. Amber Flether and Paula Musseta was judged one of the three best presentations of the entire conference.

The capacity of the Colombians to link the different areas of knowledge, both natural and social, is evident in the book *No sé qué vamos a hacer con estos climas! Vulnerabilidad y adaptación a las variaciones climáticas extremas en la cuenca de la quebrada Los Cuervos, afluente del río Chinchiná.* Colombian and Chilean colleagues collaborated to apply crop models to assess climate change impacts on both countries. Lucia Ocampo from Colombia, was trained in Chile on the use of the SIMPROC model to map climate change impacts on coffee production. Mauricio Jonnathan Burbano also received this training and then did a Master degree at the University of Chile. From the experience of constructing the RACE Index, Paula Mussetta and Julia Barrientos of Argentina, along with Sandra Turbay, Erika Acevedo and Olga Ocampo from Colombia, wrote a paper on the limitations of social and quantitative indicators to account for processes of social vulnerability. The paper was submitted to the journal Empiria and was accepted with modifications.

The Brazilian (Marina Hirota, Nathan Debortoli) and Argentinean (Leandro Cara) researchers has been working collaboratively to compute the exposure indicators for RACE index within the Araranguá and Mendoza river basins.

Collaborative work among Chilean (Fernando Santibáñez, Paula Santibáñez, Carolina Caroca) and Canadian team members (Elaine Wheaton) on the application of crop modelling techniques developed tools to evaluate climate change impacts on agricultural productivity over extensive geographical territories. This lead to a scientific contribution ("Modelling productivity of cultivated species under different climate change scenarios in the Americas") to be presented at the The International Society for Ecological Modelling Global Conference 2016 (USA).

At the University of Caldas (Colombia), collaboration has been anabled with the design and implementation by 2016 of the Interactive Platform for Management Support and Management Territorial contexts Reconfiguration on Climate Change (PLAM). This platform will house research products of the Colombian team, aimed at contributing to support local communities and governments located in the Chinchiná River basin.

Another case of VACEA researchers working across geo-political boundaries is the exchange of students from South American to Canada. IN 2015, five students from Chile spent two months at the Univesity of Regina. Previously, three students from Colombia spent five to six months at the U of R, taking advantage of the Emerging Leaders the Americas Program.

Section F: Other

8. Looking forward, please briefly outline active or planned activities involving team members or partner organizations that build on the results of your work.

ARGENTINA

As the result of the bonds established from the VACEA project, team members will be part of a Territorial Observatory developed by INTA. In addition, the team started a collaboration with members of the Research Institute for Family Farming of INTA, an organization that works directly

with rural technicians. As for academics, some team members, along with colleagues from the Chilean team and Canada have submitted a new research proposal.

CHILE

The Chilean team was requested by the Pacific Alliance (Mexico, Colombia, Peru and Chile) to train persons from these countries in applying the VACEA methodology to assess climate change impacts on ecosystems. A training workshop will be held in Santiago in June 2016. Each country will send 2 to 4 participants. Afterward these people will work on preparing a diagnosis of climate change threats on the Pacific coast of America. This will include concrete commitments of the four countries to support and launch a Common Ecosystem Protection Strategy.

The Ministry of the Agriculture required the Chilean VACEA team to prepare an application of the VACEA system to map climate change scenarios, to apply this methodology to the whole Chilean territory and to prepare a Bioclimatic Atlas and Climate Change. This information will be adopted for designing the adaptation strategy of the agricultural sector. The Ministry of the Agriculture assigned funds (230,000 dollars for this action).

The National Commission on Science and Technology (Chile) assigned funds (205,000 dollars) to the VACEA team to apply the VACEA methodology to assess climatic risks derived from climate extreme events frequency. This action will lead to an extensive application of the VACEA methodology to the Chilean territory in order to map climatic threats to shape climate change adaptation strategies in the context of the National Climate Change Adaptation Strategy.

BRAZIL

The Brazilian team will exchange knowledge, methodologies and even research partnerships with other South American countries, while seeking adaptation synergies and discovering barriers within the south-American realm. Although the case studies encompass dissident local realities, physical features and climates, institutional failures in farming activities such as corruption, lack of effective governance policies, and mismanagement of the environment resources are a common practice in these developing countries. Such common characteristics found in one another may help to develop think tank solutions in a larger scale. Together with Canada, the Brazilian team expects to create links to further promote research partnerships that include the design of integrative inter-boundaries methodologies and macro analysis of indicators related to climate change vulnerability and adaptation, and if feasible the interchange of researchers within these two countries.

CANADA

Changes in governing political parties in Alberta and Ottawa should create new opportunities for the scientific support of climate change policy. The Canadian VACEA team is in a good position to inform these new climate change policy initiatives.

COLOMBIA

The team at the University of Caldas is currently collaborating with the design of the Departmental Development Plan of Caldas, within the context of VACEA´s interests and objectives, in particular in the construction of water resources planning and management in the Chinchiná River Basin. This work is being carried out along with other trans-disciplinary research teams from Colombia, aimed at a comparative study of diverse types of river basins in Colombia.

Annex 1: List of Current Team Members

Name (Last, first)	Name of Organization (for universities please include the department)	Role (e.g. Principal investigator, co-applicant, partner organization representative)	Country	Joined (mm/yyyy)	Departed (mm/yyyy)
Santibanez, Fernando	Centro de Agricultura y Medio Ambiente, Unversidad de Chile	Principal investigator	Chile	03/2011	
Sauchyn, David	PARC, University of Regina	Principal investigator	Canada	03/2011	
Montana, Elma	Universidad Nacional de Cuyo	Co-applicant	Argentina	03/2011	05/2014
Musetta, Paula	Instituto de Ciencias Humanas, Sociales y Ambientales INCIHUSA – CCT CONICET	Co-applicant	Argentina	05/2014	
Villalba, Ricardo	Consejo Nacional de Investigaciones Científicas y Técnicas	Co-applicant	Argentina	03/2011	
Cavagnaro, Juan	Universidad Nacional de Cuyo	Co-applicant	Argentina	03/2011	
Da Silva, Daniel	Universidade Federal de Santa Catarina	Co-applicant	Brazil	03/2011	12/2013
Muza, Michel	Instituto Federal de Santa Catarina	Co-applicant	Brazil	03/2011	
Debortoli, Nathan	Universidade Federal de Santa Catarina	Co-applicant	Brazil	01/2015	
Hirota, Marina	Universidade Federal de Santa Catarina	Co-applicant	Brazil	12/2014	

Poveda, German	Engineering, Universidad Nacional de Colombia	Co-applicant	Colombia	03/2011	
Turbay, Sandra	Universidad de Antioquia	Co-applicant	Colombia	03/2011	
Velez Upegui, Jorge Julian	Engineering, Universidad Nacional de Colombia	Co-applicant	Colombia	03/2011	
Nates-Cruz, Béatriz	Universidad de Caldas	Co-applicant	Colombia	03/2011	
Salas, Sonia	Psychology, Universidad de La Serena	Co-applicant	Chile	03/2011	
Diaz, Harry	Sociology, University of Regina	Co-applicant	Canada	03/2011	
Hurlbert, Margot	Sociology, University of Regina	Co-applicant	Canada	03/2011	
Marchildon, Gregory	Public Policy, University of Regina	Co-applicant	Canada	03/2011	
Piwowar, Joseph	Geography, University of Regina	Co-applicant	Canada	03/2011	
McMartin, Dena	Engineering, University of Regina	Co-applicant	Canada	03/2011	
Kulshreshtha, Suren	Agriculture, University of Saskatchewan	Co-applicant	Canada	03/2011	
Wheaton, Elaine	Geography, University of Saskatchewan	Co-applicant	Canada	03/2011	
Bonsal, Barrie	Geography, University of Saskatchewan	Collaborator	Canada	03/2011	
Kienzle, Stefan	Geography, University of Lethbridge	Co-applicant	Canada	03/2011	
Corkal, Darrel		Partner organization representative	Canada	03/2011	
Paula Santibañez	University of Chile	Co-applicant	Chile	03/2011	
Carolina Caroca	University of Chile	Co-applicant	Chile	03/2011	
Paulina Gonzalez	University of Chile	Collaborator	Chile	03/2011	

Felipe Huiza	University of Chile	Collaborator	Chile	03/2011	

3. Annex 2: Main Research Components/Projects				
Project title	**Project Lead(s), Affiliation**	**Location of research (if geographically located)**	**Specific project-level research objectives** Please include references here to research outputs listed in Annex 3	**Status (start/ finish, mm/yy)**
1. Climate change scenarios creation	Carolina Caroca and Paula Santibañez (AGRIMED) Ricardo Villalba (CONICET) German Poveda (UNC)	Large scale, from Canada to Magelan zone Argentinean Andes Colombian Andes	To create a high resolution climatic database (10x10 Km) including temperature, precipitation, solar radiation, air humidity and evapotranspiration + 15 bioclimatic indices) Climatic trends in the upper Andean slopes.	A database that includes primary climatic variables in all study areas, with a 1x1 km resolution. These data are also available for the whole continent at 10 x 10 km spatial resolution. (05/14-3/15)
2. Modelling Agricultural Vulnerability	Greg Marchildon Amber Fletcher Paula Santibáñez Fernando Santibañez (AGRIMED) Paula Mussetta (CONICET) Sandra Turbay (University of Antioquia) Michel Muza (Brazil)	All pilot areas from Canada, Chile, Argentina, Colombia and Brazil	To elaborate an integration model, on the basis of socioeconomic and biophysical variables to assess vulnerability of agricultural and social system facing climate change.	The RACE integrated index of vulnerability was developed. This Index includes biophysical and socioeconomic variables. The RACE index started to be applied in all pilot areas in order to test it. (09/14- 09/15)
3. Modelling risk and exposure	Viviana Tudela (AGRIMED)	Agricultural systems between latitudes -30 and	Develop mathematical algorithms to evaluate	A mathematical model for calculating frequency of

	Bruno Cavagnaro (University Cuyo)	-40 (Chile), pilot areas of Brazil, Colombia and Argentina.	impact of climate extremes, on crop productivity	extreme temperatures and rainfall events was developed, calibrated and applied in the Chilean pilot area. Each country compiled the information to calculate frequency and variability of extreme events. (04/14-03/15)
4. Crop modelling	Fernando Santibañez Paula Santibañez (AGRIMED) Elaine Wheaton (U of Saskatchewan)	Chile-Colombia Argentina,Brazil and Canada Impact assessment covering the complete America's territory	To improve and to calibrate the SIMPROC model in order to have an effective tool to quantify the impacts of climate change on agricultural suitability in different areas of the continent. The model was applied to map climate change impacts over the whole continent. It is being distributed among partners in order to prepare detailed case studies in each pilot area.	The SIMPROC model was tested in the pilot area of the five countries. Simulations for several crops were run: soybean, maize, oat, bean, tomato, potato, rice and wheat. A database that includes potential productivity, sowing date, water requirements, and others variables is available for the whole Chilean territory, with 1x1km spatial resolution. For the rest of the continent it is available at 10 x 10 Km resolution. (09/11 – 05/14)
5. Climatic trends and variability.	Ricardo Villalba Mariano Masiokas (CONICET) German Poveda (UNC)	Chile-Colombia Argentina y Brasil	To establish changes in frequency and intensity of climate extremes in different time horizons in pilot areas of each country	On the basis of long term climatic series, the main trends were established. Several secular trends were established: temperature, precipitation, number of frost, aridity and rain indices. The most part of time

	Viviana Tudela (AGRIMED)			series had more than 100 years of data. A paper on climate trends is being prepared. (06/14-03/15)
6. Synoptic circulation associated with extremes hydro-climatic events	Barrie Bonsal, (Environment Canada, US)	Oldman and Swift Current Watersheds (Canada)	Identify and quantify synoptic circulation features associated with historical and projected future extreme hydro-climatic events including droughts and excessive moisture.	Drought index database created. (01/13-05/14)
7. Scenarios of climate variability and extremes	David Sauchyn (UR) Elaine Wheaton (US) Barrie Bonsal (US)	Oldman and Swift Current Watersheds (Canada)	Derive from climate models scenarios of shifts in climate variability and extremes	A set of RCMs evaluated for their capacity to simulate the climate of western Canada (01/13-03/15)
8. Climatic trends and variability	Elaine Wheaton (US) Barrie Bonsal (US) Stefan Kienzle (UL) Dave Sauchyn (UR)	Oldman and Swift Current Watersheds (Canada)	To establish changes in frequency and intensity of climate extremes in different time horizons	Large amount of instrumental and proxy data complied and analyzed; reports produced for the study areas (09/11-12/14)
9. Community Vulnerability Assessment	Polo Diaz and Margot Hurlbert (Canada), Elma Montana and Paula Musseta (Argentina), Sandra Turbay (Colombia), Sonia Salas (Chile)	Chile, Canada, Colombia, Argentina	Advance our understanding of the past, current and future vulnerabilities of rural agricultural and indigenous populations to climate hazards and related stressors	I all the assessments were completed and reports have been prepared or they are in progress
10. Assessment of Governance and Best Practices	Polo Diaz and Margot Hurlbert (Canada), Elma Montana and Paula Musseta (Argentina), Sandra Turbay (Colombia), Sonia Salas (Chile)	Oldman and Swift Current Watersheds (Canada)	Evaluate and communicate adaptive management practices and governance policies that improve adaptive capacity and reduce climate-related risk	I all the assessments were completed and reports have been prepared or they are in progress
11. Vulnerability of Integrated Crop-Livestock farms	Suren Kulshreshtha (US)	Oldman and Swift Current Watersheds (Canada)	To assess the likely economic impact and the viability of mix crop-beef	Assembling database of relevant socio-economic and environmental data.

			farm to future climate scenarios.	(01/13-12/14) Developed an interegrated crop yield, livetock operations, and economic model for a mixed farm setting in Pincher Creek and Swift Current sites.
12. Modeling Impacts of Climate Change on Ecosystems and Water Resources	Stefan Kienzle (UL) Joseph Piwowar (UR)	Oldman and Swift Current Watersheds (Canada)	Model the response of ecosystems and hydrologic systems to climate change and variability	A large amount of GIS data has been compiled. Models have been calibrated and validated (09/11-05/14)
13. Vulnerabilty of natural ecosystems and living resources.	Fernando Santibañez (AGRIMED) Carolina Caroca Paulina Gonzalez	Chile (national territory) The whole Americas territory	To extend the concept of vulnerability to natural ecosystems in order to identify risk hotspots of biodiversity conservation	An analytic methodology for evaluating the possible ecosystem bioclimatic stress due to climate change was developed. This model was applied to evaluate the 127 main ecosystems (17 biomes) composing the Natural Heritage of Chile. During 2014 this methodology was applied to the whole American continent, result are under analysis and organized to write a paper. (05/14-03/15)
14. Climate change education cycle	Carolina Caroca , Fernando Santibáñez and Paula Santibáñez (AGRIMED) + two specialists on instructional design + Teachers of Huneus school from La Pintana, Santiago	Created by the Chilean team but available for all countries (Spanish language)	To create an educational tool to be operated on an Internet platform addressed to schools and general public	A set of 10 multimedia modules was created, covering the main aspects of the VACEA project; also every module is accompanied with "learning roads" helping teachers to plan learning activities in the classrooms. The first educational experiences were made in a school which

				collaborated with our VACEA team. This Educational Resources are available in an educative website. This step is completed (05/13-05/14)
15. Methodological Manual for Vulnerability and Impact Evaluation of Climate Change	Fernando Santibáñez Paula Santibáñez Carolina Caroca and Paulina González (AGRIMED)	Chilean team in collaboration with all other groups providing methodological approaches.		Second version of methodological manual includes assessing impact of climate change on biodiversity conservation. This manual will be published at the end of the project for public use. The draft is under revision and will be ready during the first semester 2015. (05/12-05/15)
16. Set of Maps for America	Paula Santibáñez and Carolina Caroca (AGRIMED, UCH)	Chilean team but available for all countries	To establish the main impacts of climate change and the hotspots of impact.	Set of maps including: Primary climatic Variables, Secondary bioclimatic indices, Crop Productivity, crop seasonality, water consumption. It is available for the whole continent (10 x 10 Km). Result are being analysed to prepare a publication during 2015. (01/14- 3/15)
17. Portfolio of Climate Change Adaptation actions and strategies	Fernando Santibañez Paula Santibáñez Carolina Caroca and Viviana Tudela (AGRIMED, UCH) Michel Muza (UFSC)	Chile	To select a set of actions and strategies to face climate change as an adaptation strategy valid for the Chilean reality.	Portfolio of adaptation initiatives, including actions and strategies to neutralize the increasing climatic risks (this portfolio was delivered to the Ministry of Agriculture in Chile). Activity completed

				(01/13- 3/15)
18. Simproc Model VACEA Version	Fernando Santibañez Paula Santibañez (AGRIMED, UCH) Elaine Wheaton (University of Saskatchewan)	Chilean team in collaboration with Canadian team. Working group is open to other members available to calibrate the model in their pilot areas. Applications in Colombian and Chile case study.	To develop a SIMPROC version that can be used by several users of VACEA project (user friendly design)	We have developed a version of SIMPROC model, user friendly, which has low computer requirements. This software will be distributed among those partners who are interested. (01/13- 3/15)
19. Adaptive qualitative integrated scenarios	Elma Montaña – Paula Mussetta	Initially developed in Mendoza, ARG and then proposed for the 5 countries	Future vulnerability assesment and viability analysis of adaptive practices (for rural actors and institutions), The tool explores the impact that -some critical variables potentially operable- could have on adaptation processes toward a sustainability that include.	Portfolio of institutional adaptations. Systematization of these adaptations according to their area of concern. Building profiles based on attributes and producers already known variables affecting vulnerability. Development of qualitative adaptations and description of the impacts for each group. Assessment of impacts on user profiles 12/2013 – 12/2014
20. Vulnerability Nodes Assessment	Paula Mussetta Julia Barrientos Margot Hurlbert	Initially developed in Mendoza, ARG and then proposed for the 5 countries	The project aims to contribute to a qualitative / narrative assessment or the most critical aspects of the vulnerability of rural communities and future challenges of adaptation. The main input for the preparation of this exercise	Reflexive reading of findings from the analysis of qualitative interviews in dialogue with the results of other working groups searching critical nodes. selection of critical nodes that contain the different analysis dimensions (climate, water, social, political and economic).

			are farmers and institutional referents interviews.	Each node should allows a transversal analysis of the problem. Depth analysis of each critical node, describing present vulnerabilities and future recommendations. 09/1015 – 06-2016
21. Methodology manual for the community and governance vulnerability assessments	Polo Diaz and Margot Hurlbert, with the collaboration of Elma Montana and Sandra Turbay		to establish a common methodology for all the research activities in Theme 1. The manual was discussed and approved in the VACEA Annual Meeting in Manizales Colombia.	March 2011 – December 2011.
22. Facilitating Knowledge Mobilization at the Science/Policy Interface Workshop	Margot Hurlbert	Annual Meeting of the VACEA project, Alberta, 2012	to identify the main issues of the science/policy interface; to discuss experiences in relation to the science/policy interface; and to define an agenda for the science/policy interface in the VACEA project. SSHRC supported the implementation of the workshop with a small grant.	March 2012 – December 2012.
23. Process of Governance in reducing vulnerability to extreme weather events of the rural population of the Chinchiná.	Luisa Fernanda Giraldo Zuluaga Beatriz Nates-Cruz (UCALDAS)	Colombia. Chinchiná River Basin, municipalities and Villamaría Manizales.	Deepening aspects of governance and its impact on reducing vulnerability to extreme weather events.	Project completion. (03 / 13-03 / 15)

Annex 3: Research Output Bibliography

Indicate the number of items per category (3.1 to 3.11) and list research outputs below.

Research Outputs	***Number***
3.1 Journal Articles (published/accepted)	*22*
3.2 Journal Articles (submitted)	*16*
3.3 Conference Papers	*37*
3.4 Presentation (non-academic)	*9*
3.5 Book Chapters	*12*
3.6 Books	*5*
3.7 Theses	*2*
3.8 Databases (GIS, and other information systems)	*4*
3.9 Websites, social media (Facebook, Twitter), multimedia (YouTube, others)	*13*
3.10 Media coverage. Articles in local or international media	*11*
3.11 Other	*8*

Research Output Bibliography

Include only those publications that you consider a research result of the project (or identifies IRIACC as the funding source).

*Citation: author(s), date, title, publisher /weblink if available)

3.1 Journal Articles (published/accepted)

1. Alvar J. F. Santibañez y P. Perry 2015 Climate Change in Chile: Farmer´s perceptions and meteorological data. Climate Policy (accepted)
2. Cara, L.; Masiokas, M.H.; Viale, M.; Villalba, R. (in press). Análisis de la cobertura nival de la cuenca superior del río Mendoza a partir de imágenes MODIS. Revista Meteorológica.
3. Cara, L.; Masiokas, M.H.; Viale, M.; Villalba, R. (in press). Snow cover assessment of the upper Río mendoza basin using MODIS satellite images (in Spanish). Meteorológica.
4. Deis, L.; de Rosas, M.I; Malovini, E.; Cavagnaro, M.; Cavagnaro, J.B. (2015) Impacto del Cambio Climático en Mendoza. Variación climática en los últimos 50 años. Mirada desde la fisiología de la vid. Revista de la FCA. Nº47, (1). http://revista.fca.uncu.edu.ar/index.php?searchword=deis&ordering=&searchphrase=all&Itemid=26&option=com_search
5. Hurlbert M. y P. Mussetta Creating Resilient Water Governance for Irrigated Producers in Mendoza, Argentina Environmental Science and Policy 58(2016) 83–94
6. Hurlbert, M, Gupta, J. 2015. "The Split ladder of Participation: A diagnostic, strategic, and evaluation tool to assess when participation is necessary" Environmental Science and Policy. 50, pp. 100-113. (Case studies in Canada, Chile and Argentina)
7. Hurlbert, M., Gupta, J. 2016. "Adaptive Governance, Uncertainty, and Risk: Policy Framing and Responses to Climate Change, Drought, and Flood" Risk Analysis. 36(2), pp. 339-356. (Case studies in Canada, Chile and Argentina)
8. Hurlbert, M., Montana, E. 2015. "Dimensions of Adaptive Governance and Drought in Argentina and Canada" Journal of Sustainable Development. 8(1), pp. 120-137.
9. Hurlbert, M., Mussetta, P. (2016) "Creating resilient water governance for irrigated producers in Mendoza, Argentina." Environmental Science & Policy 58 83-94.
10. Marchildon, G, E. Wheaton, A. Fletcher, and J. Vanstone. 2016. Extreme drought and excessive moisture conditions in two Canadian watersheds: comparing the perception of farms and ranchers with the scientific record. Natural Hazards DOI 10.1007s11069-2190-7
11. Martín, F y R. Larsimont (2016) ¿Es posible una ecología cosmo-política? Notas para la desregionalización de las ecologías políticas. Revista POLIS Nº 45, Diciembre. Accepted.
12. Masiokas, M.H.; Christie, D.A.; Le Quesne, C.; Pitte, P.; Ruiz, L.; Villalba, R.; Luckman, B.H.; Berthier, E.; Nussbaumer, S.U.; González-Reyes, A.; McPhee, J.; Barcaza, G. (in press). Reconstructing glacier mass balances in the Central Andes of Chile and Argentina using local and regional hydro-climatic data. The Cryosphere.

13. Masiokas, M.H.; Christie, D.A.; Le Quesne, C.; Pitte, P.; Ruiz, L.; Villalba, R.; Luckman, B.H.; Berthier, E.; Nussbaumer, S.U.; González-Reyes, A.; McPhee, J.; Barcaza, G. 2015. Reconstructing glacier mass balances in the Central Andes of Chile and Argentina using local and regional hydro-climatic data. The Cryosphere Discussions, 9, 4949–4980.
14. Muñoz, Ariel A.; Alvaro González-Reyes, Antonio Lara, David Sauchyn, Duncan Christie, Ricardo Villalba, Isabella Aguilera-Betti, Rocío Urrutia, Ignacio Mundo, Paul Szejner, Carlos LeQuesne, Paulina Puchi, Jessica Vanstone and Daniel Stahle. In press. Streamflow variability in the Chilean Mediterranean-Temperate climate transition (35°S-42°S) during the last four hundred years inferred from tree-rings records. Climate Dynamics
15. Musseta P., Barrientos, M.J., Acevedo E., Turbay S., Ocampo O. (2016). Vulnerabilidad a eventos climáticos extremos: Dificultades en el uso de indicadores en dos cuencas de Colombia y Argentina. Sometido. Revista Empiria.
16. Mussetta P. y J. Barrientos. (2015) Adaptaciones de productores rurales de Mendoza ante el Cambio Global: clima, agua, economía y sociedad. Revista de la Facultad de Ciencias Agrarias. UNCuyo. Tomo 47 Núm. 2: pp. 145-170.
17. Ocampo O.L. (2016). Modelación hidrológica y agronómica de los efectos del cambio y la variabilidad climática en la producción cafetera de Caldas. Universidad Nacional de Colombia sede Manizales.
18. Pitte, P.; Berthier, E.; Masiokas, M.H.; Cabot, V.; Ruiz, L.; Ferri Hidalgo, L.; Gargantini, H.; Zalazar, L. 2016. Geometric evolution of the Horcones Inferior Glacier (Mount Aconcagua, Central Andes) during the 2002-2006 surge. Journal of Geophysical Research – Earth Surface. 121, 111–127, doi:10.1002/2015JF003522.
19. Santibáñez F, J Mendoza, C Muñoz,C Caroca, P Santibañez and L Prat 2015 Systems to establish bioclimatic analogies to predict the area of adaptability of plant species to new environments: The case of Moringa oleifera Lam. in Chile. Chilean Journal of Agr. Res. 75:4
20. Sauchyn, David J., Jeannine-Marie St-Jacques, Elaine Barrow, Michael W. Nemeth, Ryan J. MacDonald, A. Michael S. Sheer, and Daniel P. Sheer, 2016. Adaptive Water Resource Planning in the South Saskatchewan River Basin: Use of Scenarios of Hydroclimatic Variability and Extremes. Journal of the American Water Resources Association (JAWRA) 1-19. DOI: 10.1111/1752-1688.12378
21. Tudela V. y F. Santibañez, 2016, Modelling frost impact on fruit trees species. Agriculture and Forest Meteorology (accepted)
22. Turbay, Sandra, Margot Hurlbert, Erika Cristina Acevedo, Kelly Johanna López y Martha Elena Barco. “Governance and climate variability in Chinchiná River, Colombia”. Journal of Climate Change Strategies and Management.

3.2 Journal Articles (submitted)

1. Acevedo, E., Turbay, S. Hurlbert, M. Barco, M.H, López, K.. forthcoming “Governance and Climate Variability in Chinchina River, Colombia” International Journal of Climate Change Strategies and Management.
2. Barrow, EB and DJ Sauchyn. In review. An Analysis of the Performance of RCMs in Simulating Current Climate over Western Canada. International Journal of Climatology. Submitted 01 March 2016.
3. Bedoya, J.M., D. Sauchyn, G. Poveda and J.J. Vélez (2016b), Interannual modulations of regional and local mechanisms influencing climate in a tropical Andean basin, Journal of Hydrological Engineering, submitted.
4. Bedoya, J.M., G. Poveda, J.J. Vélez, and K. Trenberth (2106a), Interannual Hydro-Climatic Variability and the 2009-2011 Extreme ENSO Phases in Colombia - From Andean Glaciers to Caribbean Low-Lands, Journal of Hydrometeorology, submitted

5. Deis Leonor; de Rosas María Inés; Arancibia, Celeste; Martinez, Liliana Duran, Martína, Malovini Emiliano; Cavagnaro Juan Bruno. Bud burst plasticity of diverse Vitis vinifera cvs to climate change. Possible consequences in vineyards. (Mendoza, Argentina). Submitted to Journal of Berry Research.
6. Gonzalez-Reyes, A.; McPhee, J.; Le Quesne, C.; Christie, D.A.; Masiokas, M.H.; Villalba, R.; Szejner, P.; Muñoz, A.A.; Crespo, S. (submitted). Spatio-temporal variations in hydroclimate across the Mediterranean Andes (30º-37ºS) since the early 20th century. *Journal of Hydrometeorology*.
7. Lettelier, D. y C. Dalmasso "La interfaz ciencia- política en torno al cambio climático en la provincia de Mendoza, Argentina" Submitted to Revista Ambiente e Sociedade. Manuscript ID is ASOC-2015-0193. ISSN 1809-4422.
8. McMartin, D.W., A.J. Sammel, K. Arbuthnott. 2016. Community Education, Response and Empowerment Models for Extreme Water Events. Submitted to Mitigation and Adaptation Strategies for Global Change
9. Montana, E., Diaz, H., Hurlbert, M. forthcoming. "Development, local livelihoods and vulnerabilities to global environmental change in the dry Andes of South America" Regional Environmental Change.
10. Mussetta, P. , J. Barrientos, E. Acevedo, S. Turbay, O. Ocampo. Vulnerabilidad a eventos climáticos extremos: Dificultades en el uso de indicadores en dos cuencas de Colombia y Argentina. Submitted to Revista Empiria. España.
11. S. Poudel and S. Kulshreshtha. An Integrated Climate-Economic Model for the Canadian Prairie Mixed Farm. Submitted to Agricultural Systems Journal.
12. S. Poudel and S. Kulshreshtha. Choice of Beef Herd Adaptation Strategy in Dealing with Extreme Climate Events: A Case of the Canadian Prairie Mixed Farms. Submitted to Canadian Journal of Animal Science.
13. S. Poudel, S. Kulshreshtha and E. Wheaton. Economic Impacts of Climate Change and Extremes on the Canadian Prairie Mixed Farm. Submitted to Climate Change Impact and Responses Journal.
14. Santibañez Q.F y P. Santibañez 2015 "Simulation model to evaluate climate change impacts on agricultural productivity: The case of maize (Zea mays)". International Journal of Biometeorology. (submitted)
15. Sauchyn, David; Bedoya, Mauricio, González-Reyes, Álvaro; Muñoz, Ariel; Velez Upegui, Jorge Julian. In review. ENSO Signals and Impacts along a Semiarid to Humid Transect Across the Americas. Proceedings of the 9th Biennial Rosenberg International Forum on Water Policy, University of Southern California.
16. Turbay, Sandra, Margot Hurlbert, Erika Cristina Acevedo, Kelly Johana López, Martha Elena Barco. Governance and climate variability in Chinchiná River, Colombia. Journal of Climate Change Management (submitted)

3.3 Conference Papers

1. Acevedo Mejía Erika y Sandra Turbay. Vulnerabilidad y Adaptación ante eventos climáticos extremos en las Américas. Segundo Congreso Nacional de Ciencias Ambientales, Pereira, 21-23 de octubre de 2015.
2. Ander Egg, G.; Lettelier, D.; Nieto, A.; Bernabé, E. (2015) "La extensión y el desarrollo rural. Nuevos paradigmas de la extensión y crisis de los modelos tradicionales, en el marco de las transformaciones del espacio rural" En: IX Jornadas Interdisciplinarias de Estudios Agrarios y Agroindustriales Argentinos y Latinoamericanos. Organizado por la Facultad de Ciencias Económicas –Universidad de Buenos Aires. Buenos Aires, Argentina. 3-6/11/2015. ISSN 1853-6050.

3. Bonsal, B.R. and C. Cuell, An Assessment of Past and Projected Future Hydro-Climatic Extremes over Key Watersheds within Western Canada. Joint Assembly of the American and Canadian Geophysical Unions, May 3-7, 2015, Montreal, QC.
4. Cobos, David; Malovini, Emiliano; Fernandez Arias, Romina Belen; Cornejo, Romina Mariana; De Huin, Luis; Gutierrez, Emiliano; J. B. Cavagnaro. Equilibrio en vitis vinífera. Evaluación de tres propuestas de poda corta y de dos momentos de raleo, en seis variedades de vitis vinífera. Temporada 2014.. Brasil. 2015. Congreso. XV Congresso Latino-americano de Viticultura e Enologia e XIII Congresso Brasileiro de Viticultura e Enologia.
5. Deis, L; de Rosas, I; Malovini, E.; Cavagnaro, J. B. "Impacto del Cambio Climático en Mendoza. Variación climática en los últimos 50 años. Mirada desde la fisiología de la vid." XXIV Jornadas de Investigación y VI de Posgrado. 10 y 12 de noviembre 2015.
6. Deis, L. 2015. Academia de la vid y el vino. SEMINARIO "EL TERROIR Y SU EXPRESIÓN EN EL VINO" 27 de octubre de 2015- Auditorio OSDE – Belgrano 827- Ciudad de Mendoza. Tema de Exposición: Cambio climático y vitivinicultura. Respuestas fenológicas y fisiológicas.
7. Deis, Leonor. 2015. Seminario Universidad, Sociedad y Estado titulado "Desafíos de la democracia en Latinoamérica". 4 y 5 de noviembre de 2015. Universidad Nacional de Cuyo. Tema de Exposición: Cambio climático y vitivinicultura. Respuestas fenológicas y fisiológicas.
8. Ferrer. C; Julia Barrientos; Oscar Carballo; Paula Mussetta. (2015) Políticas públicas, desarrollo rural y cambio climático en la provincia de Mendoza, Argentina. IX Jornadas Interdisciplinarias de Estudios Agrarios y Agroindustriales Argentinos y Latinoamericanos. Buenos Aires. Argentina.
9. Harry Diaz, 2015, "A Conceptual Framework for Understanding Vulnerability to Extreme Climate Events", presented at the World Symposium on Climate Change Adaptation 2015, Manchester, September.
10. Harry Diaz, 2015, "Adaptation to Climate Change and Sustainability in Chile" presented at the Annual Colloquium of Chilean Researchers in Canada (REDICEC), Toronto, November.
11. Harry Diaz, 2015, "Vulnerability and Adaptation to Extreme Climate Events in the Americas", presented at the annual conference of the Canadian Association for Latin American and Caribbean Studies, Universidad de Costa Rica, Costa Rica, June
12. Henao, César (Agosto de 2015).Vulnerabilidad y adaptación de los sistemas de producción campesinos en escenarios de cambio climático en la Cuenca del Río Chinchiná. 1er Congreso Internacional de Estudios Rurales y 2da Cátedra de Estudios en Territorio, Conflicto y Cultura, Universidad del Tolima. Ibagué, Colombia.
13. Hurlbert, M. 2015. "A Comparative Analysis of Instruments for Responding to Drought" presented at the World Water Congress XV, International Water Resources Association (IWRA) Edinburgh, Scotland, May 26, 2015.
14. Hurlbert, M. 2015. "Integrative Local Watershed Governance in the Canadian Prairies: Responding to Climate Change" presented at the World Water Congress XV, International Water Resources Association (IWRA) Edinburgh, Scotland, May 26, 2015.
15. Hurlbert, M., Diaz, H., Montana, E., de Callejo, I., Salas, S., Lettelier, D. "Bringing Together Climate, Science and Policy: a study of the interface" " presented at the 2015 Canberra Conference on Earth System Governance: 'Democracy and Resilience in the Anthropocene', December 14, 2015.
16. Hurlbert, M., Gupta, J. "Uncertainty and Risk: Climate Policy Framing, Scientists, and Inclusive Development" presented at the 2015 Canberra Conference on Earth System Governance: 'Democracy and Resilience in the Anthropocene', December 14, 2015.

17. Hurlbert, M., Mussetta, P., Turbay, S. “Canadian, Argentinean, and Colombian Programs Building Resiliency to Extreme Events” presented at the World Symposium on Climate Change Adaptation, Manchester, UK, September 4, 2015.
18. Jaramillo, Juliana (Junio 2015).Aproximaciones etnográficas al turismo rural comunitario: espacios de construcción para la gobernanza y el desarrollo territorial. XV Congreso de Antropología en Colombia: Regiones "Posconflicto" y futuros posibles. Santa Marta, Colombia.
19. Kulshreshtha. S. Estimation of crop yields under future climate extremes. Presentation made at the Adaptation Canada 2016 Symposium, Ottawa, April 2016.
20. Lettelier, D.; Dalmasso, C.; Sepúlveda, L. (2015) “El análisis de la interfaz ciencia-política en la formulación de políticas públicas de desarrollo rural en la provincia de Mendoza” En: XII Congreso Nacional de Ciencia Política, organizado por la Universidad Nacional de Cuyo y la Sociedad Argentina de Análisis Político (SAAP). Mendoza, Argentina. 12-15/08/2015. ISBN 978-987-26929-4-0
21. Lettelier, D.; Dalmasso, C.; Sepúlveda, L. (2015) “La interfaz ciencia-política y su influencia en las políticas públicas orientadas a la agricultura familiar” En: IX Jornadas Interdisciplinarias de Estudios Agrarios y Agroindustriales Argentinos y Latinoamericanos. Organizado por la Facultad de Ciencias Económicas –Universidad de Buenos Aires. Buenos Aires, Argentina. 3-6/11/2015. ISSN 1853-6050.
22. Malovini, E; Sari, S; Cobos, D; Deis, L; de Rosas, I; Duran, M; Martinez, L; Cavagnaro, J.B. “Cambio Climático. Estudio a campo en tres ciclos consecutivos del efecto del aumento de temperatura y la restricción hídrica sobre la composición de vinos en vitis vinífera L cv Malbec.” XXIV Jornadas de Investigación y VI de Posgrado. 10 y 12 de noviembre 2015.
23. Martín, F. (2015) Seguridad hídrica y vulnerabilidad de pequeños agricultores en la Provincia de Mendoza, en Taller de Adaptación al Cambio Climático a escala de Cuenca. Experiencia Proyecto MAPA, Maipo, Chile. Organizado por la PUC y CEPAL
24. Masiokas, M.H., Le Quesne, C., Christie, D., Villalba, R., Luckman, B., Cara, L., Viale, M., Ruiz, L. Breve reseña de la gestión del agua en Mendoza (Argentina), y análisis de la sequía 2010-2015 en un contexto de largo plazo. Simposio y Capacitación Profesional - Hidrología Andina para el manejo de los recursos hídricos: conceptos y herramientas. UNESCO – IHP, 17 – 20 November 2015, Santiago, Chile
25. Masiokas, M.H.; Christie, D.A.; Le Quesne, C.; Pitte, P.; Ruiz, L.; Villalba, R.; Luckman, B.H.; Berthier, E.; Nussbaumer, S.U.; González-Reyes, A.; McPhee, J.; Barcaza, G. 2015. Reconstructing glacier mass balances in the Central Andes of Chile and Argentina using local and regional hydro-climatic data. *The Cryosphere Discussions*, 9, 4949–4980.
26. Masiokas, M.H.; Villalba, R.; Le Quesne, C.; Christie, D.; Luckman, B. Cara, L. Viale, M. Variaciones recientes de nieve y caudales en los Andes Centrales analizadas a partir de observaciones directas y sensores remotos. Taller - Variabilidad hidroclimática de los Andes semiáridos: mirada de largo plazo. Dirección Meteorológica de Chile, 28 October 2015.
27. Poudel S. and S. Kulshreshtha. Choice of Adaptation Strategies in Extreme Weather Events: A Case of Swift Current ad Pincher Creek farms. Presentation made at the 22nd Annual Conference “Farming for Profit”, Moose Jaw, June 2015.
28. Poudel S. and S. Kulshreshtha. Systems Analysis of Economic Impact of Climate change and Extremes: A Case of a Canadian Prairie Mixed Farm. Poster Presentation at the International Institute for Systems Analysis Conference “Systems Analysis 2015”. November 2015.
29. Poudel, S. Kulshreshtha and E. Wheaton. Economic Impacts of Climate Change and Extremes on Canadian Prairie Mixed Farm. Presentation made at the Climate Change: Impacts and Responses Conference, Hanoi, April 2016.

30. Poudel, S. Kulshreshtha and O. Modongo. Climate Change Impact on Canadian Prairie Agriculture: Implications for World Food Security: A Review. Poster Presentation at the Agricultural Biotechnology International Conference, Saskatoon, October 2014.
31. Poveda, G., Bedoya, J.M., Aristizábal, E., Carmona, A.: Mountain Tropical Rainfall: Evidence of Phase-Locking between the Diurnal, Annual and Interannual Cycles in the Andes of Colombia. 2015 American Geophysical Union Meeting, San Francisco, CA, USA; 12/2015
32. Santibáñez F. 2015 Los desafíos de los recursos hídricos en Chile. Conferencia dictada en ECLAC. 10 pp.
33. Santibáñez F. 2015. La profunda mirada de la ciencia. Revista Innova Agro. Ministerio de Agricultura (CHILE). Fundación para la Innovación Agraria. N°2: 38-43.
34. Sauchyn, D. Vélez, J.J., Masiokas, M., Ocampo, O.L, Cara L. y Villalba R. Exposure of Rural Communities to Climate Variability and Change: Case Studies from Argentina, Colombia and Canada. World Symposium on Climate Change Adaptation. (WSCCA 2015). Manchester, UK, 2-4 September, 2015. ORAL
35. Sauchyn, D.J. 2015. Availability of Agricultural Water in a Warming Climate, Canadian Climate Forum, 12-13 November 2015, Ottawa, ON. INVITED.
36. Sauchyn, David; Mauricio Bedoya, Álvaro González-Reyes, Ariel Muñoz, Jorge Julian Velez Upegui. 2016. El Niño Tele-Connections and Their Role in Drought, 9th Biennial Rosenberg International Forum on Water Policy, Panama City, 25-27 January, 2016. INVITED
37. Vélez, J.J., Ocampo O.L., Londoño, A. , Wahl, M., Giraldo, D.C., and E. Sánchez. 2015. Comparative analysis of environmental flows and ecological flows in the Chinchina river basin, Colombia. XVth World Water Congress. International Water Resources Association IWRA. Edimburgo, Escocia. Del 22 de mayo al 01 de junio de 2015. ORAL. Organizado por: Enviromental & Water Resources Congress-EWRI.

3.4 *Presentation (non-academic)*

1. Masiokas M.H. and team of the National Glacier Inventory. Participation in documentary about Argentinean glaciers. Canal Encuentro. March 2015. https://www.youtube.com/watch?v=q4nTbghYy4M
2. Masiokas, M.H. Dissemination article for kids in “Suplemento Infantil Tintero”, Diario Los Andes, Mendoza. ¿Por qué es importante la nieve en la Cordillera? 11 October 2015. http://imd.uncuyo.edu.ar/cuyun-en-el-tintero
3. Sauchyn, D.J. 2015. “Our Water Future: Climate Change and Surface Water Availability in the South Saskatchewan River Basin”, Lumsden Valley Community Association Public Meeting, 29 October 2015. Lumsden, SK
4. Sauchyn, D.J. 2015. “Climate Change Risks and Opportunities”, Lunch and Learn, TransCanada Corporation, May 28, 2015, Calgary, AB
5. Sauchyn, D.J. 2015. “Climate Oscillations and Teleconnections”, Instituto Geographie, Pontificia Universidad Católica de Valparaíso, 02 December 2015, Valparaíso, Chile,
6. Sauchyn, D.J. 2015. “Climate, trees and people: Collaborative Climate Change Research in the Americas”, Public Presentation, Pontificia Universidad Catolica de Valparaiso, 09 December 2015, Valparaiso, Chile
7. Sauchyn, D.J. 2015. “Vulnerability and Adaptation to Climate Extremes in the Americas (VACEA)”, Community Based Research Showcase, 06 November, 2015, Regina
8. Sauchyn, D.J. 2015. “When will we Notice Climate Change”, APEGS AGM, 01 May 2015, Regina, SK

9. Sauchyn, D.J. 2016. "Sustainable Agriculture as Adaptation to Climate Change", 14th Annual Bentley Lecture in Sustainable Agriculture, University of Alberta, 24 February, 2016

3.5 Book Chapters

1. Diaz, H. and M. Hurlbert, 2015, "Making Science Count: Climate change and the Science/Practice Interface", in W. Leal, ed., Climate Change in Latin America, Springer.
2. Hulbert, M. Paula Mussetta, Sandra turbay. 2015 Canadian, Argentinean and Colombian Programs Building Resilience to Extreme Events. Climate Change Adaptation, Resilience and Hazards. Editores: Walter Leal Filho; Haruna Musa; Gina Cavan; Paul O `Hare . Springer. 2015. In preparation.
3. Hurlbert, M. 2015. "Assessing the Capacity of Law to Facilitate Adaptation to Climate Change" (pp 707-723) in Leal Filho, W. (Ed.) Handbook of Climate Change Adaptation. Springer –Verlag, Berlin, Germany.
4. Leal, W., M. Hurlbert, and H. Diaz, (forthcoming), "The Role of Governance in Supporting Climate Change Adaptation Process", in J. Knieling, ed., Climate Adaptation Governance. Theory, Concepts and Praxis in Cities and Regions, John Wiley & Sons: N.Y.
5. Montana, E., H. Diaz, and M. Hurlbert, 2015 "Development, Local Livelihoods and Vulnerabilities to Climate Change in the Andes", Regional Environmental Change Journal, 15, 8, DOI 10.1007/s10113-015-0888-9
6. Mussetta, P. Sandra Turbay, Amber Fletcher 2015. Adaptive Strategies Building Resilience to Climate Variability in Argentina, Canada and Colombia. En: Climate Change Adaptation, Resilience and Hazards. Editores: Walter Leal Filho; Haruna Musa; Gina Cavan; Paul O `Hare Springer. 2015. In preparation.
7. Santibáñez F, P. Roa y P. Santibáñez. 2015. El Medio Físico. EN: La biodiversidad en Chile. Ministerio del Medio Ambiente, Chile
8. Santibáñez F. 2015. Los escenarios del clima en América Latina. EN: Los cambios climáticos en América del Sur y el Perú. Universidad del Señor de SIPAN, Chiclayo, Perú
9. Sauchyn, D. and Kerr, S. In press. Drought from a Paleoclimatic Perspective, Chapter 2 in: Harry Diaz, Margot Hurlbert, James Warren (Editors), Vulnerability and Adaptation to Drought: The Canadian Prairies And South America, University of Calgary Press.
10. Sauchyn, David; Jorge Julian Velez Upegui, Mariano Masiokas, Olga Ocampo, Leandro Cara, Ricardo Villalba. In Press. Exposure of Rural Communities to Climate Variability and Change: Case Studies from Argentina, Colombia and Canada, In : Walter Leal Filho, Kathryn Adamson, Rachel Dunk (editors), Implementing Climate Change Adaptation in Communities, Cities, Countries and via Outreach Programmes, Springer Science, Berlin.
11. Wheaton, E, D Sauchyn and B Bonsal. In press. Future Possible Droughts, Chapter 3 in: Harry Diaz, Margot Hurlbert, James Warren (Editors), Vulnerability and Adaptation to Drought: The Canadian Prairies And South America, University of Calgary Press.

3.6 Books

1. Diaz, H., co-ed., 2015, *Handbook Climate Change Adaptation: Policy and Climate Change*, Volume 2, Springer: Hamburg (with Dr. Walter Leal as editor-in-chief)

2. Diaz, H., M. Hurlbert, and J. Warren, editors, 2016, Vulnerability and Adaptation to Drought on the Canadian Prairies, University of Calgary Press: Calgary (with the collaboration of Sauchyn, Wheaton, Bonsal, Kulshreshtha, Fletcher, Knuttila, Marchildon, Corkal, Unvoas, Santibanez –Paula—Montana, and Boninsegna)
3. Ocampo O.L.; Velez J.J. (2015). El Clima en el Departamento de Caldas como Elemento de Planificación. En: Entendimiento de fenómenos ambientales mediante análisis de datos. National University of Colombia.
4. Santibáñez F, P. Santibáñez, C. Caroca, P. González, F. Huiza, 2015. La Evapotranspiración de referencia en Chile: base para el cálculo de los requerimientos de agua de la agricultura chilena. Ministerio de Agricultura (CHILE).
5. Santibañez QF, P Santibañez, C Caroca, P. Morales, P Gonzalez, P. Perry 2013. Atlas del Cambio Climático en las Zonas de Régimen Arido y Semiárido de Chile. Universidad de Chile, 136 pp.
6. Warren J., and H. Diaz, 2012, *Defying Palliser. Stories of Resilience from the Driest Region of the Canadian Prairies*, CPRC Press: Regina

3.7 Thesis

1. DEBORTOLI, N.S (2016). Adaptação e Vulnerabilidade do meio rural aos Eventos Meteorológicos Extremos nas Américas (VACEA): Estudo de caso da Bacia do Rio Araranguá no Sul Catarinense. Universidade Federal de Santa Catarina – UFSC - Curso de Pós-Graduação em Ecologia.
2. SUNG, C.L (2016). Construção social de prevenção e redução de desastres e proteção frente a eventos severos do clima com atores locais: uma experiência no município de Araranguá/SC. Universidade Federal de Santa Catarina – UFSC - Curso de Pós-Graduação em Geografia e Processos Educativos.

3.8 Databases (GIS, and other information systems)

1. Gridded SPEI dataset for western Canada
2. Dataset of validated climate time series in Chile
3. Dataset of climate data to evaluate water requirements of the Chilean agriculture
4. Climate dataset in grid format for the whole Americas

3.9 Websites, social media (Facebook, Twitter), multimedia (YouTube, others)

1. Twitter handle at @VACEA1
2. Facebook: http://www.facebook.com/permalink.php?story_fbid=206923246019292&id=352916791217
3. https://www.facebook.com/pages/Vulnerability-and-Adaptation-to-Climate-Extremes-in-the-Americas-VACEA/271211079611742?fref=ts https://www.facebook.com/pages/Vulnerability-and-Adaptation-to-Climate-Extremes-in-the-Americas-VACEA/271211079611742?fref=ts

4. Social Network in http://www.facebook.com/pages/Vaceabrasil/
5. Twitter: regular updates on project activities and findings are also shared over Twitter. To date, the VACEA Twitter account has shared 18 "tweets" (i.e., updates) and has 38 followers.
6. VACEA Canada facebook page: https://www.facebook.com/permalink.php?story_fbid=206923246019292&id=352916791217#!/pages/Vulnerability-and-Adaptation-to-Climate-Extremes-in-the-Americas-VACEA/271211079611742
7. VACEA Project web site: www.parc.ca/vacea
8. Web Site for Educational resources: http://agrimedudechile.wix.com/educlima
9. Web site in Latin America: http://agrimedudechile.wix.com/vacea
10. Web site Youtube:https://www.youtube.com/watch?feature=player_embedded&v=L9ZdiTx8iAE
11. Interactive platform VACEA. Product derived from the Research Project "Vulnerability and Adaptation to extreme climates in the Americas -V.A.C.E.A. Institute for Research in Social and Human Sciences, University of Caldas. (2016)
12. Dissemination of results on the blog research group Environment and Society: http://grupomasoudea.blogspot.com.co/p/vulnerabilidad-yadaptacion-eventos.html
    as well as in the web page of the VACEA project: http://www.parc.ca/vacea/assets/PDF/colombia.pdf
13. The National University of Colombia, Sede Manizales developed an application APP "Aliaterras" for cell phones under Android system. It is a a game for high school students and the main goal of the game is to restore the Chinchiná River Basin. It can be downloaded from: https://play.google.com/store/apps/details?id=com.none.pomca
    The app was developed with the technical support of the VACEA team from Manizales, and it was funded by the National University of Colombia, Sede Manizales.

3.10 Media coverage. Articles in local or international media

1. Afternoon Edition CBC Radio Regina (04 January 2016)
2. Araranguá Municipality Magazine: http://www.ararangua.sc.gov.br/noticias/index/ver/codMapaItem/5288/codNoticia/52822
3. BLOG do JAIRO: http://morrodosconventos-jairo.blogspot.com.br/2016_03_01_archive.html
4. Blue Sky CBC Radio Regina (23 September 2015)
5. DAE Magazine: http://revistadae.com.br/site/noticia/11695-Veja-possiveis-efeitos-das-mudancas-climaticas-no-Brasil
6. Global News Calgary (22 June 2015)
7. Global News, Lethbridge (Jan, 8, 2015) Global, News, Calgary (Jan14, 2016)
8. Maple Creek News (06 Oct 2015)
9. Radio Canada (16 November 2015)
10. The Western Producer 31 December 2015)
11. Top Crop Manager (19 October 2015)

3.11 Other

1. Lettelier, D.; Montaña, E.; Bertotto, C.; Gudiño, J., Mussetta, P.; Dalmasso, C.; Sepúlveda, L.; Del Barrio, L. (2016) “La interfaz ciencia – política en torno a las políticas publicas orientadas al desarrollo rural en Mendoza” En: XXIV Jornadas de Investigación y VI Jornadas de Posgrado de la UNCuyo. Mendoza, Argentina. 5-8/04/2016.
2. Marino, T; Lettelier, D.; Belmonte, A. (2015) “La evaluación en la provincia de Mendoza” En: Natalia Aquilino y Paula Amaya (compiladoras) Eva Arias (editora) Mapa diagnóstico de la evaluación en la Argentina. Red Argentina de Evaluación – EvaluAR. Pag. 38-45. http://www.politicaspublicas.uncu.edu.ar/upload/Diagnostico_Evaluacion_de_PP_en_Argentina.pdf
3. Sauchyn, D.J. 2015. The earth is round but is the climate warming? Farming for Tomorrow, Fall 2015, pages 16-18, 28.
4. Wittrock, V., E. Wheaton, and B.R. Bonsal. 2015. Groundwater Resources and Climate Connections: Examples from the Swift Current and Oldman River Watersheds, Saskatchewan Research Council Publication #13224-1E14, 23pp.
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