

**CRN3056 – Project: “Innovative Science and Influential Policy Dialogues  
for Water Security in the Arid Americas”**

**Cumulative Technical Report  
January 15<sup>th</sup>, 2019**

**1 Project Title, Project Number, Principal Investigator and contact details**

Title: Innovative Science and Influential Policy Dialogues for Water Security in the Arid Americas (*“Aguascapes”*)

Project Number: CRN3056

Principal Investigator: Christopher Scott  
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**2. Project Funding**

The *Aguascapes* project has completed its final year of IAI support (2012-14 with Francisco Meza as Lead PI at the Pontificia Universidad Católica de Chile and 2014-18 with Christopher Scott as Lead PI at the University of Arizona). This builds on the IAI-supported Opportunity Grant SGPCRA005, “Information Flows and Policy: Towards an Integrated Assessment of Water Security under Global Change in the Americas” (C.A. Scott and F.J. Meza, Joint Principal Investigators), which was closed in 2014.

The following complementary grants, awarded to team members, remain in implementation, demonstrating continuity of the AQUASEC network:

Chile

Digital agriculture network to strengthen agricultural resilience under climate change. Conicyt Programa Cooperación Internacional. REDES 180025 USD 25,000

Plataforma Agrícola Satelital para el seguimiento y determinación de los requerimientos hídricos de los principales cultivos agrícolas del país. FIA PYT2018-0033 USD 140,000  
Mapa dinámico a escala diaria de la Evapotranspiración de referencia (ET<sub>o</sub>) para determinar las necesidades de riego en Chile. FIA PYT2018-0189 USD 150,000

Fortalecimiento de la actividad multidisciplinaria a través de la implementación de una unidad de experimentación de impactos del cambio climático para la adaptación de agricultura y recursos hídricos. FONDEQUIP EQM170024, Chile, USD 315,000

Integrating crop simulation models, ground observations, and remote sensing data to improve the estimation of actual evapotranspiration. Fondecyt 1170429, Chile (Abr 2017-Mar 2021), USD 240,000

Aplicación de la metodología de actualización del balance hídrico nacional en las cuencas de las macrozonas norte y centro. Dirección General de Aguas, Chile (2016-2018), USD 250,000

Measuring evaporative water loss in arid environments using optical and microwave scintillimeters. Fondecyt 1170921, Chile, USD 270,000

Combination of weather information and remotely sensed data to analyze the variability of water footprint indicators at a basin scale (F. Meza, Fondecyt 1120713, \$250,000)

Crossing scales and disciplines understanding challenges for climate change adaptation and water resources management in Chile and California. (PUC Internal Grant. USD 15,000)

Optimising Resilience of Nexus Systems for a More Sustainable Future in South America” (Opti-Nex). CONICYT Newton RCUK-CONICYT Broadening Impact Call NEXUS Newton RCUK-CONICYT Broadening Impact Call NEXUS

Agricultura climáticamente inteligente: acciones para fomentar la adaptación al cambio climático en viñedos y huertos frutales de la región de O’Higgins. CONICYT Accion Regional

Optimización y validación de modelo de predicción de proxy de biomasa agrícola para Chile, del investigador postdoctoral Francisco Zambrano Bigarini.

## U.S.

Evaluation of the transboundary impact of wastewater infrastructure project in Ambos Nogales. Binational collaboration with El Colegio de la Frontera Norte Nogales funded by the North American Development Bank. Project from May 2018 to January 2019. Total amount is \$25,000.

Addressing environmental injustice around green infrastructure in Tucson, Arizona. Implementation project funded by the University of Arizona Green Fund. Project from July 2018 to June 2019. Total amount is \$25,025.

The Lloyd’s Register Foundation International Water Security Network – IWSN (R.G. Varady, PI, and C.A. Scott, Co-PI of £735,439 Univ. Arizona/ AQUASEC component of larger £2,538,205 award to C. Staddon, PI, University of West of England), 2013-19, Lloyd’s Register Foundation.

Coupled Networks in Urbanized Landscapes: Linking Ecosystem Services and Governance for Water Sustainability, T. Meixner, University of Arizona, PI. NSF CNH Program. Total amount for 5 years: \$1,797,799 (amount to AQUASEC associate A. Gerlak and one RA: \$149,984).

International Memorandum of Agreement, Departamento General de Irrigación (DGI), Mendoza, Argentina, invested est. \$5,000 in local accommodations, meals, and institutional support for numerous international participants in the Aguascapes project meetings and water governance workshop held in Mendoza in March 2019.

State of the Health of the Cienega Watershed. A. Zuniga-Teran, University of Arizona, PI. Total amount of \$21,000 from 2015 - ongoing. (Project: UA29244).

### Mexico

Sustentabilidad y resiliencia en las regiones áridas y semiáridas de la frontera México-Estados Unidos. Investigator Nicolás Pineda Pablos, with Margaret Wilder. Supported by Conacyt for the year 2018-2019, for a sabbatical year at the University of Arizona. Funds for stipend only.

Water Security and Adaptation Challenges in the Sonoran Desert Region. Investigators: Nicolás Pineda Pablos and Alejandro Salazar Adams. This project was funded by Lloyd's Register Foundation and was awarded a \$25,000 USD for the fiscal year 2017-2018.

Urban Water Security: A comparative study of cities in the arid Americas. By Rolando Díaz Caravantes.

Prevention of Natural Risks for Health of Vulnerable Populations in Northwest Mexico. 2014-2019. Awarded to Rolando Díaz and José Eduardo Calvario by CONACyT. Total amount is \$26,058 USD

### Argentina

Problemas ambientales y reconfiguraciones sociohistóricas. Conflictos, controversias y agendas sobre la "cuestión ambiental" en Mendoza (Facundo Martín y Paula Mussetta CoPIs). PICTO-Universidad Nacional de Cuyo. \$ 16,000. 2016-2019.

Assessing the Impacts of Climate Change on Ecosystem Services in South America (CCES-SA) to be submitted to Horizon 2020 call "Interrelations between climate change, biodiversity and ecosystems LC-CLA-06-2019: Climate change, biodiversity and ecosystems services: optimising mitigation and adaptation strategies".

Land, water, raw materials: Natural resource distribution and social inequalities from a transnational perspective. Initiative Global Issues – Integrating Different Perspectives on Social Inequality. Volkswagen Stiftung.

### Brazil

Adaptive Measures to Facing Climate and Hydrological Extreme Events in Pernambuco State. Alfredo Ribeiro Neto, PI, World Bank, 2018-2020, \$64,730.

Brazilian Research Network on Climate Change (joint coordination of the Water Resources component). Alfredo Ribeiro Neto, Ministry of Science and Technology. 2019.

Master Program in Water Resources Management and Regulation. Brazilian National Water Agency (ANA) and CAPES. 2016 - .

Doctoral Scholarship (M.R.F. Moura – USD 49,000 - currently active)

Professional Master Course in Management and Regulation of Water Resources supported by the Brazilian National Water Agency (ANA) and CAPES. 2016 - .

Brazilian National Institute for Science and Technology for Global Change: Vulnerability-Impact-Adaptation-Resilience for Sustainability (INCT MG-VIARs) – sub-component water security.

Universitas Consortium – Water Resources in Semiarid (The Pernambuco Research Foundation - FACEPE). The consortium integrates five universities of Pernambuco (UFRPE, UFPE, UPE, UNIVASF and UNICAP).

Use of Remote Sensing and Mathematical Modelling for Assessment and Monitoring of Droughts. Chamada Universal 2018 - Conselho Nacional de Desenvolvimento Científico e Tecnológico.

### 3. Research Activities and Findings

#### Summary of findings, lessons learned, and citations from IAI-supported research

##### *Task 1 - Undertake river-basin assessments by linking biophysical monitoring with social-institutional analyses of current conditions and projection/ modeling of future scenarios*

- Drought monitoring and intervention require the use of multivariate indices and basin specific definitions and characterizations to develop effective drought mitigation policies. The work of our team has been able to a) Propose a multivariate drought index for its assessment (**Oertel et al., In Press**), and characterize drought at basin levels, comparing the different situations that are present in the Arid Americas (**Oertel et al., 2018**).
- Seasonal dynamics, discrete events (e.g. fires, heavy precipitation), and human dynamics (particularly urbanization associated with population growth) potentially have impacts on vegetation cover in all the arid basins subject to these dynamics (**Bustos and Meza 2015**). This project has demonstrated the dynamics of vegetation cover in the Santa Cruz River (US-Mexico) (**Mendez Estrella et al 2016**).
- Mexico, Chile, and other countries in the arid Americas are defining new ways to understand and approach drought events to incorporate these into water planning and management (**Pineda Pablos and Salazar Adams 2016; Curl, Neri and Scott 2014**). But addressing more regionally located drought issues remains a challenge (**Oertel, Meza and Gironás 2015**).
- Rural communities in the Maipo basin deal with long/standing water scarcity that, although exacerbated by drought, cannot be explained by drought alone (Chile) (**Meza and Scott 2016; Meza et al 2014; Meza 2013a, b**). This was also observed in the San Miguel Watershed, within the Sonora River Basin (Mexico), where water scarcity is a product of mismatching institutions across local, regional, and federal levels, as well as

urban and rural areas (**Halper et al 2014; Prichard and Scott 2013**). New remote sensing methods are implemented to assess trends in agriculturally relevant indices (**Orellana, 2017**) and to evaluate droughts (**Zambrano et al., 2017**).

- The lack of surface water availability is fostering a shift from surface water dependence to groundwater dependence, which alters the types of stressors to which social groups are exposed (Mendoza and Tunayan basins in Argentina; Yaqui and Sonora basins in Mexico) (**de Chaisemartin et al 2016; Scott 2013; Scott 2014**).
- Water availability is a strong factor in the transitions in land use change in agriculture. A second important factor is the ever-increasing participation of local farmers in global commodity chains (Uco Valley in Argentina; San Miguel Watershed in Mexico) (**Lee, Herwehe and Scott 2015; Díaz Caravantes et al 2014**).
- Institutional factors (policies, legal frameworks, decision-making outcomes) not only regulate the relationships between social groups and watershed resources, they are also sources of further conflicts (Maipo in Chile; **Borgias 2016**), stressors to rural livelihoods and public health (San Miguel Watershed in Mexico) (**Díaz Caravantes, Duarte Tagles and Durazo Galvez 2016**), and energy-water planning in Brazil and other countries (**Pasqual et al 2016**).
- Information acquired by aerial survey was used to characterize water supply reservoirs in the Pajeú River Basin (Pernambuco State/Brazil). The survey was carried out with digital cameras of high spatial resolution and laser relief profiling (LiDAR technology). The storage in these reservoirs and maximum surface area were estimated using DTM and geoprocessing tools. From the total of 31 reservoirs evaluated, eight were completely empty at the time of the LiDAR data collection. The official registers reported 83.83 million m<sup>3</sup> for the storage capacity of these eight reservoirs, whereas our applications estimated the value at 70.23 million m<sup>3</sup>. This difference is explained by the loss of volume in the reservoirs due to the process of sediment transport. Accurate and up to date information on water availability are elements necessary for satisfactory management (Nascimento and Ribeiro Neto, 2017)
- Validation of soil moisture data from Soil Moisture Ocean Salinity (SMOS) using two in situ databases for Pernambuco State, located in Northeast Brazil. The validation process involved two approaches, pixel-station comparison and areal average, for three regions in Pernambuco with different climatic characteristics. After validation, the SMOS data were used for drought assessment by calculating soil moisture anomalies for the available period of data (Souza et al., 2018).
- Application of analysis methods of the temporal variability of precipitation and streamflow in Capibaribe River Basin (CRB), Pernambuco-Brazil, using Mann-Kendall and Pettit tests showed no trend change during the period of 1933 to 2009. On the other hand, according to the IPCC scenarios generated by the HadCM3 and Eta-CPTec models, it was possible to verify the existence of a change in both rainfall and streamflow in the XXI Century (Moura et al., 2017).
- The hydrological model MGB-IPH showed good performance for simulating river basins with semiarid climate (**Felix et al., 2017**). This model has as main characteristic the distribution simulation and take into account the land use and cover in its parameterization. This will be useful for simulation of climate change, land use and land cover change scenarios.
- Acquisition of a matrix of land use change in the zone located between El Molinito Dam and Abelardo L. Rodriguez Dam, years 1993, 2002 and 2011. The outcome of this activity is the quantification of land use change during that time frame. The main change was a drastic decline in agricultural use, from 8,818 hectares in 1993 to 2,983 hectares in 2011; this use was replaced mainly by mesquite, grassland and riparian

vegetation. The driver of this decrease is lack of water availability for irrigated agriculture. Evidence of this has been reported in Díaz-Caravantes, R. E., & Wilder, M. (2014). Water, Cities and Peri-urban Communities: Geographies of Power in the Context of Drought in Northwest Mexico. *Water Alternatives*, 7(3), 499–517. ISSN: 1965-0175. **(Díaz Caravantes)**.

- In addition, the paper “Analyzing the changes in land use and cover produced by an urban’s dam: the case of El Molinito in the Sonoran River Basin” is prepared for submission in *Applied Geography*. **(Díaz Caravantes)**
- Between October 2015 and January 2016, a team led by R. Díaz from El Colegio de Sonora conducted an analysis of health threats in the broader Sonora river basin due to water quality issues. The following is the abstract of the paper: On August 6th, 2014, the event labeled as the “worst environmental disaster of the mining industry in Mexico” occurred in the Sonora River, when Buenavista del Cobre mine spilled around 40,000 cubic meters of an acidic leachate. In order to expand our knowledge of the consequences of this event, the water-quality monitoring database was analyzed for groundwater from the Río Sonora trust fund webpage. Due to the health relevance of the spill, the reported data was compared to the established maximum allowance values of Mexican regulations. Furthermore, for an enhanced discussion, the case of arsenic was also analyzed, comparing the data with Mexican regulations as well as with the WHO guidelines for drinking water. This study identifies some spatiotemporal trends of some metals and physical-chemical parameters of surface and groundwater quality. In the case of groundwater, taken the guideline of the World Health Organization as a criterion for the permissible limit in the case of arsenic, the lower part of the basin of the Sonora River is where more times is observed to exceed the limit of 0.01 milligrams per liter. According to the WHO guidelines, the places with more frequency of values exceeding this limit were La Labor, San Rafael de Ures y El Molinito. Specific details of these analyses can be found in: Díaz Caravantes, R. E., Duarte Tagles, H., & Durazo Gálvez, F. M. (2016). Amenazas para la salud en el Río Sonora: análisis exploratorio de la calidad del agua reportada en la base de datos oficial de México. *Revista Salud UIS*, 48(1), 91–96. **(Díaz Caravantes)**.
- In addition, a team led by R. Díaz also conducted the study about “Analysis of criteria to protect aquatic life: The Sonora River after the 2014 mining spill”. It was submitted to *Aqua-Lac*, a journal of the Regional Office of Science for Latin America and the Caribbean of the United Nations Educational, Scientific and Cultural Organization. This is an abstract of the paper: When water systems become contaminated, water safety is seriously threatened. A recent case is the spill of 40,000 cubic meters of acid leachate discharged into the Sonora River, Mexico, on August 6, 2014. Unfortunately, studies about aquatic ecosystems after this event are scarce. This lack of research reveals the importance of analyzing cases of surface water quality samples that comply or not with the criteria for aquatic life protection according to the records of the monitoring database of the Fideicomiso Río Sonora **(Díaz Caravantes et al. 2018)**.
- To achieve this goal, we conducted a review of the literature on water quality in the Sonora River. The 2012 Mexican standard for ecological flows is not mandatory and it does not either provide a detailed guidance on the quality of water suitable for the protection of aquatic life. Since this guidance is included in the federal law: *Ley Federal de Derechos. Disposiciones Aplicables en Materia de Aguas Nacionales*, we use it to compare the data of surface water samples for the 38 sites observed during the period from August 2014 through September 2015. We created a database from information about monthly frequencies per sites for each of the study parameters. Finally, the

sampling sites were mapped using the frequency obtained during the period under study. As an underlying result, we found a two-letter symbol in the database without a specified meaning or implications of this category on the webpage of the Fideicomiso Río Sonora: NE (analysis not performed). In this work, we also remark that this federal law provides two sets of criteria: the guidelines, which are set to determine who can be exempted from payment of national water rights, and the maximum permissible limits, which indicate the values under which anyone would be exempted of paying fees and rights for wastewater discharges. The thresholds of the guidelines are more rigorous than the maximum permissible limits and, for this reason, there is a greater number of cases that exceed this former criterion as compared to the maximum permissible limits. In spite of the relevance that these findings may have for the protection of aquatic life, this academic exercise has its limitations, since the water quality criteria of this law is for tax collection purposes (**Díaz Caravantes et al. 2018**).

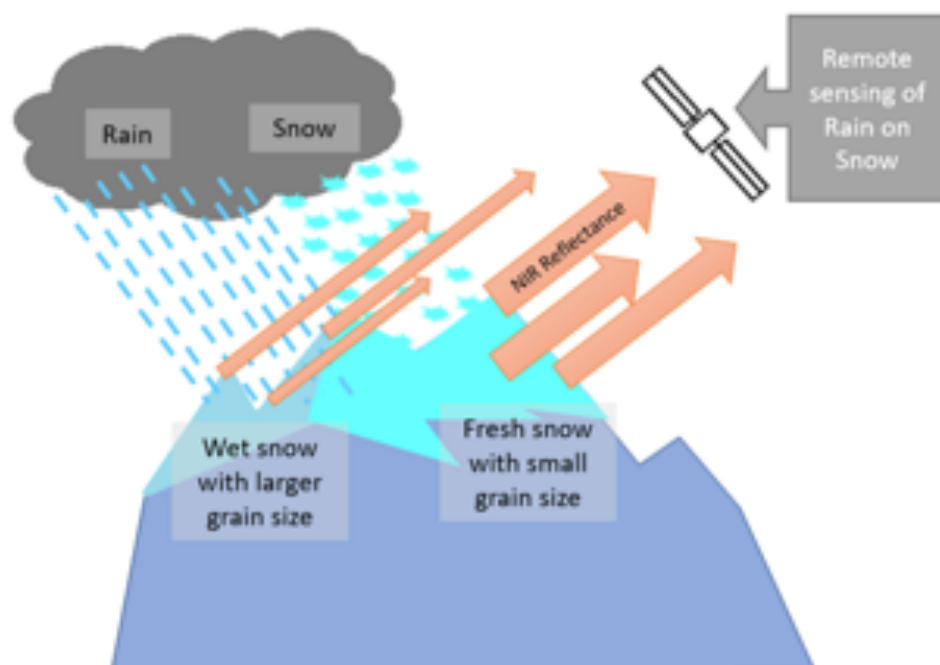
- In the Mendoza and Tunyan River Basins processes of agricultural expansion and retreat have provoked sensible changes in land uses and hidrological cycle. They have been no published studies on changes in land use and land cover (LU/LC) in these basins for irrigated lands that cover more than five years. Thus, we evaluate large-scale LU/LC changes over 32 years from 1986 to 2018 at eight-year increments. We present public data created with open-source tools for monitoring LU/LC in irrigated drylands. We provide the first quantifications of surface areas and fine-grained maps of long-term LU/LC changes. Results indicate marked cropland expansion in the upper Tunuyán River basin while in the lower Tunuyán River basin, small cultivated plots were abandoned. In the Mendoza River basin, there was significant urban expansion onto previously cultivated land but cropland did expand in some areas. We suggest three main drivers of LU/LC change: abandonment of vineyards and orchards in the lower Tunuyán River basin, agricultural expansion in the upper Tunuyán River basin, and peri-urbanization in the Mendoza River basin. This task fills a notable gap in the literature with abundant and consistent information using mainly open source tools (**Rojas, Rubio, Rizzo, Martín, Bernabeu, Akil, submitted to Applied Geography**).
- Additionally, in collaboration with the ARSC-UofA, the previous LU/LC analysis has been expanded using others open source R-code that run the CART classification which resulted in a refinement of results and higher standards for data quality (**van Leewen, Hartfield, Rojas, Rizzo & Rubio, in preparation**).
- Regarding specifically urbanization as one of the main drivers of land use change we investigated the production and transformation of peri-urban waterscapes in the Mendoza river basin. The analysis showed a deep change in water users and regulation at the same time that inequalities in water access has been maintained (**Bernabeu & Martín, submitted to Revista Quid16**).
- In Arizona, we employed participatory research methods to assess the state of the Cienega Watershed, located southeast of Tucson. This watershed includes five rare habitats including “cienegas” or marshlands, and contains on the last perennial streams in Southern Arizona. With emerging threats, stakeholders have undertaken an effort to evaluate the watershed’s health through a long-term monitoring process. We identified 20 indicators to monitor that were categorized into (1) climate, (2) water, (3) ecological, and (4) socio-cultural. Data from the indicators show that the stream is dewatering, groundwater levels are declining, there are more frequent and more devastating wildfires, and invasive species are proliferating. Data also shows climate change

evidence in terms of warming, declining winter rains, and extended drought. Monitored species show recovery after active management efforts, and recreational permits have increased which suggest this region is still a valued recreational destination. **(Zuniga-Teran et al. 2017).**

- We are conducting an assessment of the impacts of a binational wastewater treatment plant that is located in Rio Rico, Arizona along the Santa Cruz River. This plant treats water from Ambos Nogales. For this project, we are looking at physical factors that are linked to the functioning of the plant, as well as social perceptions.
- The U.S. team is also examining environmental justice issues around the spatial distribution of green infrastructure in Tucson. In this city, as many others in the world, low income communities are deprived of vegetation putting families that are already stressed at a higher vulnerability level against climate change impacts. For this project, we examine physical data (heat, tree canopy cover, flooding risk) as well as socioeconomic data. We aim to address these justice issues by engaging the community, city officials, and UA faculty.

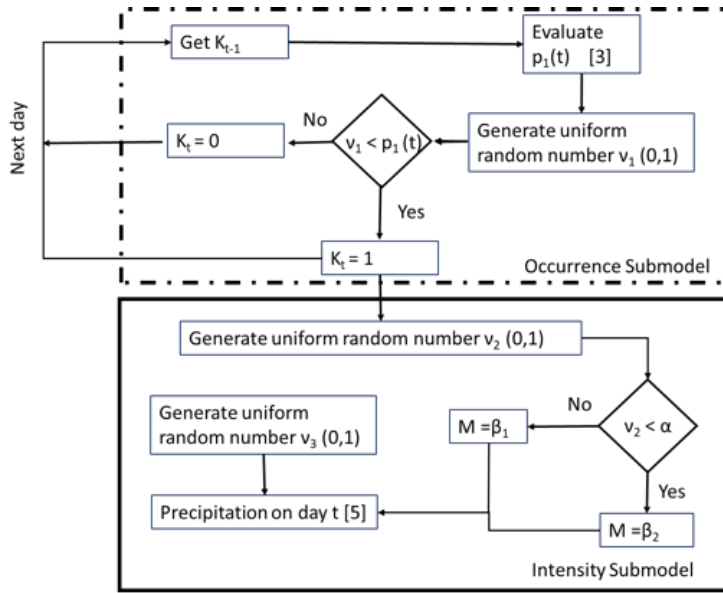
***Task 2 - Document human and ecosystem exposures to hydro-ecological and globalization processes thereby addressing specific risks and strengthening river-basin resilience***

- Surface water resources in Chile and Argentina are the key element of vulnerability under Climate Change. An innovative approach has been developed by members of the Chilean team to characterize snow as a transboundary resource and analyze the vulnerability of snow packs by looking at Rain on Snow events that can alter the specific properties of snow and explain changes in snowmelt dynamics. **(Ocampo and Meza, submitted).** The graphical summary of the M.Sc. thesis of Diego Ocampo is presented below.



*The team has also investigated on the effect of large scale climatic patterns (ENSO type) on rainfall occurrence and intensity to improve the capabilities of weather generator models to simulate rainfall for impact studies (Urdiales et al., 2018)*

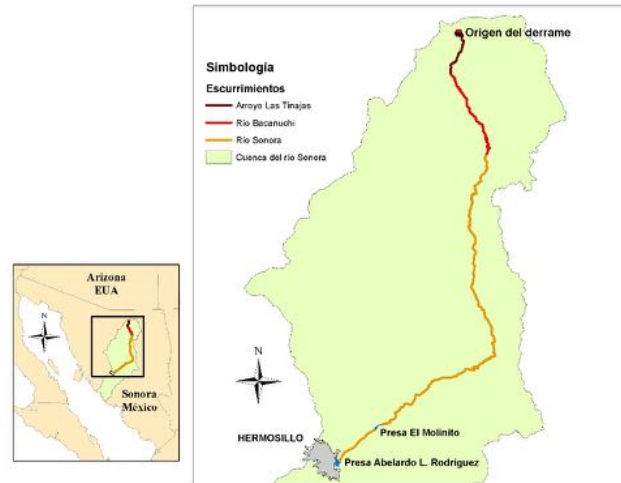




- The process of socio-economic integration of regions also modifies livelihood structures within traditional agriculture-oriented communities towards more diversified systems. Different socio-economic groups (of farmers in Argentina and Brazil and of rural households in Mexico) relate to different ways of perceive and adapt to climate events and broader global socio-environmental changes (**Herwehe and Scott 2017**).
- Determinants of vulnerability are closely related to a) fragmentation of the political-institutional framework (Argentina, SRB in Mexico, Maipo in Chile); b) production loss due to climate events (Argentina, YRB in Mexico); c) lack of profits from regional agriculture (Argentina); and d) hegemony of eco-technocratic views (Argentina, and Maipo in Chile). Other more punctual factors adding to vulnerability in the arid Americas are decreasing water quality (SRB in Mexico, and Pernambuco in Brazil), decreasing agricultural area due to water scarcity (SRB in Mexico, and Pernambuco in Brazil), and population growth increasing pressure on environmental sanitation services (all the basins) (**Mussetta et al. 2017**).
- In the majority of basins there is also a trend toward a widening gap between the most and least vulnerable farmers (or rural households) to global change (**Wilder et al 2016**). Another trend observed is a disconnection between economic and environmental performance in terms of water management (Brazil) (**Ribeiro Neto et al 2014**).
- Characterization of climate spatial variability and mechanisms used to deal with hazards in the Capibaribe River Basin – Brazil. A comparison with similar regions helps identifying the level of climate variability in the CRB, the solutions developed to deal with both shortage and excess of water, and the status of the study area in terms of vulnerability caused by this characteristic. The main strategies identified in the basin for dealing with both drought and flood events are the construction of reservoirs (**Batista et al., 2017**).
- The use of indicators of sustainability can be applied for water management as shown in **Dutra et al. (2017)** using information of Gross Domestic Product, water quality, agriculture expansion, demography dynamics and development index. The indicators were applied with information of 2010 and 2013 in order to estimate the improvement of the water sustainability in the Capibaribe River Basin (**Dutra et al. 2017**) and Pajeú River Basin (**Gonçalves et al., 2017**).

- Project: Analysis of criteria to protect aquatic life: The Sonora River after the 2014 mining spill. By Rolando Díaz. When water systems become contaminated, water safety is seriously threatened. A recent case is the spill of 40,000 cubic meters of acid leachate discharged into the Sonora River, Mexico, on August 6, 2014. Unfortunately, studies about aquatic ecosystems after this event are scarce.

#### Mine tailings spillage damage zones in the Sonora River



This lack of research reveals the importance of analyzing cases of surface water quality samples that comply or not with the criteria for aquatic life protection according to the records of the monitoring database of the Fideicomiso Río Sonora.

- In order to understand the interaction between the concepts of vulnerability and risk, R. Díaz wrote and submitted the following paper: “Vulnerability and risk to climate threats: an integrative approach” (Díaz Caravantes 2018).
- **Urban Water Security: A comparative study of cities in the arid Americas.** In this study, we compare three cities that share similar aridity and size conditions: Hermosillo, Mexico; Mendoza, Argentina; and Tucson, USA (Fig. 1). As of 2008, more than 50% of the world's population lived in cities and the proportion is expected to reach 69.6% by 2050 (United Nations, 2009, The Worldwatch Institute, 2007). This global trend is evident in Latin America, which has the highest proportion of urban inhabitants worldwide, with more than 72% of its population living in cities (Jiménez-Cisneros, 2015). Although there has been significant progress in potable water supply and sanitation services, urban residents in Latin America do not always receive good quality of drinking water. In addition, there are still serious problems associated with improved sanitation coverage in many cities (Galizia, 2015, p. The purpose of this study is to analyze water security in three cities in the arid Americas (Hermosillo, Mexico, Mendoza, Argentina, and Tucson, Arizona), and extract lessons that can be transferred to other cities facing similar challenges. The Urban Water Security framework includes five domains: Sociodemographic, Economic, Technological, Ecological, and Governance (SETEG) (Díaz Caravantes et al. Submitted to *Environment and Urbanization*).

*Next steps:*

- Finish the paper: “Urban Water Security: A comparative study of three cities of arid Americas” that includes the cases of Hermosillo, Tucson and Mendoza. In this paper we also study the vulnerability of traditional rural livelihoods. (**Davila Luna et al. 2018**).
- Write a paper about perception of vulnerability and water security in the Sonora river basin based on interviews conducted in rural communities. (**to be led by Díaz Caravantes**).
- Write the following paper: (In) water security in the Sonora River due to the spill of the Buena Vista del Cobre mine: analysis and reflections on the quality of water for human consumption reported in the official database of Mexico. (**Díaz Caravantes et al. 2017**).

### All basins

- In all the basins the effects of climate change combine with, and are heightened by, the impacts of globally driven changes in broader socio-environmental conditions associated to multiple dynamics: mining, commercial agriculture, further economic integration into global markets; specific dynamics are presented by **Bonelli et al (2014)** and **Scott et al (2014)**.
- The process of socio-economic integration of regions also modifies livelihood structures within traditional agriculture-oriented communities towards more diversified systems. Different socio-economic groups (of farmers in Argentina and Brazil and of rural households in Mexico) relate to different ways of perceive and adapt to climate events and broader global socio-environmental changes (**Herwehe and Scott 2017**).
- Vulnerability to global change is built on structural deficiencies related to poverty, resource access, institutional factors and market disadvantages, all of which are enhanced by the threat of climate change and water variability (Argentina, Chile, and Mexico) (**Mills Novoa et al 2016**).
- Determinants of vulnerability are closely related to a) fragmentation of the political-institutional framework (Argentina, SRB in Mexico, Maipo in Chile); b) production loss due to climate events (Argentina, YRB in Mexico); c) lack of profits from regional agriculture (Argentina); and d) hegemony of eco-technocratic views (Argentina, and Maipo in Chile). Other more punctual factors adding to vulnerability in the arid Americas are decreasing water quality (SRB in Mexico, and Pernambuco in Brazil), decreasing agricultural area due to water scarcity (SRB in Mexico, and Pernambuco in Brazil), and population growth increasing pressure on environmental sanitation services (all the basins) (**Mussetta et al. 2017**).
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- In order to understand the interaction between the concepts of vulnerability and risk, R. Diaz wrote and submitted the following paper: “Vulnerability and risk to climate threats: an integrative approach” (**Díaz Caravantes 2018**).

***Task 3 - Conduct policy dialogues to diagnose current adaptive capacity and promote the feasibility of future adaptation outcomes leading to enhanced water security***

Mexico

- Workshop on Urban Water Scenario Planning organized with Agua de Hermosillo. This workshop had the purpose to devise strategies for the institutional development and water security of the utility Agua de Hermosillo in the long range. The workshop consisted of 12 weekly three-hour sessions under the supervision of researchers of El Colegio de Sonora. The sessions were held from September to December, 2017. Later on, on April 25, 2018, the utility director and Nicolas Pineda presented the main results and future planning guidelines for the city mayor, state water management officers and municipal and utility officers and personnel. The new ideas about the future path for the utility were considered a breakthrough on the way to approach water planning in the city of Hermosillo and will likely keep producing results in the future.
- Paper presented by Nicolás Pineda Pablos, Stephen Mumme, Ricardo Figueroa Mimbela, Robert Varady, Margaret O. Wilder & Adriana Zuñiga. “The prospects of desalination for export in the Mexico-U.S. border region: A survey of Mexican opinion” in the international conference: Cutting - Edge Solutions to Wicked Water Problems. Tel Aviv, Israel. In this event, the paper presented the Mexican perspective on the project to build a water desalination plant to export water. September 11, 2017. See: <https://drive.google.com/open?id=1a3uN1v46SvPe2XbZiUHxCpfNKZHweRDG>
- Participation and paper presented on the *Foro para el Plan Hídrico del estado de Chihuahua* in the *International Conference on water quality, health, remediation and perspectives*. Titled: “*Gobernanza del agua y el marco institucional de los servicios de agua en México*” (Water Governance and the institutional framework of water services in Mexico). Chihuahua, Chihuahua, México. In this event, an analysis of the institutional framework of urban water agencies in Mexico was presented, as well as a series of rules and uses that do not contribute to have effective, self-sufficient and autonomous water utilities in Mexico. September 20, 2017. See: [https://drive.google.com/open?id=1SjB1hZoSeASYpVuD9CRUS5BAkH\\_A\\_TzG](https://drive.google.com/open?id=1SjB1hZoSeASYpVuD9CRUS5BAkH_A_TzG)
- Participation as a speaker in the thematic round table on Management tools to improve water management in the *Convención Anual de la Asociación Nacional de Empresas de Agua y Saneamiento (ANEAS)*, in Puebla, México. In this event, Nicolas Pineda presented the idea that the main tool is strategic planning, which includes jointly

defining and elaborating the mission, vision, objective, values, information system, management indicators, control panel, monitoring, feedback loops, and evaluation. Water services management must be oriented to the user / citizen / client and not to the personal objectives of the politicians in office. December 01, 2017.

See: <https://drive.google.com/open?id=1QP9QglT8Y2C81jQKNMdMRAq-kZCeQyWv>

- We received the visit of Dr. John Cameron (from the Erasmus University Rotterdam). He gave a seminar and a talk about sustainability and unsustainability. Economic evaluation in water projects in South Africa. February 27, 2018.  
See: [https://drive.google.com/open?id=11TjGqKYgJK2C9\\_Q7OUgyfVuvAG700aGg](https://drive.google.com/open?id=11TjGqKYgJK2C9_Q7OUgyfVuvAG700aGg)
- Organization of the Congress “Desafíos en seguridad hídrica y resiliencia ante el cambio global en zonas áridas del continente americano” which took place on April 17, 18, 19 y 20. Guaymas, Sonora, México. January, February, March & April, 2018. This congress was attended by the members of the International Water Security Network and by researchers of the Aguasec Center for Excellence for Water Security from Arizona (USA), Argentina, Chile, Brazil, Bolivia, Peru, and Sonora (Mexico).  
See: [https://drive.google.com/open?id=1P3\\_UVtSWCTH5uV75-CDOWMgbit1NcVLR](https://drive.google.com/open?id=1P3_UVtSWCTH5uV75-CDOWMgbit1NcVLR)
- Ongoing collaboration with the Government Board of the utility Agua de Hermosillo in order to present a legal initiative to the State Congress and further the institutional development of the water utility. The main hurdle to achieve water management efficiency, higher sustainability and water security for Mexican water utilities is the lack of technical autonomy and long-term planning. Therefore, the main purpose of this taskwork was to make the financial self-sufficiency and professionalization of the utility more viable. This is an independent, honorary participation to improve the institutional framework of the utility. So far, the main product has been a proposal of legal reform aimed at gaining technical autonomy and independence for water utilities en Sonora.
- The Sonora research team has been working intensively to gather information and gain insights on the Institutional and Management capacity of watershed councils in North West Mexico. The team has participated in meetings, workshops, interviews and fieldwork to gain understanding of the operation of the performance of these new forms of decentralized and participatory instances of water management in Mexico. These studies have been promoting a more local and participatory management in Mexico (**Nicolás Pineda**). Several seminars, interviews, fieldtrips, meeting participation and collaborations different agencies have been carried out to achieve the goal of assessing and making recommendation to improve the performance of watershed councils in the region (**Rolando Diaz**).
- A special case of study has been the assessment of the toxic spill over in the Sonora River have been carried out. The Research Team has conducted studies of the geo-reference of water samples along the river during different dates after the mining toxic spill over occurred on August 6, 2014 (**Diaz Caravantes et al 2018; Davila Luna et al. 2018; Diaz Caravantes and Calvario Parra 2017**).
- In order to build and strengthen the capacity of the utility Agua de Hermosillo, and as a follow up of the scenario planning workshop of April 2016, the Sonora research team organized a workshop with the directives and selected personnel of Agua de Hermosillo to devise the different medium and long term scenarios for water management in the

city of Hermosillo. The workshop consisted on a series of 12 weekly sessions held during the months of September, October and November 2017 in El Colegio de Sonora (**Alan Navarro, Alejandro Salazar, and Rolando Diaz**).

- During 2017, Nicolas Pineda has participated in a series of meetings and workshops organized by the Government Board of the utility Agua de Hermosillo in order to modify and improve the legal framework of water management in Hermosillo. The legal modifications have the purpose of providing a new framework in order to achieve a more professional and effective water management so as to achieve higher levels of sustainability and water security (**Nicolás Pineda**).
- The Sonora State Water Commission (CEA in the Spanish acronym) has also invited the Sonora research team to participate in talks aimed to devise an overseeing or regulatory agency for water utilities in Sonora. The research team has also been an observer of the process to design, bid and construct a desalination plant in Empalme, Sonora (**Nicolás Pineda**).

## Chile

- In Chile, a new administrative region has been created. Researchers of the team have been asked to develop a project proposal that creates a road map for water security in the new Ñuble Region and have met with resercahers of Universidad de Concepción (Dr José Luis Arumí) and the new Intendente (Mr. Martín Arrau) to elaborate an agenda based on water security that will combine biophysical modelling with participatory Science Policy dialogues.



- Stakeholders workshops focusing on dialogue towards common understandings on water issues, new approaches to measuring or evaluating vulnerability or adaptation, or new planning approaches (especially Scenario Planning as reported here) have all been effective ways of increasing climate science inclusion in water planning and management (all countries) (**Ocampo Melgar et al 2016; Varady et al 2016**)
- Concepts such as “ecological uses of water”, “water-food-energy nexus”, “water security” and “scenario planning” are gradually being recognized by policy makers as science-based tools that can potentially improve their work in terms of watershed management (Argentina, US, Mexico, Chile) (**Pineda Pablos and Zúñiga Teran 2016; Meza et al 2015; Scott and Zugg 2015; Scott, Kurian and Wescoat 2015; Scott and Buechler 2013; Scott et al 2013; Varady et al 2013; Zúñiga Teran and Díaz Caravantes 2015**)



- Inclusion of young scientists and graduate student researchers in these dialogues or through participation in decision-making arenas, improve their capacity to address challenges in the science-policy translation required in future planning and research (Brazil, Chile, Mexico, US) (**numerous studies including students and postdocs**).

### Brazil

- The Capibaribe's Hydro-Environmental Master Plan established a set of water infrastructure actions to be implemented in the basin. The identification of the main challenges showed that the water infrastructure actions were not implemented in accordance with the hydro-environmental plan, due to lack of coordination between the agencies to monitor the investments. The administrative continuity and discontinuity issues present themselves as a major obstacle to the development of public policies for water security. The interruption of programs, projects and actions due to fragile institutional capacities has been a reality in water resources management, and these problems were also identified in the Capibaribe Basin. Despite the legitimacy of the hydro environmental plan and its water infrastructure investment plans, to prioritize the environmental agenda and to put it above political interests has been one of the biggest challenges regarding water security in the basin. (**Moura et al., 2018**).

### United States

- In collaboration with the Mexican Team, we organized a Science-Policy Dialogue in Guaymas, Mexico in April 17-21, 2018. The congress “Desafíos en Seguridad Hídrica y Resiliencia ante el Cambio Climático en Zonas Áridas del Continente Americano” brought together academics from Argentina, Chile, Brazil, Peru, Mexico and the U.S. with water managers from Mexico (Comision Estatal del Agua) and Argentina (Departamento General de Irrigacion). In this congress, researchers presented their findings and water managers presented their challenges. In addition, there were round tables that allowed discussions on focused topics and a field trip to local water infrastructure projects in Sonora. During this event, not only the transfer of knowledge happened, but our networks strengthened and expanded. As a result, the U.S. team was invited to participate in a workshop in Mendoza by the Departamento General de Irrigacion to be held in April 2019.
- In collaboration with Nicolas Pineda, who is spending a sabbatical in Arizona, we organized a workshop in Tucson to reflect on the 75<sup>th</sup> anniversary of the Water Treaty between the U.S. and Mexico. This workshop titled “Binational Water Relations at 75 Years: Retrospectives, Resilience and the Future of the U.S.-Mexico Water Resources Governance” was held on October 15-17, 2018 at the University of Arizona. Academics from both countries attended this event, as well as water managers, including the two commissioners from IBWC and CILA – the institutions that manage transboundary water issues along the border. As a key-note speaker, we had the privilege of having Prof. Stephen Mumme from Colorado State University, who is the expert on the Water Treaty. We also heard remarks from prominent figures on the topic including Ambassador Alberto Szekely, who was present during the negotiations of the La Paz Agreement. As a result of this event, we plan to submit a set of papers for a special issue on the journal *Environmental Science and Policy*.
- Zuniga-Teran has presented the results of the participatory assessment of the state of the Cienega Watershed to multiple audiences in the region. For example, she presented results during the event “Science on the Sonoita Plain” last June 2018. During this

event, stakeholders of the watershed get together and share their issues and findings and find ways to collaborate on important issues. Zuniga also presented at the Brown Bag Lunch at Pima County Flood Control District on August 8, 2018, and during a workshop organized by the French Institute OHMI-iGlobes. The French scientists are very interested in this project because its objective is to monitor the state of the watershed before the opening of the Rosemont Mine, which aligns with their main objective as a human and environmental observatory in Pima County. This presentation to the French scientists led to an invitation for Zuniga to present a poster at a seminar in France in October 2018.

- The U.S. team organized a workshop in collaboration with the French Scientists from OHMI-iGlobes on “Human Challenges in Extreme Environments” that was held on November 12, 2018. During this workshop, scientists from Mexico, the U.S., and France shared their research findings. This event is expected to lead to future collaborations on research projects and proposals.

### 3.1 Objectives (from the proposal)

*To develop and apply innovative science and conduct influential policy dialogues through the perspective of water security in a manner that strengthens global-change adaptation in the arid Americas.*

All partners attended the April 2018 project team meeting, held in Guaymas, Mexico.

### 3.2 Research Activities (from the proposal)

*Task 1 - Undertake river-basin assessments by linking biophysical monitoring with social-institutional analyses of current conditions and projection/ modeling of future scenarios*

*Task 2 - Document human and ecosystem exposures to hydro-ecological and globalization processes thereby addressing specific risks and strengthening river-basin resilience*

- Research and field work in the río Sonora
- Assessment of rio Sonora levels of contamination

*Task 3 - Conduct policy dialogues to diagnose current adaptive capacity and promote the feasibility of future adaptation outcomes leading to enhanced water security*

- Collaboration with the utility Agua de Hermosillo in order to achieve scenario planning.
- Participation in the taskforce organized by the Junta de Gobierno de Agua de Hermosillo to devise a legal reform for the utility autonomy and planning institutional capacity. There has been progress in this regard since it requires lobbying and a deliberation process with policymakers.
- Organization of the Guaymas (Mexico) Congress held on April 2017 that was attended by around 30 scholars from six countries of the Americas. This implied the commitment of a good amount of budgetary resources and the coordination of a large number of assistants and participants.
- Participation in the process of institutional reform of the Juntas de Agua of the State of Chihuahua. Inputs were proposed for the new Law of Water of the State of Chihuahua passed on December 2017.



- Paper research and preparation for different congresses and meetings related to water security. These papers generally are the output of literature reviews, seminars, talks, interviews, documentary content analysis and field research on different topics related to water policy and dissemination of scientific knowledge. Among the main papers presented were the ones presented in Israel, in the ANEAS congress, among other.
- Several guided tours and visit to the Hermosillo wastewater treatment plant, with students from the Sonora University and researchers from El Colegio de Sonora. In this visit to the plant operated by the TIAR company, a tour was made to know the facilities and their operation. The quality standards of the water produced by this plant is higher than the required for agricultural use and may also have other urban and industrial uses; however, it is not suitable for domestic use. Currently, the bio-digester structures are being filled up to start up operating in the coming months. That way the contractor will reduce its operating costs. November 27, 2017.
- An Interview and talk were carried out with doctoral student Jorge Alberto Arriaga Medina of Imperial College London. The subject was the management of urban water utilities in Mexico. August, 2018.

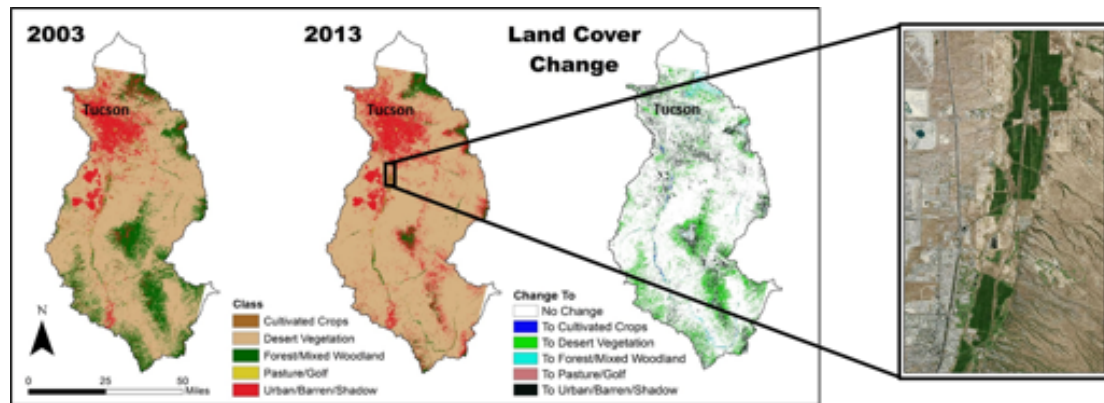
### 3.3 Main Results and Findings (based on the objectives, reported below by tasks)

#### ***Task 1. Undertake river-basin assessments by linking biophysical monitoring with social-institutional analyses of current conditions and projection/ modeling of future scenarios***

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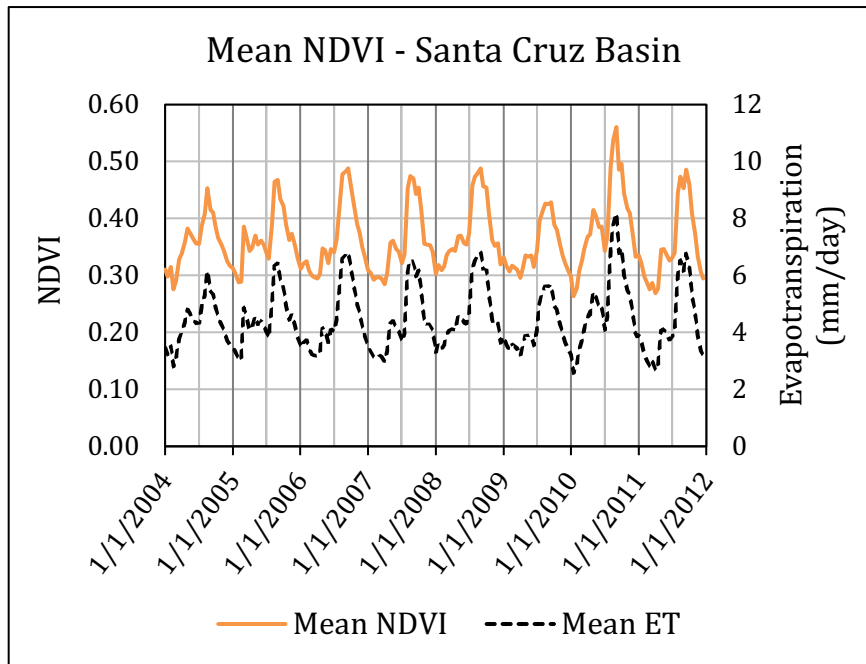
##### *Multiple countries/ basins:*

- Collection and processing of data for hydro-bio-climatological observations and models for Arizona (U.S.) and Sonora (Mexico) study area based on weather stations, satellite data and flux towers.
- Creation of unique land cover changes/ classifications using Multi m-temporal imagery approach to improve accuracy of agricultural and other vegetation types within each land cover classification
  - Unique land cover classifications were built for both 2003 and 2013 using a classification and regression tree (CART) model and multiple inputs.
  - Inputs include: (1) multi-date Landsat TM surface reflectance imagery, (2) Normalized Difference Vegetation Index (NDVI), (3) mountain filter (> 2500 meters), and (4) Soil Adjusted Vegetation Index (SAVI).
  - The classification structure was based on the same system as the National Land Cover Database (NLCD) and was reclassified into 5 general classes for application within the METRIC model.
  - Classification image dates: (1) 2003 – March 12<sup>th</sup>, July 2<sup>nd</sup>, October 22<sup>nd</sup>; (2) 2013 – June 27<sup>th</sup>, October 1<sup>st</sup>.



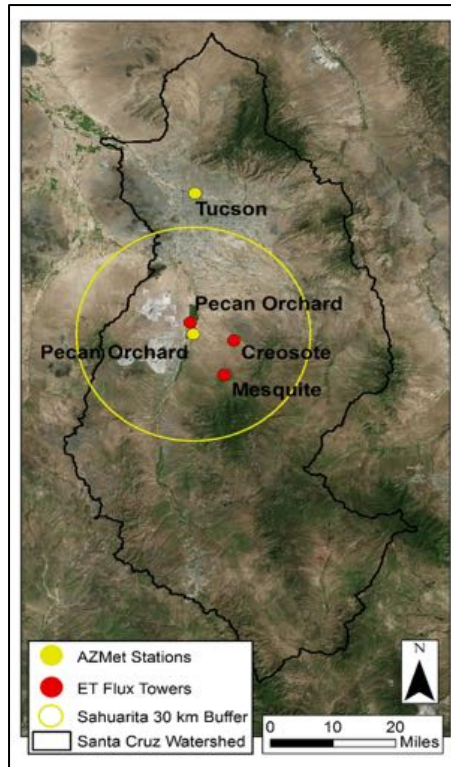
*Multi-temporal Landsat based vegetation cover/use type classification and change results for 2003 and 2013 when flux tower data were available.*

- Land Cover Change:
  - Seasonal dynamics have a large influence on the vegetation land cover within the Santa Cruz basin.
  - Greater forest/woodland cover in 2003 was due to higher precipitation during the winter of 2002 – 2003 that results in more vigorous leaf-out and less drought deciduous behavior of woody cover; some contributions from winter annuals could contribute to this increase as well and results in larger errors of commission:
    - June 15<sup>th</sup> 2002 – June 14<sup>th</sup> 2003 = 21.4 inches
    - June 15<sup>th</sup> 2013 – June 14<sup>th</sup> 2014 = 14.8 inches
  - There was an increase in the area of urban land cover, particularly to the north, south, and west of Tucson.
  - Due to a large fire in 2003, there was forest regrowth to the northeast of Tucson in 2013.
- Water use observations in terms of NDVI → higher NDVI means more water use:
  - Remotely sensed ET provides a snapshot of ET at a specific time and date; The MODIS ET model extrapolates this snapshot to daily ET (mm/day) data at 16-day intervals for the MODIS data record.
  - It is dependent on environmental variables including current temperature, wind speed, and precipitation.
  - Land cover classifications must use consistent inputs from year to year due to the seasonal variations within the basin.
  - Correlations between ET<sub>METRIC</sub> and NDVI could possibly be used to predict ET seasonally – using seasonal Landsat and MODIS NDVI time series data.
- MODIS evaluation from 2004-2012. This ET time series could be up verified with local observations from flux tower data and Landsat derived ET.

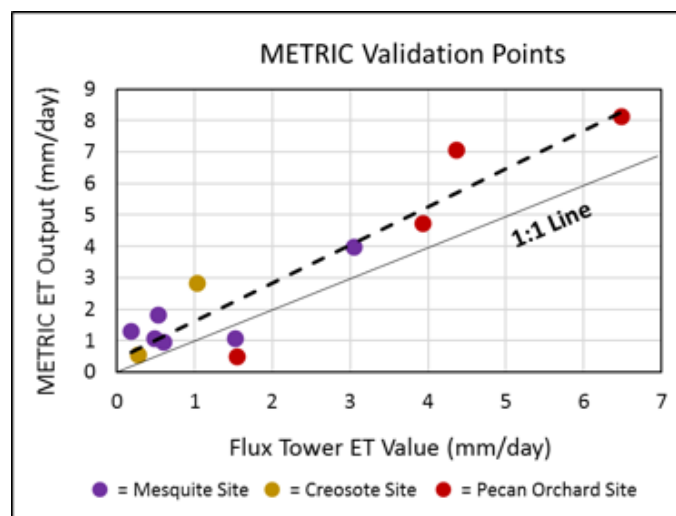


*Time series of MODIS based NDVI and ET data*

- The figure shows significant relationships. Correlation between MODIS NDVI and ET:  $ET = 18.94 \cdot NDVI - 2.43$ ;  $R^2 = 0.634$ , METRIC-model: Mapping of Evapotranspiration at high resolution with internalized calibration, METRIC is a “hot/ cold” pixel evaluation, but it does not work well for urban areas.
  - Input: Landsat, thermal band, weather data, (air temperature and potential ET) study area boundaries.
  - Output: e.g. Evapotranspiration, Net radiation, Latent, Sensible and Soil Heat Flux, Vegetation Indices, Temp.
  - Comparison of METRIC-modeled evapotranspiration results and eddy covariance flux tower measured evapotranspiration data to validate the accuracy of modeled evapotranspiration on arid lands.



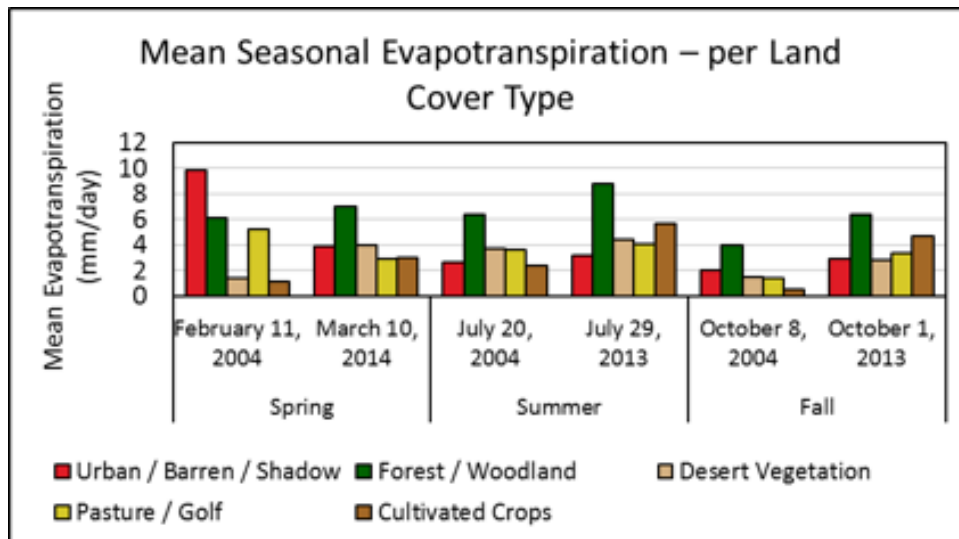
*Location of land cover and flux tower sites*



*Validation of the METRIC modeling results with the Flux tower reference data.*

- METRIC based ET results generally overestimate ET reference data obtained from flux towers.
- **Landscape scale results based on Landsat based METRIC modeling results for the Santa Cruz watershed:**

- The METRIC model was not designed for urban areas with limited vegetation cover, likely resulting in an overestimation of ET within urban areas (ex. 9.9 mm/day in Feb. 2004).
- The METRIC Hot/Cold pixel selections were from cultivated cropland areas only.
- Mean ET was higher for 2013/2014 than 2004.



*Mean ET for several times during the season in 2004 and 2013/2014 based on Landsat derived reflectance/albedo and surface temperature data and Landsat derived land cover types.*

- Three land cover land use classifications were produced for the San Miguel and the Zanjón Rivers (SMR and ZR), two sub-watersheds in arid Northwestern Mexico representing 1993, 2002 and 2011 to examine change over time.
- The San Miguel and the Zanjón maps were used to examine changes in water use in relation to changes in land cover/use mainly looking at invasive species.

Next steps:

- Seasonal quantification.
- Optimization and automation of the Metric Model.
- Land use / land cover classifications and changes for other AguaScapes basins.
- Bi-directional exchange of data.

## Chile

We used standardized indices (SPI, SPEI, SSI, and SSMI) and applied the methodology tested in the Maipo river basin, to the Sonora (Mexico), and Mendoza-Tunuyán (Argentina) as well. Drought propagation types were identified, acknowledging differences in semi-arid river basins, even when they are neighboring river basins (case of Mendoza-Tunuyán). Besides, by modeling an “Interconnected” river basin (hybrid of Maipo precipitation and Mendoza temperature and streamflow), it is illustrated that drought processes can be influenced by precipitation patterns from outside its boundaries. Other influences beyond

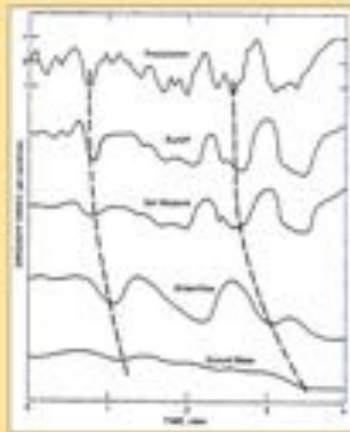
basin boundaries affecting basin specific drought properties are addressed by correlating results of indices with ENSO anomalies. This chapter is published in Water (Oertel et al., 2018).

A graphical summary of all three chapter is shown in the figure below.



## Chapter 1

### Multivariate Standardized Drought Indices to Identify Drought Events: Application in the Maipo River Basin



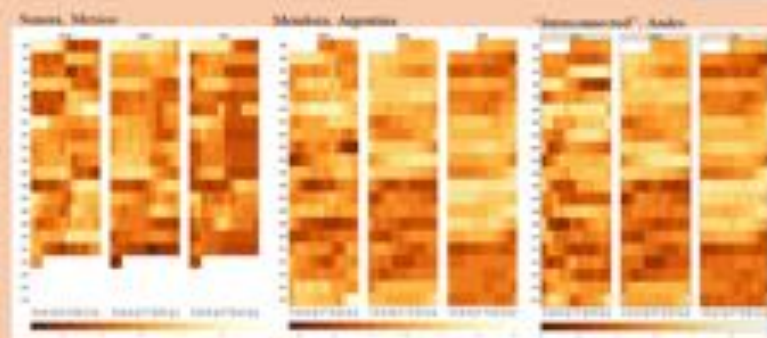
#### Findings:

- 1) As higher the accumulation period the lesser the influence of the chosen distribution, and for all distributions same drought events were detected.
- 2) Standardized indices are powerful tools to detect propagation patterns
- 3) Index values are Gaussian values and allow straightforward modeling (here autoregressive model)

Ortiz, M., Mesa, F.J., & Gironde, J. (2018). In Lars Ribbe, Andreas Hauererik, Rabea Muband, Sudeb Debnari and H.K. Rensaldi (eds.) *Water Security and Climate Change*, Springer, Zug. In print.

## Chapter 2

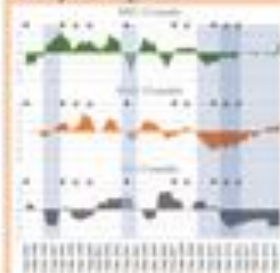
### Drought Propagation in Semi-Arid River Basins in Latin America: Lessons from Mexico to the Southern Cone



#### Major findings:

- 1) Identification of three propagation types
- 2) Easy replicable method to study drought propagation

#### Turkey, Argentina



Ortiz, M., Mesa, F., Gironde, J., A. Scott, C., Rojas, F., & Pineda-Pablos, N. (2018). *Water*, 10(11), 1564. <https://doi.org/10.3390/w10111564>

## Chapter 3

### Assessing ENSO and PDO influences and drought trends using standardized hydrometeorological indices in basins with near-natural regimes in Chile

Ortiz, M., Mesa, F.J., & Gironde, J. (2018). submitted to *Hydrological Processes*



Major findings: 1) ENSO influence in winter and summer for SPEI and SSI is stronger than PDO, 2) Trend analysis show increase of meteorological and hydrological drought are probable, and 3) occurrence of dry events related to ENSO for SPEI

This thesis elaborated in the first step the necessity of river basin drought definitions. Then, to understand the behavior of drought events, and their relation to the hydrological cycle, the focus shifted to drought propagation on river basin scale. For this purpose, we used standardized indices (SPEI, SSI, and SSMI) and applied the methodology to the Maipo (Chile) (1<sup>st</sup> chapter, focus on suitability), Sonora (Mexico), Mendoza-Turkey (Argentina) (2<sup>nd</sup> chapter, focus on propagation types). To recognize influencing factors of drought events, we analyzed influences of the ENSO and PDO as well as drought trends along three climate zones in Chile (3<sup>rd</sup> chapter). All three chapters serve the main objective to better define the nature of drought events.

To acknowledge influencing factors of drought events, we analyzed influences of the ENSO and PDO as well as drought trends along three climate zones in Chile, as the 3<sup>rd</sup> chapter of this thesis. Considering the climatological variety in Chile, this chapter has it regional focus

on semi-arid, Mediterranean, and temperate-oceanic climate zones, found in Chile from Lat. 29°S to Lat. 40°S. For SPEI 18 precipitation and temperature stations were used, related to near-natural streamflow regimes, as considered by 20 streamflow gauges to calculate SSI series. As data were mostly available from 1970 on, trends were detected for summer and winter drought events. Findings of this chapter are based on results for both indices accomplished by multiple regression (ENSO/PDO and time as independent variables) and GLM (ENSO and time).

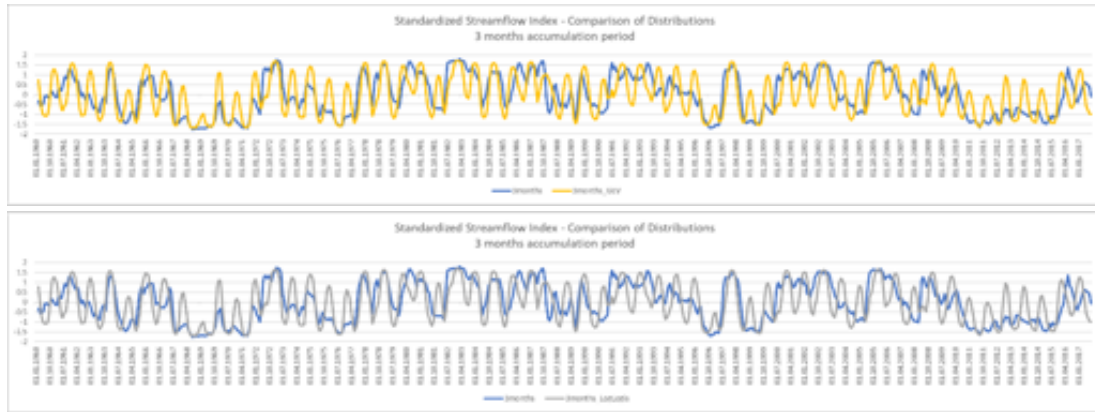
Ongoing work on river basin assessments of the Maipo and Elqui/Limari Basins is linking biophysical monitoring with social-institutional analyses of current conditions and projection/modeling of future scenarios.

- **River Basin Drought Definitions:** ongoing PhD-thesis research by Melanie Oertel that focuses on regional drought detection and understanding (i.e. on river-basin scale) to set thresholds and analogous drought severity levels to reflect drought events realistically and hence to minimize negative impacts.
- **Progress:** The PhD-thesis of Melanie is still in progress and will be finalized by mid 2018.
- As mentioned in the last report, **the analysis of the propagation of the Drought signal from meteorology to hydrology and agriculture looking at correlation and lag structure has been carried out.**

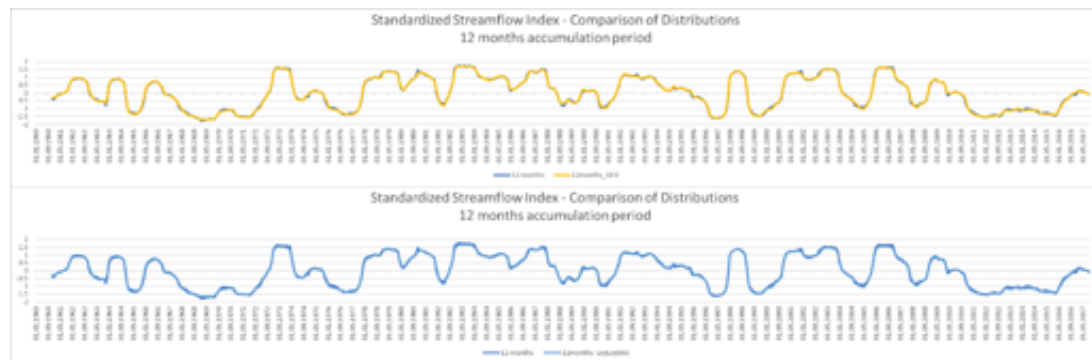
We apply the Standardized Drought Index (SPI) as it is the recommended drought index by the World Meteorological Organization, the Standardized Precipitation-Evapotranspiration Index (SPEI), and the Standardized Runoff Index. Further we included soil moisture data derived from the ESA Climate Change Initiative Soil Moisture v03.2 combined data set. This data set combines active and passive sensor data with a spatial resolution of 25 km<sup>2</sup>. It is the most comprehensive data set available as it provides daily data from 1978-2015 on a global scale. However, for our research we used data from 1995-2015 due to less missing values.

- **Findings:**
  - **Distribution fitting,** to obtain standardized indices, monthly time series are fit to distribution functions, which are then normalized to obtain the final values of the indices. We applied the same procedure for all four indices. It is common to apply one distribution to the monthly values, we were interested how results differ comparing the best fit versus using only one distribution. We found that as shorter the accumulation period results of the indices differ, and as higher the accumulation period results equal.





*SSI 3-months for the Maipo Basin (1960-2017), blue graph refers to best fit for each month, yellow to results obtained with GEV distribution and grey Log-Logis respectively.*



*SSI 12-months for the Maipo Basin (1960-2017), dark blue graph refers to best fit for each month, yellow to results obtained with GEV distribution and light blue Log-Logis respectively.*

- **Correlations with time lag in months**, to identify propagation patterns we correlated the results of the indices among each other. As the SPI and the SPEI are highly correlated ( $> 0.8$ ) in the Maipo Basin, the following graphs are based on the SPEI. The higher the accumulation period the higher the correlations. Further we can identify the influences among each other, e.g. soil moisture responds immediately, whereas streamflow responds with a minimum time lag of three months. According to the results we can therefore state that it is not sufficient to rely only on one index for drought management, as the end of the drought might be seen by one index (e.g. SPEI), but another variable (e.g. streamflow) might be still below average.

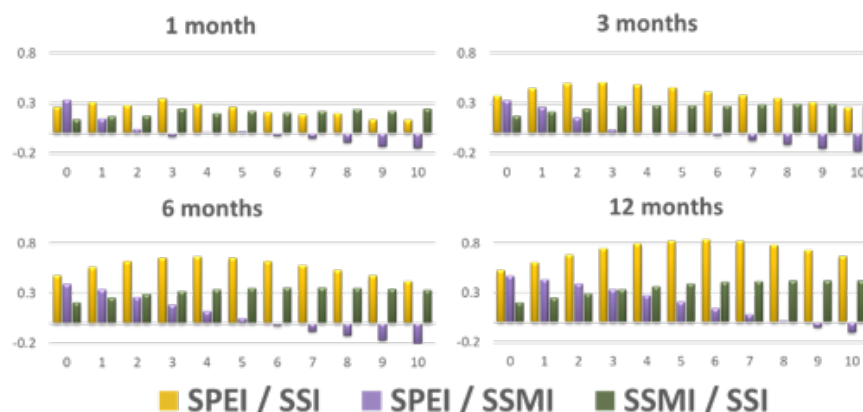


Figure: Correlations between the indices shifted by months (on the x-axis).

- **Answering proposed questions:** *How can we show drought propagation?* We compared four standardized indices among each other, using the SPI, SPEI, SSI, and SSMI. This provides insights of the linkage between meteorological, agricultural and hydrological droughts. *Do drought events behave similarly or is each one unique?* Each drought events is unique – as duration, magnitude and severity differ. However, we can see that results between the SPI/SPEI and SSI and SSMI follow a basin-specific pattern. This means that e.g. in the Maipo basin a drought event detected by the SPI/SPEI can be seen in the SSI with a time lag of 3-4 months. We performed the same analysis in other semi-arid river basins in the Americas, recognizing that data gathering is an obstacle for on-time drought assessment. Selected river basins are: Mendoza (Argentina), Capibaribe (Brazil), and Sonora (Mexico). Results of the e.g. Capibaribe basin (Brazil) show that streamflow response with no time lag to the SPI/SPEI. *Is it possible to identify a “drought function”, describing its propagation within a river basin?* Yes: 1) Comparing results of different accumulation periods show us which one is suitable to recognize propagation in each basin. 2) Using meteorological, streamflow and soil moisture data provides a firm base to study propagation, and by analyzing those results we can identify a propagation pattern for each river basin.
- **Operational forecast**, forecasting droughts is challenging, but to identify a reliable method would improve drought management a lot. We are currently working on the development of a model for operational forecast based on results obtained by studying propagation patterns. We expect to have those results ready by end of the year.
- **Maipo Basin:**
  - **Social-institutional analysis:** Based on two and a half months of fieldwork in the Maipo River Basin in summer 2015, M.A. student Sophia Borgias completed her thesis in May 2016, entitled Law, Scarcity, and Social Movements: Water Governance in Chile's Maipo River Basin. An abstract and summary follows.
  - **Abstract:** The challenges of water governance in Chile today lie at the confluence of growing water demands, increasing climatic variability, and mounting discontent with neoliberal water policy. These dynamics coalesce in the Maipo, Chile's most

densely populated river basin and seat of the capital city, Santiago. The Maipo River sustains the growing capital city of Santiago, booming agricultural production in the Santiago valley, and hydroelectric generation from the river's swift descent from the Andes. Now, with the population of Santiago exceeding 5 million, a seventh year of drought racking central Chile, and controversial hydropower development sparking mass protests, the stakes of water governance in this critical river basin are higher than ever.

- Based on in-depth empirical research in the Maipo River basin, this thesis explores how processes of environmental and social change interact with Chile's internationally famous water laws to shape water governance, understood as the set of processes through which actors influence decision-making and conflict resolution related to water resources. Bringing legal geography and political ecology into conversation with water governance literature, I analyze the ways that law, social mobilization, and water scarcity are shaping water governance. In Chapter 1, I analyze the law of river sectioning and the way it influences water use and management practices throughout the Maipo River basin. Chapter 2 explores the Alto Maipo hydropower conflict in the upper basin and demonstrates the important role of social movement actors trying to shift water governance in new directions. Themes from both of these chapters converge in Chapter 3, which examines the struggle over the meaning of water scarcity in the context of increasing attention to drought and climate change. These dynamic socio-environmental processes are considered in relation to each other as integral parts of the ongoing negotiation of water governance. This research aims to insert considerations of social and environmental justice into ongoing policy debates about water governance in Chile to address the conflicts stemming from uneven access to resources and decision-making.
- Summary of Key Findings: In Chapter 1, I introduced the legal concept of river sectioning and examined the ways it has been interpreted by water users, government officials, and scholars. I demonstrated how government officials interpret river sectioning as an administrative tool that is "artificial" and "apolitical," somehow separated from water user practices. I argue, however, that river sectioning is very real and has significant material, discursive, and socio-political implications for water governance. The material impacts are best illustrated by the dry riverbed at the end of the first section of the river, a stark testament to the socio-ecological consequences of protecting the collective right to exhaust the river's flow. This right to leave the river dry also takes on discursive power, as users call on the logic of the law in order to justify excluding downstream users from their management. These actions reverberate throughout the basin, since the river sectioning not only shapes user practices within each section, but also stands as a barrier to basin-wide coordination and integrated management of the river. Far from functioning as a legal simplification as intended, river sectioning is complicated and contentious. And yet, it has received very little attention from government officials, policy-makers, and scholars. This thesis research is just a first step in opening up the topic, and there is great potential for further research and policy discussion, which I propose in more detail below.
- In Chapter 2, I examined the polemic water conflict sparked by the audacious Alto Maipo hydroelectric project in the upper part of the Maipo basin. While Chapter 1 followed the formal mechanisms for water management and water user organization, Chapter 2 focused on the water politics that do not fit as neatly into the legal framework, instead spilling into the streets in protest. The Alto Maipo

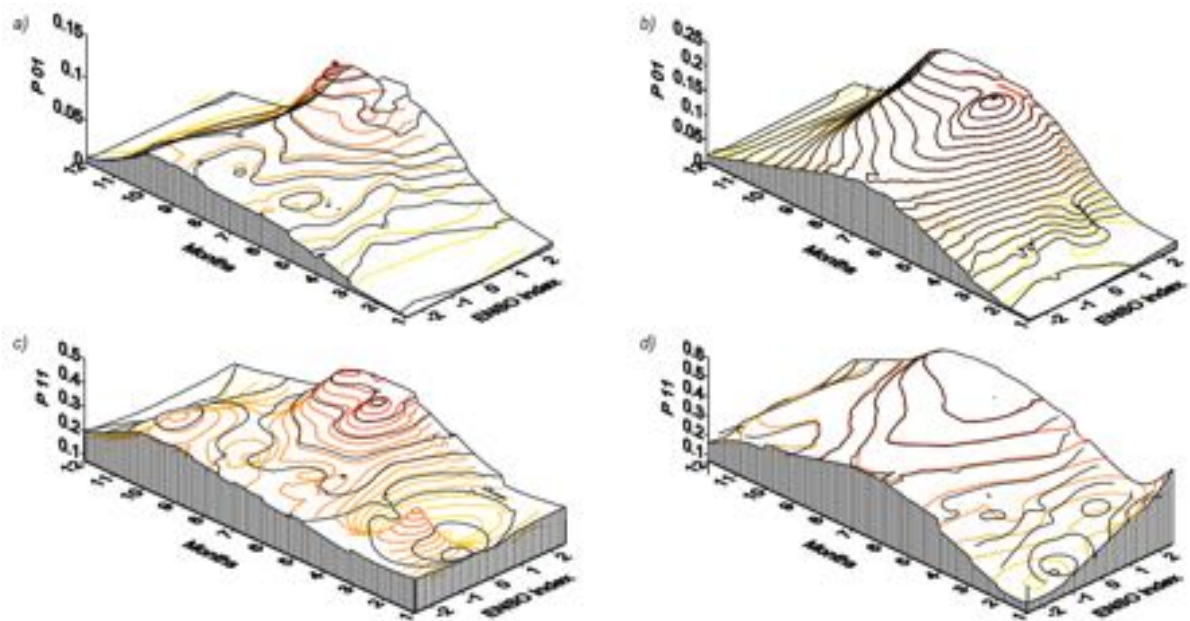
conflict offers a glimpse into the dynamic tensions between conservation and development amidst the wealth of both biodiversity and natural resources in the Chilean Andes. It also highlighted the complex but increasingly common conflicts between local communities, activists, international corporations, and the state. I argue that social movement actors, though technically outside the scope of Chile's legal framework for water management, play an important role in water governance by filling in for the absence of the state in its regulatory role, while also demanding more state accountability. In addition to "subsidizing" the work of monitoring the conduct of the hydropower company, social movement actors are also engaged in facilitating legal reform and building political pressure for change. As key actors in the growing number of water conflicts around the nation, social movements merit a closer look in terms of how their politics of resistance articulate with the legal frameworks for water and environmental governance in Chile.

- Chapter 3 built on the previous two chapters to examine how drought and climate change concerns are shifting responses to water scarcity. I demonstrated that there are several rural communities around the Maipo River basin that are struggling with long-standing issues of water scarcity that, though exacerbated by drought, cannot be explained by drought alone. Though these areas have received some attention during the recent drought crisis, government and mainstream media narratives have tended to frame water scarcity as a natural consequence of drought, overlooking or even obscuring the political origins of scarcity. Formal state and non-state responses to the drought have done little to address the issues of uneven access and control that lead to enduring problems of socially produced scarcity. In San Jose de Maipo, the politics of water scarcity have become entangled in the Alto Maipo conflict as social movement actors try to redefine and repoliticize water scarcity to contest the uncertainty and risk posed by the hydropower project. This broader struggle over the meaning of water scarcity is likely to take on increasing relevance across the river basin as the latent conflicts in water-scarce communities flare up under new pressures.
- Borgias and Dr. Carl Bauer wrote and submitted a paper about the historical and contemporary trajectory of water conflict and collaboration in the Maipo basin, with emphasis on the new institutions and collaborations forming in response to drought and water scarcity. The paper is under review at Water Alternatives, (currently being revised to resubmit). Borgias is now in her Ph.D. program.
- Projection/modeling: The Aguascapes team has been in ongoing collaboration with the parallel "MAPA" project, Adaptation Plan for the Maipo Basin, which developed numerous models of the Maipo Basin under climate change projections.
- Regional Analysis of impacts of ENSO on the occurrence of precipitation:  

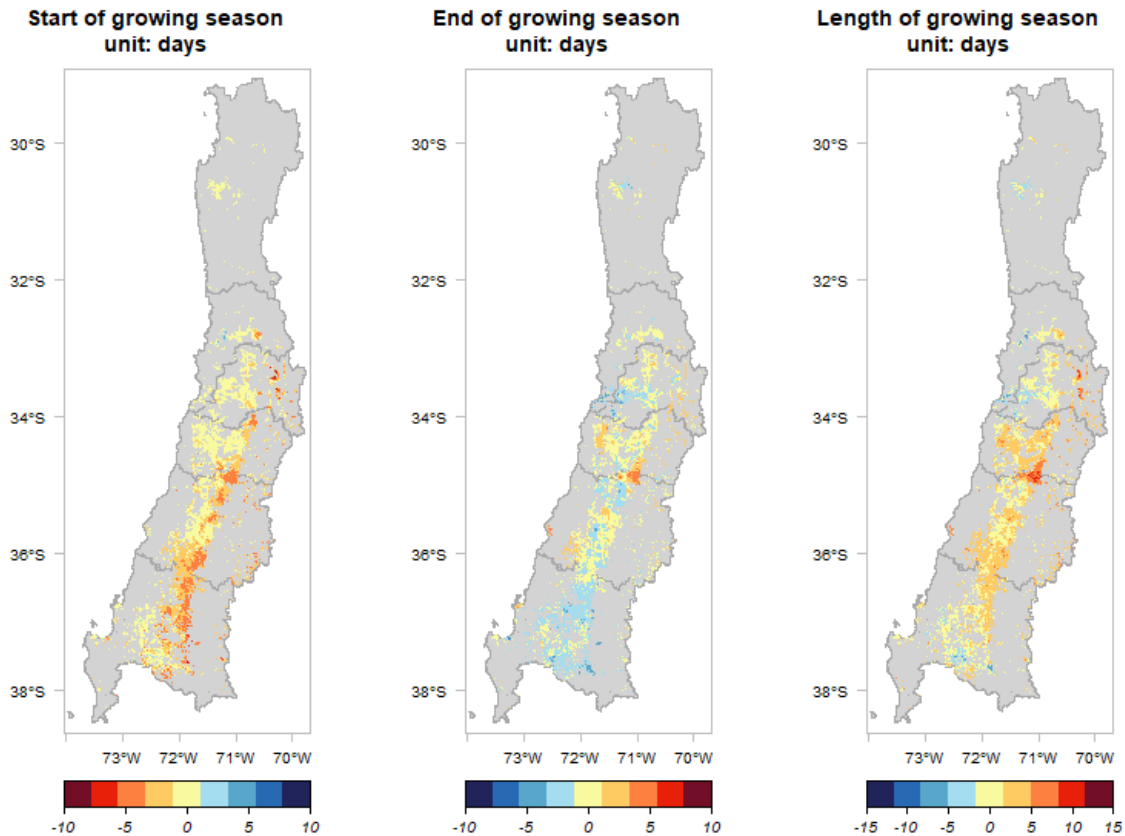
Stochastic weather simulation or weather generators (WGs) have gained a wide acceptance and have been used for a variety of purposes, including climate change studies and the evaluation of climate variability and uncertainty effects. The two major challenges in WGs are: improving the estimation of interannual variability and reducing overdispersion in the synthetic series of simulated weather. The objective of this work is to develop a WG model of daily rainfall incorporating a covariable that accounts for interannual variability and apply it in three climate regions (Arid, Mediterranean and Temperate) of Chile. Precipitation occurrence was modeled using a two stage first-order Markov chain whose parameters are fitted with a generalized lineal model (GLM) using a logistic function. This function considers the observed Sea Surface Temperature

Anomalies of the Region 3.4 of El Niño-Southern Oscillation (ENSO index) as a covariable. Precipitation intensity was simulated with a mixed exponential distribution fitted using a maximum likelihood approach. The stochastic simulation shows that the application of the approach to Mediterranean and Arid climates largely eliminates the overdispersion problem, resulting in a much improved interannual variability in the simulated values.

The summary of the effects of ENSO on the probability of precipitation occurrence is presented in the figure below (Urdiales et al., 2018)



- Agricultural production in Chile is heavily affected by drought. Zambrano, (2017) performed an assessment of agricultural drought impacts in Chile from freely-available near real-time data sources, testing the reliability of the methods to assess impacts of droughts. The prediction was performed for 1, 2, 3, and 4 months before the unit-specific end of season (EOS). Predictor variables included zcNDVI (before EOS); standardized precipitation indices derived from satellite rainfall estimates for time-scales of 1-, 3-, 6-, 12- and 24-months; two climate indices being the Pacific Decadal Oscillation (PDO) and the Multivariate ENSO index (MEI); and latitude and longitude. Results for both methods showed a good prediction accuracy, but the deep learning approach that incorporated multiple parameters in a single model performed better with mean R2 cv values of 0.98, 0.87, 0.69 and 0.63 against 0.94, 0.79, 0.63 and 0.51, for one, two, three and four months before EOS respectively.
- Remote sensing techniques have been used to assess changes in the development of agricultural production systems at regional scale that can be linked with impacts of water scarcity and affect the rate of consumption of water. We have started a project to determine trends in agriculturally relevant indices that show how the start of the growing season and end of the growing season have suffered modifications. Results show that start of the growing season has been observed earlier (consistent with recent climatic trends) and that end of growing season is expected to occur later. See figure with a synthesis of the results.



### *Changes in the agricultural production systems*

The study of recent trends in agroclimatic indices based on satellite images of land surface temperature developed in this project allows us to analyze recent and current changes in the basic climatic conditions associated with agriculture. This type of spatial analysis provides the possibility of studying areas where the coverage of meteorological stations is nonexistent or heterogeneous and their limitations due to temporal coverage will be replaced in the future when the registration period increases.

Agroclimatic indices evaluated for the heat category showed consistent trends that suggest an increase in the growing season determined by the increase in temperatures affecting the Start of Growing Season, but the End of Growing Season presents variable trends according to geographical location. For Growing Degree Days exist a remarkable positive trend for winter crops calculation that suggest a higher heat accumulation in months with lesser temperature. For cold category indices, a lesser number of pixels with significant trends were found but a consistent trend towards an increase of extremes events was found.

In NDVI analysis of growing season parameters, we found an adaptive debt because agricultural vegetation does not respond to the changes in growing season propitiated by the increase in temperatures. This situation should be considered as an opportunity to improve field techniques, such as the choice of crop varieties and irrigation systems.

The use of satellite information allows a systematic study both in time and space of variables that allow to better understand the phenology and the early detection of climate change impacts on agriculture. It is essential to make greater use of satellite information and available

technologies to communicate accurately the changes in the normal conditions that represent risks and development opportunities for farmers in the context of climate change.

The analysis of temporal trends is a method that becomes more robust as soon as a great number of data is evaluated, for the case of the agroclimatic indices that are yearly calculated, a joint analysis with registers of meteorological stations can be useful to know the variation regarding to the historical period not covered by satellite information. The analysis of spatial trends presents potential research by including covariates that can explain the values of differentiated trends in valleys and zones of agricultural development in the future; regionalization tools such as spatially restricted conglomerates can be used for agricultural territory planning.

- This creates a new scenario. If new varieties are developed and adapted to this conditions, water demand will increase as irrigation will have to be applied for longer periods within the growing season. (Orellana et al., under development)
- Analysis of the dynamic relations between water insecurity and land use change for the selected basins.
- Research advances:
  - There is a displacement of agricultural and domestic use of surface water to groundwater due to surface water variability. Andean basins have been experienced a drought cycle of 5-6 years (2010-2015). This displacement is reflected in the rising of groundwater licenses requested to and delivered by the water public agency (DGI) as well as in the expansion of the agricultural frontier beyond the surface irrigated oases. In sum, this displacement is a combined and complex process, which entails more pressure on the aquifers – primarily in the upper Tunuyan basin-, and the growing competition between uses and users. This dynamic is now being measured and quantified through the relationship of land use change and water balance studies. We expect to finish that analysis for the end of the project. In reference to the assessment of groundwater depletion, we analyze secondary data collected by DGI through Water Balances.
  - Comparatively, both basins (the Mendoza and Tunuyan) pose demonstrable threats to water security as defined by Grey and Sadoff's (2007, 547–48). Mendoza and Tunuyan river basins have increasing water related risks to people, environment and economies. Droughts, pollution, salinization, flood, and unequal distribution, are the main threats to water security in these Andean river basins.
  - Agriculture (viticulture) is expanding from the Uco Valley to shrublands, while in the East Zone there is increased land abandonment. The driver of this dynamic is the economic profitability of traditional viticulture, located mainly in the East Zone, and the global market participation of the Uco valley. This valley traditionally produced apple, pear and vegetables, but in the last 20 years, new investments arrived to develop “high altitude” viticulture, and totally transformed the valley. Currently more than 50% of the irrigated lands are cultivated with fine grapes destined to make premium wines for the globalized market. This phenomenon is entirely related to water because this agricultural expansion was based on groundwater extraction, and there are serious risks of aquifer depletion if this dynamic continues. As mentioned above, this is currently being investigated through land use change and water balances studies and extensive fieldwork interviews.



- Development of a monitoring tool to detect land use change for the province. Some features are: 1) Temporal analysis of satellite images, with periods as broad as possible, 2) easy replicability, 3) free accessibility to image input, software and tools, 4) possibility to compare with other work from CCUS and more regions. Although there exist dozens of land use tools, they don't focus on the evaluation of change and/or they are so complex that public stakeholders don't use them. Besides, they are not adapted to monitoring the dynamics of the main local land uses. All these considerations were developed in Bernabeu, M; Martín, F & Rojas, F. "Reflexiones teórico metodológicas para el estudio de los cambio de uso del suelo en Mendoza, Argentina". Paper presented in V ELMeCS, Universidad Nacional de Cuyo, 2016.

#### Future steps:

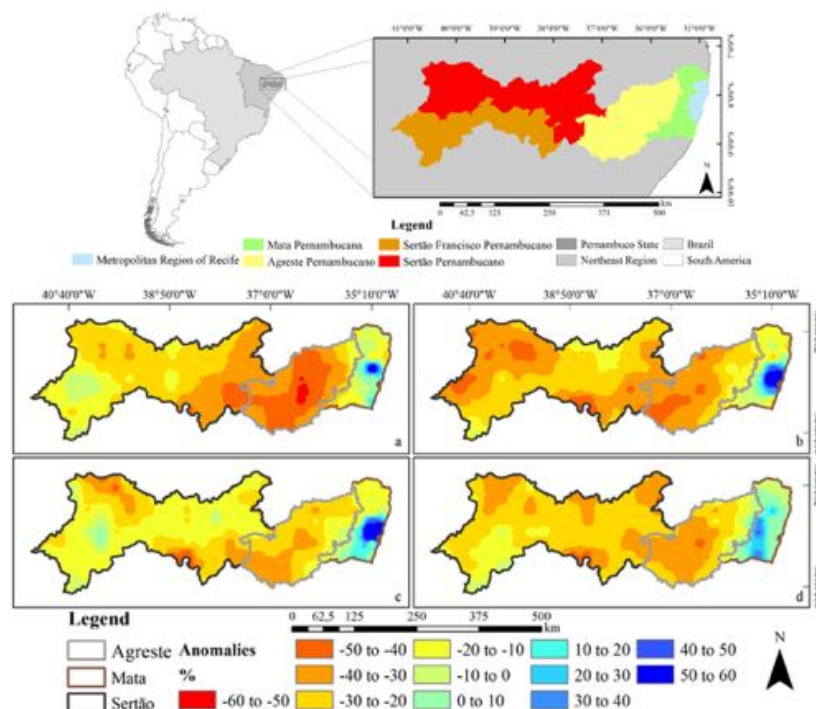
- Continue research and fieldwork to improve the identification of land use changes.
- Integrate with other working groups from Mendoza (IADIZA, Rural Development Institute, General Irrigation Department).
- In order to complete a comparative analysis of land use change and water insecurity between the Mendoza and Tunuyan river basins, we have been conducting different activities:
  - Conceptualize and review specific bibliography and local case studies on land use, land use change, and water insecurity. Facundo Martín, Facundo Rojas and María Marta Bernabeu are working to write a scientific paper on Land Use Change Studies in Mendoza and Tunuyan River Basins.
  - Produce land cover classifications for main crops and uses in the basins.
  - In looking for the definition of what kind and time of Landsat images to use, the phenology cycle for the main identified crops is needed (to capture the growth of grapes the images must have been taken during summer; on the contrary to capture garlic dynamic it must have been taken on winter/spring).
  - Take training points around the basins (more than 100 for each class). Training points are necessary to check and optimize the model. They were taken to cover all the study area by maintaining proportional distribution within basins and cover classes.
  - Map land cover change over the last 25 years.
  - Development of a series of maps on changes based on Landsat images. The model is currently in adjustment. We plan to have the first results on the 2017 Report. We are planning to produce three co-authored scientific papers (see details below).
- Producers' vulnerability research: Mendoza has 25 % of all irrigated agricultural land of Argentina, and different sources of vulnerability (crop type, size of cultivated area, etc.). This study developed methodology and applied a social typology of agricultural producers based on secondary information (National Agricultural Census). Also included conducting interviews with farmers and institutions related to water management.
- Innovation: "Climate Extreme Index for rural adaptability", environmental exposure data + sensitivity indicators + adaptive capacity.
- Theoretical research on Vulnerability Assessment (e.g. Vulnerability & Resilience Index – linking scenarios with biophysical data and policy guidelines)
- We have been conducting several Science Policy Dialogues. Plan Agua 2020; follows a technical and scientific strategy. CONICET Staff is working on methodological



aspects of Water Balance Assessments conducted by DGI over Mendoza and Tunuyan River Basin.

## Brazil

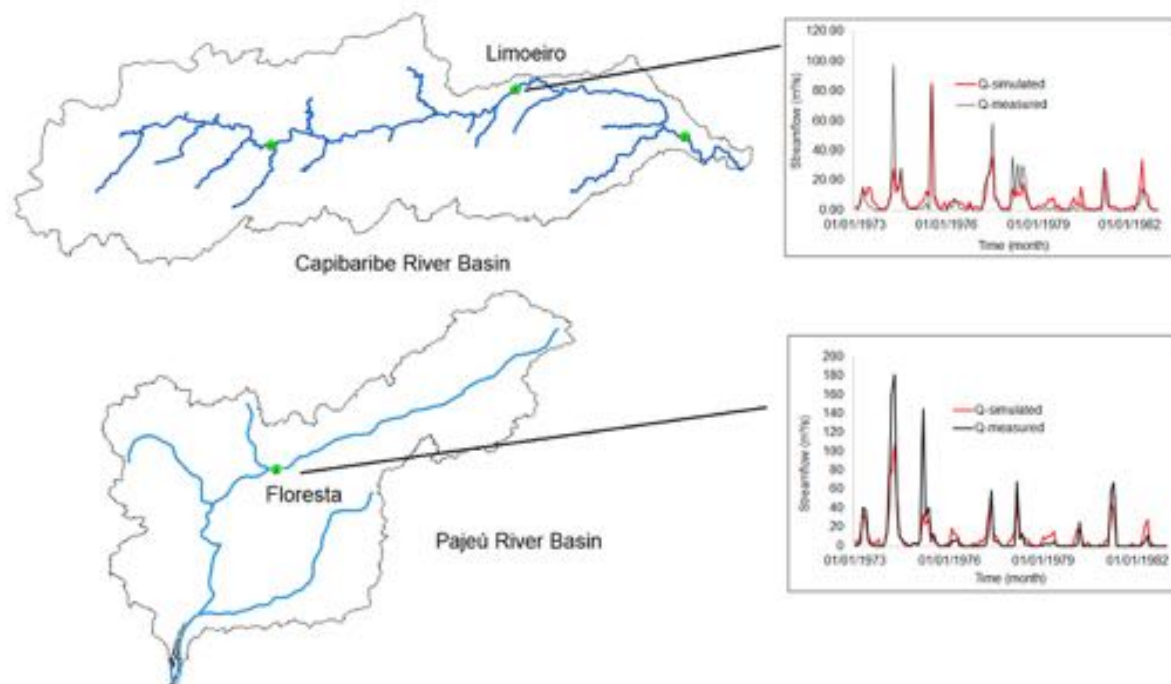
A PhD student is developing work to use remote sensing products to calculate drought index for agriculture purposes in Pernambuco State, Brazil. An important step of this study was to validate soil moisture data from Soil Moisture Ocean Salinity (SMOS) using two in situ databases. The validation process involved two approaches, pixel-station comparison and areal average, for three regions in Pernambuco with different climatic characteristics. After validation, the SMOS data were used for drought assessment by calculating soil moisture anomalies for the available period of data. Four statistical criteria were used to verify the quality of the satellite data: Pearson correlation coefficient, Willmott index of agreement, BIAS, and root mean squared difference (RMSD). The average RMSD calculated from the daily time series in the pixel and the areal assessment were  $0.071 \text{ m}^3 \cdot \text{m}^{-3}$  and  $0.04 \text{ m}^3 \cdot \text{m}^{-3}$ , respectively. Those values are near to the expected  $0.04 \text{ m}^3 \cdot \text{m}^{-3}$  accuracy of the SMOS mission. The analysis of soil moisture anomalies enabled the assessment of the dry period between 2012 and 2017 and the identification of regions most impacted by the drought. The driest year for all regions was 2012, when the anomaly values achieved  $-50\%$  in some regions. The use of SMOS data provided additional information that was used in conjunction with the precipitation data to assess drought periods. This may be particularly relevant for planning in agriculture and supporting decision makers and farmers.



Soil moisture anomaly in 2012–2017 compared to 2010–2011 for the (a) JFM, (b) AMJ, (c) JAS, and (d) OND seasons.

The large scale distributed hydrological model called MGB-IPH has been applied in both river basins (Capibaribe and Pajeú). This model has been widely applied in distinct South-American watersheds, for different purposes, such as streamflow forecasting, simulation of land-use

changes, evaluation of climate change impacts and assessment of hydrological processes. The calibration and validation of the model used five streamgauges in Capibaribe River Basin (CRB) and three in Pajeú River Basin (PRB). Figure below shows the results of calibration with simulated and observed streamflow.



*Model calibration in Capibaribe and Pajeú River Basins.*

Next step – after calibration and validation, the model will be used for simulations of land use and climate change scenarios. The land use scenarios have to consider possible future arrangements in the basins. The Land Use and Cover Change modeling framework (LuccME) developed by the National Institute for Space Research (INPE) will be tested for production of the scenarios. The climate change scenarios will use simulations from the regional model Eta-CPTEC nested to the global circulation models HadGEM2-ES and MIROC5.

In the Pajeú River Basin, it was done application of information acquired by aerial survey to characterize water supply reservoirs. The survey was carried out by the Government of Pernambuco State and used digital cameras of high spatial resolution and laser relief profiling (LiDAR technology). Two areas were selected to apply the remote sensing products. Small reservoirs in the Quixaba Creek Basin were identified based on their topographic characteristics. In another application, the storage capacity of the reservoirs belonging to the hydrosystems of Pajeú River Basin was estimated. The storage in these reservoirs and maximum surface area were estimated using DTM and geoprocessing tools. From the total of 31 reservoirs evaluated, eight were completely empty at the time of the LiDAR data collection. The official registers reported 83.83 million m<sup>3</sup> for the storage capacity of these eight reservoirs, whereas our applications estimated the value at 70.23 million m<sup>3</sup>.

## Mexico

- Furthering institutional change in urban water management in the Sonora and chihuahua regions
- Lobbying policymakers for institutional reform of water management in Mexico

- An assessment of the perspective of desalination of sea water for export in the Gulf of California.
- In general, raising awareness about water security and the demands of sustainability and adaptation for water management in Mexico. This includes the participation in academic meetings, as well as in a number of op ed. editorials in newspapers, radio talk shows as well as direct liaisons with public agencies.
- Bibliographic research about climate change and its possible impact on Sonora River Basin: The outcome of this activity is a spreadsheet of the main ideas of each article. Among the most important results are: 1) a consensus on larger climate variability projected for the Sonora River Basin, with a trend to increasing temperatures and decreasing precipitations, but the magnitude of change varies across locations, seasons, and models. 2) For the broader southwest U.S.- northwest Mexico region, a light increase in precipitation is expected, but combined with higher temperatures and evapotranspiration, less runoff from rivers could be happening. Climate models for this region tend to be more consistent between them. 3) Increased intensity for ENSO events is expected in the region. 4) The reservoir system of the Sonora River Basin has reported progressively less storage volume (including aquifers in the region), and this is connected to a hydrological regime change in the river (from perennial to intermittent).
- In parallel to this bibliographic research, one of the RAs -A. Lutz- partially funded through this project conducted a literature review on adaptation strategies to global change in rural communities of Mexico and the southwest United States. The outcomes of this activity are a database that systematizes this literature and a research paper that will be submitted to an English-language peer-reviewed journal in 2017. The main findings of this literature review are that: 1) rural households in the Southwest United States and Mexico perform adaptation strategies within the spaces in which they have more decision-making power (the farm and the household), and more institutional or policy-oriented strategies that go beyond the local scale or have more transactions costs, are barely pursued. 2) A large majority of these studies equaled rural adaptation with just agricultural adaptation, and adaptation of those livelihoods that are non-agricultural is neglected, although they are also part of contemporary rural communities. 3) While land policy is considered an important factor affecting adaptation options for Mexican rural communities, water policy is not included, in contrast with studies of rural communities in the Southwest U.S., where water has been early recognized as a limiting factor. 4) Except by one study that focused specifically on the landscape effects of adaptation strategies in rural communities of southern Mexico, there is no assessment or evaluation of the long-term effects or outcomes of adaptation strategies. Further development of indicators to measure long-term impacts of these adaptation actions will be required as global change further advances.
- Acquirement of a matrix of land use change in the zone located between El Molinito Dam and Abelardo L. Rodriguez Dam, years 1993, 2002 and 2011. The outcome of this activity is the quantification of land use change during that time frame. The main change was a drastic decline in agricultural use, from 8,818 hectares in 1993 to 2,983 hectares in 2011; this use was replaced mainly by mesquite, grassland and riparian vegetation. The driver of this decrease is lack of water availability for irrigated agriculture. Evidences of this has been reported in Díaz-Caravantes, R. E., & Wilder, M. (2014). *Water, Cities and Peri-urban Communities: Geographies of Power in the*

Context of Drought in Northwest Mexico. *Water Alternatives*, 7(3), 499–517. ISSN: 1965-0175.

- Search of climatological variables with an outcome of the exploration of Daymet database <http://daymet.ornl.gov/>: In this database we can find different variables, such as maximum temperature, minimum temperature, humidity, solar radiation. Unfortunately, we found information gaps in different periods, so we could not use this source.
- Precipitation data analysis of 14 climatological stations operated by CONAGUA. The outcome for this activity is a visualization of spatial distribution during a 10-year period. Information will be uploaded in the map project.
- Indexing the land use behavior for the years 1993, 2002 and 2011 in wet and dry conditions: the outcomes for this activity are maps of vegetation indexes for the period. Although mesquite, grassland and riparian vegetation were the types of land use that grew more between 1993 and 2011, they do not seem to represent positive changes for productivity, since the 2011 vegetation index is much lower than in 1993. This trend of decreasing vegetation index has occurred even for those vegetation types that did not change from 1993 to 2011, such as riparian vegetation.
- Sonora River Basin (SRB):
  - Between June and August 2015, surveys were conducted by A. Lutz from the University of Arizona in 100 rural households of the upper, mid, and lower communities of the San Miguel Watershed (SMW), a sub-basin of the SRB. Given the size and characteristics of the communities, the sampling procedure combined purposive sampling with snowball technique. The surveys collect information on socio-economic variables (demographics, education, livelihood systems); access to productive assets (land and water); and biophysical indicators of change perceived by the community members (changes in precipitation, temperature, biodiversity and wildlife, and economic animal and plant species). An excel database was created to capture all the collected data and descriptive analysis was conducted on the variables included in the survey. Several livelihood groups were defined from these data utilizing qualitative criteria backed by factor analysis.
  - Some preliminary findings include: 1) An increasing complexity and variety of livelihoods pursued in rural communities beyond ranching and farming. **Four livelihood profiles were defined based on the socio-economic characteristics of households: fully agrarian (those performing exclusively ranching and farming activities), diversified agrarian plus non-agrarian (people that has diversified to businesses beyond ranching and farming), fully non-agrarian (miners, small commerce, services), and diversified with non-steady income (mostly daily wage laborers). Each of these profiles vary in their dependence on natural resources and their levels of vulnerability to global change-related stressors.** 2) **Households with different livelihoods have varying** perceptions and knowledge on global change stressors and shocks, which suggest that sources of vulnerability in rural communities are highly dependent on the livelihood resources or capitals that are impacted by global change. Temperature and precipitation changes were the most noticeable stressors for those in the first group, lack of public services and domestic water for the second and third group, and lack of employment for the fourth group. This points out to the importance of considering climate change in a context where other parallel stressors are occurring and where the level of importance of climate change depends on livelihoods profiles. 3) There were differences in

the scope and nature of adaptive strategies mentioned based on the type of livelihood pursued by households, with bigger variety of strategies reported by agrarian households, but these differences were not significant. Almost all the households referred to strategies to manage the cattle or the farming land because they think that mainly ranchers and farmers would be affected by climate change, and not much impact would be felt on non-agrarian households.

4) Several institutional factors acting as stressors or as enhancers of adaptive capacity in terms of water and other critical resources for adaptation at the level of rural communities in the basin. Lack of public investment and services, and lack of domestic water were indicated as the main stressors by two of the four livelihood groups. While these stressors can be thought of as economic and environmental, they have an important institutional component, in the first case because it is decision-making by governance structures what defines how much public resources are directed towards rural communities in contrast with cities; and in the second case because the rules regulating internal distribution of water within communities, and the lack of infrastructure for domestic water supply are both dependent on institutional arrangements by local authorities and water users. Overall, these findings illustrate the relationships between physical change and social dynamics (related to task 1 of this project), as well as the sources of vulnerability associated to different livelihood groups in rural Sonora (task 2). The findings also relate to the conditions of water and land resource management as reported in other study (Lutz and Scott 2016).

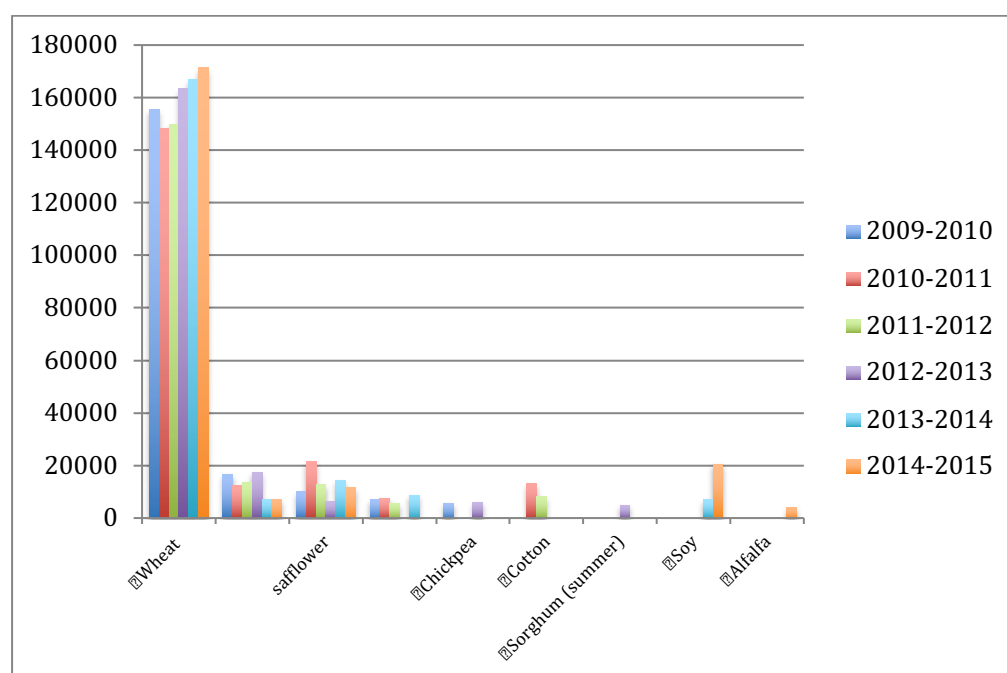
- o Also in the summer of 2015 an undergraduate student of the University of Arizona- UROC Program worked with A. Lutz and C. Scott. The student analyzed water rights spatial concentrations by plugging in well coordinates, by sector, into Google Earth. She also calculated the degree of use-rights concentration with Gini-coefficients calculated from water rights data from the Mexican water commission's (CONAGUA) public registry of water rights (REPDA) database, which has numerical well information, such as amount allotted to water rights users. We found an important level of inequity amongst agricultural water rights holders, a sector that holds most of the allotted volume among all the sectors in the basin. In the future when there may be a drought, this could become a problem for the many water rights holders who are allowed to extract smaller quantities than the few agriculture operations who extract larger quantities of the water, which will leave many small agriculture operations vulnerable. The results of this work were presented in academic and non-academic forums by the student, who now is a master student of the program Water, Society, and Policy at the University of Arizona. In the months after this collaboration, the feasibility of conducting a similar study for the entire SRB was analyzed. However, there is work already published by some participants in this project regarding water rights evolution and distribution in the SRB (Pineda-Pablos et al. 2014). Then, the feasibility of using updated rural and urban water rights information coupled with spatial information on water extractions will be considered as a potential study to be developed by a postdoctoral researcher in 2017.
- o In September 2015 spatial data were obtained from the Mexican National Institute of Statistics and Geography (INEGI). These data were used to inform the biophysical context of the San Miguel Watershed, within the broader SRB (Lutz-Ley 2016, Ph.D. dissertation). These data will be used in 2017-2018 to support a comparative analysis of land use change tied to changes in water and

land policy in the San Miguel Watershed and the transnational San Pedro River Basin to understand how different socio-economic drivers (mining, de-agrarianization, and urbanization) interact with policies to produce different types of results. We expect to find large landscape changes in terms of reduction of agricultural land connected to lack of water due to drought (in the SMW) and population growth (in the transboundary San Pedro river)

- Between October 2015 and January 2016, a team led by R. Díaz from El Colegio de Sonora conducted an analysis of health threats in the broader Sonora river basin due to water quality issues. The outcome of this analysis is an academic paper. This is an abstract of the paper:
  - Abstract and Key Findings: On August 6th, 2014, the event labeled as the “worst environmental disaster of the mining industry in Mexico” occurred in the Sonora River, when Buenavista del Cobre mine spilled around 40,000 cubic meters of an acidic leachate. In order to expand our knowledge of the consequences of this event, the water-quality monitoring database was analyzed for groundwater from the Río Sonora trust fund webpage. Due to the health relevance of the spill, the reported data was compared to the established maximum allowance values of Mexican regulations. Furthermore, for an enhanced discussion, the case of arsenic was also analyzed, comparing the data with Mexican regulations as well as with the WHO guidelines for drinking water. This study identifies some spatiotemporal trends of some metals and physical-chemical parameters of surface and groundwater quality. In the case of groundwater, taken the guideline of the World Health Organization as a criterion for the permissible limit in the case of arsenic, the lower part of the basin of the Sonora River is where more times is observed to exceed the limit of 0.01 milligrams per liter. According to the WHO guidelines, the places with more frequency of values exceeding this limit were La Labor, San Rafael de Ures y El Molinito. Specific details of these analyses can be found in: Díaz Caravantes, R. E., Duarte Tagles, H., & Durazo Gálvez, F. M. (2016). Amenazas para la salud en el Río Sonora: análisis exploratorio de la calidad del agua reportada en la base de datos oficial de México. *Revista Salud UIS*, 48(1), 91–96.
  - Between March and September of 2016, this team also conducted data collection in the Sonora river basin for input into geographic information system analysis. Training points were collected for remote sensing procedures, polygons were built after these, and preliminary analysis of land use and land cover for the region of Ures, in the lower Sonora river basin was performed.
- Yaqui River Basin (YRB): This part of research is in part designed under two baseline studies:
    - “In name only: Water policy, the state, and ejidatario producers in northern Mexico” (2002 Ph.D. dissertation), conducted by Dr. Margaret Wilder.
    - “Understanding community-based adaptations to climate change: droughts, disturbance characteristics, household strategies, and collective action in Mexican irrigation communities” conducted by Dr. Sergio Villamayor-Tomas where a Ph.D. student, Yulia Peralta, led fieldwork, applying and coordinating 74 interviews, during January-May 2014.
      - In November 2014 a scope fieldwork was conducted in the Yaqui River Irrigation District to collect initial information about the farmers’ visions, perceptions and main problems related to climate change within their water

management and agricultural activities. This visit allowed us to establish a connection with the Yaqui River Irrigation District (DRRY 041), and their senior irrigation district personnel. The team also visited the irrigation module 02, and applied open interviews to their personnel and farmers.

- o During May 2015, semi-structured interviews were applied to irrigation-module staff, producer group representatives and irrigation district personnel: large, medium and small farmers, to gather physical information about their land, crops, irrigation methods, and general challenges related to climate/global change. We found an initiative of experimental fields with less water intensive crops (castorbean, also known as ricinus), based in a communal-land based irrigation module. This is an interesting experiment to study, considering that wheat (a very water intensive crop) is still the dominant crop that is grown in this irrigation district. Communal-based farmers and the private company “castor fields” who are experimenting with castorbean seek to recommend this crop to the rest of the irrigation modules as an affordable option that will require less water for production.



*Number of hectares planted at the Yaqui Valley Irrigation District from 2009-2015. Source: Rio Yaqui Irrigation District data, 2015.*

- o Some biophysical climate change findings include reduced rainfall and higher temperatures. **The following information was recollected from interviews applied to the irrigation district and module personnel, farmers, and data from the irrigation district (DRRY 041):**
- o A 26% reduction of the average flow in the storage/reservoir system of the district (the first 40 years: 3,312MM3 vs. the last 16 years: 2,454 MM3) and an addition, in 2010-11, reduced further to: 2,030 MM3 (represents a 36% reduction in the average flow).
- o Prolonged drought has reduced Rio Yaqui reservoirs—at its lowest point, on July 1, 2003, to 76% of capacity on average, including all 3 dams



- In interviews in Rio Yaqui irrigation district in May 2015, there was a consensus among irrigation district representatives and irrigation modules leaders that: 1) climate change is the most significant problem confronting them; and 2) that the increase in temperature and lack of ‘cold hours’ (horas frias) had adversely affected wheat crops. The warmer temperatures allowed a new pest (or fungus) invasion that had reduced wheat yields by up to 30%. This was causing 2015 wheat crop to shape up as one of worst years. Low wheat productivity in turn is driving more reliance on “segundos cultivos” (a second round of crops) using groundwater from wells. So, higher temperatures causing more use of irrigation water generally, and intensified reliance on groundwater sources translates into continued depletion.
- During July- August 2015, we applied semi-structured interviews to credit unions, trading companies, the Ministry of Agriculture, and started to establish contact with NGOs and civil society alternative networks.
- The Association of Farmers' Organizations of Southern Sonora (AOASS). AOASS is one of a kind trading company that agglutinates seven organizations of producers summing approximately a quarter of the Yaqui Valley’s producers. It is important to mark that these producers own a quarter of the Yaqui Valley’s land. A summary of the main results from the survey are:
  - The main crops that their associates produce are: wheat, corn, soy, sorghum, and sesame seed.
  - Usually, 50% of the associates are oriented to the national market and the other half exports their products in the international market. During 2015, their associates commercialized more to international markets.
  - 80% of the commercialization is wheat (600 to 650 thousand tons of wheat is commercialized per cycle. Each cycle last approximately 7 months).
  - 30% of the profits are decreasing because of the cold-hours.
  - The average yield was 7.2 tons per hectare; the last cycles have decreased to 5.3 tons per hectare.
  - AOASS, along with their associates and other organizations (INIFAP and CIANO) are looking for other diversities, more resilient to climate change. But it takes from 5 to 7 years to find a new diversified crop.
- The Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) has a department in the trading companies to facilitate the process.
  - SAGARPA has a federal office and connects with state offices, and then with the Center for Rural Development Support of the Secretariat (CADER).
  - The main program they manage is PROCAMPO. This program started at the beginning of the 90’s to support the establishment of crops (for auto consumption and sale).
  - PROCAMPO is complemented with ASERCA, which is a governmental program independent of SAGARPA.
  - The government policies have evolved into an unclear system of rules that are contradicted between its objective and operationalization, supporting the same pattern of agriculture and crops that need more agrochemicals and water to grow.



- It is necessary to have more workshops within the government organizations, producers, and the intermediaries involved (like the trading companies).
- In August 2016, Ph.D. student Yulia Peralta was awarded the Peter Johnson scholarship to visit the NGOs identified during the previous summer, and engage key stakeholders in this research. An overview of the Yaqui tribe and the situation with irrigation, hydraulic infrastructure, and vulnerability was conducted as potential future research.
- The remote-sensing and land use/ land cover work described above has primarily been developed for the Santa Cruz River Basin and adjoining areas in both Arizona and Sonora.
- The findings of this research include:
  - Remote sensing of evapotranspiration at high resolutions allows for large-scale measurement as well as the ability to observe changes over time at specific locations.
  - Evapotranspiration is a highly complex landscape process, which is challenging to accurately measure directly or indirectly, and requires an extensive validation process.
  - METRIC might not be as applicable to urban areas, where high values of ET are reported based on the modeling results. Irrigation activities could play a role in this case.
  - More validation would be needed to further explore these ET values where they are extrapolated to urban and dryland cover types. METRIC works well within agricultural areas, but could underestimate ET.
  - Increases in overall ET due to land use change or higher temperatures, with the same or declining precipitation rates, will result in a decline of the water availability, highlighting questions about water security in arid regions.
- These results indicate that the Santa Cruz River Basin represents a region with extreme variability in weather and events (e.g. fire) that make it hard to measure trends.
- Also a literature database was built for the Santa Cruz River regarding ecological and social variables impacting water resources development and ecological services associated to this. This work was supported by collaboration of an Honors undergraduate student doing her summer work at the Udall Center with A. Lutz and C. Scott. The database is available on request at the Udall Center for Studies in Public Policy.
- The upper Yaqui River Basin geographically starts within the United States, near Douglas, Arizona, where the San Bernardino River flows north-south into Sonora to become a tributary of the Bavispe river, that later joins the Yaqui river main stream. During 2017, an exploration of data availability for this area will be conducted through documentary and literature collection, and field visits. Previous work funded by NSF-CNH focusing on the San Pedro River can offer valuable lessons regarding transboundary river basins subject to rapid environmental, socio-economic, and demographic change. In the case of the upper YRB region, the pertinent focus could be the interplay between rural, urban, and ecological water uses and actors in the U.S. but also in the Mexican side since most of the work has been focused in the lower river valley and the Yaqui Valley Irrigation District. An additional component of this analysis can include also the horizontal and vertical

transboundary interactions of organizations and institutions in charge of managing these resources on both sides of the US-Mexico border.

## Task 2 - Document human and ecosystem exposures to hydro-ecological and globalization processes thereby addressing specific risks and strengthening river-basin resilience

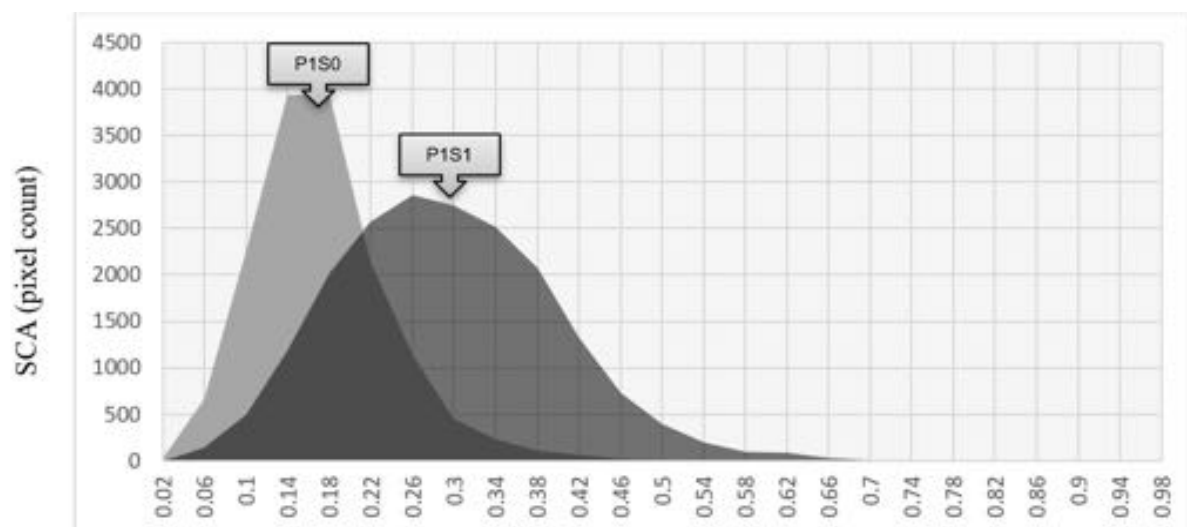
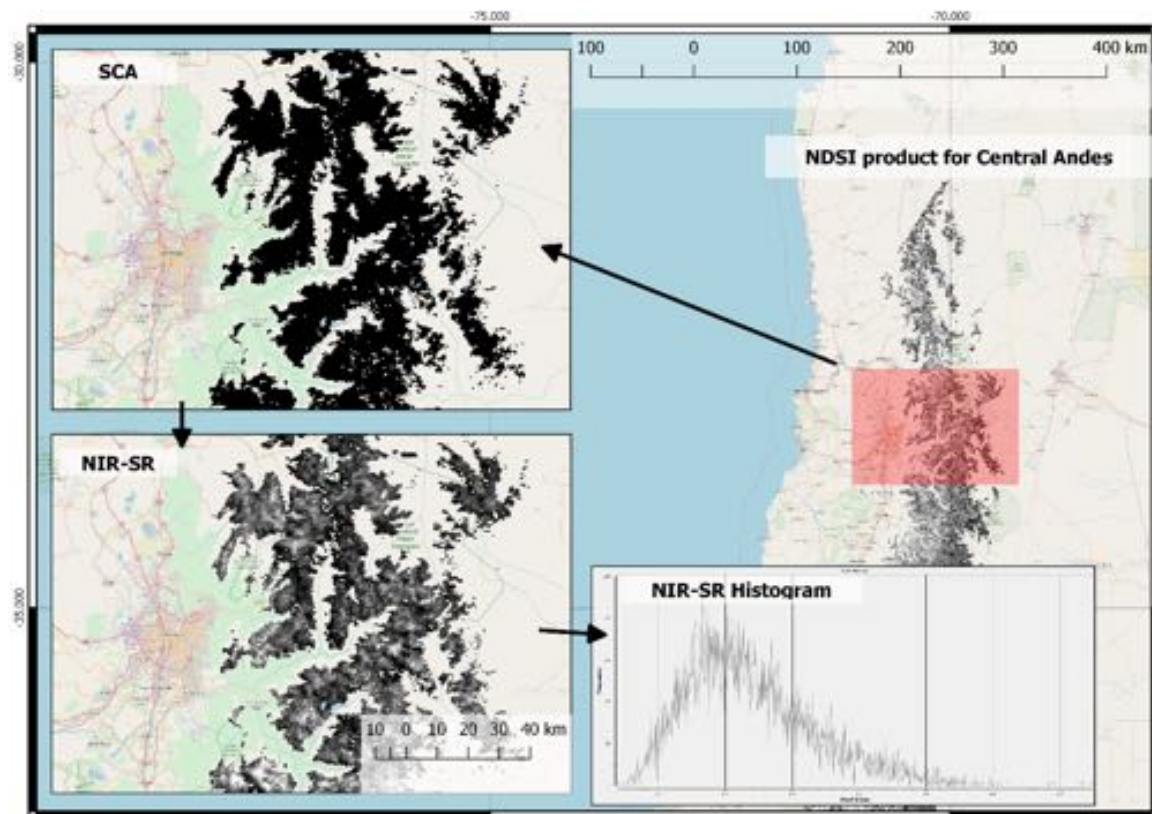
Climate change and uncertainty in the availability of water, coupled with rising demand for water for human consumption endanger the availability and quality of freshwater in the basins proposed for this study. The project's task 2 aims to:

- Identify, analyze and classify the main critical nodes of vulnerability in each area of study, evaluating the processes and consequences that influence them.
- Identify and consider -current and potential present and future- adaptation strategies developed by rural producers, institutions, and resilience factors, evaluating the impact that these adaptations have or would have to reproduce or transform existing conditions of vulnerability.

We applied the theoretical and methodological proposal built during this period.

### Chile and Argentina

Snow is a fundamental resource to ensure water supply in the Maipo-Mendoza regions. It can be regarded as transboundary resource. We developed a research to analyze the effects of climate change on the vulnerability of this resources, particularly looking at Rain on Snow events. Rain on Snow events Rain-on-snow (ROS) events can alter nival regimes by intensifying snowmelt and peak river-flow, and reduce water storage, leading to earlier and shorter melting. Our objective is to study ROS occurrence and its fingerprint on snow-reflectance and patterns on Andean snowpack, using fifteen years of MODIS imagery, weather, and hydrology data. Using snow-masks and near-infrared reflectance, we created Snow Cover Area and Near Infrared Snow Reflectance variables and assessed their responses to identify precipitation events. The statistical moments of snow and rain events were significantly different across study basins. Rain events reduced snow cover and reflectance, with higher skew and kurtosis and lower mean and standard deviation, consistent with theory. Maximum and minimum temperatures increased prior to ROS and subsequently decreased. River-flow effects were observed during the subsequent summer, with significantly different hydrographs between years with high and low ROS occurrences. Years with more than nine events showed larger and more-skewed hydrographs, with earlier peak-flow, and some sub-basins changed from nival to pluvial regimes. Years with fewer than six events had normally-distributed hydrographs, with lower peak-flows. This methodology identifies likely past rain events and helps explain effects on snow and temperature, improving streamflow predictability, and elucidates climate-change impacts on mountain snowpack.



- Maipo Basin: Building upon the social-institutional analysis for Task 1, the research team is in the process of assessing vulnerability and resilience across the basin.
  - Critical productive systems/activities have been identified and exposure and sensitivity components are being assessed based on Task 1 data.
  - Data analysis is underway for interviews with key stakeholders about climate change adaptation and vulnerability (conducted in 2015).
  - Ongoing collaboration with the MAPA Adaptation project has allowed for dialogue about adaptation planning, potential for implementation of adaptive measures and triangulation of data.

- Elqui/Limari: critical productive sectors have been identified, contact with key stakeholders has been established, and vulnerability and resilience will be assessed and compared to the Maipo during 2016 and 2017.
- A conceptual framework for the development of vulnerability assessment based on the concept of water security has been developed and applied to the Maipo River.

### Argentina

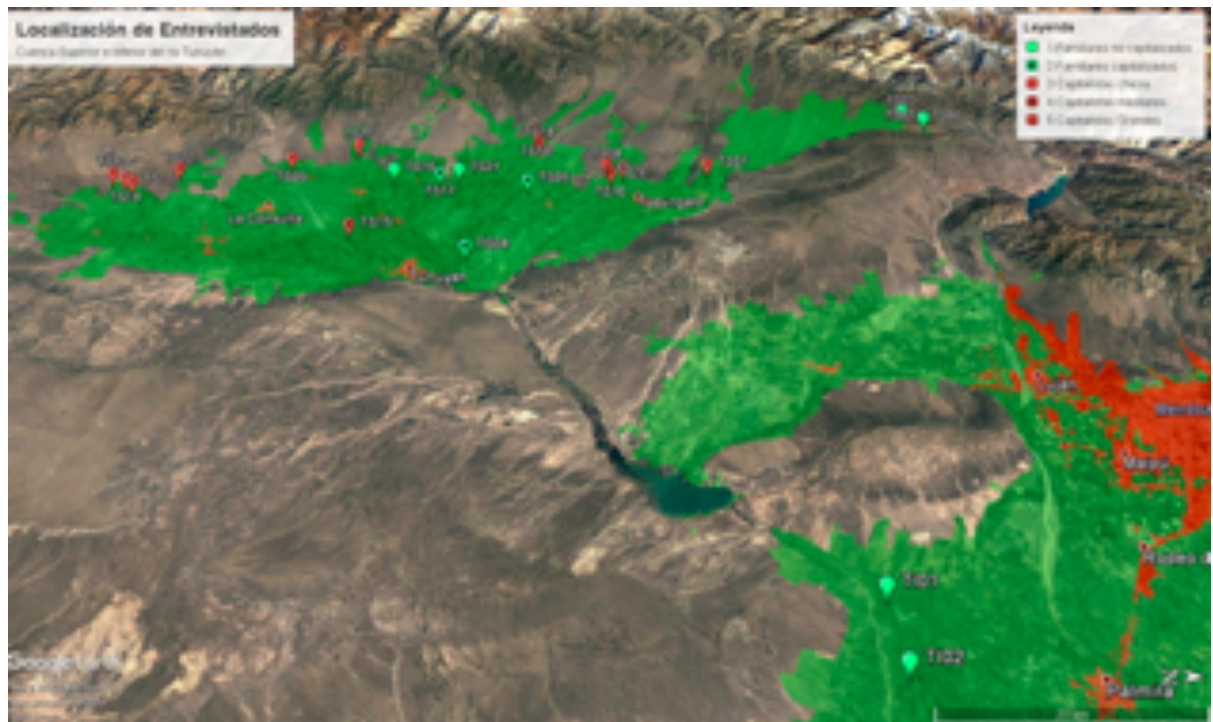
On the vulnerability assessment section, during last period with data provided by National Agricultural Census 2008, we developed a typology of producers. This instrument was defined with variables grouped around the **organization of work (family or; paid work)** the **cultivated surface** and the **capitalization**. One of the most relevant aspect of this typology is that it is built from variables specifically selected for local context & regional production. In this way, the output was a typology theoretically founded on local specificities of the study area, with 5 types of producer

#### *Typology of producers*

Family Producers		Capitalized Producers		
No Capitalization	Capitalized	Small	Mid	Big

Based on the comprehensive typology of producers built during previous cycle, we applied the theoretical sampling for conducting the interviews. Previously, we trained students for following the methodological guide for this social research. Within the general project's task 2 goals, the interviews aim to assess environmental/agri/social transformations in the basins (who wins, who loses); vulnerability social production and determinants of vulnerability; and vulnerability trajectories/processes.

In different field visits we conducted a total of 46 interviews in both Upper and Low Tunuyan River Basin. We also complete the transcription of all the interviews conducted so far. The figure shows some of the interviews locations. We also conducted and transcribed 11 interviews with institutional representatives.



*Location of interviews.*

### **Preliminary results and findings.**

This analysis presents preliminary results related to vulnerability, the agrarian problems of Mendoza and particularly in the area of the Uco Valley.

From the beginning we have tried to understand rural vulnerabilities deeply. That is, to address the root causes of vulnerability and to demonstrate the complexities of the processes that frame vulnerability.

The main thrust of the analysis indicates that in its roots, vulnerability is associated to territorial transformation unleashed in this region and that is the core of a new agribusiness-based development model. Along with this process, the agricultural frontier extended uphill triggering environmental and socio-economic changes: on the one hand, ecosystems modification is altering the dynamic of natural runoff in the basin and changes in the levels of the aquifer. On the other hand, regarding social and economic dimensions, the emergence of new national and transnational actors fostering better returns (wine, horticulture, estate) changed not only the value of the land, but also the threshold of profitability of the complete farming system. In addition, these processes of concentration of resources and returns in hands of a few actors (linked to the production and export of agricultural products) enhance as also increases - by contrast - the loss of a traditional way of doing agriculture.

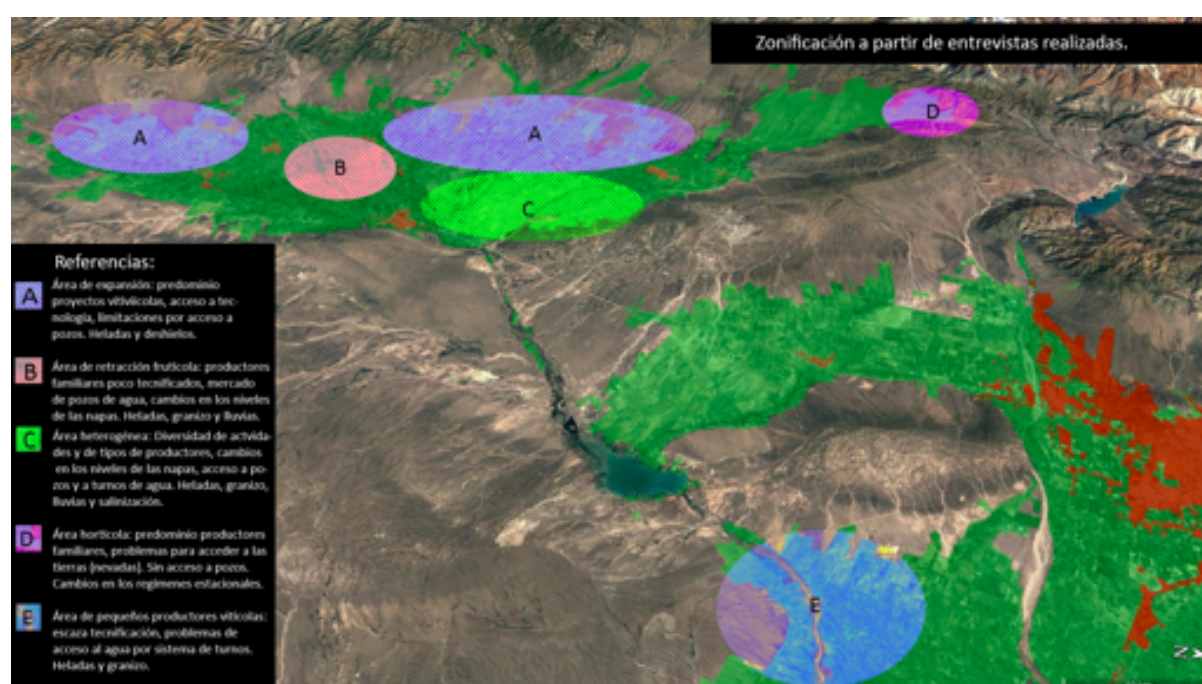
In this way, a model of agricultural development boosted by transnational actors, that engender a high investment in capital and shifts labor by modernization and productive resources it is consolidating. Consequently, some groups of small and mid family producers are disappearing due to successive crises and transformations (social decomposition).

In summary, we observe that these territorial changes bring new challenges to these areas, including: more competition for resources such as water, land abandonment, consolidation of the foreign component of the territory, deforestation of native vegetation, alteration of the natural runoff drainage network, job losses.



With the data released so far, it is possible to identify 5 large areas in the study area.

- A. Expansion area. Predominance of wine-growing projects, access to technology, constrained by lack of access to groundwater. Problems by frost and thawing.
- B. Fruit retraction area. Family Producers, low technified, market of water wells. Napa retreat. Frost, hail and rain.
- C. Heterogeneous area. Diversity of activities and types of producers. Napa retreat. Access to surface water and groundwater. Frost, hail, rain, and salinization.
- D. Horticultural area. Predominance of family farmers. Problem to access farms because of snowfall. No access to groundwater. Changes in weather seasons.
- E. Area of small wine producers. Low-tech. Problems of access to surface water. Frost and hail.



*Location of study areas.*

Other preliminary results of the analysis:

Differential impact of climate variability: climate variability is a more or less random factor that regulates the market. That is to say, there is a climate regulation of the market and a differential use of such regulation because best positioned actors always have a competitive advantage on this and are able to capture more of the total profitability. Access to large tracts of land distributed in different areas allow these large producers to adapt better to climate variability. Climate is also a market regulator of the market for small producers in a different sense. When unusual rains affected the whole province, there was a general increase in the price of crops that benefit small producers who were not affected and could offer some product. However, these benefits are situational and are often limited by market policies (for example, when the price of the grapes increase the wineries imported grape of Chile to lower price).

Decapitalization/social decomposition: small producers can control much less factors and are much more exposed to changes in the macroeconomics (exchange rate policy, imports, etc.),

the increase in costs and the lack of price for their primary products. All interviewees expressed an important decrease in profitability since year 2010 -2011. This is typical for producers that only access local markets, where the price of goods and services fails to match the inputs costs.

Changes in the productive strategies: After a string of negative years those who are able to maintain a capital investment vary their productive strategies. For example, there is less pears and apples production with the advance of the surface planted with vines. Or garlic instead of horticulture.

Technological Change: Uco Valley region experiences a significant technological change, specifically but not exclusively, in water use. Drip irrigation technology allows irrigating more acres with the same amount of water and getting greater yields. This change allows increasing cultivated areas in a region where water is one of the limiting factors in every case. These irrigation systems are typically associated with the possibility of accessing water: in some cases farms have surface irrigation licenses, other only have groundwater access and many have both types of irrigation. New agricultural entrepreneurship - real estate can expand into uphill areas thanks to these water technologies as well as to the possibility of using the soil as a mere support of crops since the whole process of fertilization is artificial.

Next steps:

- Feldwork (interviews with producers and institutional referents).
- Transcription and analysis of the new interviews.
- Development of presentations/ conferences.
- Articles with the results.

## Brazil

The participation of the community in the decision making process is not restrict to river basin committees in the semiarid of Pernambuco State. The major reservoirs for water supply have Water User Councils that play an important role the process of water management. These councils ensure decentralized and participatory representation among public authorities, users and civil society for the promotion of water management. The framework of the participatory entities in the Pajeú River Basin was analyzed based on the minutes of meetings of the Committee River Basin and the Reservoirs User Council and workshop for application of questionnaires. According to the data collected, the following conclusions were gotten:

- The frequency of meetings increased after the intensification of the drought started in 2012;
- The plenary meetings of the Water User Councils highlighted the difficulty of access to the monitoring data of reservoirs for decision making. This information is essential to deliberate on the values of discharge, opening and closing of the floodgates, based on the diagnosis and prognoses presented by the official water management institutions;
- The discussions do not cover the entire basin, being limited to the area immediately upstream and downstream of the reservoirs;
- The legislation defines that the Committees must approve the water resources master plan and follow up its execution. In the Pajeú River Basin, this attribution is not complied by the committee;



- The research identified that these councils face limitations from the point of view of technical knowledge and that this gap can compromise their autonomy in understanding water management, making the decision process vulnerable and imprecise;
- There are no articulated actions for water management in the basin between the Committee and the Water User Councils.

In the Pajeú River Basin, it was also evaluated the performance of hydroenvironmental sustainability indicators in a similar way done in Capibaribe River Basin and showed in prior reports. Five indicators were selected for the evaluation: Agricultural Expansion, Water Quality, Demographic Microregional Dynamics (DMD), FIRJAN Municipal Development Index (IFDM) and Gross Domestic Product per capita. Data were collected from the official databases, considering the years 2010 and 2013. From the data obtained, it was observed that for the per capita GDP, only the municipality of Salgueiro suffered a reduction of 35.9%. For the IFDM, it was found that, on average, the performance was 9.29% better. On the other hand, there was a decrease in the crop area in the order of 69.06%, indicating an agricultural retraction. However, it was not possible to infer the performance of the Water Quality Index due to lack of monitoring data for the year 2010, and in the year 2013 water quality was classified as regular. It was also verified that there was a growth of DMD in the municipalities, in the order of 12.91%, leading to an increase in the need to sewage services, among other social challenges.

In the context of the Capibaribe River Basin, the research evaluated the performance of five indicators proposed in the master plan of the basin, corresponding to the period 2010 to 2013, and pointing out the major factors of vulnerability and resilience.

#### Vulnerability:

- The water quality today is in an unsatisfactory state, according to analysis of water accomplished by the monitoring of the Environment Agency of the State of Pernambuco (CPRH). The classification of the water quality is polluted in 7 of 9 stations located along the basin. The pollutants are predominantly from industrial sources in the Upper and Middle Capibaribe and domestic sources in the lower Capibaribe.
- It was also identified reduction in the cultivated area in the most part of the 42 municipalities inside the basin. This may be an effect of the water shortage in the Brazilian semiarid in the last five years.
- The population has increased in the majority of the municipalities, which reflects in the increasing of demand for environmental sanitation services.

#### Resilience:

- The GDP per capita and the Firjan index (quality of employment and income, education and health) exhibited growth in the majority of the 42 municipalities in the basin.
- Three workshops took place in the Upper, Middle and Lower Capibaribe to promote the dialogue with the local stakeholders about the water sustainability indicators, using group dynamics for choosing the indicators in addition to those used in the master plan.
- As an outcome of the workshops, 19 indicators were aggregated in the dimensions environmental (9 indicators), social (4 indicators), economic (1 indicator) and institutional (5 indicators). This approach is based on the methodology of the official system of the Sustainable Development Indicator – IDS (IBGE, 2015).

- The aggregation of the 19 indicators will result in a proposal of the Hydro-Environmental Sustainability Index in River Basins – ISHBA. The objective is to apply the ISHBA in both basins of the Aguasçapes in Brazil: Capibaribe River and Pajeú River. The Table below shows the indicators defined.

Matrix of indicators defined for the Hydro-Environmental Sustainability Index in River Basins

DIMENSION	THEME	INDICATOR
ENVIRONMENTAL	Biodiversity	- Protected areas
	Sweet water	- Inland water quality
	Sanitation	- Water service
		- Sewage collection
		- Sewage treatment
		- Solid waste collection
		- Solid waste treatment
	Climate	- Drought evolution
SOCIAL	Health	- Diseases related to environmental sanitation
	Education	- Literacy rate
	Population	- Population growth rate
	Work and income	- Household income <i>per capita</i>
ECONOMIC	Economic board	- Gross Domestic Product per capita
INSTITUTIONAL	Institutional capacity	- Hydrographic basin committee
		- Water rights (Permits) - Water charge - Water body classification - Framework of water bodies

#### Lessons learned:

- Despite the improvement of economic indicators, the environmental indicators did not have positive performance. For this reason, the set of indicators must be analyzed in an integrated way.
- The group dynamics used in the workshops made possible an intense dialogue among the participants, with large group discussion about the problems verified in the Capibaribe River Basin. This process guided the choices for the indicators.
- One conclusion is that the workshops represented a forum of water governance in the basin, once the local stakeholders share information and experiences. In addition, they proposed together which indicators could be considered in a hydro-environmental evaluation system in the basin. The stakeholders are from civil institutions (associations and educational institutions), public sector (environmental agency, water agency, municipal secretariats of environment) and water users.
- The participation of the Doctoral student Tereza Dutra in the Capibaribe River Basin Committee strengthened the integration of the actions of the Aguasçapes with this space for discussion, facilitating data collection in official institutions, improving the

understanding of the water resources management process in the basin and taking contributions from the academy to support the decision process in the Committee.

Next steps:

A student of the Professional Master Course in Management and Regulation of Water Resources will work in the application of the Hydro-Environmental Sustainability Index in River Basins – ISHBA in the Pajeú River Basin in the next year.

### Mexico

- Assessment of the lack of water security and level of contamination of the Rio Sonora

Lessons learned:

- In the local level, global change is combined with other environmental alterations, such as the mine spill in the Sonoran River. In this case, for example, in 2014, the Sonora River basin had an extraordinary rainfall due to Hurricane Odile. The Molinito Dam, which is one of the most important on the Sonora River, was almost full. However, the city of Hermosillo could not use that water for a year because the contaminating metals from the spill were contained in that dam.
- Perception of vulnerability is a fundamental tool to address the perspective of local actors. The perception of vulnerability and risk is a fundamental component of global vulnerability, since the presence or absence of vulnerability can determine the actions, or lack thereof, that are taken to confront water insecurity.
- Environmental degradation and water vulnerability are coupled in a specified context. In the case of the Sonora River, the spill of the Buenavista del Cobre mine was coupled with water vulnerability in the context of a pre-existing prolonged drought from a decade ago.

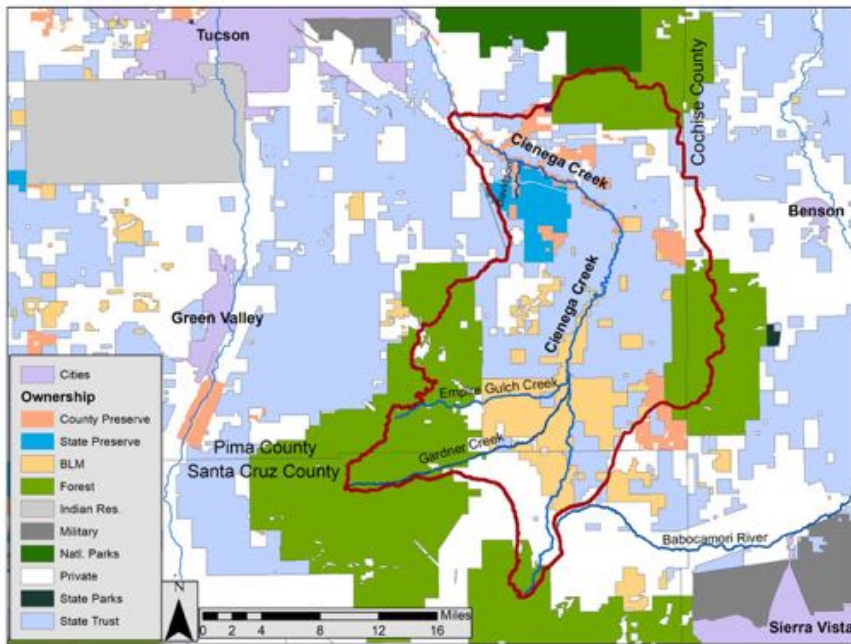
Next steps:

- Write the paper: “Transfer of water and vulnerabilities: The peri-urban interface in arid Americas”
- Write the paper: “Water (in)security in the Sonora River by the mine spill: examining the water quality parameters reported in the official database of Mexico”
- Finish coding and analyzing interviews Ures Valley (the transcript was finalized).
- Survey and analysis of interviews in the Peri-Urban Zone.
- Finish article on changes in land use in the riparian area (Peri-Urban Zone).
- In related work to provide input to the World Water Council, a questionnaire survey on water security in Arizona and Sonora was designed and distributed to 105 invited respondents from governmental agencies, NGOs, and academia (50 in Arizona and 55 in Sonora).
- In Survey Monkey, the online tool utilized for conducting these surveys, random sequencing of potential responses for each question was used in order to minimize the bias that might result from preset sequencing. Additionally, a straightforward Likert scale was used for responses, from 0 (not important, not effective) to 5 (most important, most effective).

- A total of 50 complete surveys (48%) were received online, 34 from Arizona and 16 from Sonora. Eight additional surveys were conducted in person to improve representativeness of the Sonoran governmental sector that had a low response rate in the online survey, maybe because 2015 was an electoral year in Sonora state, and there was a shift in governmental positions. Some findings of the study indicate that:
  - In both, Sonora and Arizona, inadequate management of water resources is seen as the main factor affecting water security. While “inadequate” management was not predefined by the researchers in the survey and rather was left to the interpretation of each participant, it broadly refers to the activities conducted by the managerial and user units responsible for water administration, distribution, and final use. In Arizona, prolonged drought is the second most important factor; in Sonora this is increased water demand and water quality deterioration. All the responses and scores can be seen in the published book chapter that contains these results and rationales (Scott and Lutz 2016).
  - Sonoran respondents think that 45% of the investment in the water sector in the state has been used for building new aqueducts and inter-basin water transfer projects. In Arizona respondents think that around half of the investment has been more or less equally distributed between three things: awareness and conservation programs, increased wastewater treatment, and increased groundwater pumping. When asked in which types of actions they would like to see investments in the next decade, in both states relatively low priority was given to increasing storage in dams, or to develop other types of large-scale water infrastructure.
  - Sonoran respondents think that the main outcomes of hard-path policies (engineering or infrastructural-oriented strategies) are less inclusion of stakeholders in water management, and a better match between water demand and availability. For Arizonans this match is the most important outcome regarding hard-path policies, and in second place, they think reduced environmental quality is an outcome of these types of actions.

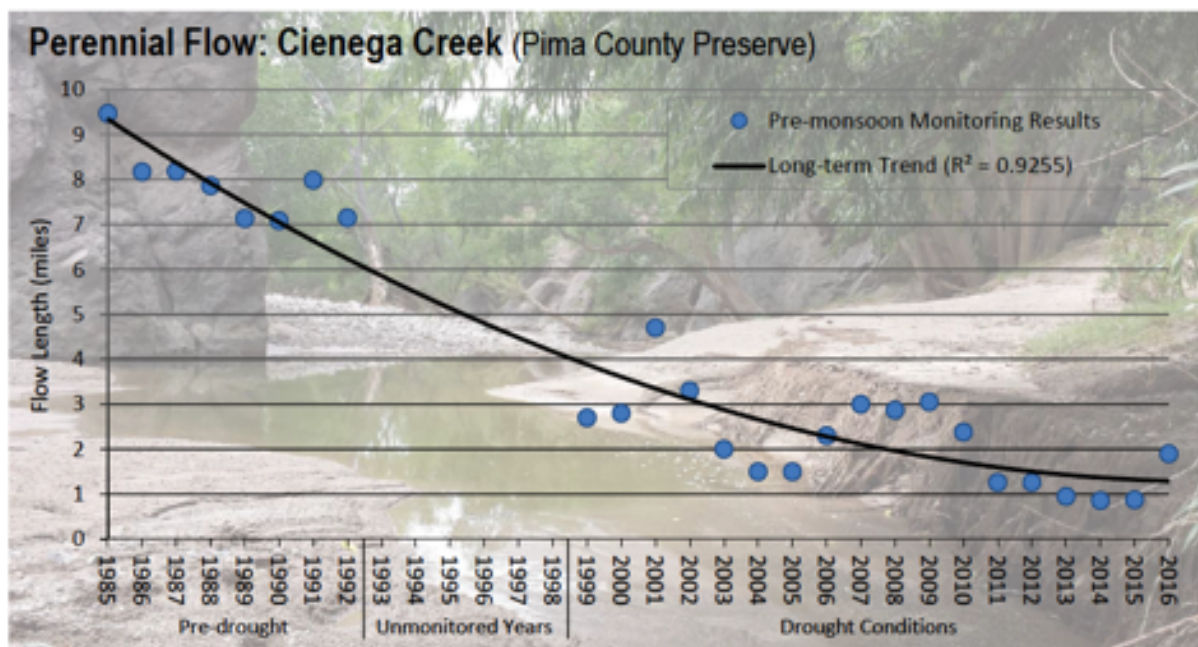
### United States

The Cienega Watershed is part of the Santa Cruz River Basin and provides clean groundwater for the City of Tucson. This year, we worked on a participatory effort to monitor its state, by compiling the data collected by multiple stakeholders including the Bureau of Land Management, Pima County, US Geological Survey, Pima County Parks and Recreation, Desert Botanical Gardens, The Nature Conservancy, and more.

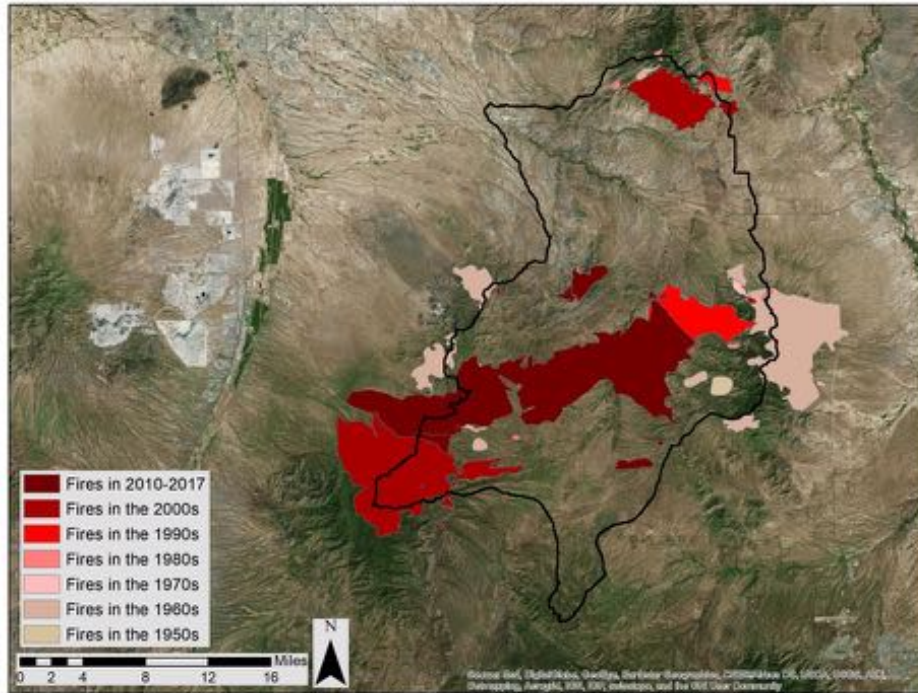


Land Tenure in the Cienega Watershed.

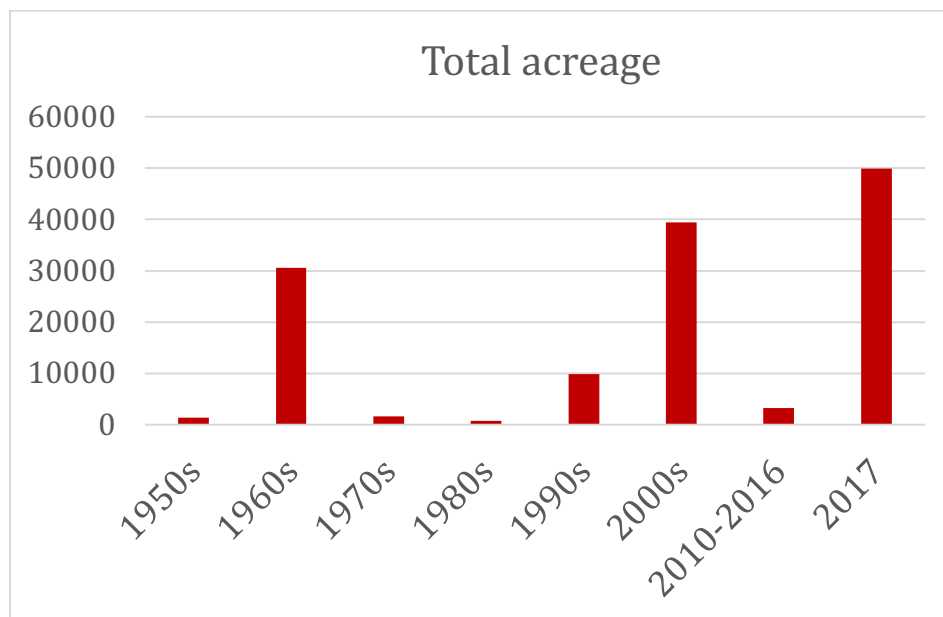
This participatory assessment is used to guide programs and management actions by stakeholders. It is also meant to serve as a communication tool to involve the community at large. Examples of this assessment includes wet-dry lengths, wildfires and wells installed in the watershed.



Wet length of the Pima County Preserve in the Cienega Watershed over time.



Wildfires by decade in the Cienega Watershed.























Acreage burned in the Cienega Watershed over time.

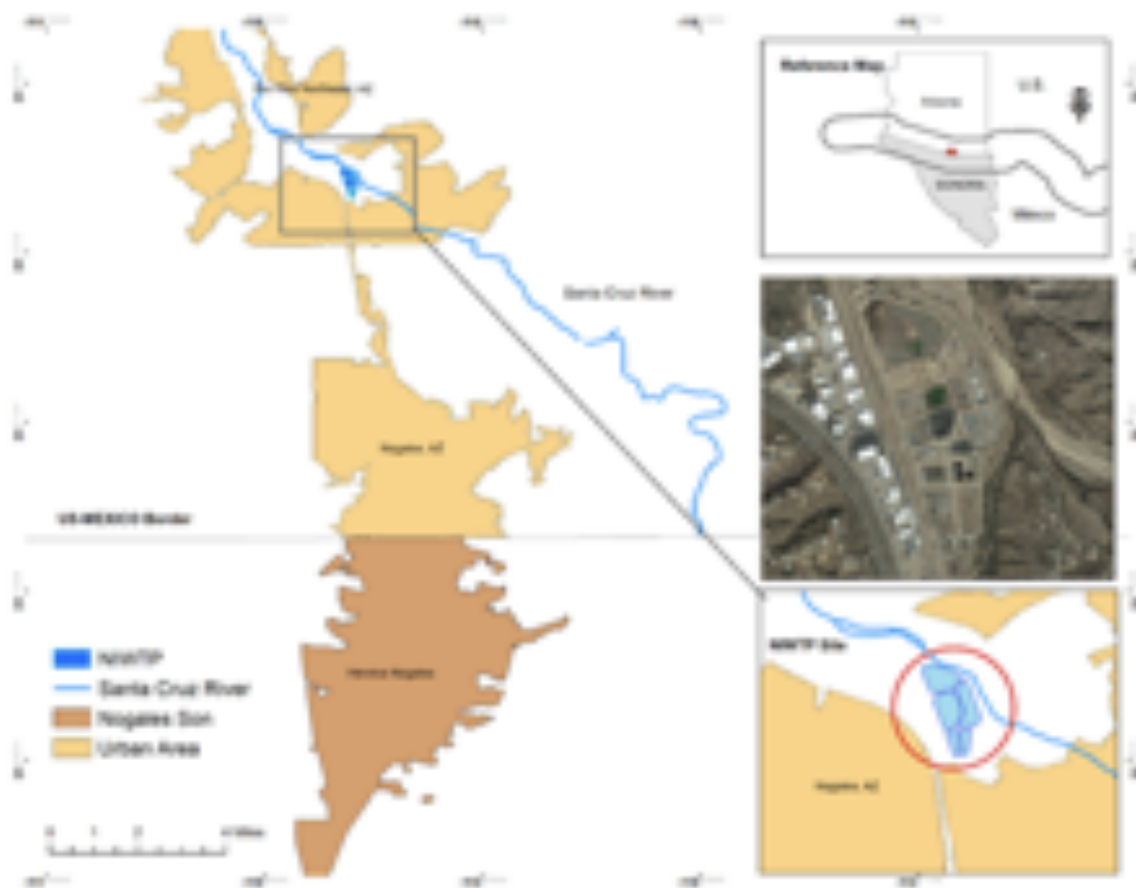






No.	Indicator	Description	Ranking
1	Precipitation	Decrease in winter precipitation in the last 20 years	
2	Temperature	Dramatic increase in temperature since 1980	
3	Drought	Since the mid 1990s, we have been in a drought with wet swings	
4	Groundwater levels	Although there is a slight recent upward trend, current groundwater levels are still lower than they were prior to the 1980s.	
5	Wetlands	Baseline produced for spatial location and extent of wetlands for 2017.	
6	Wet-dry	Slight increase in 2016, but wet lengths are lower than they were prior to 1999, and significantly lower than the early 1980s.	
7	Gauges	Significant decrease in annual average stream flow in Pantano gauge, slight increase in Cienega Creek gauge.	
8	Winter stream flows	Decrease in winter stream flows in CC2 (Preserve) and Upper Cienega Creek (BLM), but slight increase in the Empire Gulch (spring source at BLM).	
9	Water quality	Preserve - Decrease in TDS, decrease in PH (except in Davidson 2) BLM – no clear trend.	
10	Vegetation composition/cover	Shrub cover has been decreasing due to mesquite removal and prescribed-fire projects. Perennial grass basal cover has declined, but 2015 and 2016 have shown some recovery. Invasive perennial grasses (e.g., Lehman lovegrass) have shown increase. Bare ground has decreased, while litter has increased.	
11	Pronghorn	Slight recovering after a decline in population numbers in 2002.	
12	Fish	Endangered species recovering since 2014.	
13	Frogs	Recovery of endangered species and reduction of invasive species since 2013.	
14	Wildfire	Significant acreage burned in the 1960s. Dramatic increase in acreage burned in the 2000s resulting in significant damage to vegetation and infrastructure.	
15	Economic vitality	Baseline created for 2016. Median household income is \$47K, median house/condo value is \$227K, unemployment is 4.88%, residents below poverty level is 6.22%.	
16	Land use land cover change	Downward trend in shrub cover since 1979. Increase in development with a peak in 1999 and slight decrease in 2009. No clear trend in other land cover classifications.	
17	Number of wells	Peak in number of wells installed in the 1990s and decline in more recent decades. Dramatic upward trend since pre 1990s (cumulative).	
18	Archaeological site conditions	Intra-agency collaboration to monitor site conditions consistently.	
19	Number of recreational permits	Increase in recreational permits and visitors since 2013, less so in number of schools and organizations.	
20	Stewardship engagement programs	13 stewardship engagement programs were identified. The earliest program started operations in the mid 1980s.	

The U.S. team in collaboration with researchers from Nogales, Mexico are working on a project to evaluate the impacts of the Nogales International Wastewater Treatment Plant. This project is funded by the North American Development Bank and is led by researchers from El Colegio de la Frontera Norte in Nogales. Our team of researchers is working on the collection of secondary data on several indicators of wellbeing on both sides of the border. We are also collecting empirical data on the social perceptions on wellbeing before and after the functioning of the treatment plant through surveys and interviews with key stakeholders. This project is still in progress.



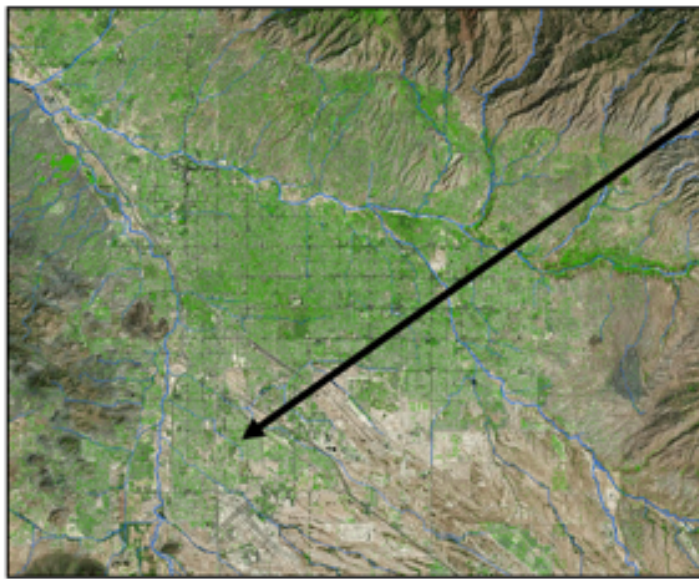
Mapa referente de la Planta Internacional de Tratamiento de Aguas Residuales de Nogales. Fuente: Census <http://www.census.gov/geo/www/tiger/>, INEGI Cartografía geoestadística urbana. <http://www.inegi.org.mx/geo/contenidos/urbana/>; mapa elaborado por Jose Luis Manzanares Rivera).

Preliminary findings show a greening of the Santa Cruz River downstream of the treatment plant. This effect is likely to result in wellbeing benefits for people living downstream of the plant (north) because of the restored ecosystem that leads to an increase in property values. However, upstream from the treatment plant (south) we find negative effects on human wellbeing because the water tunnel that conveys raw water from Mexico to the plant has not been maintained for decades and leaks raw sewage to the water bodies, particularly during storm events. On the Mexican side of the border, we find that the introduction of the sewage network along the streets without stormwater infrastructure in place has resulted in severe flooding episodes that negatively affect the population. In addition, the Mexican water treated in the U.S. is not returned to Mexico and is released to the Santa Cruz River flowing north. Therefore, the positive effects of water in the river are not enjoyed by the Mexican population. Instead, they are charged with fees to treat their sewage. These fees increase exponentially during storm events when stormwater is combined with sewage and conveyed together to the plant. As Mexico refuses to pay for the increased fees, conflict has arisen with the City of Nogales, who also refuses to pay for the treatment of sewage that is not coming from their residents. This conflict has left without funds to treat water and maintain the infrastructure.

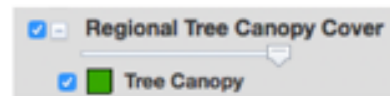


Hábitat ribereño en Rio Rico impactado por la PITARN (Fuente: Census <http://www.census.gov/geo/www/tiger/>; mapa elaborado por Jose Luis Manzanares).

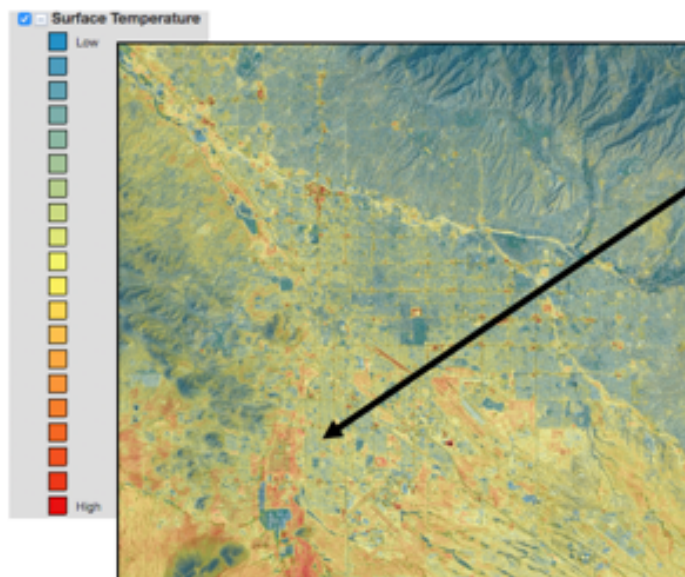
The US team has also examined environmental justice issues around green infrastructure in Tucson. We found that low income communities, mainly Hispanic families, show less tree canopy cover. This difference in vegetation increases vulnerability against climate change impacts and puts stressed communities at risk. These neighborhoods show more heat and a higher risk of flooding.



Street in the south side of Tucson



Tree canopy in Tucson, AZ (data from Pima Association of Governments, PAG)

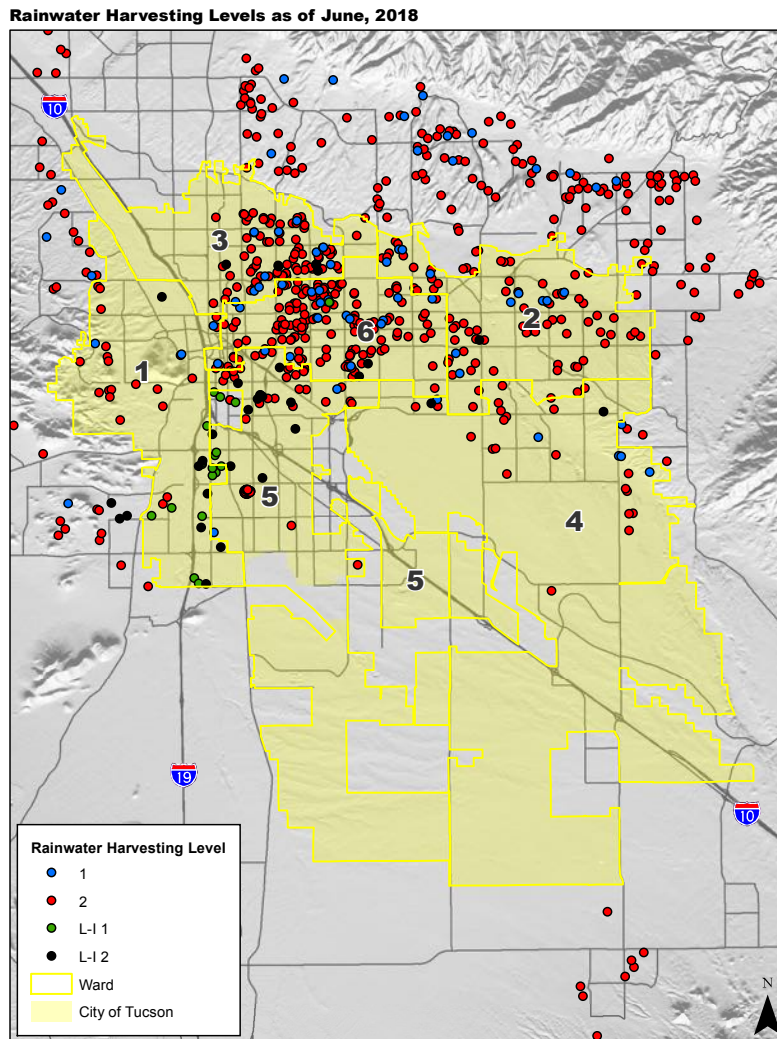


Flooding in the south side of Tucson

Surface temperature in Tucson, AZ (data from PAG)

The City of Tucson has tried to address these inequities and has launched programs to incentivize the adoption of rainwater harvesting throughout the city. However, low income communities have not benefitted from these incentives.





Location of rainwater harvesting projects (data from the City of Tucson)

We found that one of the reasons that low-income neighborhoods do not apply to incentives include lack of neighborhood associations, higher likelihood of renting homes, immigration status, and poverty in general.

A successful engagement effort happened at Star Academic High School. We engaged with the school community for several months until they were eager to implement green infrastructure in their campus. Master's in landscape architecture students designed the landscape in a participatory way and we engaged the community at large in the implementation. Now the school has more trees, seating areas, educational signage, artwork, and a bus shelter is in the process of being built by the City. More importantly, highschool students connected with university students, inspiring them to apply to college after graduation.



High school and university students planting trees at Star Academic High School

#### Findings:

- Adaptive management at the watershed scale has proven useful to assess the state of a watershed. Achieving consensus among the stakeholders on the number and type of indicators to use in the assessment has been a priority for the project. However, ongoing monitoring requires resources for the continued engagement of stakeholders.
- Participatory assessments are useful in considering multiple types of indicators that can resonate with a diverse population. This is important because these assessments also serve as communication tools to connect with the community at large.
- We found that often times, physical factors determine the level of vulnerability in the population. For example, less vegetation increases vulnerability against heat in urban environments. However, social networks can play a significant role in reducing vulnerability of the population. These social networks may not be related to physical conditions of the landscape, but more to socioeconomic conditions.
- Community engagement shows promise in addressing the social aspect of vulnerability against climate change. But it takes time, effort and resources to make things happen. Connecting researchers to community members, city officials, NGOs and other organizations not only enhances social resilience, but brings people together against potential threats.

#### Next steps:

- We plan to continue engagement in the Cienega Watershed and in low income communities of Tucson. Established relationships are important for fundraising and proposal development. We plan to conduct transdisciplinary research to expedite the connection of research into practice.

### 3.4 Outcomes and impacts: Stakeholder participation and policy impacts

Here we report on specific activities conducted under task 3 of the project.

Task 3 - Conduct policy dialogues to diagnose current adaptive capacity and promote the feasibility of future adaptation outcomes leading to enhanced water security

#### Chile

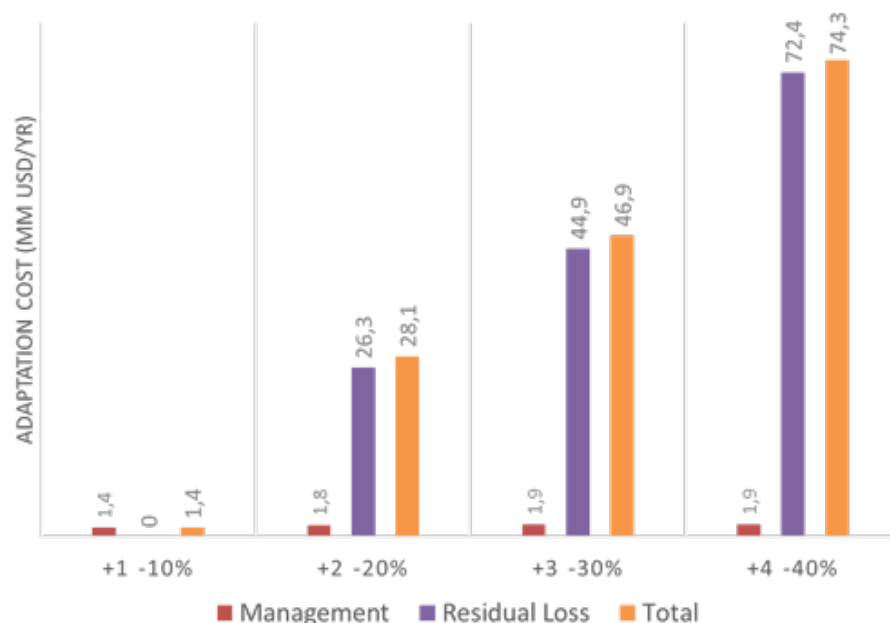
Adapting agriculture to climate change is one of the most important challenges that our society will have to face in the next decades. However, there are still many fundamental questions that have to be answered to ensure an effective use of resources and avoid maladaptation practices. One of them corresponds to the assessment of costs/benefit ratio of adaptation options and its comparison against a no adaptation case.

We developed a simplified methodology based on results obtained from a calibrated hydrological and crop simulation model (WEAP and PGM respectively) has been implemented. Climate change scenarios are defined as a combination of changes in temperature and precipitation. The model is run for each scenario to obtain yield losses and water demand and availability as function of climate in two different basins of central Chile.

A set of adaptation options derived from the National Adaptation Plan for the Agricultural sector were classified and evaluated in their ability to contribute to satisfy new water demands and reduce yield penalizations. An optimization algorithm was implemented to select alternatives that minimize cost subject to the satisfaction of water demands.

Results show that, regardless of the adaptation measure, the cost of adaptation is smaller than the cost of no adaptation. For less severe climate change scenarios, adaptation options based on improving water management practices produce better results than investing in infrastructure, especially if water use efficiency is relatively low.

During 2016 we carried a study to estimate the cost of adaptation in the agricultural sector with the aim to promote water security. The study was supported by the Economic Commission of Latin America and was done in cooperation with the Ministry of Agriculture and the Ministry of Environment. We developed a novel methodology for the evaluation of impacts and the determination of optimum paths for adaptation and the determination of avoided losses. Figure shows an example of the adaptation costs.



*Adaptation costs.*



The study gave us a unique opportunity to analyze the existing adaptation plan developed by the Ministry of Agriculture and, together with officers and policy makers, identify the major problems that make its effective implementation difficult.

Lessons:

The adaptation plan for the agricultural sector lacks of strategies that can be evaluated in terms of cost effectiveness. It was advised that new plans should contain metrics that allow us to quantify its impact in terms of securing water supply per unit cost so under several strategies and levels of climate change severity, the most effective measures are adopted.<sup>1</sup>

### Argentina

- The CONICET team continued with the science-policy dialogues through Water balances collaboration on Tunuyán and Mendoza river basins. Facundo Martín, Nicolás Parise, Alejandro Tonolli, Robin Larsimont and Paula Mussetta actively participated in several DGI workshops and fieldworks.
- José Luis Álvarez, former DGI Superintendent and Mario Salomón, DGI Director, attending the XVI WWC-IWRA hold in Cancún jointly with Paula Mussetta. Mario Salomón presented a conference paper in an special session organized by the CRN3056 Team. “Water security and climate adaptation: Bridging science and policy”. The case of the Mendoza River Basin. May.
- Development of the AQUABOOK “Manual Digital del Agua” en el marco del programa de Ciudadanía del Agua. Ley Provincial Nro. 8629. 23 de Diciembre de 2016.
- Mario Alberto Salomón, former DGI Director finished his doctoral dissertation “Modelo de gestión para la administración hídrica de un área en proceso de transformación territorial. Sistema integral cuenca del Río Mendoza (Argentina)” Universidad de Valencia (España), Directores Dr. Jorge Chambouleyron Guiñazú y Joaquín Farinós Dasi. Calificación: excelente (cum laude).
- Presentación al Gobierno Provincial - Agencia Provincial de Ordenamiento Territorial y al Instituto de Tecnología Agropecuaria (INTA) del documento técnico “Propuesta de Clasificación Territorial y Protección de Zonas Rurales Irrigadas de la Provincia de Mendoza”. Resolución 1086/16 de Superintendencia del Departamento General de Irrigación. Mendoza, 11 de Octubre de 2016.
- Master student Ángel Coronel (Sonora, México) attended several meetings and fieldworks as part of his thesis workplan. He also conducted interviews with DGI authorities, professionals and CONICET researchers.
- Establishment of a Network for the development and sustainability of the regional agri-food system of Mendoza and San Juan based on urban-rural and irrigated-non irrigated interfaces. The main goal of this unit is to create a socio-technical joint unit, for the understanding of the dynamics and prospects of the territorial system. The network aims to produce of information and knowledge to contribute to the formulation of strategies and public policies in favor of a sustainable development for the region of Mendoza and San Juan. The unit it is conformed by National University of Cuyo, CONICET Mendoza INTA; National University of San Juan; San Juan Government (Ministries: Planning and

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<sup>1</sup> Meza, 2017. Estimación de costos asociados a la seguridad hídrica en la agricultura como medida de adaptación al cambio climático en Chile. Un estudio en el contexto del Plan de Adaptación al Cambio Climático del Sector Silvoagropecuario. Serie. Estudios del Cambio Climático en América Latina. CEPAL. EUROCLIMA. Santiago. Cjhile. 56 pags.

Infrastructure and Production and Economic Development) and Mendoza Government (Ministry of Economy, Infrastructure and Energy and Ministry of Environment and Territorial Planning). 2017-2021

- Paula Mussetta and Tomás Manzur were involved in the INCIHUSA's consulting committee to review and comment the PLAN PROVINCIAL DE ORDENAMIENTO TERRITORIAL previous to the final approval of the law. The document was presented at Consejo Provincial de Ordenamiento Territorial.
- *Workshop: Complexities and territorial transformations.* The goal of this workshop were:  
-to discuss about territorial transformations and the components that help to understand the future of the region. - To debate on the potential of some instruments of intervention, contained in the PROVINCIAL TERRITORIAL ORDERING PLAN, to impact favorably or unfavorably in the identified changes in the regional agri-food system.
- Argentina team take part in the preparation of the TERCER FORO REGIONAL 'LOS DESAFÍOS DE LA GESTIÓN TERRITORIAL RURAL'. FCA.UNCUYO. CONICET. Noviembre 2017 and the Segundas Jornadas Regionales de Estudios y Experiencias en los Territorios de Interfaz. FCA.UNCUYO. CONICET. Noviembre 2017.

#### Lessons learned:

- There are several uses and trajectories of knowledge / information on science-policy dialogues.
- They are useful to complement and strengthen the climate and hydrological models
- They contribute to strengthen on integrative hydroclimatic knowledge more effectively into decision making
- They promote a better understanding of the demands and needs of stakeholders
- They create the positive conditions to develop informed policy measures and programs in the areas of addressing climate change

#### Brazil

- Session coordination in the 8° World Water Forum took place in Brasília/Brazil in May 2018:
  1. CLIMATE – Water security and climate change
    - 1.d. Climate science and water management: the communication between science and decision/policy making.
    - 1.d.3. Uncertainty and limitation of Science and Science Communication

The theme key strong political messages were:

- ✖ Uncertainty reduction and climate information availability can support the definition of public policies and laws in order to reduce vulnerability.
- ✖ The scientific community must to pursue ways of communicating climate impacts and vulnerability assessment to stakeholders involved in these policies.
- ✖ The participation of scientists in water resources management systems (e.g., water councils and basin committees) is crucial to understand how they can contribute for the formulation of public policies.
- ✖ Other channels of communication must be identified besides papers published in academic journals.

#### **WATER SECURITY CHALLENGES IN PERNAMBUCO: PLANNING AND**

## **GOVERNANCE IN THE CAPIBARIBE RIVER BASIN.**

### **1. Challenges of watershed hydro environmental master plans (case study)**

The work aimed to identify the main challenges to the implementation of the water infrastructure actions foreseen in the Capibaribe's Hydro-Environmental Master Plan, also suggesting a methodology for monitoring process optimization. The study was developed through a survey of data in several governmental institutions, internship at the State Agency of Water and Climate and participation in Capibaribe Committee meetings. Thus, the methodology was structured in the stages of documentary research, critical analysis of the data, methodological proposal for monitoring optimization and also characterization of the study area. The results showed that the water infrastructure actions were not implemented in accordance with the hydro-environmental plan, due to lack of coordination between the agencies to monitor the investments, among others.

As conclusions from this research, it could be observed that the Government made important investments to ensure water security in Capibaribe River Basin. However, it was also noticed that the hydro environmental plan has not been a guide for these investments, highlighting the necessity to develop a methodology for restructuring actions and optimized monitoring. The administrative continuity and discontinuity issues present themselves as a major obstacle to the development of public policies for water security. The interruption of programs, projects and actions due to fragile institutional capacities has been a reality in Brazilian water resources management, and these problems were also identified in the Capibaribe Basin. Despite the legitimacy of the hydro environmental plan and its water infrastructure investment plans, to prioritize the environmental agenda and to put it above political interests has been one of the biggest challenges regarding water security in the basin.

The manuscript results were presented at the International Workshop on Linking Water Security to the Sustainable Development Goals (Exceed/DAAD) August 29 – September 1 of 2018, USP-University of São Paulo, Brazil. It will also be published as a book chapter of the Exceed-Swindon Books Series. A result discussion from this work will be presented and shared at the 1st Youth Meeting of the Capibaribe River Basin (November 24 ad 25- Carpina, Pernambuco, Brazil).

### **2. Elaboration of plans for water infrastructure improvement as an institutional mechanism for coping with drought**

The study aims to evaluate the Improvement Plans effectiveness as institutional measures for coping with drought and to make a literature review of recent publications in the field in order to propose contents adjustments to encourage the practical implementation of this mechanism. First results presented at the 1<sup>st</sup> International Conference on Water Security- Toronto June 17-20, 2018.

- Two events have been supported by the Brazilian team: Third Civil Engineering and Environmental Brazilian Congress and Democratization of Water Policy and Management - a Transdisciplinary Challenge (seminar of the Waterlat Network). Both events took place in Recife/Pernambuco and had the participation of students, researchers and stakeholders of the water resources sector.

Mexico

- Furthering institutional change in urban water management in the Sonora and chihuahua regions
- Lobbying policymakers for institutional reform of water management in Mexico
- An assessment of the perspective of desalination of sea water for export in the Gulf of California.
- In general, raising awareness about water security and the demands of sustainability and adaptation for water management in Mexico. This includes the participation in academic meetings, as well as in a number of op ed editorials in newspapers, radio talk shows as well as direct liaisons with public agencies.

#### United States

- The Second Triennial Budapest Water Summit organized by the Hungarian government was held Nov. 28-30, 2016. Robert Varady served on the International Program Committee and was a speaker in the closing high-level panel in the Summit's Science and Technology Forum. The theme was, "Turning the tide? How can scientific knowledge guide Sustainable Development Goals policy making at different scale?" Varady discussed recent political developments on the global stage and their likely impacts on the gap between science and policy. He cautioned that the combined forces of anti-globalization, reactionary populism, and aspects of social media (fake news, especially), which question the legitimacy of science, would complicate bridging the gap.
- The UA team organized the Science Diplomacy and Policy with Focus on the Americas Symposium that took place on Feb. 22-24, 2017, at the University of Arizona. Many prominent scientists shared their findings during this event. Keynote speakers include E. William Colglazier, the former US science and technology adviser to US secretaries of state; Norman Neureiter, science and technology adviser to four US presidents; and Vaughan Turekian, science and technology adviser to US secretary of state; Thomas R. Pickering, former US ambassador to the UN, Israel and Russia, and Nobel laureate Peter Agre, director of the Malaria Research Institute at the Johns Hopkins Univ. Given the state of current events in the US, the event was extremely timely.
- Varady traveled to Laxenburg, Austria, to meet with officials and with the water resources group at IIASA (International Institute for Applied Systems Analysis), where he will spend part of spring 2018 sabbatical working on water governance and water security. He also went to Kőszeg, Hungary, to meet with officials of the Institute of Advanced Studies Kőszeg, where he also expects to spend some time in 2018.
- Zuniga participated in the 54<sup>th</sup> International Making Cities Livable Conference that took place in Santa Fe, New Mexico. This conference brings together city officials, planners, practitioners, researchers, and graduate students to discuss ways in which cities can provide more inclusive and livable spaces. The conference took place on October 2-6, 2017. As a follow up from this conference, Zuniga presented her research on neighborhood walkability and the use of greenspace at the 55<sup>th</sup> International Making Cities Livable Conference in Ottawa, Canada in May 2018.
- In a CRN3056-leveraged activity that engages with researchers and policy-makers alike, Christopher Scott serves as Director of the Consortium for Arizona – Mexico Arid Environments (CAZMEX). Since 2014, CAZMEX has worked to support collaborative research projects and post-doctoral scholars in the study of the shared arid lands of the United States of America and Mexico. The Consortium now includes partners from a range

of Mexican institutions working with University of Arizona researchers. Collaborative, comparative research and outreach are supported by CAZMEX under a leveraged funding model (totaling approx. \$2.1 million) in which CONACYT (Mexico's National Council for Science and Technology) support is matched by resources the UA receives from the Agnese Nelms Haury Program in Environment and Justice, the Brown Foundation, UA's internal resources, and other sources. Since FY 2014–2015, CAZMEX has supported 6 postdoctoral scholars and 23 collaborative projects. The 2017 CAZMEX Summit, "Science Crossing Borders," held at the Biosphere 2 in Tucson, Arizona on May 5th and 6th, 2017, brought together sixty project partners and key stakeholders to discuss strategic lines of scientific collaboration and societal impact in four principal areas: 1) Diagnostic and adaptation tools for climate variability and change; 2) Monitoring and remediation of water quality and mining impacts; 3) Ecology of climate change: impacts and conservation; and 4) Adaptation to environmental and socio-economic change in arid North America. The summit allowed colleagues to explore new pathways for future collaborations, reflect on the grand challenges for the U.S.- Mexico shared arid region, and agree on the environmental and socio-economic approaches to address challenges that the region faces now and in the future.

- Zuniga attended the World Water Week in Stockholm, Sweden in August 2018. During this event, Zuniga learned the latest research findings on nature-based solutions for water management. She connected with other researchers who are interested in similar topics and is part of a team developing a proposal for a Horizon 2020 grant.
- Zuniga was invited by French scientist to present a paper on the State of the Cienega watershed in Martigue, France in October 2018. During this event, Zuniga met other scientists working on similar issues, including scientists from Pontificia Universidad Catolica de Chile, who were part of the team applying to the IAI Small Grants.
- On November 27-30, 2018, UA and Mexican researchers traveled to Delhi and Nimli, Rajasthan, India to participate in a workshop titled "Knowledge Conclave *cum* Workshop – Nature-based Solutions for Water Security". This event was organized by Centre for Science and the Environment. As part of this event, researchers grouped in teams to produce ideas for future collaborative research projects.

#### Mexico and the United States

- The Mexican and US teams organized a binational workshop in Tucson, Arizona titled: Binational Water Relations at 75 Years: Retrospectives, Resilience, and US-Mexico Border Water Resources Governance." This workshop brought together scientists and practitioners who work on water-related issues along the border. This event took place on October 15-16, 2018 at the University of Arizona.
- The Mexican and US teams co-organized the congress "Desafíos en Seguridad Hídrica y Resiliencia ante el Cambio Global en Zonas Áridas del Continente Americanos" in Guaymas, Sonora, Mexico on April 17-21, 2018. This congress was planned to overlap with our annual project meeting. Academics as well as water professionals from Mexico and Argentina attended this event.
- Nicolas Pineda and Christopher Scott organized a visit of Sonoran water officials from Hermosillo to Tucson, AZ that took place on March 3-4, 2017. This included visits to the Central Arizona Project and to local wastewater treatment plants. Prior to the visit, the

visitors attended a short seminar that informed them about the sites. Water officials learned about various water management strategies undertaken in Tucson that might be implemented in their state.

- The UA team co-organized and participated in a special session on climate change adaptation and water security for the World Water Congress. The session was attended by ~50 people including water professionals. This event took place in Cancun, Mexico from May 29 to June 3. Partners from the UK, US, Mexico, Peru, Chile, Argentina, and Brazil participated in the special session. The team also attended an annual project meeting in Cancun on June 1, 2017, where partners shared results on their work. They also planned the next steps for the research project.

### 3.5 Assessment of findings and relation to knowledge in the field

- Network affiliates of the AQUASEC Center of Excellence for Water Security – from Argentina, Chile, Brazil, Peru, Mexico, and the U.S. – held the annual workshop of the Aguascapes project supported by the Inter American Institute for Global Change Research (IAI). The workshop was hosted by El Colegio de Sonora in coordination with the Udall Center for Studies in Public Policy, with additional support from the International Water Security Network. The workshop consisted of a set of presentations and panels to present Aguascapes project results and water security-related activities of the Udall Center for Studies in Public Policy (University of Arizona), El Colegio de Sonora, Federal University of Pernambuco, Brazil, Pontifical Catholic University of Chile, National Scientific and Technical Research Council of Argentina, National University of Cuyo (Argentina), and Centro de Competencias de Agua (Peru). A series of science – policy dialogues at the workshop included guest speakers from the Sonora State Water Commission, the General Irrigation Department of Mendoza, Argentina, the Northwest Biological Research Center of Sonora, and a representative of the US-Mexico Transboundary Aquifer Assessment Program. Other activities included fieldtrips to water-related infrastructure in Hermosillo such as the Independence Aqueduct pump-station and a water treatment plant (Hermosillo), and presentations on the desalination plant in Guaymas by executives of the Sonora State Water Commission at their headquarters in Hermosillo.

### Contributions of the Co-PIs

**Francisco Meza** has been working as lead author for the upcoming IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. In addition, he has opened a new field of research on the integration of crop simulation models, remote sensing and in situ data to improve estimates of evapotranspiration. He has been recently awarded with a small grant for collaborative networks in Digital Agriculture. He continues to work in the installation of large-scale equipment to monitor evapotranspiration and study adaptive strategies to improve water use efficiency in agriculture. The research group has been invited to join the network of Centers for Natural Resources and Development (Meeting in Bonn Germany).

Dr Meza has joined a team that will produce a roadmap for water security and agricultural development of the newly created administrative region of Ñuble in Chile.

Dr Meza has worked in the development of a book chapter on WEF Nexus in Chile. (Arce, G.; Gironás, J.; Molinos-Senante, M.; Suárez, F.; Pastén, P.; Meza, F.; Donoso, G.; Vicuña, S.;

Vargas, I. 2018 *The Food-Water-Energy Nexus in Chile: Agriculture, Water Companies, and Mining*. Encyclopedia of Water: Science Technology and Society. Wiley).

Dr Meza has also integrated the multidisciplinary team to develop a Platform to support irrigation decisions using remote sensing and weather networks (see. Balbontín C., Ortega S., Selles G., Morales L., Odi M., Riveros C., Lagos O., Meza F., Gil P., Neira J., Lillo M., Holzapfel E., de la Vega X., Ferreyra R., Antúnez A. 2018. PLataforma Agrícola Satelital para Chile (PLAS). Uso de información agroclimática y satelital en el monitoreo y la determinación de los requerimientos hídricos de los cultivos en las zonas agrícolas del país. *Revista Mundoagro*). He has actively been collaborating with the MAPA project (led by PUC colleague, Sebastian Vicuña). Meza has also been developing active links with UNU-Bonn, Germany, on water-energy nexus activities. Additionally, he participated in the IPCC Workshop of WG I on Regional Climate Projections and their Use in Impacts and Risk Analysis Studies, 15-18 September 2015, Sao Jose dos Campos, Brazil. Also, WORKSHOP EUROCLIMA/AGMIP, launching of the first AgMIP project in Latin America. Chile, Peru, Bolivia and Colombia. Analysis of Vulnerability of Potato Crop to Climate Change in Andean Region. Recently he was nominated as author of the upcoming report on IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.

**Robert Varady** continues to strengthen the water security initiative through approved funding for the Lloyd's project for which he is Americas region PI. Additionally, he has actively disseminated the project's conceptual approach and findings via his ongoing work with UNESCO-IHP, IHE-Delft, and with a Global Environment Facility (GEF)-supported project on global groundwater governance (Varady et al., 2013).

**Carl Bauer** was actively involved in policy research and outreach in Chile, stimulated particularly by public debate about the national government's renewed efforts to reform the Water Code. He made two invited trips to Chile to present his work, invited by different schools at the U. of Chile. Bauer also made two invited trips to the U. of California (Berkeley and Davis) to present work in the context of Chile/California academic and governmental cooperation. He spoke at the 3rd annual Chile/California Conference, held at U. California-Berkeley, organized by the association of Chilean graduate students at U.C.-Berkeley, U.C.-Davis, and Stanford and sponsored by the Government of Chile. That government later invited him to U.C.-Davis to meet with Chile's visiting Presidential Delegate for Water Resources. He traveled to Chile in October 2015 for the public release of the expanded 2<sup>nd</sup> edition of *Canto de Sirenas: El Derecho de Aguas Chileno como Modelo para Reformas Internacionales* (Siren Song: Chilean Water Law as a Model for International Reform), at Chile's International Book Fair. He made an invited trip to Chile in June 2016 to present work to two different schools at the U. of Chile, and to the Catholic U. Law School in Santiago.

**Margaret Wilder** is directing and conducting project-related fieldwork in the Rio Yaqui basin. Wilder and graduate assistant Yulia Peralta are preparing an article manuscript on the Rio Yaqui research for submission to an academic journal in fall 2016. Wilder and Peralta are planning a workshop on climate adaptation with water stakeholders and IAI team members in the Rio Yaqui basin.

**Adriana Zuniga** has been actively involved in research studies on transboundary water security, green infrastructure, binational desalination and groundwater governance. She continues to lead a research project on the assessment of the health of the Cienega Watershed (southeast of Tucson). Zuniga has also been working on addressing environmental injustice



around green infrastructure in Tucson, leveraging funding for implementation. She has also been collaborating on project coordination activities at the Udall Center for Studies in Public Policy, highlighting the planning of the Binational Workshop on Water Relations (October 2018), the special session on green infrastructure in the Agua Andes Congress in Ayacucho, Peru (Sept. 2017). She has been an important communication link between the Latin American partners and U.S. partners. Zuniga also teaches undergraduate courses for the Sustainable Built Environment Degree Program at the University of Arizona and involves her students in her research projects as part of their training.

**Nicolás Pineda** has been leading research with graduate students and other colleagues on water security in Northwest Mexico and publishing academic and divulgation papers regarding this research. His work topics include desalination in the U.S. -Mexico border region, social impacts of water infrastructure, and institutional factors affecting water security in urban settings. He also is currently leading a project on hydric vulnerability and urban adaptive policies in the context of watershed management in the Gulf of California region. He continues to be an active participant in outreach activities through his contribution to newspaper op-ed pieces, radio emissions, and public meetings.

**Rolando Díaz** was conducting fieldwork in the lower section of the Sonora River Basin regarding natural risks to human health. During 2015 and 2016 he led design and piloting of data collection instruments, as well as the later analysis and interpretation of data. His focus on vulnerability to risks from the point of view of human health and geography adds an interesting interdisciplinary perspective to this project. As N. Pineda, he is also participating in both academic publications and public outreach of the results and outcomes of this research. Additionally, he is participating in parallel research projects on dengue fever in connection to environmental and social indicators, and co-leading another project for risk preventions in Northwest Mexico.

**Facundo Martín** is directing and conducting fieldwork in the Mendoza and Tunuyán Basins as well as articulating Science Policy Dialogues with Departamento General de Irrigación (DGI). He has been working on methodological aspects to improve and strengthen the Water Balance initiative from DGI. He is preparing three paper related to Task 1 and 3, two of them in collaboration with Paula Mussetta, Carla Bauer and Rolando Díaz. He participated in several national meetings and conferences networking the Aguascapes initiative.

**Paula Mussetta** has been part of the team conducting field work in Mendoza. In collaboration with other members of the team she obtained the first preliminary results for vulnerability assessment in Mendoza's River Basin. During this period, she focused on data collection through interviews. At the same time, she acted as lead authors of a comparative study on vulnerability and will be co-authors of other two papers.

**Alfredo Ribeiro** has been contributing in the coordination of the water resources component of the Brazilian Research Network on Global Climate Change and participating in projects that deal with climate modelling and flood studies. He is advising one PhD student whose thesis will contribute for Task 1. He also advises a master student who is contributing for data analysis of a paper about drought indices in partnership with Chilean team. In 2017, he started partnership with researchers from the Observatoire Midi-Pyrénées (Toulouse/France) aiming to apply remote sensing products for water security studies.

**Suzanna Montenegro** is coordinating jointly with Alfredo Ribeiro the professional master course in Management and Regulation of Water Resources funded by Brazilian National Water Agency (ANA) and Coordination for the Improvement of Higher Education Personnel (CAPES). One PhD student and one master student are advised by Suzana Montenegro on themes inserted in Tasks 2 and 3.

#### 4. Cumulative list of publications

(PLEASE SEE EXCEL SPREADSHEET)

##### 4.1 Posters and other presentations made at meetings, conferences (comprehensive list since 2014, when UA assumed project lead)

1. Abarzua, F.; Brouchoud, S.; Carballo, O.; Gusman, N. (2017) Producción hortícola en el Valle de Uco (Mendoza) y en el Valle Medio (Río Negro): un análisis comparativo desde las configuraciones territoriales y los sujetos sociales hortícolas. Conference paper at X Jornadas Interdisciplinarias de Estudios Agrarios y Agroindustriales Argentinos y Latinoamericanos. Buenos Aires.
2. Albuquerque, D.O., Dutra, M.T.D., Barbosa, I.M.B.R., Lyra, M.R.C.C., Carvalho, R.M.C.M.O., Montenegro, S.M.G.L. Aplicação de indicadores de sustentabilidade hidroambiental na bacia hidrográfica do rio Capibaribe, Pernambuco (Application of hydro-environmental sustainability indicators in the Capibaribe river basin, Pernambuco). In: XXI Simpósio Brasileiro de Recursos Hídricos, 2015, Brasília. Anais do XXI Simpósio Brasileiro de Recursos Hídricos. Porto Alegre: ABRH, 2015.
3. Albrecht, T. R., R. G. Varady, A. A. Zuniga-Teran, R. De Grenade, A. Lutz-Ley, F. Martín, S. B. Megdal, F. Meza, D. Ocampo Melgar, N. Pineda, F. Rojas, R. Taboada, B. Willems. 2017. Transboundary water security in the arid Americas. Presented by Varady and Zuniga-Teran at I Congreso Peruano Agua-Andes: “Dialogos Ciencia-Politica para el Desarrollo Sostenible” (First Peruvian Agua-Andes Congress: “Science-Policy Dialogues for Sustainable Development”). National Univ. of San Cristóbal de Huamanga, Ayacucho, Peru. Sept. 19.
4. ÁLVAREZ, J., FERNÁNDEZ, H., SALOMÓN, M., SOSA, P. y D. COLLADO, 2016. “Herramientas de Gestión. Zonificación para la protección de zonas rurales”. *Segundo Foro Regional Los Desafíos de La Gestión Territorial Rural Primeras Jornadas de Estudios y Experiencias en los Territorios de Interfaz, Urbano-Rural y Oasis-Secano*. Universidad Nacional de Cuyo. Facultad Ciencias Agrarias. pp 12. [http://inta.gob.ar/sites/default/files/foro-jornada\\_regional\\_observatorio\\_final.pdf](http://inta.gob.ar/sites/default/files/foro-jornada_regional_observatorio_final.pdf)
5. ÁLVAREZ, J. y M. SALOMÓN, 2016. “Clasificación y protección de zonas agrícolas irrigadas en el marco del Plan Provincial de Ordenamiento Territorial (PPOT) de Mendoza”. III jornadas Técnicas sobre Investigación en Recursos Hídricos. Víctor Burgos (Ed.) Editorial de la Universidad Tecnológica Nacional. Mendoza. 5:15. [http://www.edutecne.utn.edu.ar/jirh/jirh\\_2016.pdf](http://www.edutecne.utn.edu.ar/jirh/jirh_2016.pdf)

6. Barrientos, M.J y Ferrer, C. Experiencia tecnológica y diálogo de saberes: programa “campesino a campesino para el acceso al agua.” comunidad de lagunas del rosario, Mendoza. Pre congreso ALASRU: “La sociología rural en la encrucijada: vigencia de la cuestión agraria, actores sociales y modelos de desarrollo en la región”. Santiago del Estero, Octubre, 2016.
7. Batista, L.F.D.R., Ribeiro Neto, A., Montenegro, S.M.G.L. Adaptation mechanisms for extreme events in the Capibaribe River Basin. In: XVI World Water Congress, 2017, Cancun. Proceedings of XVI World Water Congress, 2017.
8. Bauer, C. 2014. “Ventajas y debilidades del modelo chileno de la gobernanza del agua,” Diplomado en Gestión de Aguas, U. of Chile, Dept. of Environmental Sciences and Renewable Natural Resources, Santiago, Chile (May) and Copiapó, Chile (June). [“Strengths and weaknesses of the Chilean model of water governance”]
9. Bauer, C. 2014. “Mercados de aguas con fines ambientales y gobernanza de cuencas/GIRH,” Iniciativa del Agua y Medio Ambiente, Santiago, Chile (June). [“Water markets for environmental purposes and integrated basin governance”]
10. Bauer, C. 2014. “¿La ley del péndulo? Conflictos de aguas y gobernanza en Chile desde 2005” (The law of the pendulum? Water and governance conflicts in Chile since 2015). Inaugural plenary lecture. VII Jornadas de Derecho Ambiental, University of Chile Law School, Santiago, Chile.
11. Bauer, C. 2014. “Drought, water rights reform, and hydropower in Chile and California.” 3<sup>rd</sup> Chile-California Conference, U. of California-Berkeley, Berkeley, CA.
12. Bauer, C. 2014. “Water, law, and development in Chile/California cooperation, 1960s-1970s.” Hemispheric Institute on the Americas, U. of California-Davis, Davis, CA.
13. Bauer, C. 2014. “Chilean water policy and water rights.” U. of California-Davis Law School, Water Association of Law & Policy and the Environmental Law Society, Davis, CA.
14. Bauer, C. 2015. “Water, law, and development in Chile/California cooperation, 1960s-1970s,” Law and Society Association Annual Conference, Seattle, WA (May).
15. Bauer, C. 2015. “Ventajas y debilidades del modelo chileno de la gobernanza del agua” (Advantages and weaknesses of the Chilean model of water governance). Diplomado en Gestión de Aguas, U. of Chile, Dept. of Environmental Sciences and Renewable Natural Resources, Santiago, Chile.
16. Bauer, C. 2015. “Conflictos de agua y problemas de gobernanza en Chile” (Water conflicts and governance problems in Chile). Reunión de Expertos, “La Formulación de Políticas de Agua en el Contexto de la Agenda de Desarrollo Post-2015,” CEPAL, Santiago, Chile.

17. Bauer, C. 2016. "Water conflicts and entrenched governance problems in Chile's market model," American Association of Geographers Annual Conference, San Francisco, CA (March).
18. Bauer, C. 2016. "Ventajas y debilidades del modelo chileno de la gobernanza del agua" (Advantages and weaknesses of the Chilean model of water governance). Diplomado en Gestión de Aguas, U. of Chile, Dept. of Environmental Sciences and Renewable Natural Resources, Santiago, Chile.
19. Bauer, C. 2016. "Cuatro mitos sobre el derecho y economía del agua en Chile," Viernes Constitucionales: Derecho y Función Social de la Propiedad, U. of Chile, Dept. of Economics and Business, Santiago, Chile. ["Four myths about water law and economics in Chile"]
20. Bauer, C. 2016. "Represas y mercados: Ríos y energía eléctrica en Chile," Training Workshop in Water Security and Management of Water Demand in the Arid Americas, CONICET, Mendoza, Argentina (August). ["Dams and markets: Rivers and electric power in Chile"]
21. Bernabeu, M. M. 2017 "El Código de Convivencia y la proliferación de barrios privados en la ciudad de Mendoza: ¿la ciudad para quiénes?" Conference paper at Clases Sociales, Renovación Urbana y Gentrificación Área de Estudios Urbanos del Instituto de Investigaciones Gino Germani (Universidad de Buenos Aires). Agosto.
22. Borgias, S. 2016. A right to leave the river dry? The politics of river sectioning in Chile. Under Western Skies Conference, Royal Mount University, Calgary, AB, Canada.
23. Borgias, S. 2016. Politicizing drought: Social movements and water scarcity in Chile's drought 'crisis'. American Association of Geographers Conference, San Francisco, CA.
24. Borgias, S. 2015. Conflict, change, and the challenges of water governance in Chile's Maipo River basin. Annual Tinker Symposium, Tucson, AZ.
25. Borgias, S. 2015. Without water there is no city: Conflict, change, and the challenges of water governance in Chile's Maipo River basin. American Association of Geographers Conference, Chicago, IL.
26. Carballo, O.; Fili, J. 2016 Transformaciones en la organización del trabajo en la producción de vid en el Valle de Uco. Conference paper at Pre Congreso ALASRU (Asociación Latinoamericana de Sociología Rural). Universidad Nacional de Santiago del Estero. Argentina. October.
27. Carballo, O., Fili, J.P. y Engelman, A. (2017) "El paisaje y su trastienda: el caso del Valle de Uco (Mendoza)". Paper presented at XXX Congreso ALAS Uruguay 2017. Las encrucijadas abiertas de América Latina. La sociología en tiempos de cambios. November.
28. Cordeiro, L.E., Albuquerque, F.A., Montenegro, S.M.G.L.. Evapotranspiração de referência em bacia experimental do riacho Gameleira, Pernambuco, usando o método Penman-Monteith da FAO (Reference evapotranspiration in experimental Gameleira basin, Pernambuco, using the Penman-Monteith method of FAO). In: XXI Simpósio

Brasileiro de Recursos Hídricos, 2015, Brasília. Anais do XXI Simpósio Brasileiro de Recursos Hídricos. Porto Alegre: ABRH, 2015.

29. Díaz Caravantes, R. 2016. "Amenazas para la salud en el Río Sonora: análisis exploratorio de la calidad del agua reportada en la base de datos oficial de México. Agosto 2014-Septiembre 2015". Presentation in a citizen conference in the Sonora River. Aconchi, Sonora. July, 2016.
30. Díaz Caravantes, R. 2016. "The socio-environmental vulnerability in the Sonora River". Presentation in the Training Workshop on Water Security and Demand Management. Mendoza, Argentina, August 2016.
31. Díaz Caravantes, R. 2016. "Seguridad Hídrica y Salud: Una Aproximación Necesaria". Presentation in regional meeting of health researchers, society and the environment. Hermosillo, Sonora. November 2016.
32. Díaz-Caravantes, R.E. (2016) La necesidad de repensar el concepto de vulnerabilidad a la luz del Quinto Reporte. Panel: Acuerdos de Paris 2015. Sexto Congreso Nacional de Investigación en Cambio Climático. 18 de Octubre de 2016. Universidad Nacional Autónoma de México y Universidad de Sonora. Hermosillo, Sonora.
33. Díaz-Caravantes, R.E., Duarte Tagles, H., Pallanez Murrieta, M. & Durazo Gálvez, F. (2016) La calidad del agua del Río Sonora reportada en la base de datos del Fideicomiso del Río Sonora, 2014-2015. V Congreso de Ecología. 4 de noviembre de 2016. Universidad Estatal de Sonora. Hermosillo, Sonora.
34. Díaz-Caravantes, R.E., & Pineda Pablos, N. (2017) Water (in) security in the Sonora River by the mine spill: examining the water quality parameters for urban public use reported in the official database of Mexico. XVI World Water Congress. 31 de mayo de 2017. Cancún, Mexico.
35. Díaz-Caravantes, R.E., Duarte Tagles, H., Pallanez Murrieta, M., Moreno Vázquez, J.L., Mejía, J.A., & Durazo Gálvez, F. (2017) Revisión del monitoreo de calidad del agua para la protección de la vida acuática en el río Sonora de agosto de 2014 a septiembre de 2015. Simposio Internacional Interdisciplinar de Investigación sobre Violaciones a Derechos Ambientales. 11 de mayo de 2017. Universidad de Sonora. Hermosillo, Sonora.
36. Díaz-Caravantes, R.E., Duarte Tagles, H., Pallanez Murrieta, M., Moreno Vázquez, J.L., Mejía, J.A., & Durazo Gálvez, F. (2017) Análisis de los resultados del monitoreo de calidad del agua para la protección de la vida acuática en el río Sonora. 3er. Congreso Instituciones, Gobierno y Sociedad. 28 de abril de 2017. El Colegio de Sonora. Hermosillo, Sonora.
37. Díaz-Caravantes, R.E., Robles Morua, A., Navarro, J., Verduzco, V. (2017) Riesgo y vulnerabilidad a las altas temperaturas en la ciudad de Hermosillo. Primera Reunión de Investigadores en Salud Ambiental. 5 de septiembre de 2017. Universidad de Sonora, Hermosillo, Sonora.
38. Engelman Anabella (2016) "El tratamientos de nuevos territorios rurales desde la Geografía Rural Argentina". Conference paper at Pre Congreso ALASRU. La sociología

rural en la encrucijada: vigencia en la cuestión agraria, actores sociales y modelos de desarrollo en la región. October.

39. Dutra, M.T.D., Gonçalves, M.L.A., Barbosa, I.M.R., Braga, R.A.P., Ribeiro Neto, A., Silva, A.A., Montenegro, S.M.G.L. Desempenho de indicadores do plano hidroambiental da bacia hidrográfica do rio Capibaribe, em Pernambuco, Brasil. In: 13º Simpósio de Hidráulica e Recursos Hídricos dos Países de Língua Portuguesa, 2017, Porto. Anais do 13º Simpósio de Hidráulica e Recursos Hídricos dos Países de Língua Portuguesa, 2017.
40. Felix, V.S., Melo, R.R.R., Ribeiro Neto, A. Simulação hidrológica da dinâmica do uso e ocupação do solo da bacia hidrográfica do rio Capibaribe-PE com modelagem hidrológica distribuída. In: 13º Simpósio de Hidráulica e Recursos Hídricos dos Países de Língua Portuguesa, 2017, Porto. Anais do 13º Simpósio de Hidráulica e Recursos Hídricos dos Países de Língua Portuguesa, 2017.
41. Fili, J. P. 2017 "El desarrollo desigual y combinado en el espacio rural de San Juan". 1º Jornadas de Ciencia, Técnica y Posgrado de la Facultad de Filosofía y Letras. Mendoza, UNCuyo. November.
42. García, V; Meza, F., Sandaña P, Lizana, C. 2018. Comparing the performance of SUBSTOR and CropSyst in five potato varieties under different model calibration strategies. 7th Global Workshop of The Agricultural Model Intercomparison and Improvement Project AgMIP7, April 24-26, 2018, San José, Costa Rica,
43. Garcia, H., Zuniga-Teran, A.A. 2016. Huertos comunitarios, dieta y actividad física en población femenina en las ciudades de la frontera norte (Community gardens, diet and physical activity in female populations of cities along the northern Mexican border). Presented at the Red de Cooperación Binacional para Comunidades Saludables (Binational Cooperation Network for Healthy Communities). Nogales, Mexico. May 9.
44. Gerlak, A. Zuniga-Teran, A., Murrieta, J. Ruiz, N., Rodriguez, C., Shepard, J., and Shipek, C. 2018. Presented by Zuniga-Teran, A. 2018. "Urban resilience and green infrastructure: A case study of environmental justice in Tucson, AZ." Presented at the event "Urban Resilience Networking Hour," at the University of Arizona. September 19.
45. Gerlak, A. Zuniga-Teran, A., Murrieta, J. Ruiz, N., Rodriguez, C., Shepard, J., and Shipek, C. 2018. Presented by Zuniga-Teran, A. Invited speaker to the class EPID 606 - Changing Global Health Policy through Epidemiological Analysis and Cultural Understanding. University of Arizona. Title of the presentation "Water security through green infrastructure: A case study on environmental injustice in Tucson, Arizona." April 3.
46. Gerlak, A. Zuniga-Teran, A., Murrieta, J. Ruiz, N., Rodriguez, C., Shepard, J., and Shipek, C. 2017. "Equity in green infrastructure: A case study in Tucson, AZ." Presented by Zuniga-Teran, A. at the Resilience & Complexity Workshop. University of Arizona. Tucson, Arizona. November 6.
47. Gerlak, A. Zuniga, A., Murrieta, J. Ruiz, N., Rodriguez, C., Shepard, J., and Shipek, C. 2017. Equity in green infrastructure: A case study in Tucson, AZ. Presented by Gerlak at I Congreso Peruano Agua-Andes: "Dialogos Ciencia-Politica para el Desarrollo Sostenible" (First Peruvian Agua-Andes Congress: "Science-Policy Dialogues for

Sustainable Development”). National Univ. of San Cristóbal de Huamanga, Ayacucho, Peru. Sept. 19.

48. Gonçalves, M.L.A., Aguiar, V.C., Dutra, M.T.D., Ribeiro Neto, A., Montenegro, S.M.G.L. Desempenho de indicadores de sustentabilidade hidroambiental na bacia hidrográfica do rio Pajeú, em Pernambuco, Brasil. In: XXII Simpósio Brasileiro de Recursos Hídricos, 2017, Florianópolis. Anais do XXII Simpósio Brasileiro de Recursos Hídricos, 2017.
49. Haro, Jesús, Maribel Pallanez, David Morales y **Rolando Díaz**. *Área natural protegida Bavispe: un diagnóstico desde el ámbito institucional*. VI Congreso de Ecología. Universidad Estatal de Sonora. In Hermosillo, Sonora, México. January 25, 2018
50. Henríquez-Dole, L., Pulido-Velásquez, M., Vicuña, S., Gironás, J., Meza, F., 2018. Coupling cost effectiveness analysis and robust decision making for selecting adaptation measures. Application to the Maipo river basin, Chile. European Geophysical Union General Assembly. Viena 8-13 Abril 2018.
51. Henríquez, L., Vicuña, S., Gironás, J., Meza, F.J. Adaptation measures evaluation on agriculture under future climate and land use scenarios in central Chile. American Geophysical Union Fall Meeting. San Francisco. 12-16 December 2016
52. Hurlbert, M., Mussetta, P., Turbay, S. 2015 Canadian, Argentinean and Colombian Programs Building Resilience to Extreme Events. World Symposium on Climate Change. Manchester Metropolitan University.
53. Ibarra Ozuna, F. 2015. “Gestión del agua y saneamiento en la localidad yaqui de Pótam” (Water management and sanitation in the Yaqui town of Potam), presented at the 2º Congreso Instituciones, Gobierno y Sociedad, Hermosillo, Sonora, Mexico. May 22.
54. Ibarra Ozuna, F.O. & Pineda Pablos, N. 2015. “Gestión del agua y saneamiento en la localidad yaqui de Pótam” (Water and sewage management in the Yaqui town of Potam). Presentation given at the 2º Congreso Instituciones, Gobierno y Sociedad (2nd Congress Institutions, Government and Society). Hermosillo, Sonora. May 20 and 21.
55. IVARS, J 2017 “Las potencialidades del concepto de servicios ecosistémicos para la ecología política”. Conference paper at X JORNADAS INTERDISCIPLINARIAS DE ESTUDIOS AGRARIOS Y AGROINDUSTRIALES ARGENTINOS Y LATINOAMERICANOS
56. IVARS, J. 2017 “La configuración del dispositivo eco-tecnocrático”. Conference paper at X JORNADAS INTERDISCIPLINARIAS DE ESTUDIOS AGRARIOS Y AGROINDUSTRIALES ARGENTINOS Y LATINOAMERICANOS
57. Justo, Saúl; Nicolás Pineda Gestión integrada de recursos hídricos (GIRH): Consejo de cuenca de los ríos Yaqui y Mátape. 3er. Congreso Instituciones, gobierno y sociedad. Hermosillo, Son. 27 abril, 2017.



58. Lutz Ley, A. N. 2012. "Social Distribution of Water in the Sonora River Basin". Environmental Research Grad Blitz. Institute of the Environment. The University of Arizona, Tucson, AZ.
59. Lutz Ley, A. N. 2013. "Gestión del agua subterránea en el desierto de Sonora: diferencias institucionales a través de la frontera Sonora-Arizona". 1er Congreso de Investigación Instituciones, Gobierno y Sociedad Civil. El Colegio de Sonora, Hermosillo, Mexico.
60. Lutz Ley, A. N. 2014. "Institutional Frameworks for Managing Groundwater in Rural Arizona and Sonora". Annual Conference of the American Institute of Professional Geologists and the Arizona Hydrological Society. Water and Rocks. The Foundations of Life. September 13-16, 2014. Prescott, Arizona.
61. Lutz Ley, A. N. 2014. "Watersheds and Social-sheds: Adaptive Agricultural Systems in the Arid Americas". UA Science Cafes Series- Borderlands Brewing Science Café. Tucson, AZ., October 9.
62. Lutz Ley, A. N. 2015. "The Death of Local Knowledge in the Race for Rural Adaptation to Global Change. Evidences from an Arid Basin in Northwest Mexico." Environmental Grad Blitz. Institute of the Environment, University of Arizona, Tucson, AZ, November 2015.
63. Lutz Ley, A. N. 2016. "Navigating through uncertain waters in the COP21-CMP11". Talk presented in the Panel Reflections on the Paris Climate Negotiations, COP21. University of Arizona- Institute of the Environment. Tucson, AZ., February 11.
64. Lutz Ley, A.N. and P. A. Reyes. 2016. "Human health in a warmer world: the challenge of interactive social impacts". 10th Annual Social Justice Symposium. No One is Immune: Social Justice, Climate Change, and Health. University of Arizona- Mel and Enid Zuckerman College of Public Health. Tucson, AZ., April 15.
65. Lutz Ley, A. N. 2016. Global change and rural livelihoods in a water-scarce watershed in northwest Mexico. Presentation awarded 1st place in the 3-minute talk challenge of the Arid Lands Resource Sciences annual retreat. September 16, 2016.
66. Marra, R., Zuniga-Teran, A.A. Lutz-Ley, A. Peralta, Y., Mejia, J. 2016. Scenario planning workshop and rationale to water interests in Hermosillo. El Colegio de Sonora and Agua de Hermosillo. Hermosillo, Mexico. April 8-9 2016.
67. Manzur, T. & Carballo, O. "Aportes a la estrategia de convergencia metodológica. Análisis de tipologías de Explotaciones Agropecuarias a partir del Censo Nacional Agropecuario 2008". Conference paper presented at V ELMECS, Universidad Nacional de Cuyo. Noviembre 2016.
68. Manzur, T. y Barrientos M.J. 2016 "Sobre la conflictividad social en los sitios del orden: líneas de investigación en torno al Ordenamiento Territorial de la Provincia de Mendoza. "Foro Regional Los Desafíos de la Gestión Territorial Rural - 1as Jornadas Regionales de Estudios y Experiencias en los Territorios de Interfaz, Urbano-rural y Oasis-secano". November.

69. Martín, F., Mussetta, P., Salomón, M. & Scott, C.A. 2014. "Science-Policy Dialogues and Adaptation. Facing short, medium and long term scenarios in Mendoza, Argentina." III International Climate Change Adaptation Conference - Adaptation Futures 2014, Fortaleza, Ceara, Brazil, May
70. Martín, F. 2014. Conference "Diálogos Ciencia-Política en contextos de sequía. Aportes aportes a partir de la experiencia del Balance Hídrico en Mendoza, Argentina" (Science-Policy Dialogues in drought contexts. Insights form Water Balance experience in Mendoza, Argentina) en "I Congreso Internacional Retos para la gestión integrada de cuencas andinas frente al Cambio Global" Universidad Nacional Mayor de San Simón, Lima. Abril
71. Martín, F 2014 "Políticas territoriales y regulación de suelo rural: estado del debate y experiencias en Argentina" (Territorial policies and rural land regulation: current sitation and experiences). Paper presented at Jornadas Nacionales CELS-HABITAR ARGENTINA, December.
72. Martín, F. 2015. "Seguridad Hídrica y Vulnerabilidad de los pequeños agricultores en la Provincia de Mendoza" (Water Security and Vulnerability of small farmers in the Mendoza Province). Taller Plan de Adaptación al Cambio Climático a escala de cuenca (Workshop Plan for Climate Change Adaptation at the basin scale) . Experiencia proyecto MAPA (Experience Project MAPA), Maipo Basin, Chile. June.
73. Martín, F. 2016. "Agua, poder y desigualdad socio-espacial" (Water, power and socio-spatial inequality). Jornadas de Investigación de la Universidad Nacional de Cuyo, Mendoza. May.
74. Martín, F. 2016. Conference "Es escasa el agua en Mendoza. Conflictos y distribución" (Water scarcity in Mendoza? Conflicts and distribution). Conference at Curso Educación y Ambiente. Saberes, perspectivas y herramientas didácticas para educadores. Diario Los Andes y Mesa Provincial de Educación Ambiental. Julio.
75. Martín, F. & Rojas, F. 2016. Grandes sequías en Mendoza. Administración de la carencia y disputas socio-políticas. Jornadas Nacionales de Investigación en Ciencias Sociales. Universidad Nacional de Cuyo. Agosto.
76. Martín, F. 2016. Conference "Cambio Ambiental Global, Seguridad y Soberanía Alimentaria" Taller de Economía Crítica, Facultad de Ciencias Económicas, Universidad Nacional de Cuyo. Noviembre.
77. Martín, F. 2016. Conference "Agua para el futuro: Cambio climático y Seguridad hídrica, la relevancia de educar". Jornadas Agua y Educación. Departamento General de Irrigación. Mendoza. Noviembre.
78. Martín, F. & Rojas, F. 2016. "Cambios en los Usos del suelo e (in)seguridad hídrica en las cuencas del Río Mendoza y Tunuyán, Argentina (1986-2015)" (Land use change and water (in)security in Mendoza and tunuyán River Basin, Argentina (1986-2015). Jornadas de integración DGI-IANIGLA. Octubre.

79. Martín, F.; Rojas, F. & Prieto, M.R. 2016 “Grandes sequías en Mendoza, Argentina. Administración de la carencia y disputas socio-políticas.” Paper presented at II Congreso Latinoamericano de Ecología Política, Universidad Católica del Norte, San Pedro de Atacama, Chile. Noviembre.
80. Larsimont, R. & Martín, F. 2016 “Modelo de agronegocio de specialities, ruralidad y spatial fix: el caso del Valle de Uco, Mendoza-Argentina” Paper presented at II Congreso Latinoamericano de Ecología Política, Universidad Católica del Norte, San Pedro de Atacama, Chile. Noviembre.
81. Martín, F. & Langbhen, L. 2017 “Claroscuros de un federalismo ambiental en construcción: las leyes de Bosques y Glaciares y su aplicación”. Poster presented at the III Jornadas de Ecología Política, Universidad Nacional de San Juan, San Juan, Argentina. Marzo.
82. Martín, F.; Rojas, F.; Wagner, L.; Barbosa, L. 2017 & Larsimont, R. 2017 “Disputas socioambientales por el agua del Río Atuel, Mendoza” Poster presented at the III Jornadas de Ecología Política, Universidad Nacional de San Juan, San Juan, Argentina. Marzo.
83. Martín, F. 2017 “Land Struggles, State “Absence” and Territorial Justice. Agribusiness Expansion vs. Peasant Re-emergency in Mendoza, West Argentina”. Paper presented at LASA 2017, Pontificia Universidad Católica del Perú (PUCP), Mayo.
84. Martín, F. 2017 “El “estado” de los recursos naturales en América Latina: balances y perspectivas sobre el (neo)extractivismo” Paper presented at the International Conference “La crisis en América Latina: causas y salidas”, Kassel University, Weingarten, Germany. June.
85. Martín, F. 2017 “Conflictos actuales por recursos naturales en Sudamérica. Un diálogo desde la ecología política” Workshop Panel member at Institut für Geographie, University of Innsbruck, Austria. June.
86. Martín, F & Carballo, O. 2017 “Cambia Ambiental Global y transformaciones territoriales en el Valle de Uco, Mendoza” Workshop held at INTA-La Consulta, San Carlos. August.
87. Martín, F. & Healey, M. 2017 “Conflictos y consensos en la historia del agua en la Mendoza moderna”. Workshop panel held at Departamento General de Irrigación, Mendoza. July.
88. Martín, F. & Healey, M. 2017 “The Faltering of the Hydraulic Mission: Technology and the limits of irrigation in Cuyo, Argentina (1960-1990)” Paper presented at the Conference for the History of Technology (SHOT) Philadelphia. October.
89. Rubio, M. C. Nur Akil, Facundo Rojas, Facundo Martín, María Marta Bernabeu & Martín Rizzo 2017 “Aportes metodológicos para el análisis de cambios de uso y cobertura de suelo con código abierto. Cuencas de los ríos Mendoza y Tunuyán, 1985-2016 (Mendoza, Argentina)” Congreso Internacional de Servicios Ecosistémicos en los Neotrópicos, CISENV, Oaxaca, México. November.

90. Maya Rodríguez, J.M. & Pineda Pablos, N. 2015. "Avances en la política de saneamiento en el noroeste de México. Algunas pautas para el análisis de una problemática compleja" (Advances in the sanitation policy in the northwest of Mexico. Guidance for the analysis of a complex issue). Presentation given at the 4th IWA México Young Water Professionals Conference. Guanajuato, Guanajuato. April 27 to 29.
91. Maya Rodríguez, J.M. & Pineda Pablos, N. 2015. "Muchos intentos y nulos resultados: notas sobre los intentos fallidos para dotar de una planta de tratamiento de aguas residuales a la ciudad de Hermosillo, Sonora 1994-2015" (Many attempts and no results: notes about the failed attempts to donate a wastewater treatment plant to the city of Hermosillo Sonora 1994-2015). Presentation given at the 2º Congreso Instituciones, Gobierno y Sociedad (2nd Congress Institutions, Government and Society). Hermosillo, Sonora. May 20 and 21.
92. Maya Jesús Miguel; Nicolás Pineda. El saneamiento de las aguas residuales, la política en tiempos de difíciles relaciones binacionales. Caso: mexicali, Baja California. 3er. Congreso Instituciones, gobierno y sociedad. Hermosillo, Son. 28 abril, 2017.
93. Maya Jesús Miguel and Nicolás Pineda Pablos. "Saneamiento de aguas residuales, la dinámica de la obligación municipal y la realidad económica de las agencias del sector" (Sanitation on wastewater, the dynamics of the municipal obligation and the economic reality of the agencies of the sector). In the 1st Meeting of auxiliary organisms of Cuenca. Universidad Metropolitana, Mexico City. October 10, 2017.
94. Mercadante, Giankarla; Nicolás Pineda Pablos. El Consejo de Cuencas del Alto Noroeste: Avances y Retos. 3er. Congreso Instituciones, gobierno y sociedad. Hermosillo, Son. 27 abril, 2017.
95. Melo, O., Vicuña, S., Meza, F., Medellín J., Herman, J., Sandoval S. Crossing scales and disciplines to understand challenges for climate change adaptation and water resources management in Chile and California. American Geophysical Union Fall Meeting. New Orleans. 11-15 December 2017
96. Meza, F. 2018 Assessing adaptation costs in irrigated agriculture integrating hydrological and crop simulation models: case study from central Chile. 7th Global Workshop of The Agricultural Model Intercomparison and Improvement Project AgMIP7, April 24-26, 2018, San José, Costa Rica,
97. Meza F.J., Poblete D., Vicuña S., Gurovich L., Miranda M. & Melo O. 2015. "Facilitating climate adaptation in irrigated agriculture with decision support systems: El Molino platform." Climate Smart Agriculture: Global Science Conference. Montpellier 16-18 March.
98. Meza F. J. 2015. "Sustainable Development Goals: A Water Perspective. Indicators, Interlinkages and Implementation." International Conference. Bonn, 17-18 August. Meza, F.J. 2017. Water security in the agriculture of Central Chile: Assessing impacts, alternatives and adaptation costs. XVI World Water Congress. 29 Mayo -3 Junio. Cancun. Mexico.

99. Meza, F.J. Dávila, W. 2016. Calibration of CropSyst combining publically available climate information, remote sensing and data and minimum yield data. 6th AGMIP Global Workshop. Montpellier, France 28-30 June, 2016.
100. Meza, F.J. Morales, D, Orellana, S., Flores, P. 2016. Co-production of knowledge for Agricultural Adaptation: Using Climate Information and Crop Model outputs in the Wine Industry and the Maipo Adaptation Plan. 6th AGMIP Global Workshop. Montpellier, France 28-30 June, 2016.
101. Meza, F.J. Henríquez, L, Poblete, D., Vicuña, S. 2016. Integrated assessments in Irrigated Agriculture linking Crop and Hydrological Models : The case of Central Chile. 6th AGMIP Global Workshop. Montpellier, France 28-30 June, 2016
102. Moura, M.R.F., Ribeiro Neto, A., Santana, M.C.N., Campos, B.V.R., Montenegro, S.M. G.L. Hydrological variability in the Capibaribe River Basin in the 20th and 21st centuries. In: XVI World Water Congress, 2017, Cancun. Proceedings of XVI World Water Congress, 2017.
103. Mussetta, P., Turbay, S., Fletcher, A., 2015. Adaptive Strategies Building Resilience to Climate Variability in Argentina, Canada and Colombia. World Symposium on Climate Change. Manchester Metropolitan University.
104. Noreña Rivera, D.D. & Yocupicio Torres, D. 2015. “Gestión Integral del Agua y Consejos de Cuenca en Sonora” (Integrated water management and basin councils in Sonora). Presentation given at the 2º Congreso Instituciones, Gobierno y Sociedad (2nd Congress Institutions, Government and Society). Hermosillo, Sonora. May 20 and 21.
105. Noreña Rivera, Daniela and Nicolás Pineda Pablos in the 4th International Sustainability Congress Hegemony and alternative visions in the current context. Toluca, State of Mexico, Mexico. October 18, 2017.  
See: <https://drive.google.com/open?id=1dennoaZuzhcKuZ6QDSi2WM0jT8MWEUKD>
106. Ocampo, D., Meza, F. 2016 Dinámica del régimen nival en la cordillera de los andes: estudio de eventos de lluvia sobre nieve. . I Congreso chileno de ingeniería ambiental en sistemas acuáticos, cchiasa Santiago. 30 nov- dic 2. 2016
107. Oertel, M., Meza, F. 2017. Propagation of Drought in Semi-Arid River Basins Revisiting the Report of Changnon (1987). Water Security and Climate Change Conference. 18-22 Septiembre. Colonia. Alemania.
108. Oertel, M., Meza, F., Gironás, J. & Scott, C.A. 2014. “The Role of Drought Indices in Drought Management - Global Experiences and Opportunities for Chile.” 65º Congreso Agronómico, Santiago, October 27-29.
109. Oertel, M., Meza, F. & Gironás, J., 2014. “Why do drought definitions on basin scale make sense?” Poster Presentation. International Drought Expert Symposium, November 19-21.

110. Oertel M., Meza F.J. & Gironás J. 2015. "Improving operational drought definitions – taking them to basin scale." International Conference on DROUGHT: Research and Science-Policy Interfacing, València, Spain, 10-13 March.
111. Oertel, M., Meza, F. 2017. Propagation of Drought in Semi-Arid River Basins. Revisiting the Report of Changnon (1987). Water Security and Climate Change Conference. 18-22 Septiembre. Colonia. Alemania
112. Oliveira, L.M., Montenegro, S.M.L.G., Silva, B.B., Coelho, V.H.R., Gusmao, A.C. V.E.L. Valores instantâneos dos fluxos de calor no solo, sensível e latente por geoprocessamento e SEBAL em bacia hidrográfica no estado de Pernambuco (Instantaneous values of heat fluxes in the soil, sensible and latent using geoprocessing and SEBAL in river basin in the state of Pernambuco). In: XVII Simpósio Brasileiro de Sensoriamento Remoto, 2015, João Pessoa. Anais do XVII Simpósio Brasileiro de Sensoriamento Remoto, 2015.
113. Pacheco Rosas, J.C. & Pineda Pablos, N. 2015. "Los obstáculos para la cobranza efectiva del servicio de agua potable en Los Mochis, Sinaloa: Una propuesta de análisis del marco legal en políticas públicas" (The obstacles for the effective charge of potable water service in Los Mochis, Sinaloa: A proposal for an analysis of the legal framework in public policy). Presentation given at the 3er Congreso Internacional de Ciencia Política (3rd International Congress of Political Science). Guadalajara, Jalisco. July 15 to 18.
114. Pacheco Rosas, J.C. & Pineda Pablos, N. 2015. "Marco legal de la cobranza efectiva en el servicio de agua potable en Hermosillo, Sonora: una propuesta de modelo para el análisis de los servicios públicos urbanos" (Legal framework for the effective charge of the potable water service in Hermosillo, Sonora: a proposal for a model that analyzes the urban public utilities). Presentation given at the 2º Congreso Instituciones, Gobierno y Sociedad (2nd Congress Institutions, Government and Society). Hermosillo, Sonora. May 20 and 21.
115. Parise, N. 2017 "¿El oasis como dispositivo? Vigilancia epistemológica en torno a la producción de oasis en el oeste argentino". Conference paper at Jornadas Debates Actuales de la Teoría Política Contemporánea. FCPyS, UNCuyo. November.
116. Parra Armenta, E.M. 2015. "Alcances y limitaciones del Consejo Consultivo de Agua de Hermosillo: análisis de su marco legal" (Scope and limitations of the Water Consulting Council of Hermosillo). Presentation given at the 2º Congreso Instituciones, Gobierno y Sociedad (2nd Congress Institutions, Government and Society). Hermosillo, Sonora. May 20 and 21.
117. Parra Erik and Nicolás Pineda Pablos. "Una propuesta para el estudio de la gestión integrada de los recursos hídricos en los consejos de cuenca" (A proposal for the study of the Integrated Management of Water Resources in the watershed councils). In the 1st Meeting of auxiliary organisms of Cuenca. Universidad Metropolitana, Mexico City. September 06, 2017.  
See: <https://drive.google.com/open?id=1gL8Qp5BqeiVl7yJ9ERbTzKT9tvP2pD7C>

118. Petrakis, R., Hartfield, K., Barrera, P., van Leeuwen, W., Papuga, S. & Scott, C.A. 2014. "Multi-Temporal Remote Sensing Data for Modeling of Dryland Evapotranspiration and Land Cover Change." Poster Presentation. American Geophysical Union Fall Meeting 2014. San Francisco, CA. December 19.
119. Peralta, Y. & Wilder, M. 2016 "Community vs. Commodity: The struggle of small-scale producers in the Yaqui Valley". Conference Presentation. American Association of Geographers. San Francisco, California, USA. April, 2016.
120. Peralta, Y. 2016. "Going backwards to move forward: the role of water in food production between traditional and alternative agriculture in Northwest Mexico". ALRS Fall 2016 Student Retreat, Tucson, Arizona, USA. September, 2016.
121. Peralta, Y., Wilder, M., Scott, C. 2016. "Going backwards to move forward: The role of water in food production between conventional and alternative agriculture in Northwest Mexico". Food and Water in Arid Lands. Dialogues across Contemporary and Traditional Knowledge. Poster Presentation (in preparation). Tucson, Arizona, USA. Nov. 2016.
122. Pineda Pablos, Nicolás. Conferencia Magistral "Notas para discutir la adaptación del cambio climático y la gestión del agua en Sonora". 7mo Congreso nacional de investigación en cambio climático. Hermosillo, Son. 02 octubre, 2017.
123. Pineda Pablos, Nicolás. "Gobernanza Hídrica". Congreso internacional calidad del agua, salud, remediación y perspectivas. Chihuahua, México. 20 septiembre, 2017.
124. Pineda Pablos, Nicolás; Stephen Mumme; Ricardo Figueroa Mimbela; Robert Varady; Margaret O. Wilder; Adriana Zuñiga. "The prospects of desalination for export in the Mexico-U.S. border region: A survey of Mexican opinion". International conference: Cutting - Edge Solutions to Wicked water problems. Tel Aviv, Israel. 11 septiembre, 2017.
125. **Pineda Pablos, Nicolás.** Conferencia Magistral "*Notas para discutir la adaptación del cambio climático y la gestión del agua en Sonora*" (*Master Conference Notes to discuss the adaptation of climate change and water management in Sonora*). In 7th National Congress on Climate Change Research. Hermosillo, Sonora, México. October 2, 2017
126. Pineda Pablos, Nicolás. Lecture given at the Diploma in Humanism and Indigenous Leaders, presenting a paper entitled "Political System and Public Administration in Mexico, its dimensions, actors and dynamics". In Hermosillo, Sonora, México. January 25, 2018.  
See: <https://drive.google.com/open?id=1uApD-7aV74I5dFkipRI1c81wL0bpp9D2>
127. Pineda Pablos, Nicolás. Participation in the panel "Fortaleciendo la seguridad hídrica en cuencas del Desierto de Sonora" e informe del proyecto sobre biodiversidad y servicios ecosistémicos" (Strengthening water security in watersheds of the Sonoran Desert "and report of the project on biodiversity and ecosystem services). April 18, 2018.



128. Pineda Pablos, Nicolás. Moderator at the round table “Gestión y cooperación transfronteriza Sonora-Arizona” (Sonora-Arizona Transboundary Management and Cooperation). April 18, 2018.
129. Pineda Pablos, Nicolás. Field work and interviews conducted to executives and experts on water management in León, Guanajuato, as part of research of institutional change in water utilities. Interview of Director of the System of Drinking Water of León (SAPAL), Lic. Leonardo Lino. May 21, 2018.  
See: <https://drive.google.com/open?id=1B46aIQG8tBhS4M7KBxXFpJ3TJv7F3h7X>
130. Pineda Pablos, Nicolás. “Tres enfoques para la gestión del agua urbana y la sostenibilidad” (Three Approaches to Urban Water Management and Sustainability). In the 5th. Symposium on Sustainability. Universidad Autónoma del Estado de México. State of México, México. May 24, 2018.
131. Parra, Erik; Nicolás Pineda. “Una propuesta para el estudio de la Gestión Integrada de los Recursos Hídricos en los consejos de cuenca”. 1er Encuentro de organismos auxiliares de Cuenca. Cd. De México. 06 septiembre, 2017.
132. Pineda Pablos, Nicolás. “Modificaciones legales y del marco institucional que requiere el mejoramiento de los organismos de agua potable en México”. Seminario Políticas Públicas en Materia de Agua en México. 06 julio, 2017.
133. Pineda Pablos, Nicolás. “Water security and global change adaptation: Bridging science and policy”. XVI Congreso Mundial del Agua. Cancún, Quinta Roo, México. 01 junio, 2017.
134. Pineda Pablos, Nicolás; Margaret Wilder; Steve Mumme; Jamie Mcevoy. “International governance dimensions of desalination border US- México”. Asociation of Borderland Studies (ABS). Estados Unidos de América. 10 mayo, 2017.
135. Pineda Pablos, Nicolás. “Notas para un marco institucional efectivo de los servicios urbanos de agua en México”. Taller de Gobernanza. México. 9 febrero, 2017.
136. Pineda Pablos, N. 2016. “Management by basin ans water rights in the Sonora River”. Presentation in the Training Workshop on Water Security and Demand Management. Mendoza, Argentina, August 2016.
137. Pineda Pablos, N. 2015. “Tendencias de la política pública en materia hídrica en México a la luz de la reciente ley general de aguas, en un contexto de pautas internacionales y realidades locales” (Tendencies in public policy about water in Mexico with regards to the recent general water law, in an international context and local realities). Presentation given at the 3er Congreso Internacional de Ciencia Política (3rd International Congress of Political Science). Guadalajara, Jalisco. July 15 to 18.
138. Pineda Pablos, N. & Sanchez Meza, J.J. 2014. “La jurisdicción y gestión local del río Sonora 1911-1960”, presented at Seminario de Recursos Naturales, El Colegio de Sonora, Hermosillo, Sonora Mexico. October.

139. Pineda Pablos, N. 2014. "El enfoque de los sistemas ecológico-sociales aplicado a la gestión urbana del agua" (The social and ecological systems approach to urban water management), presented at Conference, Toluca, Mexico. November 6.
140. Pineda Pablos, N. 2015. "La gestión de acuíferos y la tragedia de los Comunes" (Aquifer management and the tragedy of the commons), presented at the School of Geology, Universidad de Sonora, Hermosillo. March 8.
141. Pineda Pablos, N. 2015. "La gestión de acuíferos y la tragedia de los Comunes" (Aquifer management and the tragedy of the commons), presented at Seminario Hidrico, Universidad Nacional Autónoma de México, Mexico City. March 25.
142. Pineda Pablos, N. & Maya Rodriguez, J.M. 2015. "Tendencias de la política pública en materia hídrica en México a la luz de la reciente ley general de aguas, en un contexto de pautas internacionales y realidades locales" (Water public policy trends in Mexico under the recent general water law, in the context of international patterns and local realities), presented at 3er Congreso Internacional de Ciencia Política, Guadalajara, Jalisco, Mexico. July 15.
143. Pineda Pablos, N. & Salazar, A. 2015. "Strategies for Addressing Urban Water Security: Adaptation through Information Management", presented at the Water and Development Congress and Exhibition IWA, Jordania. October 21.
144. Pineda Pablos, N. 2016. "Delphi Consultation on desalination for export". Second Panel on the Desalination of Seawater option for Puerto Peñasco. El Colegio de Sonora, Hermosillo, Sonora. June 15.
145. Ribeiro Neto, A., Montenegro, S.M.G.L., Cirilo, J.A. Adaptation measures for facing drought periods in Northeast Brazil. 2017. XVI World Water Congress, Special Session "Water Security and Global Change Adaptation: Bridging Science and Policy".
146. Ribeiro Neto, A., Cirilo, J.A., Asfora, M.C. Medidas adoptadas en el Estado de Pernambuco (Brasil) para enfrentamiento de la sequía 2012-2017. 2017. I Congreso Peruano Agua-Andes: "Diálogos Ciência-Política para el Desarrollo Sostenible".
147. Ribeiro Neto, A. Adaptation mechanisms for extreme events in the Capibaribe River Basin. In: XVI World Water Congress, 2017, Cancun. Proceedings of XVI World Water Congress, 2017.
148. Ribeiro Neto, A. Simulação hidrológica da dinâmica do uso e ocupação do solo da bacia hidrográfica do rio Capibaribe - PE com modelagem hidrológica distribuída. In: 13º Simpósio de Hidráulica e Recursos Hídricos dos Países de Língua Portuguesa, 2017, Porto. Anais do 13º Simpósio de Hidráulica e Recursos Hídricos dos Países de Língua Portuguesa, 2017.
149. Rodríguez, Luis Carlos; Nicolás Pineda. "Estudio exploratorio de las licitaciones de obra pública en el gobierno del estado de Sonora". 3er. Congreso Internacional Gobierno, Gestión y Profesionalización. Hermosillo, Son. 13 jul, 2017.

150. Rodríguez Salazar, J.A. & Pineda Pablos, N. 2015. "Entre la formalidad y la informalidad: el servicio de agua y alcantarillado en el pueblo de Vícam" (Between formality and informality: the water and sewage service in the town of Vicam). Presentation given at the 2º Congreso Instituciones, Gobierno y Sociedad (2nd Congress Institutions, Government and Society). Hermosillo, Sonora. May 20 and 21.
151. Romo-Leon, J.R., Mendez-Estrella, R., Gandarilla-Aizpuro, F.J., Hartfield, K. & Castellanos-Villegas, A.E. 2016. "Land Cover and Carbon Stock Dynamics on Riparian Environments of the Sonoran Desert." EcoSummit 2016, Le Corum, Montpellier, France, August 29 – September 1.
152. Salgueiro, J.H.P.B., Montenegro, S.M.L.G., Pinto, E.J.A., Silva, B.B., Souza, W.M., Oliveira, L.M. Análise da não-estacionaridade da precipitação no município de Vitória de Santo Antão – Pernambuco (Analysis of non-stationarity of the rainfall in the municipality of Vitória de Santo Antão — Pernambuco). In: XXI Simpósio Brasileiro de Recursos Hídricos, 2015, Brasília. Anais do XXI Simpósio Brasileiro de Recursos Hídricos. Porto Alegre: ABRH, 2015.
153. Salomón, M. y J. Álvarez, 2016. "Preservación y Promoción de Zonas Irrigadas en el marco del Plan Agua 2020 y Plan de Ordenamiento Territorial de Mendoza" I Jornadas Nacionales de Investigación en Ciencias Sociales. Cambio Climático y Desarrollo Sostenible en las Ciencias Sociales. Facultad de Ciencias Políticas. Universidad Nacional de Cuyo. Mendoza. Argentina. Políticas Públicas. Mesa 1:14. <http://fcp.uncuyo.edu.ar/upload/programa-jnics-uncuyo-definitivo.pdf>
154. Sandaña, P., Mallory E., Lizana, C., Meza, F., García V. Simulating the yield response of potato crops to projected climate scenarios for southern Chile using SUBSTOR-POTATO. 7th Global Workshop of The Agricultural Model Intercomparison and Improvement Project AgMIP7, April 24-26, 2018, San José, Costa Rica.
155. Sandaña, P., Mallory, E., Lizana, C., Meza, F., García V. 2018. Assessing risk of potato crops of southern Chile under projected climate scenarios using the SUBSTOR-Potato model. 10th World Potato Congress - XXVIII Congreso de la Asociación Latinoamericana de la Papa.
156. Santos, J.Y.G., Montenegro, S.M. G. L., Santos, C.A.G., Silva, R.M., Ribeiro Neto, A. Implicações das mudanças do clima na vazão da bacia do rio Tapacurá, Pernambuco (Implications of climate change in the flow of Tapacurá river basin, Pernambuco). Conferência Internacional do INCT para Mudanças Climáticas, 2016, São Paulo.
157. Scott, C.A. 2013. "Seguridad hídrica y adaptación al cambio climático en zonas áridas" (Water security and climate-change adaptation in arid regions), Cuarto Seminario Internacional de Potamología (Fourth International Potamology Seminar), Jiutepec, Mexico, October 24-15.
158. Scott, C.A. 2013. "Adaptación a la sequía" (Drought adaptation), Water and agriculture planning committee, General Irrigation Department (invited but I requested to present via Skype and YouTube [http://youtu.be/Qq8s\\_QUEP3U](http://youtu.be/Qq8s_QUEP3U)), Mendoza, Argentina, October 31 – November 1.

159. Scott, C.A. 2013. The Water-energy-food nexus: Adaptive capacity to complex global challenges. Position paper presented at Workshop on Nexus of Water, Soil and Waste, United Nations University, Dresden, Germany, November 11-12.
160. Scott, C.A. 2013. Strengthening resilience of riparian-corridor coupled natural-human systems, Towards socio-hydrologic synthesis: modeling the co-evolutionary dynamics of coupled human, water, and ecological systems, National Socio-Environmental Synthesis Center (SESYNC), Annapolis, Maryland, December 13-16.
161. Scott, C.A. 2013. "Is groundwater depletion inevitable?" Udall Center Policy Fellows Speaker Series, Udall Center for Studies in Public Policy and Institute of the Environment, University of Arizona. Tucson, Arizona. January 30.
162. Scott, C.A. 2013. "Diálogo entre ciencia y política para la seguridad hídrica." (Science-policy dialogues for water security). Ciencia y toma de decisiones para la adaptación al cambio climático (Science and decision-making for climate-change adaptation). Santiago, Chile. July 4.
163. Scott, C.A. 2013. "Fortalecimiento de la resiliencia de corredores riparios" (Strengthening riparian-corridor resilience). Universidad Nacional Mayor de San Marcos. Lima, Peru. April 26.
164. Scott, C.A. 2014. Water management capacity building of professionals in MWAR-LAC and the Lloyd's Register Foundation-International Water Security Network, Managing Water Resources in Arid and Semiarid zones of Latin America (MWAR), Montevideo, Uruguay (remote presentation via Skype), [http://www.cazalac.org/mwar\\_lac/index.php?id=63](http://www.cazalac.org/mwar_lac/index.php?id=63), February 3-4.
165. Scott, C.A. 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability – Panel Discussion on IPCC Working Group II: Fifth Assessment Report: C. Scott – water; S. Jackson – ecosystems; K. Jacobs – N. America regional; D. Liverman – adaptation, food security. University of Arizona, Student Union Kiva Room, March 31.
166. Scott, C.A. 2014. "Resiliencia de cabeceras de cuencas andinas frente al cambio global" (Strengthening resilience of Andean river basin headwaters facing global change), Lima and Cajamarca, Peru, April 3-9.
167. Scott, C.A. 2014. Red AQUASEC de seguridad hídrica (AQUASEC water security network), "Desde lo global a lo local: gobernanza sustentable de los recursos hídricos para América Latina y el Caribe" (From global to local: sustainable water resource governance for Latin America and the Caribbean), Earth Systems Governance workshop, Santiago, Chile, May 5-8.
168. Scott, C.A. 2014. "Mapeo de actores institucionales para la adaptación en la cuenca del río Maipo" (Hydroinstitutional mapping for Maipo basin adaptation), MAPA: Maipo Plan de Adaptación (Maipo Adaptation Plan), training workshop, Centro de Cambio Global, Santiago, Chile, May 4-5.
169. Scott, C.A. 2014. Organizer, science-policy workshop, AQUASEC – Water security in river basins of the arid Americas, for 30 researchers, agency managers, NGOs, and

decision-makers from Chile, Argentina, Brazil, Mexico, Peru, and the U.S., held in Fortaleza, Brazil, May 10-11, 2014; and AQUASEC panel session coordinator, Adaptation Futures 3<sup>rd</sup> International Conference, Fortaleza, May 12-16.

170. Scott C., Meza F., Martin F, Mussetta P, Willems B, Ribeiro A, Pineda N, Díaz R, van Leeuwen W. 2014. Networked knowledge systems in the arid Americas and beyond, III International Climate Change Adaptation Conference - Adaptation Futures 2014, Fortaleza, Ceara, Brazil, May 12-16.
171. Scott, C. A., R. G. Varady, and A. A. Zuñiga-Terán. 2016. Science-policy dialogues and resilience. Presented (by C. Breen) at “Achieving Resilience by Design,” workshop organized by the International Water Security Network (IWSN) at the Institute of Natural Resources. Pietermaritzburg, South Africa. Aug. 10.
172. Scott, C.A. 2014. Socio-hydrology of water scarcity in the United States – Mexico borderlands, International Association of Hydrological Sciences, Bologna, Italy, June 4-6.
173. Scott, C.A. 2015. “Cambio climático en regiones áridas de las Américas” (Climate change in the arid Americas). Simposio: Agua como factor estratégico para el desarrollo en el context global de escasez. (Water as a strategic factor for development in the global context of scarcity), Consejo Argentino de Relaciones Internacionales. Buenos Aires, Argentina. July 22.
174. Scott, C.A. 2015. “Cambio global y seguridad hídrica en el continente Americano” (Global change and water security in the Americas). Mendoza Provincial Irrigation/ Water Resources Department – University of Arizona collaborative agreement signing ceremony. Mendoza, Argentina. July 21.
175. Scott, C.A. 2015. “El nexo agua-energía-alimentación” (The water-energy-food nexus). Universidad de Piura y Universidad Nacional Mayor de San Marcos. Piura, Peru. July 14-15.
176. Scott, C.A. 2016. Beyond the resource nexus: Food-energy-water security. Graduate Water Program Colloquium, Texas A&M University, September 12, 2016.
177. Scott, C.A. 2016. Keynote address: Water security in the face of climate change and economic globalization. International Forum on the Future of Water, Argentine Ministry of Science, Technology and Productive Innovation and University of San Martin, Buenos Aires, October 18-21, 2016.
178. Scott, C.A. 2016. Water-energy-food nexus. International Forum on the Future of Water, Argentine Ministry of Science, Technology and Productive Innovation and University of San Martin, Buenos Aires, October 18-21, 2016.

179. Scott, C.A. 2017. Binational United States - Mexico initiatives to address complex environmental challenges in the border region, Council of Environmental Deans and Directors - 2017 Summer Meeting: Higher Education, Science, and the Environment: Identifying Gaps and Building Bridges, Tucson, June 19-20, 2017.
180. Scott, C.A. 2017. Convener, “Science Crossing Borders” Summit of the Consortium for Arizona-Mexico Arid Environments (CAZMEX), Biosphere 2, Tucson, May 5-6, 2017.
181. Scott, C.A. 2017. et al. 1) A paradox of plenty: renewable energy on Navajo Nation lands; (2) Hydropower development benefit-sharing in Uttarakhand, India and Nepal; and (3) The irrigation-hydropower nexus in the Ganges headwaters – posters presented at Institute for Energy Solutions Kickoff, University of Arizona, January 9, 2017.
182. Scott, C.A. 2017. Evidence-based decision making: Science-policy dialogues of the Udall Center for Studies in Public Policy. Colloquium – Department of Soil, Water, Environmental Science, University of Arizona, October 16, 2017.
183. Scott, C.A. 2017. Member, Program Committee (unable to attend in person), International Energy Conference, Mexican Energy Academy, Instituto Politécnico Nacional, Mexico City, Sept. 4-8, 2017.
184. Scott, C.A. 2017. Moderator: 2017 IANAS – Smart Villages Symposium, University of Arizona, the Inter-American Network of Academies of Sciences (IANAS), the Smart Villages initiatives, and UNAM Tucson, Biosphere 2, Tucson, April 25, 2017.
185. Scott, C.A. 2017. Pursuing Water Security in Socio-hydrological Systems, joint session moderator, *American Geophysical Union*, New Orleans, December 11, 2017.
186. Scott, C.A. 2017. *Resilience and complexity: Frameworks and models to capture social-ecological interactions*, Joint-convener, CNRS/UMI and the Udall Center for Studies in Public Policy, University of Arizona, Tucson, Nov. 6-8, 2017.
187. Scott, C.A. 2017. Science and policy networks in the Southwest and U.S.-Mexico borderlands, Western Coalition of Arid States, Tucson, October 26, 2017.
188. Scott, C.A. 2017. Seguridad hídrica en la región fronteriza EEUU-México: Lecciones para la resiliencia de zonas áridas (*Water security in the U.S.-Mexico borderlands: Lessons for arid-region resilience*), **and** El desafío de las métricas significativas en la gobernanza del agua: implicaciones para la equidad y la justicia (*The Challenge of meaningful metrics in water governance: Implications for equity and justice* – presented on behalf of Margaret Wilder). Seminario de perspectivas actuales de la gestión del agua en México (Seminar

on current perspectives on water management in Mexico), El Colegio de la Frontera Norte, Monterrey, Mexico, Dec. 7-8, 2017.

189. Scott, C.A. 2017. Una paradoja de la abundancia: energía renovable en tierras de las Naciones Indígenas de la región transfronteriza (A paradox of plenty: renewable energy on Native Nations lands in the transboundary region), Skype presentation to Primer Coloquio Internacional - Pobreza Energética en la Región Transfronteriza México-Estados Unidos, Hermosillo, Mexico, May 18-19, 2017.
190. Scott, C.A. 2017. UNMASKing the interactions among food-water-energy security and climate risks in cities, National Center for Atmospheric Research, Boulder, Colorado, Oct. 2-3, 2017.
191. Scott, C.A. 2017. Water reuse and urban growth: Challenges and opportunities in the Southwest. John Gaw Meem Lectureship, School of Architecture and Planning, University of New Mexico, April 14, 2017.
192. Scott, C.A. 2017. Water security in the Arid Americas, *Congreso Agua Andes*, Ayacucho, Peru, September 19-21, 2017.
193. Scott, C.A. 2018. Advancing Sustainability of US – Mexico Transboundary Drylands: A Binational Workshop, scientific committee chair and plenary moderator, *US and Mexican National Academies of Science*, San Luis Potosí, Mexico, May 2-4, 2018.
194. Scott, C.A. 2018. Conference co-coordinator, *Desafíos en seguridad hídrica y resiliencia ante el cambio global en zonas áridas del continente americano*, Guaymas, Mexico, April 17-21, 2018.
195. Scott, C.A. 2018. Developing and sustaining science-policy networks, *International Center for Integrated Water Resources Management, Partners Meeting*, Washington, DC, January 19, 2018.
196. Scott, C.A. 2018. Food-energy-water nexus: Opportunities and limits of integrationist frameworks, *Weston Roundtable Series, Center for Sustainability and the Global Environment, Nelson Institute*, University of Wisconsin-Madison, November 1, 2018.
197. Scott, C.A. 2018. Gestão Adaptativa e Segurança Hídrica frente às Mudanças Climáticas: Experiência das Bacias Transfronteiriças na América Árida (Adaptive Management and Water Security Under Climate Change: Transboundary Basin Experience in the Arid Americas), Colloquium, Graduate Program in Urban Management, Pontifical Catholic University of Paraná, Curitiba, Brazil, March 13, 2018.



198. Scott, C.A. 2018. Hydropower: Renewable carbon-neutral energy or high-impact relict? *Adaptation TED-ish Talks*, Center for Climate Adaptation Science and Solutions, University of Arizona, Tucson, February 9, 2018.
199. Scott, C.A. 2018. Insights on “limits” of food, energy, and water in extreme environments, *Human Challenges in Extreme Environments*, workshop jointly hosted by Unité Mixte International – iGlobes and the Udall Center for Studies in Public Policy, Tucson, November 12-13, 2018.
200. Scott, C.A. 2018. Nexus thinking, nexus tools, nexus solutions: Origins and prospects for food-energy-water systems, *Indigenous Food, Energy, Water Systems and Security (Indige-FEWSS) Graduate Seminar*, University of Arizona, September 12, 2018.
201. Scott, C.A. 2018. The coming challenges: Water resources in the border region, *Binational Water Relations at 75 Years: Retrospectives, Resilience, and U.S.-Mexico Border Water Resources Governance*, Udall Center for Studies in Public Policy and Colegio de Sonora, Tucson, October 15-16, 2018.
202. Scott, C.A. 2018. Uncertainty and limitation of science and science communication (session co-coordinator), *8th World Water Forum*, Brasilia, Brazil, March 22, 2018. <http://www.iai.int/iai-aquasec-at-8th-world-water-forum/>
203. Scott, C.A. 2018. Water security on the third pole: Availability, use, and governance of water in the Hindu Kush Himalaya, presented by F. Zhang on behalf of C.A. Scott, F. Zhang, A. Mukherji et al. *2nd International Mountain Futures Conference*, Kunming, China, June 3-8, 2018.
204. Scott, C.A. 2018. Water-energy-food: How have integrationist frameworks altered the discourse and practice of water management? *Nature-Based Solutions Workshop*, Anil Agrawal Environmental Training Institute, Centre for Science and Environment, Neemli (Rajasthan), India, November 28-30, 2018.
205. Scott, C.A. 2018. Water security in the arid Americas: Global change drivers, science-policy network solutions, *Surviving Peak Drought and Warming Workshop*, Tucson, Arizona, March 29-30, 2018.
206. Scott, C.A. 2018. Sequía prolongada y manejo adaptativo del agua, *Perspectivas meteorológicas 2018-2019 en el contexto de cambio climático*, Mendoza Argentina, Oct. 9, 2018.
207. Scott, C.A. 2018. Socio-ecological impacts of mining in arid regions, *Territorio, Agrobiodiversidad y Patrimonio Biocultural* (Territory, Agrobiodiversity and Biocultural

- Heritage), Centro de Estudios Mexicanos y Centroamericanos, Cuetzalan, Mexico, Sept. 18-21, 2018.
208. Scott, C.A. 2018. Urban wastewater for peri-urban agriculture in northwest Mexico: Health risk, water resources, and sanitation policy challenges, *World Social Science Forum*, Fukuoka, Japan, Sept. 25-28, 2018.
  209. Scott, C.A., Zuniga-Teran, A.A., Palomo, I, Calbimonte, G. 2018. "Contribuciones del equipo de la UA." Presented at the congress "Desafíos en seguridad hídrica y resiliencia ante el cambio global en zonas áridas del continente americano." Guaymas, Sonora, Mexico. April 18.
  210. Scott, C.A., Zuniga-Teran, A.A and Palomo, I. 2018. "Seguridad hídrica en el desierto de Sonora: Cuencas, ciudades y frontera." Presented at the congress "Desafíos en seguridad hídrica y resiliencia ante el cambio global en zonas áridas del continente americano." Guaymas, Sonora, Mexico. April 18.
  211. Staddon, C., Zuniga Teran, A., Shoeman, Y., DeVito, L., Arcadis. 2017. Contributions of green infrastructure to urban resilience. Presented by Staddon and Zuniga Teran at I Congreso Peruano Agua-Andes: "Dialogos Ciencia-Politica para el Desarrollo Sostenible" (First Peruvian Agua-Andes Congress: "Science-Policy Dialogues for Sustainable Development"). National Univ. of San Cristóbal de Huamanga, Ayacucho, Peru. Sept. 19.
  212. Van den Berg, M, Rodriguez Baide , J, Meza , F, Heinemann , AB, Marin , F, Condori B, Riano N Vázquez , R, Trebejo , I, Rodriguez , G, Guevara , E, Meira , S, Rebolledo , MC, Ramírez , J,Valdivia , R. Crop Modelling in Latin America and the Caribbean: State of the art of development and applications for climate change impacts and adaptation assessments. 7th Global Workshop of The Agricultural Model Intercomparison and Improvement Project AgMIP7, April 24-26, 2018, San José, Costa Rica.
  213. Ursulino, B.S., Montenegro, S.M.G.L., Oliveira, L.M.M., Ribeiro Neto, A., Rodrigues, D.F.B. Análise multitemporal de parâmetros biofísicos por sensoriamento remoto no entorno do reservatório Jucazinho-PE. In Anais do XIV Simpósio de Recursos Hídricos do Nordeste, Maceió. 2018.
  214. Varady, R.G., Scott, C.A., Zuniga-Teran, A.A., Buechler, S., Gerlak, A., Wilder, M. 2016. Aspects of water ethics and governance. Presented at the Water Ethics Symposium - Building strategies for water ethics: Future direction in research and education. University of Arizona. Tucson, AZ, April 25.
  215. Varady, R. G., A. A. Zuniga-Teran, C. A. Scott, T. Albrecht. 2016. Resilience and diversity: Managing the water-energy nexus to enhance water security. Presented (by Varady) at conference, "International Perspective on Water Resilience," at the Schumacher Institute. Bristol, UK. 11 Oct.

216. Varady, R. G. 2016. Introducción a la seguridad hídrica – Contexto Institucional: International Water Security Network (IWSN) [Introduction to water security – Institutional context]. Presented at Taller de capacitación en seguridad hídrica y manejo de la demanda del agua en las Américas áridas, “Buenas prácticas de gobernanza del agua: Adaptando enfoques exitosos hacia la seguridad hídrica en Mendoza, Argentina (y en otros lugares)” [Training workshop on water security and demand management in the arid Americas, “Good water governance practices: Adapting successful approaches to water security”]. Mendoza, Arg. 3 Aug.
217. Varady, R. G. 2016. Gobernanza y Gestion de las Aguas Subterráneas. Presented at Taller de capacitación en seguridad hídrica (as above) Mendoza, Arg. 3 Aug.
218. Varady, R. G., C. A. Scott, and A. A. Zúñiga-Terán. 2016. Transboundary water governance and its significance for water security: Examples from IWSN experiences. Presented at Intl. Symp. on Ecosys. Benefits & Water Security. Insaka Consort. & Intl. Water Security Network. Kafue, Zambia. 15 June 2016.
219. Gerlak, A. K., L. House-Peters, T. Albrecht, C. Cook, R. Routson de Grenade, C. A. Scott, R. G. Varady, and A. Zúñiga Terán (2016). Water security: A critical review of recent studies. Presented at annual meeting of International Studies Association, Atlanta, GA, 17 Mar. 2016.
220. Varady, R. G., and C. A. Scott. 2016. Water security, governance, science-policy dialogues, and capacity building: Linking the International Water Security Network (IWSN) and the AQUASEC Center of Excellence for Water Security to the UNESCO proposed initiatives: “Enhancing Climate Services for Improved Water Resources Management...” (ClimWaR-LAC) and “Addressing Water Security: Climate Impacts and Adaptation Responses in Africa, Asia and Latin America-Caribbean.” Workshop of UNESCO International Hydrological Programme and Government of Flanders Brussels, Belgium. 25 February 2016.
221. Varady, R.G., Zuniga-Teran, A.A., Scott, C.A. 2016. Resilience and diversity: Managing the water-energy nexus to enhance water security. Talk given by R.G. Varady. International Perspectives on Water Resilience. University of the West of England. Bristol, England, October 11.
222. Yocupicio, D. 2015. “Gestión Integral del Agua y Consejos de Cuenca en Sonora” (Integrated water management and water councils in the Sonora Basin), presented at the 2º Congreso Instituciones, Gobierno y Sociedad, Hermosillo, Sonora, Mexico. May 22.
223. Zuniga-Teran, AA. 2016. Participated in a discussion panel for the workshop “How can Tucson connect to global STEM opportunities?” organized by the Office of Latin American Partnership Initiatives, University of Arizona. Pima Community College, Tucson, AZ. Oct. 15, 2016.
224. Zuniga-Teran, A. 2016. From neighborhoods to wellbeing and conservation: Enhancing the use of greenspace through walkability. Lecture given to undergraduate students of the Sustainable Built Environments Degree Program. College of Architecture, Planning, and Landscape Architecture. University of Arizona. Oct. 6.

225. Zuniga-Teran, A. 2016. From neighborhoods to wellbeing and conservation: Enhancing the use of greenspace through walkability. Lecture given via Skype to undergraduate students majoring in urbanism at Monterrey Institute of Technology and Higher Education (ITESM). Leon, Guanajuato, Mexico. Sept. 8.
226. Zuñiga-Terán, A. A., and T. Albrecht. 2016. Diversity as a key element of urban resilience. (Presented by C. Breen) at “Achieving Resilience by Design,” workshop organized by the International Water Security Network (IWSN) at the Institute of Natural Resources. Pietermaritzburg, South Africa. Aug. 10.
227. Zuniga-Teran, A.A. and N. Pineda Pablos. 2016. Desalinización binacional en la frontera entre EE.UU. y México: Un caso de estudio en Puerto Peñasco. Presented at water governance workshop “Buenas practicas de gobernanza del agua: Adaptando enfoques existosos hacia la seguridad hídrica en Mendoza, Argentina, y en otras regions áridas del continente americano.” Mendoza, Argentina. August 4.
228. Zuniga-Teran, A.A. 2016. Binational desalination in the U.S.-Mexico border: A case study of the proposed Puerto Peñasco desalination plant. Presented at the International INSAKA Research Symposium. Kafue, Zambia. June 15.
229. Zuniga-Teran, A.A. 2016. From designing buildings to researching deserts. Presented at the Annual Meeting of the United Nations Association of Southern Arizona. Tanque Verde Ranch, Tucson, Arizona. June 4.
230. Zuniga-Teran, A.A. 2016. From designing buildings to researching deserts. Presented at Session 5: Water-Energy-Food Nexus. SWAN International Conference. Tucson, Arizona. February 16-17.
231. Zuniga-Teran, A.A. 2015. Green infrastructure as a climate change adaptation strategy in cities in arid lands. Presented at Working group 3: Urban Settlements and Climate Change. Climate Change Workshop organized by Universidad Autónoma de México (UNAM). La Paz, Baja California Sur, Mexico, November 17 – 20.
232. Zuniga-Teran, A.A. 2015. Taller de Ciudades Sustentables (Sustainable Cities Workshop). Presented at the VI International Congress on Sustainable Development-Sustainability in Border Cities. Instituto Tecnológico de Nogales. Nogales, Sonora, Mexico. October 21.
233. Zuniga-Teran, A.A. 2015. Desde las Colonias hasta el Bienestar y la Conservación: Aumentando el Uso de los Espacios Verdes a través de la Caminabilidad. (From neighborhoods to wellbeing and conservation: Enhancing the use of greenspace through walkability). Presented at the 1st International Congress of Urbanism 2015, City, Urban Policy, and Borders. Instituto Tecnológico de Nogales. Nogales, Sonora, Mexico. September 30.
234. Zuniga-Teran, A.A. (2017). Neighborhood design, physical activity and wellbeing. Presented at the International Making Cities Livable conference. Santa Fe, NM. October 5.

235. Zuniga-Teran, A., Lutz-Ley, A., Peon, R. Pasqal, J., Peralta, Y. 2017. "Planning for desalination: a comparative case study." Presented by Zuniga-Teran, A.A. and Lutz-Ley, A.N. 2017. Participated in the XVI World Water Congress. Cancun, Mexico. May 31.
236. Zuniga-Teran, A.A. 2017. Invited lecturer for the class Special Topics in Architectural Research. Title of the talk was "Neighborhood design, physical activity, and wellbeing." April 13.
237. Zuniga-Teran, A.A. 2017. Participated in the CAPLA Spring Symposium. The talk was titled: "Neighborhood design, physical activity, and wellbeing". The symposium was held at the College of Architecture, Planning and Landscape Architecture at the University of Arizona on April 11.
238. Zuniga-Teran, A.A. 2017. Participated in a discussion panel for the class "Adaptation and Resilience in Water Resources Systems" at the University of Arizona. The talk was titled "Resilience through Urban Design and Walkability." January 24.
239. Zuniga-Teran, A.A. 2016. Participated in a discussion panel on sustainability for the class "Introduction to Global Change" organized by the Instructor Dr. Arin Haverland. This is a freshman level course for non-science majors in the University of Arizona. November 28.
240. Zuniga-Teran, A. 2017. Invited speaker to the science class at STAR Academic High School in Tucson, AZ. Title of the presentation: "Planning for green infrastructure." October 25.
241. Zuniga-Teran, A.A. 2017. "Neighborhood design, physical activity and wellbeing." Presented at the International Making Cities Livable conference. Santa Fe, NM. October 5.
242. Zuniga-Teran, A.A. 2017. "UNMASKing the interactions among food-water-energy security and climate risks in cities" National Center for Atmospheric Research, Boulder, Colorado, Oct.2-3, 2017.
243. Zuniga-Teran, A.A. 2018. Invited speaker to the class GEOG 6960 – Adaptation and Resilience in Water Resources Systems. Title of the presentation: "Urban resilience through green infrastructure: An environmental justice case study in Tucson, AZ." January 18.
244. Zuniga-Teran, A.A. 2018. Invited Speaker to Fundación Alfa High School for gifted and underrepresented students in Monterrey, Mexico. Title of the presentation: "Ciudades Sustantables (Sustainable Cities)." February 14, 2018.
245. Zuniga-Teran, A. and Meixner, T. 2018. "Second Annual State of the Cienega Watershed." Workshop organized by the Cienega Watershed Partnership. University of Arizona. Tucson, AZ. March 6.
246. Zuniga-Teran, A. 2018. Invited speaker to the class GEOG 302: Sustainable Development at the University of Arizona. Title of the presentation: "Green Buildings." March 14.

247. Zuniga-Teran, A. 2018. Presentation of research projects to the Udall Foundation Board of Trustees. Udall Center for Studies in Public Policy. Tucson, Arizona. April 9.
248. Zuniga-Teran, A.A. 2018. "State of the Cienega Watershed." Presented at workshop organized by Centre National de la Recherche Scientifique UMI-iGlobes. University of Arizona. April 12.
249. Zuniga-Teran, A.A. 2018. "Wellbeing synergies between walkable neighborhoods and the enhanced use of greenspace." Presented at 55th International Making Cities Livable conference. Ottawa, Canada. May 17.
250. Zuniga-Teran, A.A. 2018. "State of the Cienega Watershed." Presented at the Science on the Sonoita Plain Symposium. Elgin, Arizona. June 2.
251. Zuniga-Teran, A.A. 2018. "Planeación por Escenarios para El Colegio de Sonora." A 3-day Scenario Planning workshop for El Colegio de Sonora in Hermosillo, Sonora, Mexico. June 25-27.
252. Zuniga-Teran, A.A., Avila, S., Bernal, S., Cowan, D. 2018. Participated in a discussion panel on community engagement with teachers as part of the Arizona Project Wet to increase green infrastructure sponsored by NOAA. Project title: "Community Resilience to Climate Change: Recharge the Rain." Water Resource Research Center, University of Arizona. July 17.
253. Zuniga-Teran, A.A. 2018. "State of the Cienega Watershed." Presented at Pima County Regional Flood Control Brown Bag Series. Tucson, Arizona. August 8.
254. Zuniga-Teran, A.A. and Rivera, M. 2018. "Landscape Design at STAR Academic High School." Presented to faculty at STAR Academic High School. Sept. 12.
255. Zuniga-Teran, A.A., 2018. Chaired a panel for the "Binational Water Relations" workshop. Participants: Lutz-Ley, A., Wilder, B., Diaz-Caravantes, R. Hernandez, P. University of Arizona. Tucson, AZ. October 15-16.
256. Zuniga-Teran, A.A. 2018. "The State of the Cienega Watershed as a Sentinel Territory." Presented at the workshop "Human Challenges in Extreme Environments" organized by the Udall Center and UMI-iGlobes. University of Arizona. Nov. 12-13.
257. Zuniga-Teran, A.A., Fisher, L., Meixner, T. McFarlin, S. Postillion, F. Presented by Zuniga-Teran, A. 2018. Poster presentation at UHMI Seminar in La Martigue, France. October 8-10.



## 5. Data

IAI DIS – Data are under development, but ongoing processing and analysis mean they are not finalized and cannot at this stage be contributed to the IAI DIS.

### Mexico

The book that is being reviewed for publication at El Colegio de Sonora, contains a general geographical description of Sonoran rivers and aquifers, their main users and the performance of watershed councils.

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Río Sonoyta.....

Río Concepción o Asunción.....

Río Santa Cruz .....

Río San Pedro.....

#### CAPÍTULO IV. RÍO BACOACHI, RÍO SONORA Y AFLUENTES.....

Daniela Dafne Noreña Rivera.....

Río Bacoachi .....

Río Sonora.....

#### CAPÍTULO V. RÍO MÁTAPE Y YAQUI.....

Miryam Fernanda Ramírez Ruiz.....

Río Mátape .....

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#### CAPÍTULO VI. RÍOS MAYO Y CUCHUJAQUI.....

María Alejandra Gallardo Urrea .....

Río Mayo..... **Error! Bookmark not defined.**

Río Cuchujaqui (Arroyo Álamos)

- Launch of blog Estudios de Gestión Hídrica. Daniella Yocupicio. June 2015. [sitios.colson.edu.mx/baam](http://sitios.colson.edu.mx/baam). Research Assistant Daniela Noreña has keep updating the website through 2016.
- Map creation of the Sonora River Basin using My Maps tool. It shows aquifers delimitation, their water availability, location of climatic stations, and precipitations graphs displaying spatial and temporal distribution. Francisco Durzao. August 2015. <https://www.google.com/maps/d/u/0/viewer?mid=zQO320XwCvqw.kQt40Tbka5eo>

- Map creation of the Yaqui River Basin using My Maps tool. It shows aquifers delimitation and their water availability. Francisco Durazo. September 2015. [https://www.google.com/maps/d/viewer?hl=en\\_US&mid=zQO320XwCvqw.ktdLQHgrtwaU](https://www.google.com/maps/d/viewer?hl=en_US&mid=zQO320XwCvqw.ktdLQHgrtwaU).

### Argentina

- Map creation of the Mendoza & Tunuyan River Basin using QGIS. It shows land use change between 1986 and 2015. Facundo Rojas, María Marta Bernabeu & Nur Akil. Octubre 2016.
- Tipología de Productores Agrícolas. Mendoza and Tunuyan River Basin. It shows the social agrarian structure based on the Censo Nacional Agropecuario 2008.

### United States

- Development of a literature database with empirical studies on rural adaptation to global change in the arid Mexico and Southwest United States region. This database details the authors, years, study sites, involved ecosystems, theory and methodology frameworks, contextual factors, adaptive strategies, outcomes, and feedbacks reported in these studies.

### Brazil

- Map creation of sustainability indicators in the Capibaribe River Basin aiming to characterize the environmental, social, economic and institutional dimensions. Maria Tereza Duarte Dutra. Octubre 2016.
- Data series in the Capibaribe River Basin for the 20th and 21st centuries. Observed rainfall and modeled streamflow for the 20<sup>th</sup> century and modeled rainfall and streamflow for the 21<sup>st</sup> century.
- Land use and land cover maps of the Capibaribe and Pajeú River Basins.
- Estimate and update of the value of reservoirs capacity for water supply in Pernambuco State, Brazil.
- Time series of soil moisture and NDVI obtained from remote sensing products for drought monitoring in Pernambuco State, Brazil.
- Time series of precipitation, potential evapotranspiration, streamflow and soil moisture from different sources such as in situ stations, ERA interim's reanalysis and remote sensing for the territory of Pernambuco State.

## **6. Capacity Building**

### **6.1 Training and capacity building**

With support of the International Water Security Network, we sponsored five water professionals from Latin American countries to attend the water governance workshop in Mendoza, Argentina (Aug. 4-6). We launched a contest with an invitation to apply through our networks and our partners' networks. We received 63 applications from 11 different countries. Through a review committee, we selected five water professionals that include

Alejandra Peña from Mexico, Arles Alvarez from Honduras, Krissel Sandoval from Panama, Ninoska Briceño from Venezuela, and Cecilia Saldías from Bolivia. These young professionals are expected to take the lessons learned from this event and apply them in their countries.

- Workshop on Urban Water Scenario Planning organized with Agua de Hermosillo. This workshop had the purpose to devise strategies for the institutional development and water security of the utility Agua de Hermosillo in the long range. The workshop consisted of 12 weekly three-hour sessions under the supervision of researchers of El Colegio de Sonora. The sessions were held from September to December, 2017. Later on, on April 25, 2018, the utility director and Nicolas Pineda presented the main results and future planning guidelines for the city mayor, state water management officers and municipal and utility officers and personnel. The new ideas about the future path for the utility were considered a breakthrough on the way to approach water planning in the city of Hermosillo and will likely keep producing results in the future.

## 6.2 Outreach

See above - Section 3.4, Outcomes and impacts: Stakeholder participation and policy impacts

- Participation as a speaker in the thematic round table on Management tools to improve water management in the Convención Anual de la Asociación Nacional de Empresas de Agua y Saneamiento (ANEAS), in Puebla, México. In this event, Nicolas Pineda presented the idea that the main tool is strategic planning, which includes jointly defining and elaborating the mission, vision, objective, values, information system, management indicators, control panel, monitoring, feedback loops, and evaluation. Water services management must be oriented to the user / citizen / client and not to the personal objectives of the politicians in office. December 01, 2017.  
See: <https://drive.google.com/open?id=1QP9QglT8Y2C81jQKNMdmRAq-kZCeQyWv>
- We received the visit of Dr. John Cameron (from the Erasmus University Rotterdam). He gave a seminar and a talk about sustainability and unsustainability. Economic evaluation in water projects in South Africa. February 27, 2018.  
See: [https://drive.google.com/open?id=11TjGqKYgJK2C9\\_Q7OUgyfVuvAG700aGg](https://drive.google.com/open?id=11TjGqKYgJK2C9_Q7OUgyfVuvAG700aGg)
- Organization of the Congress “Desafíos en seguridad hídrica y resiliencia ante el cambio global en zonas áridas del continente americano” which took place on April 17, 18, 19 y 20. Guaymas, Sonora, México. January, February, March & April, 2018. This congress was attended by the members of the International Water Security Network and by researchers of the Aguasec Center for Excellence for Water Security from Arizona (USA), Argentina, Chile, Brazil, Bolivia, Peru, and Sonora (Mexico).  
See: [https://drive.google.com/open?id=1P3\\_UVtSWCTH5uV75-CDOWMgbit1NcVLR](https://drive.google.com/open?id=1P3_UVtSWCTH5uV75-CDOWMgbit1NcVLR)
- The UA team engaged community members in the south side of Tucson around green infrastructure and rainwater harvesting. The purpose of this project is to address environmental justice issues around green infrastructure where low income minority

populations are deprived of vegetation. For this project, Zuniga and Gerlak engaged Sunnyside School District's Star Academic Highschool through several visits, and giving talks to the students and faculty. We also engaged Prof. Bo Yang from the UA School of Landscape Architecture and Planning on the project. Masters student of Landscape Architecture design the campus of the school including green infrastructure as part of their design studio class. We ensured that the design process followed a participatory process and assisted with surveys, visits to the school, interviews, and invited members of the school during the design revision session. Once we had the design, we implemented raingardens in the school, engaging highschool students, university students, neighbors, faculty and staff, and city officials. This project not only resulted in greener landscapes, but in a more connected community.

### 6.3 Institutional capacity building

Administrative, policy development, facilities and infrastructure

- Ongoing collaboration with the Government Board of the utility Agua de Hermosillo in order to present a legal initiative to the State Congress and further the institutional development of the water utility. The main hurdle to achieve water management efficiency, higher sustainability and water security for Mexican water utilities is the lack of technical autonomy and long-term planning. Therefore, the main purpose of this taskwork was to make the financial self-sufficiency and professionalization of the utility more viable. This is an independent, honorary participation to improve the institutional framework of the utility. So far, the main product has been a proposal of legal reform aimed at gaining technical autonomy and independence for water utilities in Sonora.
- Participation and paper presented on the *Foro para el Plan Hídrico del estado de Chihuahua* in the *International Conference on water quality, health, remediation and perspectives*. Titled: "*Gobernanza del agua y el marco institucional de los servicios de agua en México*" (Water Governance and the institutional framework of water services in Mexico). Chihuahua, Chihuahua, México. In this event, an analysis of the institutional framework of urban water agencies in Mexico was presented, as well as a series of rules and uses that do not contribute to have effective, self-sufficient and autonomous water utilities in Mexico. September 20, 2017.

See:

[https://drive.google.com/open?id=1SjB1hZoSeASYpVuD9CRUS5BAkH\\_A\\_TzG](https://drive.google.com/open?id=1SjB1hZoSeASYpVuD9CRUS5BAkH_A_TzG)

### 6.4 Students trained & scholarships

We want to report the research team that has been involved in the activities reported:

Facundo Rojas, Researcher IANIGLA-CONICET, Argentine, Environmental History, Task 1

- Julia Barrientos, Research Assistant, Argentine, Vulnerability Studies, Task 2
- María Marta Bernabeu, Research Assistant, Argentine, Land Use Change, Task 1
- Anabella Engelman, Research Assistant, Argentine, Science Policy Dialogues, Task 3
- Nicolás Parise Schneider, Argentine, Vulnerability Studies, Task 2. Received partial IAI support.
- Nur Akil, Undergraduate Student, Land Use Change, Task 1. Received partial IAI support.

- César Ferrer, Graduate Student, Vulnerability Studies, Task 2
- Oscar Carballo, Graduate Student, Vulnerability Studies, Task 2. Received partial IAI support.
- Tomás Manzur, Graduate Student, Vulnerability Studies, Task 2
- Dolores Lettelier, PosDoc Student, Science Policy Dialogues, Task 3

We also hosted two postgraduate students, one from Mexico and one from Colombia, that made a short research visit. Angel Coronel (Colegio de Sonora) and Marina Blanco (Universidad de Manizales).

Eight graduate students received training at higher education institutions in Sonora in relation with this project. Three doctoral students studying water-related issues have been supported, in addition to five Masters students and 10 undergraduate students that study water resources, management, and policy in the region. Nine of the 10 undergraduate students received scholarship support.

Students' support					
Name/ Nationality	Affiliation/Area of Expertise	Level	Training activity/Research topic	Duration	IAI Support
Javier Navarro/MX	Instituto Tecnológico de Sonora/Sciences	Dr	Atlas of water in the Rio Sonora	2015	Yes
Ángel Coronel/Mx	El Colegio de Sonora	Mtr	Watershed management in cases of: Argentina, Brazil and Mexico	2016- 2017	Yes
Jaime Dávila Luna/MX	El Colegio de Sonora	Mtr	Basins of leachates in Sonora River Basin: A geographical approach using remote sensing	2016	Yes
Rodrigo Rivera Jécari/MX	Universidad de Sonora/Public Administration	Ugrd	Water services in the rural community of Belem, Sonora.	2015- 2016	Yes
Ana Melissa Aguirre Loreto/MX	Universidad de Sonora/Public Administration	Ugrd	Study on water rights in the basin of river Asuncion (Caborca)	2016- 2017	Yes
Miryam Fernanda Ramírez Ruiz/MX	Universidad de Sonora/Public Administration	Ugrd	Study on water rights in the basin of river Yaqui	2016- 2017	Yes
María Alejandra Gallardo Urrea/Mx	Universidad de Sonora/Public Administration	Ugrd	Study on water rights in the basin of river Mayo	2016- 2017	Yes
Fernanda Elizalde/MX	Universidad de Sonora/Sociolog y	Ugrd	Collective action in the ejido Santiago de Ures in the absence of water in the Rio Sonora	2015- 2016	Yes

Students' support					
Alejandro Navarro/Mx	Universidad de Sonora/ Economy	Ugrd	Institutional framework and transaction costs in the government's response to the contingency of the Sonora River from 2014	2016-2017	Yes
Juan Manuel Haro/MX	Universidad Estatal de Sonora/Ecology	Ugrd	Ecological Study of Natural Protected Area Ajos-Bavispe	2016	Yes
Pablo Escoboza/MX	Universidad de Sonora/Sociology	Ugrd	Study on perception of vulnerability in the Sonora River	2016	Yes
Francisco Durazo/MX	Universidad de Sonora/Geology	Ugrd	Hydrogeology, environment and mining exploitation.	2015-2016	Yes
Ana Alejandra Robles Ruiz	Universidad de Sonora/Literature	Grad	Public management of water in Mexico	2017	Yes

Students attended six workshops and seminars hosted by El Colegio de Sonora in Hermosillo. There were three field trips organized for students to nearby locations where they could see first-hand the challenges faced by the communities. Field trips also included attendance to conferences in Banamichi, Caborca, and Cajeme in Sonora.

United States:

Roy Petrakis, Yulia Peralta, Sophia Borgias, and América Lutz have joined the project, fully or partially supported on IAI funds, and receiving training in research and outreach. In addition, the project has funded the work of postdoctoral researcher Zuniga-Teran and Lutz-Ley when she finished her degree. Finally, this project has funded participation in conferences and training of Mexican and U.S. graduate students who are pursuing degrees at the University of Arizona including Rodolfo Peon, MaryBelle Cruz, Giancarlo Calbimonte, Isaac Palomo, Emma James, Grace Stoner, and Karina Martinez.

Dr Meza has actively participated in the launching of a Latin American component of AgMIP for the development of protocols and methods to analyze the impact of climate change in agriculture, particularly addressing water scarcity problems

Four Civil Engineering undergrad students were supported on CNPq funds (Carlos Bauer, Bruna Campos, Maria Clara Santana and Ronaldo Ribeiro R. Melo). Four PhD students are developing or developed activities in tasks 1 (Vagner Felix and Alzira Souza), 2 (Tereza Dutra) and 3 (Micaella Falcão Moura) and four master students are developing or developed activities in tasks 1 (Vladimir Nascimento, Tiago de Moraes Inocência and Fábio de Araújo) and 2 (Maria de Lourdes Gonçalves).

## 7. Regional Collaboration/Networking

### 7.1 Regional collaboration / networking beyond the PI and Co-PI institutions

#### Argentina

Paula Mussetta and Facundo Martin had met several times in Mendoza with Tereza Dutra, a doctoral student of UFPE, Brazil supervised by Suzana Montenegro. In these meetings, the Argentinians researchers explained how they proceed with the vulnerability assessment in the Mendoza river basin.

DGI Superintendent, José Luis Alvarez, along with Directors Mario Salomón, and Juan Andrés Pina, visited the United States in June 2016. Their trip was sponsored by the U.S. Department of State and included visits to important water management facilities in California and Arizona. The UA team hosted the Argentinean visitors for five days in Tucson taking them to field trips that portray the main governance and management strategies employed in Arizona. The DGI team learned first-hand the latest technology in wastewater treatment, and they visited the Roosevelt Dam, irrigation districts, aquifer recharge areas, and the Central Arizona Project. This visit strengthened relationships and enhanced collaboration for the water governance workshop that occurred the following month in Mendoza.

Facundo Martín participated in the prior meetings to organize the Conference of the Parties, UNFCCC 2016, convened by the IAI and MINCYT (Argentina). The meeting was held in June 2016 and was attended by: i) researchers from the IAI project, interested partners or stakeholders and with experience in applying science outcomes to public policy, ii) the IAI science-policy liaison office, and iii) political representatives and academics from the national government and the provinces. We analyzed the most successful levels of political organization to drive science-policy dialogues, exploring from regional experience the results of interactions between science and decision-making with different levels of governments (from local, to provincial and national level)

Facundo Martín, Facundo Rojas and María Marta Bernabeu maintain a work agenda with other research networks doing research on land use change through IADIZA-CONICET.

Facundo Martín and Facundo Rojas participated in a working meeting with the General Department of Irrigation and Prof. Dr. Alfonso Calera, Director of the Remote Sensing and GIS section of the Regional Development Institute, University of Castilla La Mancha. October 2016. At this meeting, the research on water governance and land use change being made by the participating institutions with a view to future joint collaborative work were exchanged.

Progress is being made in a framework agreement to develop research activities with meetings between the team led by Paula Mussetta and Facundo Martin (INCIHUSA CONICET) and the National Agriculture Technology Institute (experimental station, La Consulta, in the Upper part of the Tunuyan river basin).

Facundo Martín held a Workshop on Water Political Ecology at Universidad Nacional de San Juan, Department of Biology, involving transdisciplinary professionals and researchers. March 2017.

Facundo Martín became part of the Academic Board of Mountains 2018



## Mexico

- *Organization of the Congress “Desafíos en seguridad hídrica y resiliencia ante el cambio global en zonas áridas del continente americano”* which took place on April 17, 18, 19 y 20. Guaymas, Sonora, México. January, February, March & April, 2018. In the event, the research results of the different participants were presented and round tables were held to discuss issues related to water security. In addition, on the third day of activities, The participants presented the results of their research and discussed the future work agenda. This type of event allows to advance in the diagnosis and proposals of solution of water security in the different regions. Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of water of acceptable quality for the support of livelihoods, human well-being and socio-economic development. For that, the technical and communications barriers have to be overcome to integrate climate science data into decision-making on water resources and climate adaptation.

See: [https://drive.google.com/open?id=1P3\\_UVtSWCTH5uV75-CDOWMgbit1NcVLR](https://drive.google.com/open?id=1P3_UVtSWCTH5uV75-CDOWMgbit1NcVLR)

- *Organization of workshop Binational Water Relations at 75 years: Retrospectives, Resilience, and U.S.-Mexico Border Water Resources Governance.* October 15-16, 2018. Uniting academics and professionals who have witnessed the change in water governance in the latest trends, the workshop took a retrospective, contemporary and prospective approach: recording the origins of how to do it and evolving these cross-border governance relationships, seeking the present for to assess the problems of resistance that the region faces, and we hope to glimpse the future relations around the water resources shared by the two countries. This workshop was able to improve public knowledge about the history and contemporary significance of these institutions for the protection of environmental resources at the borders of the United States and Mexico.

See: <http://aquasec.org/events/workshops/binational-workshop-at-75-years/>

An important collaboration was the organization of the yearly Water Security Award that was granted in 2016 and 2017 to different teams of students of the Universidad de Sonora. These students presented research papers related to water security issues.

### *Expo Peru 2016*

Within the framework of the policies that the new government of the Republic of Peru, led by President Pedro Pablo Kuczynski, is undertaking to reach the total coverage of drinking water and sanitation for the year 2021, the Peru Water Expo 2016 (://expoaguaperu.com), in the city of Lima, on October 19, 20 and 21, 2016. Colson's researcher, Nicolas Pineda Pablos, was invited to participate in this event to present the experiences and lessons learned with the water policy in Mexico. The researcher was invited by the Water Competence Center and presented the experience of Mexico in relation to watershed management and watershed councils in Mexico. In particular, he referred to the hidden costs of centralized management of water rights. The researcher argued that greater decentralization is needed, as well as greater participation of local authorities, stakeholders and social actors in order to achieve a more effective management and water security.



*Video conference with Dr. Sharon Megdal of the University of Arizona*

On Friday, February 17, 2017, officials from the State Water and Water Commission (CEA) of Hermosillo, as well as scholars from El Colegio de Sonora met to attend a talk, via Skype, with Dr. Sharon Megdal of the University of Arizona's Water Resources Research Center. In her talk, Dr. Megdal explained the operation of the Central Arizona Project, as well as the storage and extraction of groundwater that is made to provide water to the city of Tucson, Arizona.



*Field trip to observe hydraulic infrastructure in Tucson*

On March 3 and 4, 2017, research professors from the Center for Studies in Government and Public Affairs (CEGAP) conducted a work tour through various sites near the city of Tucson, to observe and study the operation of important hydraulic infrastructure works of Arizona. Most importantly, the technical staff, as well as the holders of the State Water Commission (CEA) of the Government of the State of Sonora and of the Water Utility of Hermosillo (AGUAH) attended this tour. The Colegio de Sonora research team were received at the University of Arizona Water Resources Research Center by its director Dr. Sharon Megdal, a group of Arizona Water Policy Class students and researchers from the Udall Center. This event was successful to increase contacts and strengthen the liaisons between water agencies on both sides of the Mexico-U.S. border.



### *2nd. Lloyd's Water Security Award (2017)*

On August 31, 2017, three students from the University of Sonora at El Colegio de Sonora met with Dr. Nicolás Pineda to receive the Lloyd's Water Security 2017 Award that is granted for the second time by the Lloyd's Register Foundation in conjunction with the Udall Center for Public Policy Studies. The award was given to students with the best essay on the jurisprudence and legal issues related to water security and urban water management in Mexico.



### United States

Ongoing collaborator, the PhD student Janaina Camile Pasqual, attended to EMBERS - Employing Model-Based Reasoning in Socio-Environmental Synthesis, from July 11-22, 2016 at University of Texas, El Paso funded by UTEP.

As part of the International water Security Network Meeting that took place in Tucson, AZ in September 2015, IAI partners discussed follow up activities for the Aguascapes project.

In close collaboration with IAI partner Mexican Nicolas Pineda, the UA team organized the Water-Energy-Food Nexus session for the Swan International Conference in Tucson, AZ on 16-17 February 2016.

The UA team co-organized and participated in the Water Ethics Symposium in Tucson, AZ on 25 April 2016.

Different departments, like the School of Geography and the UNAM Center for Mexican Studies, from the University of Arizona co-sponsored Dr. Manuel Perlo's visit to give a talk about "Hydro-Social Sustainability of Mexico City" on August 2016. Dr. Perlo is the Director of the institute of Social Research at UNAM.

During 1-5 June 2016, three representatives from the Departamento General de Irrigación (DGI) from Mendoza, Argentina, visited the University of Arizona to participate with researchers from the Udall Center for Studies in Public Policy and the Water Resources Research Center in several academic and collaboration activities to enhance the relationships between the UA and the DGI.

The Water Resources Research Center and the Udall Center for Studies in Public Policy hosted a talk by Dr. Fernando González Villareal and Adriana Palma Nava from the UNAM Water Network about the status and challenges of the water management in Mexico, and the principles in sustainable groundwater management policy. Members from different areas participated in this event and followed roundtable tables to build dialogues about possible networking among academia and government institutions of water management in both sides of Mexico and USA.

Zuniga participated in a transdisciplinary workshop about the impacts of urbanization on the water-food-energy nexus, from 1-3 March in Boulder, CO.

### Brazil

In follow up from Fortaleza 2014, no additional network activities have occurred in Brazil. It is scheduled a visit of the PhD student Micaella Falcão in Tucson in 2018 during “The Business of Water” organized by the Water Resources Research Center. The master student Tiago Inocêncio is following up the elaboration of the paper about drought indices with the Chilean team.

In April 2018, the PhD student Micaella Moura participated of “The Business of Water” organized by the Water Resources Research Center in Tucson. She took the advantage to contact professors, researchers and students of the Arizona University, meetings and visits at Tucson Water and Environmental and Natural Resources. With the collected Information and knowledge absorbed:

- Article development: Water governance in Arid Americas: a parallel between the states of Arizona (USA) and Pernambuco (BR).
- Learn from Tucson’s experience: What can be replicated to our reality?

Participation of Alfredo Ribeiro in I Congreso Peruano Agua Andes “Diálogo Ciencia-Política para el Desarrollo Sostenible” (Ayacucho/Peru), 19-21 September 2017 with presentation of the theme “Measures Adopted in Pernambuco State for Facing the Drought 2012-2017”.

## 7.2 Link with other CRN3 projects

Thanks to the efforts of IAI’s Ione Anderson, we contributed videos along with other CRN3 project participants, to the launch of the UN Sustainable Development Goals (September 23, 2015).

Christopher Scott, Francisco Meza, and Facundo Martin all participated in the IAI PIs’ meeting in Buenos Aires (December 10-12, 2015). Collaborative links were established and strengthened, particularly with Gerardo Perillo

## 8. Media Coverage and Prizes

- Blog. Publishing: Participación en el Primer Encuentro de Organismos Auxiliares de Cuenca (Participation in the First Encounter of Auxiliary Organizations of Cuenca) in Mexico City, Universidad Autónoma Metropolitana. Erik Parra and Nicolás Pineda presented a paper. September 27, 2017.  
Access to document: <http://sitios.colson.edu.mx/baam/participacion-en-el-primer-encuentro-de-organismos-auxiliares-de-cuenca/#more-1141>
- Blog. Publishing: 4to Congreso Internacional de sustentabilidad: Hegemonía y visiones alternas en el contexto actual. (4th International Sustainability Congress: Hegemony and alternative visions in the current context). October 23, 2017.  
Access to document: <http://sitios.colson.edu.mx/baam/4to-congreso-internacional-de-sustentabilidad-hegemonia-y-visiones-alternas-en-el-contexto-actual/#more-1147>
- Blog. Publishing: Titulación de Rodrigo Rivera. (Rodrigo Rivera undergraduate exam and professional report). November 14, 2017.  
Access to document: <http://sitios.colson.edu.mx/baam/titulacion-rodrigo-rivera-jecari/>
- **OTHER MEDIA**
  1. Interview. Analysis table in the Puente Project Newsletter. Topic: Notas sobre agua y asuntos públicos (Notes on water and public affairs). Interviewed by Conrado Quezada. September 6, 2017.  
Access to interview: <https://www.youtube.com/watch?v=jhkERmNMIX4>
  2. Newspaper. Column *Y sin embargo*. Titled: *Postal hidráulica de Israel* (Hydraulic postcard of Israel). September 15, 2017.  
  
Access to document: <https://www.elimparcial.com/Columnas/DetalleColumnas/1189514-y-sin-embargo-nicolas-pineda.html>
  3. Newspaper. Column *Y sin embargo*. October, 2017.  
Access to document: <https://www.elimparcial.com/Columnas/DetalleColumnas/1189884-y-sin-embargo-nicolas-pineda.html>
  4. Interview. Analysis roundtable in the Puente Project Newsletter. Topic: Tratamiento de aguas residuales (Wastewater treatment). Interviewed by Luis Alberto Medina. October 3, 2017.  
Access to interview: <https://proyectopuente.com.mx/2017/10/03/35-del-agua-tratada-en-hermosillo-se-tira-al-rio-sonora-falta-planeacion-aprovecharla-expertos/>
  5. Interview. Analysis table in the Puente Project Newsletter. Topic: *¿Quién debe quedarse al frente de Agua de Hermosillo?* (Who should be stay as a director of Agua de Hermosillo?) Interviewed by Luis Alberto Medina. August 15, 2018.

Access to interview: <https://proyectopuente.com.mx/2018/08/15/hay-que-evaluar-si-renato-ulloa-debe-quedarse-al-frente-de-agua-de-hermosillo-nicolas-pineda/>

6. Newspaper. Column *Y sin embargo*. Titled: *¿Por qué fracasan las ciudades (y los países)?* (Why cities and countries fail?). August 17, 2018.

Access to document: <https://elimparcial.com/Columnas/DetalleColumnas/1198261-Y-sin-embargo-Nicolas-Pineda.html>

7. Newspaper. Column *Y sin embargo*. Titled: *La coyuntura de Sonora en 2018*. (The Sonora juncture in 2018). September 14, 2018.

Access to document: <https://www.elimparcial.com/Columnas/DetalleColumnas/1199479-Y-sin-embargo-Nicolas-Pineda.html>

## • SOCIAL NETWORKS

- Facebook Page: Nicolas Pineda Pablos Investigador

Access: <https://www.facebook.com/Nicol%C3%A1s-Pineda-Pablos-Investigador-903867573062531/>

The Sonora Research team has regular participation on newspapers, radio talks and TV shows regarding water issues and water security in the region. Most of these appearances are featured in the blogs and web pages who's URLs are presented in the blog section. Among the main media appearances and participation are the following:

## • El Imparcial Column

Nicolás Pineda Pablos has a bimonthly column in El Imparcial. Published every other Friday. Some of the water related columns are the following:

### • May 13, 2017



**LA NUEVA GESTIÓN ADAPTATIVA DEL AGUA**  
Habría una época en que la política de la Secretaría de Recursos Hídricos en México era que "si una gota de agua de los ríos llegara al mar". En los tiempos de la gran infraestructura y la construcción de presas, canales, diques de riego y agricultura extensiva con riesgo por inundación. En los tiempos de la gran infraestructura y la construcción de presas, canales, diques de riego y agricultura extensiva con riesgo por inundación. En los tiempos de la gran infraestructura y la construcción de presas, canales, diques de riego y agricultura extensiva con riesgo por inundación.

**NUEVOS TECNOLOGÍAS PARA UN FUTURO SOSTENTABLE**  
Tal vez, por todos los anteriores, nuestra futura está en la industria y los servicios con base en el uso de agua tratada. También en el uso sustentable de la energía solar y de la desalinización de agua de mar como tecnologías competitivas y bajo patrones más sustentables y armados con la naturaleza. Con base en estas nuevas tecnologías, pueden imaginarse y emprenderse el turismo y nuevos tipos de industria y exportaciones. La agricultura deberá reconstruirse y tecnificarse. El desarrollo urbano deberá estar sustentado en la eficiencia, el tratamiento y el uso de nuestra agua escasa.

**LA POLÍTICA HÍDRICA DEL ESTADO DE SONORA**  
La política hídrica del Estado de Sonora ya no debe de centrarse en la construcción de grandes obras de infraestructura como las presas y el acueducto. Ahora esta política debe de sustentarse en lograr una adecuada gestión del agua y en las nuevas tecnologías. Las prioridades para la seguridad hídrica de Sonora son entonces: Uno, alcanzar una eficiente gestión del agua, adecuada a los tiempos de mayor variabilidad climática, de tormentas y sequías y, segundo, el recurso privilegiado a nuevas tecnologías como la energía solar y la desalinización de agua de mar.

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### • September 30, 2016





**Y SIN EMBARGO**  
NICOLÁS PINEDA  
Investigador independiente  
Twitter: @nicanpineda

## Hermosillo y sus aguas residuales

Después de más de 30 años de jadeos y contratiempos, parece que Hermosillo, por fin, va a contar con una planta de tratamiento de aguas residuales (PTAR) para toda la ciudad y dejará de ser la única ciudad en su tamaño que no trata sus aguas negras. Una breve crónica de su antecedente en la siguiente.

Larga historia del tratamiento otorgado.

Desde 1988 se expidió la Ley General de Equilibrio Ecológico y Protección al Ambiente que estableció que "las aguas residuales de origen urbano deben recibir tratamiento previo a su descarga en ríos, cuencas, ... incluyendo las aguas del subterráneo" (art. 117). Hermosillo era sede entonces una de las ciudades

atolladas.

En 1981, la Ley Federal de Derechos (art. 278) y siguientes estableció el pago de derechos y multas a los organismos operadores de aguas que tienen sus aguas residuales sin tratar. Desde entonces Hermosillo se ha hecho acreedor al pago de derechos y multas por no tratar sus aguas residuales.

En 1984, el Gobierno del Estado contrató a una empresa de Monterrey para que construyera una gran PTAR al puerto del aeropuerto. La construcción se inició en 1984, pero fue suspendida en 1987 en circunstancias un tanto opacas. La construcción quedó abandonada y se perdieron 90 millones de pesos invertidos. Además, esta obra suspendida dejó un serio conflicto legal con la empresa contratista y otro con el ejido la Manga al que se le habían expropiado 300 hectáreas a cambio de aguas tratadas para riego. Estos conflictos legales durante varios años la construcción de una nueva gran planta.

A falta de una gran planta, se trató de construir muchas pequeñas. Una de las primeras fue la que iban

a construir en el año 1989 en el campo de la Unión, en la esquina de Colón y Suburiga, precisamente en contravención de varias resoluciones y junto a una zona residencial. Los vecinos se inconformaron e hicieron un planito que obligó a la cancelación de la construcción.

A partir de 2001 Hermosillo comenzó a incurrir en severas multas federales por no contar con planta de tratamiento. Pero no fue sino hasta cuando se pudieron resolver los conflictos legales de la planta anterior y una vez que el servicio se había municipalizado, cuando se retomó el proyecto de construcción de la PTAR.

Desde cuando menos 2006 se hicieron varios proyectos técnicos que fueron rechazados por Banobras. Había además discrepancias en cuanto al lugar en donde debía ubicarse y si debía ser una o dos PTARs.

A principios de 2010, se llevó a cabo la primera licitación, pero fue cancelada por la Secretaría de la Función Pública que ordenó que se hiciera una reevaluación de las empresas concursantes. En una segunda ronda se designó como ganadora

a la empresa Dinámica Desarrollo Sustentable pero fue nuevamente impugnada y suspendida. No fue sino hasta la tercera ronda, cuando el Gobierno municipal podía hacer una adjudicación directa, que se encargó la construcción a la empresa Pineda. La empresa creó para este propósito una filial llamada TIAH. La construcción se inició en mayo de 2012 y se concluyó este año.

Para el pago de su operación se prevé, desde el inicio, que habría un incremento de 30% en la tarifa de agua. En su defecto se afectarían la participaciones federales del municipio de Hermosillo.

Por otra parte, Hacienda canceló a Hermosillo una multa de varios miles de millones de pesos por no contar con PTAR. Parece que esta larga historia está a punto de pasar a otra etapa con el inicio de operaciones de la nueva planta.

Agradezco la invitación. Si usted tiene alguna información sobre los acontecimientos aquí mencionados, que desee compartir, favor de escribirme a nicolas.pineda@proyectopuente.com

Nicolás Pineda, Analista político

## September 15, 2017



**Y SIN EMBARGO**  
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Twitter: @nicanpineda

## Postal hidráulica de Israel

Gracias a la invitación de la Dra. Sharon Magdal (Universidad de Tel Aviv) y de la Asociación Internacional de Manejo del Agua, me encontré en la Universidad de Tel Aviv, Israel, para participar en una reunión sobre problemas de manejo del agua y conocer un poco los avances de este país en esta materia. Es ampliamente aceptado que Israel se ha convertido en un modelo mundial de gestión del agua. Israel, con un territorio mucho menor que Suiza y una población de 8 millones de habitantes, ha desarrollado un sistema integrado de manejo del agua en todo el país, ha impulsado una exitosa actividad agrícola y, fíjese usted, exporta agua a los países

vecinos. Le platico algunas de mis observaciones.

**LUGARES HIDRAULICOS**  
De una manera un tanto similar (pero inversa) a Suiza, el territorio de Israel está dividido en tres partes, el sur que es el desierto del Negev donde no llueve y solo hay arena, el centro semiárido donde se encuentran Jerusalén y Tel Aviv, y el Norte un poco más húmedo con el mar de Galilea. Para abastecer de agua a la mayor parte del país, en los años sesenta un ingeniero llamado Sima Hiss diseñó la construcción de un gran acueducto que transportaría agua del norte al centro y un poco al Sur. Este sistema de distribución hizo posible el crecimiento de las ciudades en el centro.

Por esos mismos años, para desarrollar la agricultura, el mismo señor Hiss desarrolló el sistema de riego por goteo que les permitió desarrollar la agricultura en el desierto y sembrar y cosechar más con la mitad del agua que se utilizaba en otros sistemas de riego.

Entre las actividades realizadas,

visité el Kibbutz la granja comunal Ramat Matatim, en el que se hicieron los experimentos y pruebas para desarrollar el riego por goteo. Ahí me encontré a Niv Dardik quien había por fin encontrado ya que vivió estos años en California desarrollando el riego por goteo en Sinaloa.

Además de lo anterior, para reforzar el abasto de agua, en los años ochenta construyeron una gran planta de tratamiento de aguas residuales que trata y reutiliza el 100% de las aguas negras del país y aumenta la disponibilidad de agua.

Por si lo anterior no fuera suficiente, en la última década comenzaron a desalar agua. Actualmente cuentan con la desaladora Sorek, que comenzó a operar en 2013 provee el 20% del agua del país.

En embargo, Israel también enfrenta problemas graves.

**PROBLEMAS Y BÚSQUEDA DE SOLUCIÓN**  
Uno de los problemas que Israel enfrenta actualmente son los efectos que el uso intensivo del agua ha tenido en el río Jordán y en el Mar Muerto. El río Jordán, de un gran

valor histórico y religioso, de ser un río importante se ha vuelto un riachuelo a punto de desaparecer. Actualmente el Mar Muerto ha reducido considerablemente su superficie y ha bajado de manera alarmante su nivel. Para resolver esta situación, Israel, junto con la Autoridad Palestina y con Jordania, están haciendo esfuerzos conjuntos para revivir el Jordán. Para ello, están tomando de modelo la construcción que desde hace décadas está haciendo México y Estados Unidos para administrar sus aguas transitorias y están creando un órgano similar a la Comisión de Límites y Aguas de estos dos países.

En lo que se refiere al Mar Muerto, existe un gran proyecto que planea transportar agua del Mar Rojo al Mar Muerto para que este lago, con agua más salada que la del mar y ubicado bajo el nivel del mar, no desaparezca.

En los dos días que me quedé, tuve el honor de visitar los lugares santos de Jerusalén. Pero eso es otra historia.

Nicolás Pineda, Analista político

## October 10, 2017

Internet Radio Proyecto Puente <http://proyectopuente.com.mx/>

In addition, there are regular participation on water related topics on the Internet Radio Talk Show Proyecto Puente:

<http://proyectopuente.com.mx/stream/>

Most of these talks and analysis refer to the political arena and public policies. Some of the appearances are the following:

Theme: 35% of the treated water in Hermosillo is thrown to the Sonora River, planning is lacking to take advantage of it: Pineda. 03 / Oct / 2017.

<http://proyectopuente.com.mx/2017/10/03/35-del-agua-tratada-en-hermosillo-se-tira-al-rio-sonora-falta-planeacion-aprovecharla-pineda/>

Topic: In Mexico, party regime must change for one of citizen empowerment: analysts. Pineda. September 26, 2017.

<http://proyectopuente.com.mx/2017/09/26/en-mexico-regimen-partidocracia-debe-cambiar-uno-empoderamiento-ciudadano-analistas-2/>

Theme: "The Master Scam", Nicolás Pineda and Ma. Elena Carrera, analysis table. 06 / September / 2017.

<http://proyectopuente.com.mx/2017/09/06/mesadeanalisis-nicolas-pineda-ma-elena-carrera-opinaron-reportaje-la-estafa-maestra/>



Topic: Peña Nieto cannot leave loose ends, otherwise he risks his political legacy and personal freedom: Nicolas Pineda. 01 / September / 2017.

<http://proyectopuente.com.mx/2017/09/01/pena-nieto-puede-dejar-clavos-sueltos-se-juega-la-carcel-la-libertad-nicolas-pineda-2/>

### **Internet Talk shows Foro Cuatro TV.**

Pineda Pablos, N. 2015, 2014. TV interventions on water related topics. Foro Quattro TV. November 2014 and October 2015.

Foro Cuatro TV Round Table: Theme: Water Conservation. Nicolás Pineda. 03 / March / 2017.  
<http://forocuatro.tv/2016/03/25/nicolas-pineda-el-cuidado-del-agua/>

### **Blogs**

These compile columns, radio talks and TV shows:

Colson Research Blog: Baam: <http://sitios.colson.edu.mx/baam/>

Newspaper columns: Wordpress <http://nicolaspineda.wordpress.com/>

University of Arizona. Encuentro Internacional del Agua, Mendoza, Argentina, Junio 5-6, 2-13.

[http://www.udallcenter.arizona.edu/old\\_site/news/mendoza\\_encuentro\\_del\\_agua.html](http://www.udallcenter.arizona.edu/old_site/news/mendoza_encuentro_del_agua.html)  
[http://www.udallcenter.arizona.edu/news/mendoza\\_encuentro\\_del\\_agua.html](http://www.udallcenter.arizona.edu/news/mendoza_encuentro_del_agua.html)

Pontificia Universidad Católica de Chile. La UC y la Universidad de Arizona lanzan el Centro Aquasec sobre seguridad hídrica en las Americas.

<http://www.uc.cl/es/la-universidad/noticias/6042-la-uc-y-la-universidad-de-arizona-lanzan-el-centro-aquasec-sobre-seguridad-hidrica-en-las-americas>  
<http://www.uanews.org/node/47483><http://www.uanews.org/node/47483>

Arizona Public Media. Desert dwellers deal with drought on both sides of the border. May 2012.

<https://www.azpm.org/s/8912-desert-dwellers-deal-with-drought-on-both-sides-of-the-border/>

Tucson weekly news. Water Ways: A new report puts hard facts in the hands of water policy makers. May 2012.

<http://www.tucsonweekly.com/tucson/water-ways/Content?oid=3336059>

Homeland Security news wire. Water vulnerability in the U.S. border region. April 2012.

<http://www.homelandsecuritynewswire.com/dr20120418-water-vulnerability-in-u-s-border-region>

UA News. Team identifies water vulnerability in border region. April 2012.

<http://uanews.org/node/46373>

CNN interview: Francisco Meza abordó la sequía en Chile y el fenómeno del niño (2014):

<https://www.youtube.com/watch?v=iUbU6TiNw6k>  
<http://uanews.org/node/46373>

CNN interview: Francisco Meza profundizó en la importancia y consecuencias del cambio climático (2014):

<https://www.youtube.com/watch?v=zAshp7LkwjU>

Melissa Aguirre; Miryam Ramírez; Alejandra Gallardo- “Unison alumnae win the ‘Water Security’ award”:

<http://portales.colson.edu.mx/num625/alumnas-de-la-unison-ganan-el-premio-seguridad-hidrica/> (June 2016).

Lutz Ley, America N. 2016. “Cambio Climático. Parte 3/3”. Tribuna del Yaqui. Newspaper column “Observatorios Urbanos”. Ciudad Obregon, Sonora, Mexico. May 20, 2016.

Lutz Ley, America N. 2016. “Cambio Climático. Parte 2/3”. Tribuna del Yaqui. Newspaper column “Observatorios Urbanos”. Ciudad Obregon, Sonora, Mexico. April 29, 2016.

Lutz Ley, America N. 2016. “Cambio Climático. Parte 1/3”. Tribuna del Yaqui. Newspaper column “Observatorios Urbanos”. Ciudad Obregon, Sonora, Mexico. April 22, 2016.

Lutz Ley, America N. 2016. Navigating through uncertain waters in the COP21-CMP11.

Talk presented in the Panel “Reflections on the Paris Climate Negotiations, COP21”.

University of Arizona- Institute of the Environment. Tucson, AZ., February 11.

Lutz Ley, America N. 2014. UA Science Cafes Series- Borderlands Brewing Science Café.

“Watersheds and Social-sheds: Adaptive Agricultural Systems in the Arid Americas”.

Tucson, AZ., October 9.

Pineda Pablos, N. 2016, 2015, 2014. Newspaper notes on water related topics. El Imparcial. November 2014 and October 2015.

Pineda Pablos, N. 2016, 2015, 2014. Radio appearances on water related topics. Noticiero Proyecto Puente. Uniradio 100.3 FM. November 2014, October 2015, and September 2016.

Pineda Pablos, N. 2015, 2014. Magazine articles on water related topics. Círculo. November 2014 and October 2015.

Pineda Pablos, N. 2015, 2014. TV interventions on water related topics. Foro Quattro TV. November 2014 and October 2015.

UA News. UA researchers take a closer look at the future of desalination. July 7.

<https://uanews.arizona.edu/story/taking-closer-look-desalination>

Departamento General de irrigación. (2016). Profesionales de América Latina se capacitan en seguridad hídrica y manejo de agua en Mendoza. Aug. 5.

<http://www.agua.gob.ar/dgi/novedades/profesionales-america-latina-se-capacitan-en-seguridad-hidrica-y-manejo-agua-en-mendoza>

Departamento General de irrigación. (2016). Plantean nuevos paradigmas para la distribución y administración del agua. 3 Aug. <http://www.agua.gob.ar/dgi/novedades/plantean-nuevos-paradigmas-la-distribucion-y-administracion-del-agua>

Audio interview with Paula Mussetta. (2016). Cuyo National University Open Radio. Topic: Climate change and Sustainable Development in Social Sciences. (No available link).

Interview with F. Martín for the documentary Climate Change, Water Security & Society, broadcast on Mendoza TV station Acequia TV/Canal U. (May 2016).

Interview with P. Mussetta for the documentary Climate Change and Agriculture in Argentina broadcasted by UN Multimedia and local TV stations. 26 Aug. 26.

Radio Interview for “La Conversada” with A. Zúñiga-Terán, A. Lutz Ley, and Y. Peralta Lugo on scenario planning for Hermosillo City. Radio Sonora, Hermosillo, Mexico. April 8<sup>th</sup>, 2016.

Video interviews with Robert Varady and Christopher Scott by CONICET news media (2016): <https://youtu.be/x-ObprzkKAs> and <https://youtu.be/bHYfXtJYZGo>. 3 Aug.

Video interviews with José Luis Álvarez by DGI news media (2016): <https://www.youtube.com/watch?v=vYAqSeb2m6Q>; Francisco Meza: <https://www.youtube.com/watch?v=MwJhPR2FrnI>; and Marta Paris: <https://www.youtube.com/watch?v=sHGk4B4bmAI>. 3 Aug.

Water Resources Research Center, University of Arizona. Groundwater governance and management. 2016.

<https://wrrc.arizona.edu/groundwater>

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<http://g1.globo.com/pernambuco/noticia/2015/03/pernambucanos-apostam-em-ideias-sustentaveis-para-economizar-agua.html>

Suzana Montenegro also gave interview to television broadcast on

<https://globoplay.globo.com/v/6254614/>

<http://g1.globo.com/jornal-hoje/noticia/2015/06/abrir-pocos-sem-orientacao-pode-comprometer-agua-do-subsolo.html>

Workshop INCT MC2 2018 “Segurança Hídrica sob Mudanças no Brasil” in

<http://fade.org.br/workshop-inct-mc2-2018-seguranca-hidrica-sob-mudancas-no-brasil/>

## Media

Interview for radio show InfoTrak. April 24, 2017. Radio Host and Executive Producer Randy Meyer interviewed Adriana Zuniga on her published study on neighborhood design and wellbeing. The show airs on Talk Zone ([www.talkzone.com](http://www.talkzone.com)).

Interview for “Newsweek en Español”. April 2, 2017. Reporter Marco Tulio Castro interviewed Adriana Zuniga about a published study on desalination in the U.S.-Mexico border region. Article was published on April 7, 2017 and is titled “El plan de BC y Sonora para exportar agua a Estados Unidos” (BC and Sonora’s plan to export water to the United States). <http://nwnoticias.com/#!/noticias/el-plan-de-bc-y-sonora-para-exportar-agua-a-estados-unidos>

Interview for “Dr. OZ The Good Life Magazine”. March 14, 2017. Reporter Megan Ditrollo interviewed Adriana Zuniga on her study on neighborhood design and wellbeing.

Article on “Men’s Fitness”. March 14, 2017. Article posted in website “Men’s Health” references study on neighborhood design and wellbeing. Article title “Here’s why your neighborhood can make (or break) your fitness.”  
<http://www.mensfitness.com/life/outdoor/heres-why-your-neighborhood-can-make-or-break-your-fitness>

Interview for UANews. February 7, 2017. Reporter Alexis Blue interviewed Adriana Zuniga for an article for the UANews on a recently published study on neighborhood design and walkability. UA News article posted on March 9, 2017 at  
[https://uanews.arizona.edu/story/how-your-neighborhood-may-impact-your-health-and-wellbeing?utm\\_source=uanow&utm\\_medium=email&utm\\_campaign=](https://uanews.arizona.edu/story/how-your-neighborhood-may-impact-your-health-and-wellbeing?utm_source=uanow&utm_medium=email&utm_campaign=)

Interview for UANews. January 17, 2017. Reporter Abby Dockter interviewed Andrea Gerlak and Adriana Zuniga for an article for the UANews about the Haury Seed Grant Recipients. UA News article posted on February 17, 2017 at  
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## 9. Policy Relevance

- Furthering institutional change in urban water management in the Sonora and chihuahua regions, and in some respect on the Mexican water policies via publications and participation in congresses and other events.
- Lobbying policymakers for institutional reform of water management in Mexico both at the local level and at the national level, for instance through participation in the Congresses of the National Association of Water Utilities (ANEAS)
- An assessment of the perspective of desalination of sea water for export in the Gulf of California. This was carried out by means of a Delphi survey among experts and stakeholders.
- In general, raising awareness about water security and the demands of sustainability and adaptation for water management in Mexico. This includes the participation in academic meetings, as well as in a number of opinion editorials in newspapers, radio talk shows as well as direct liaisons with public agencies

Stakeholders have played a central role in project formulation. For further details, see section 3.4 above.

The following is excerpted from the SGPCRA005 report to indicate our approach:

We have observed two fundamental shifts in the research conducted by the team and other partners, as well as interactions with decision-makers: 1) uptake of policy-relevant research on global change, and 2) modified research design based on decision-making criteria.

Global change as the interlinked set of natural and human drivers and responses, i.e., beyond just climate change, is now firmly rooted as a concept among our stakeholder partners. Perhaps the best example is Mendoza, where the Departamento General de Irrigación (DGI) Superintendent, José Luis Álvarez, and Technical Director, Mario Salomón, now clearly and eloquently identify economic-growth processes along with drought as primary drivers of the Upper Rio Tunuyán water balance. Our project team collaborated closely with DGI on

hydroclimatic assessments for groundwater availability, land-use mapping to understand the spatial extent of intensive irrigation and the ‘de-watering’ of the lower basin resulting from upstream intensification, and adaptive response practices of water users (cropping shifts) and DGI itself (conjunctive management of surface and groundwater). This contributed to support that DGI garnered directly from the Food and Agriculture Organization (FAO), and in turn, to more advanced modeling capability (WEAP model, Water Evaluation And Planning System) that we assisted DGI in contracting from the Stockholm Environment Institute (SEI, Davis, California office). IAI support covered the costs for the initial participation of Ralph Marra, Southwest Water Resources Consulting (retired as Chief Hydrologist, Tucson Water utility) in the Mendoza water balance and planning process. Mr. Marra remains involved, via FAO support, in providing expert guidance in Scenario Planning, an interactive science-policy process for considering future development pathways around water resources, climate change, environmental quality, and economic growth processes. Similarly, the project team and our network of collaborators have catalyzed interactive, applied research for policy in Chile and Peru (indeed, via exchange visits that we supported between Chile, Peru, and Argentina).

Often less apparent than the science-for-policy outreach just described are science- from policy in reach processes. That is, our team has incorporated research questions that emerge from the dialogue process. Scientists are often not comfortable with this, viewing it as ‘academic consulting’. But true relevance and broader impacts arise from sustained interactions and engagement.

Through the development of this project we have learned that actionable science cannot be built in short periods, because building trust and creating an atmosphere of mutual communication that favors the cogeneration of knowledge require time. This has been the case in the Maipo Basin where we have contributed to an entirely new project focused on an Adaptation Plan for the Maipo Basin (MAPA). This leveraged project was led by PUC collaborator Dr. Sebastián Vicuña and brings together representatives of a wide variety of actors (mining companies, utilities, farmers’ associations, hydropower companies). MAPA represents a genuine example of coordinated and scientifically informed work for the development of adaptation plans to global change.

Important dialogues are established by the University of Arizona’s Udall Center for Studies in Public Policy and the School of Geography and Development, with collaboration (and often primary leadership) of the Water Resources Research Center and the UNAM Center for Mexican Studies. These address topics within the academic community, public and private intuitions.

- Dr. Manuel Perló Cohen - Director, Institute of Social Research, Universidad Nacional Autónoma de México (UNAM), offered a talk on August, 2016 about “Hydro-Social Sustainability of Mexico City” focused in Mexico City’s water resource problems, the repercussions and the different and conflicting views on why such problems exist and, more importantly, how to address them.
- Dr. Fernando González Villarreal, Universidad Nacional Autónoma de México (UNAM), will make a visit this October 2016 to offer a talk about water management in Mexico and establish networks with different stakeholders and policy makers related to water management in Tucson, Arizona.
- Adriana Palma Nava is under current communication with Yulia Peralta, America Lutz

and Adriana Zuñiga to design a conference regarding women working in water.

- The Sonora research team participates regularly in different meetings, talks, and talks about local, regional and national issues related to water security. Some of these participation are the following:



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Aunque la iniciativa de una desdoblada guerra contra el agua a Uruguay, Ecuador y en sus Paises afortunadamente nunca llegaron en vista como positivos, fueron los diferentes sectores y partidos que elaboren la transmutación, los recursos y el impacto ambiental.

Para el caso del PIB y PIB en América, transmutación los recursos de la oferta de recursos que el Congreso de la Unión de América a continuación.

En los días de la oferta en los que se desdobló transmutación de recursos, problemas, los impactos de recursos, en los países participativos la transmutación y transmutación de recursos.

"Nunca en los últimos 40 años he visto tanta gente en la plaza como hoy", dice el Sr. Rodríguez, un hombre de 65 años que vive en la zona. Él y su familia han vivido en la zona desde hace más de 40 años. Él y su familia han vivido en la zona desde hace más de 40 años.

ES ADMIRANTE, UNIÓN DE LOS AMIGOS

**C**on un "abuso moderato" di "parole ambigue e vaghe" - sostiene il libro della London School of Economics - la lingua italiana ha imparato a distinguere tra "parole ambigue" e "parole ambigue e vaghe".

El diputado del PRI, Daniel Padilla Calero, sostiene que en caso de aprobarse la ley, habrá seriea incompatibilidad con la implementación del sistema de primeros ministros.

interconexiunile de rețea și  
desfășurarea de programe de  
marketing pe mai multe orașe  
pot avea drept consecință, în  
tranzacții comerciale, creșterea  
capacității de a pune împreună  
cunoscințele și experiențele  
pe care le au în activitatea  
de activitate în activitatea  
de activitate.

El presidente de la cámara  
dice explícito que el costo por el  
uso de las instalaciones será la  
única responsabilidad de los usuarios.  
Además, se dice que los  
usuarios de las instalaciones no

at Phoenix, Arizona.

consideration to investigate the  
N<sup>2</sup> approach.

El arquitecto de El Ciego de Guaymán, Nicolás Pérez Padilla, dijo que este inmueble no solo busca satisfacer parte necesaria de la dependencia regional en este sector, pero que importante tener estos servicios de transporte en el área.



In some other occasions the researchers interact directly with water public agencies in order to define and design public policies

- Workshop and seminars with the utility Agua de Hermosillo to discuss the future of water management in the city.
- Meetings with the Utility Government Board to design a new legal framework for the utility to achieve managerial autonomy and professional performance.
- Meetings with officers of the Sonora State Water Commission to define new policies in order to regulated municipal water utilities in Sonora.

## 10. Main Conclusions

*The activities, findings, products, networking, liaisons, and publications of this project contributed and promoted in a significant way to the dialogue between the scientific-academic community and policymakers, stakeholders and public agencies in the arid regions of Mexico in order to further the perspective of water security and global change adaptation*

The project has achieved a number of research advances, listed below by task:

Task 1 - Vegetation cover in the study basins is strongly linked to seasonal precipitation and other hydrological dynamics. Climate dynamics are causing a shift from surface water dependence to groundwater dependence, which alters the types of stressors to which social

groups are exposed. Drought events and drought planning are receiving increased attention, with particular innovations in Mexico and Chile. Policies, legal frameworks, and decision-making can often heighten tensions among social groups.

Task 2 - In all the basins studied climate change combines with the impacts of other globally driven changes in broader socio-environmental conditions (e.g., export-agriculture). This also modifies livelihood structures and vulnerability to global change. In the majority of basins there is also a trend toward a widening gap between the most and least vulnerable farmers (or rural households) to global change.

Task 3 - Stakeholders workshops focusing on dialogue towards common understandings on water issues, new approaches to measuring or evaluating vulnerability or adaptation, or new planning approaches have been effective in increasing climate science inclusion in water planning and management. Inclusion of young scientists and graduate student researchers in these dialogues or through participation in decision-making arenas, improve their capacity to address challenges in the science-policy translation required in future planning and research.

## 11. Work in Progress

### Publications in preparation

- Cañez, Antonio & Nicolás Pineda. In preparation. Scale and water billing and charges in rural communities. The case of Sonora.
- Castellanos, A.E., R. Calderón, J.R. Romo-León, R. Díaz-Caravantes, T. Arredondo, L.C. Bravo, F. García-Oliva, C.A. Scott, O. Briones, J.L. Moreno. In review. Land use changes and ecosystem services in arid and semiarid lands of Mexico. *Journal of Arid Environments*.
- Chew, E.S., C.A. Scott. K. Chief. In preparation. Resilience in indigenous water management. For special issue "Native Waters in the U.S." *Journal of Contemporary Water Research and Education*.
- de Grenade, R., C.A. Scott, M.E. Adauto, R. Taboada, J. Rudow, R.G. Varady, B. Willems. In preparation. The food-energy-water-earth systems security nexus: Analysis across an extreme gradient in the Ica Basin, Peru. *Mountain Research and Development*.
- Diaz-Caravantes, R, Salomón, M, Taboada, R, Zuniga-Teran, A, Pineda, N. En preparación. Usos ambientales indígenas.
- Diaz-Caravantes, R, Zuniga-Teran, A, Martin, F, Bernabeu, M. In preparation. Transfer of water and vulnerabilities: The peri-urban interface in the arid Americas.
- Díaz Caravantes, Rolando E., Pineda Pablos, N., & Elizalde Castillo, F. (In preparation). (In) seguridad hídrica en el río Sonora por el derrame de la mina Buena Vista del Cobre: análisis y reflexiones acerca de la calidad del agua para consumo humano reportado en la base de datos oficiales de México. For submission to COMECOS.
- Díaz Caravantes, Rolando Enrique, Elizalde Castillo, F., & Pineda Pablos, N. (In preparation). Seguridad Hídrica de la ciudad de Hermosillo: Una aproximación integral. For submission to Tecnología y Ciencias del Agua.

- Díaz-Caravantes, Rolando Enrique, Romo León, J. R., & Méndez Estrella, R. (In preparation). Analyzing the changes in land use and cover produced by an urban's dam: the case of El Molinito in the Sonoran River Basin. For submission to *Applied Geography*.
- Dutra, M.T.D., Silva, J.A.A., Ribeiro Neto, A., Montenegro, S.M.G.L.. Development of hidroenvironmental sustainability index in watersheds: the case of Capibaribe river basin, Pernambuco-Brazil. For submission to *Brazilian Journal of Water Resources*.
- Halper, E., Scott, C.A., S. Yool. In preparation. Geographies of residential water conservation: intra-urban variation in drought response. *For submission to The Professional Geographer*.
- Inocêncio, T.M., Ribeiro Neto, A., Melanie, O., Meza, F. Drought Propagation for Characterization of Episodes of Drought in Pernambuco State - Northeast Brazil. For submission to *Water (MDPI)*.
- Kurian, M., C.A. Scott, R. Reddy Vippala, G. Alabaster, A.C. Nardocci, K. Portney, R. Boer, B. Hannibal. In review. Theorizing water-energy-food interactions via place-based observatories: Bridging conceptual and practical implications of the nexus approach. *Frontiers in Environmental Science*.
- Lankford, B., A. Anwar, A. Closas, J. Dalton, E. López-Gunn, T. Hess, J. Knox, S. van der Kooij, J. Lautze, D. Molden, S. Orr, J. Pittock, B. Richter, P. Riddell, C.A. Scott, J. Vos, J.P. Venot, M. Zwarteveen. In preparation. The challenge of managing irrigation efficiency for farmers, global food production, water scarcity and water allocation. *Nature Sustainability*.
- Lopes, J, Sicre, A, Stocco, ME, Martin, F, Scott, CA, Bauer, C, Alvarez, JL, Pina, A, Salomon, M. En preparación. La gestión comunitaria del agua subterránea en Mendoza: Paradigma del manejo participativo frente a la escasez hídrica.
- Lutz-Ley, A., C.A. Scott. In preparation. Advancing adaptive governance through analysis and application of institutional mismatches: The case of the San Miguel Watershed in rural northwest Mexico. *Global Environmental Change*.
- Martín, F & Mussetta, P. In preparation. Tunuyan and Mendoza River Basin Trajectories.
- Martin, F, Bauer, C, Borgias, S, Mussetta, P, Salomon, M, Praise, N, Meza, F. In preparation. Shared paths? Comparing river basin trajectories in the Southern Cone.
- Mussetta, P, Diaz-Caravantes, T, Peralta, Y, Dutra Tereza. In preparation. Understanding the structural dimensions of climate vulnerability.
- Pasqual, J.C., H.A. Bollmann, C.A. Scott. In review. Biomethane for sustainable urban mobility in Brazil and the U.S.: Energy trade-offs with water and food. *Journal of Renewable and Sustainable Energy*. ISSN 1941-7012.
- Pineda Nicolás & Alejandro Navarro. In preparation. Transaction costs and decentralization: the case of the institutional response to the mining contamination of the Sonora River in 2014-2015.
- Pineda Nicolás, Alejandro Salazar, Alan Navarro & José Luis Moreno. In preparation. The fake decentralization of water management in Mexico 1989-2015 (Book chapter in book coordinated by Raul Pacheco Vega, in progress).
- Pineda Nicolás. In preparation. Stakeholder participation and decentralization of watershed councils in Sonora from the perspective of institutional capacity.
- Pineda Pablos, N, Willems, B, Montenegro, S. In preparation. River basin organizations: A comparison of Brazil, Mexico, and Peru.
- Rojas, F. Bernabeu, M y Martín, F. En preparación. Propuesta teórico metodológica para el estudio integral de los cambios de uso del suelo en Mendoza.

- Scott, C.A., A.K. Gerlak, R.G. Varady, S. Mumme, M. Rivera-Torres, C. de la Parra, M. Wilder, D. Liverman, B. Hurd, F. Lara, A. Lutz-Ley, R. Sánchez, K. Flessa, J. Bernal. In preparation. North American trade renegotiation and the future of US-Mexico border water management. *Science*.
- Scott, C.A., F.M. Le Tourneau (eds.). 2018 special issue proposal in review. "Resilience and complexity: Frameworks and models to capture social-ecological interactions," *Current Opinion in Environmental Sustainability*.
- Scott, C.A., S. Vicuña, S. Borgias, S. Bonelli. In preparation. Institutionalizing adaptation for river-basin management: Innovation and impediments. *For submission to Ecology & Society*.
- Varady, RG, Martin, F, Pineda, N, Zuniga-Teran, A, Lutz-Ley, A, Ocampo Melgar, D. In preparation. Transboundary water security in the arid Americas.
- Willems, B, Zuniga-Teran, A, Martin, F. En preparación. Servicios ecosistémicos de los bofedales.
- Zuniga-Teran, A, Diaz-Caravantes, R, Domizio, C, Willems, B. In preparation. Irrigation for urban greenspace: A comparison of cities in the arid Americas.

### **Publications submitted**

- Albrecht, T., Varady, R.G., Gerlak, A.K., Zuniga-Teran, A.A., Staddon, C. (In review). "The Water Security Discourse and its Main Actors." To appear in Handbook of Water Resources, edited by Bogardi, J. and Wasantha Nandalal, van Nooyen, R.P., and Bhaduri, A. Submitted to Springer.
- De Vito, L., Staddon, C., Ward, S., Zuniga-Teran, A., Schoeman, Y., Gerlak, A. (In review) Toward a framework for fairness in city resilience: Exploring potential of green infrastructure through appropriateness and inclusivity. Submitted to *Global Environmental Change*.
- Díaz-Caravantes, Rolando Enrique, Duarte Tagles, H., Pallanez Murrieta, M., Moreno Vázquez, J. L., Mejía Santellanes, J. A., & Durazo Gálvez, F. M. (In review). Análisis de los criterios para proteger la vida acuática: El río Sonora después del derrame minero de 2014. Submitted to Aqua-LAC.
- Díaz-Caravantes, Rolando Enrique, Zúñiga Terán, A. A., Martin, F., Bernabeu, M. M., Scott, C. A., & Stoker, P. (In preparation). Urban Water Security: A comparative study of three cities of arid Americas. Submitted to Environment and Urbanization.
- Félix, V.S., Ribeiro Neto, A. Hydrological simulation of climate and land use change scenarios in simiarid land under water security risk. For submission to Brazilian Journal of Water Resources. Díaz-Caravantes, Rolando E. (In review). Vulnerabilidad y riesgo para la salud ante amenazas climáticas: Una aproximación integral. Submitted to Región y Sociedad.
- Garfin, G., Falk, D., O'Connor, C., Jacobs, K., Sagarin, R., Haverland, A., Haworth, A., Baglee, A. Weiss, J., Overpeck, J., Zuniga-Teran, A. (In review). A new mission: Climate adaptation challenges and opportunities in the Department of Defense. Submitted to *Frontiers in Ecology and the Environment*.
- Gil-Loaiza, J., A.N. Lutz Ley, B.T. Wilder (with C.A. Scott, J. Ruiz, J. Lever). In press. Ciencia cruzando fronteras: El caso del Consorcio Arizona-México para Ambientes Áridos (CAZMEX). *Ciencia*.
- Ward, S., Staddon, C., De Vito, L., Zuniga-Teran, A., Gerlak, A., Schoeman, Y., Hart, A., Booth, G. (In review). Embedding social inclusiveness and appropriateness in engineering assessment of green infrastructure to enhance urban resilience. Submitted to *Urban Water Journal*.

- Zuniga-Teran, A.A., Staddon C., De Vito, L. Gerlak, A.K., Ward, S., Schoeman, Y., Hart, A., Booth, G. (In review). Challenges for mainstreaming green infrastructure in built environment professions. Submitted to *Journal of Environmental Planning and Management*.
- Zuniga-Teran, A.A.; Gimblett, R.H.; Orr, B.J.; Marsh, S.E.; Guertin, D.P.; Chalfoun, N.V.; (In review). Exploring wellbeing synergies between walkable neighborhoods and the enhanced use of greenspace. Submitted to *Landscape and Urban Planning*.

## Conferences

- World Water Forum in Brasilia. March 2018.
- Resilience and Complexity Workshop. University of Arizona. Tucson, AZ. November 6-8, 2017.
- Participation of PhD student Micaella Moura in WRRC Annual Conference-The Business of Water, Tucson 2018.
- Participation of Micaella Moura and Suzana Montenegro in 1<sup>st</sup> International Conference on Water Security, 17-20 June 2018.

## 12. Work Plan for Next Year with Associated Costs (cash-flow projection)

See financial report.



## ANEX 1 –TASK 1 WORK

*Research made by Nicolas Pineda about river basin councils in Mexico*

### **La política pública de los consejos de cuenca en México**

Para este trabajo, la política pública es la voluntad de los órganos de gobierno, principalmente del ejecutivo y del legislativo, manifestada principalmente, pero no de manera exclusiva, a través de las leyes y disposiciones legales, de establecer una pauta de acción o alguna manera de atender algún asunto o problema. En los países con derecho positivo, como México, la legislación constituye la columna de la política pública. De este modo, la política pública sobre los consejos de cuenca se define principalmente en las siguientes leyes y reglamento:

- Ley de Aguas Nacionales (LAN), expedida en 1992 (SARH, 1992);
- Reglamento de la Ley de Aguas Nacionales (RLAN) expedido en 1994 (SARH, 1994);
- La Ley de Aguas Nacionales reformada en 2004 (SEMARNAT, 2004).

Revisaremos entonces las disposiciones legales sobre los consejos de cuenca.

### **Ley de Aguas Nacionales de 1992**

La LAN de 1992 fue la ley que creó los consejos de cuenca y los definió como: Instancias de coordinación y concertación entre la Comisión [Nacional del Agua], las dependencias y entidades de las instancias federal, estatal o municipal y los representantes de los usuarios de la respectiva cuenca hidrológica, con objeto de formular y ejecutar programas y acciones para la mejor administración de las aguas, el desarrollo de la infraestructura hidráulica y de los servicios respectivos y la preservación de los recursos de la cuenca (LAN 1994, art. 13)

La definición de los consejos de cuenca denota una intención descentralizadora hacia instancias locales, principalmente hacia la participación de los gobiernos estatales y municipales en la gestión del agua; convirtiendo la que era una administración vertical y jerárquica en una red transversal de gobernanza. Asimismo, el objeto de “formular y ejecutar programas y acciones para la administración de las aguas ...” sugiere que estos consejos serían los encargados de la gestión del agua a nivel local.

Sin embargo, la ley disponía además que los consejos de cuenca fueran establecidos por decisión o acuerdo del Consejo Técnico de la Conagua (Art. 13, segundo párrafo). Esto significa que los consejos de cuenca no se conciben como una iniciativa de los actores locales, de abajo hacia arriba, sino que es la decisión cupular de un órgano colegiado nacional vinculado a la Conagua para que sea ejecutada por los actores locales. Por otra parte, la LAN también dispone que la Comisión Nacional del Agua promovería y apoyaría la organización de los usuarios e impulsaría la participación de éstos a nivel estatal, regional o de cuenca (LAN art. 14). Esto significa que los consejos de cuenca y la organización de los usuarios son instancias diferentes. La organización de los usuarios se hace por acuerdo de los derechohabientes del agua a nivel local, mientras que los consejos de cuenca son instancias creadas desde arriba en los que concurren los representantes de los gobiernos federal y estatal con los representantes de los usuarios. Éstas son entonces las principales disposiciones sobre los consejos de cuenca en la LAN de 1992 y con las cuales se comenzó a impulsar la política

de los consejos de cuenca. Como puede verse, los define, dice quién los establece y cómo es su composición general pero no entra en detalles.

### **Reglamento LAN 1994**

Dos años después de promulgada la ley de 1992, en 1994 se expidió el Reglamento de la LAN el cual detalla algunos aspectos de las disposiciones de la ley. En cuanto a la integración, este reglamento dispone que los consejos de cuenca estarán integrados por los siguientes miembros:

1. El Secretario de Agricultura y Recursos Hidráulicos, que posteriormente, cuando desaparece la SARH, recaerá en el Secretario de Medio Ambiente y Recursos Naturales (SEMARNAT), quien lo presidirá;
2. El Director General de la Comisión [Nacional del Agua], quien asumirá las funciones de secretario técnico y suple las ausencias del presidente;
3. Representantes de los titulares de las Secretarías de Hacienda y Crédito Público (SHCP), de Desarrollo Social (SEDESOL), de Energía, Minas e Industria Paraestatal (SEMIP), de Salud y de Pesca; o sea son otros cinco representantes de la Administración Pública Federal.
4. El titular del Poder Ejecutivo de la entidad federativa que corresponda. Cuando la cuenca comprenda más de una entidad, se invitará a los de las entidades comprendidas dentro de la jurisdicción.
5. Hasta seis vocales de los usuarios representantes de los diferentes usos, los cuales son designados por las organizaciones de usuarios y deberán estar debidamente acreditados por la Comisión.

Es relevante observar cómo a partir de la integración de sus miembros se da el control gubernamental de los consejos. Primeramente la presidencia recae en el secretario del sector, es decir la SARH o la SEMARNAT; esto significa que este secretario sería el presidente de los 26 consejos de cuenca que a partir de esta ley se crearán en México. Es de suponer que el secretario no asistirá personalmente a las sesiones de los diferentes consejos en diferentes regiones del país y que tampoco se familiarizará con las diversas situaciones y particularidades de cada uno; sin embargo, es él quien formalmente preside los consejos. Esta disposición sobre la presidencia fue modificada con una reforma en 1997 (SEMARNAP, 1997) que estableció que la presidencia recayera en el Director General de la Comisión Nacional del Agua quien tendría voto de calidad. Asimismo, el secretario técnico sería designado por el Director General de la Comisión, aunque éste no tendría voto. Se observa que, a pesar de que se sustrajo al secretario del sector de la presidencia y se descendió un

nivel en la jerarquía federal, sigue siendo muy centralizador que el presidente de todos los consejos de cuenca del país sea el mismo Director General de la Comisión Nacional del Agua y, aunque más relacionado con el tema que el secretario del sector, sigue siendo difícil que asista a sus sesiones y esté familiarizado con sus diversas situaciones.

El Reglamento señala también que se pueden invitar a otros miembros según se considere conveniente, entre éstos se encuentran los ayuntamientos u organizaciones o representantes de la sociedad que estén interesados en participar. Las reglas de esta participación y de la operación de los consejos son expedidas por la Comisión.

De este modo, un consejo típico estaría formado por siete representantes de altos funcionarios federales, uno o más titulares de los gobiernos estatales (de los cuales no se menciona que sean representantes) y seis representantes de los usuarios. En total sería un mínimo de 14 miembros, de los cuales ocho serían funcionarios gubernamentales y de éstos siete son federales. Hay que señalar que la participación de los gobiernos municipales y sus organismos operadores de agua potable solo pueden participar en el consejo en calidad de usuarios del agua y solo uno como representante del uso público-urbano. Está claro entonces el control y dominio federal de los consejos de cuenca. Esta composición puede variar en caso de que, según lo establece el reglamento, “se invite” a más representantes de la sociedad, pero el control de dicha participación lo tendrá la Comisión Nacional del Agua. En cuanto a las funciones de los consejos de cuenca, el art. 16 del Reglamento menciona actividades que de manera resumida son las siguientes:

- Conocer y difundir los lineamientos generales de la política hidráulica;
- Organizar foros para la participación de las autoridades estatales y municipales, así como de los usuarios y grupos interesados de la sociedad;
- Promover la integración de comisiones de trabajo para plantear soluciones y recomendaciones de asuntos específicos;
- Concertar con la Comisión las prioridades de uso, así como los mecanismos para enfrentar situaciones extremas;
- Apoyar las gestiones para la concurrencia de los recursos técnicos, financieros, materiales y tecnológicos;
- Participar en los estudios financieros que lleve a cabo la Comisión;
- Participar o intervenir en los demás casos previstos en la Ley.

Como puede observarse aquí, ya no aparece tan claramente la facultad para llevar a cabo la gestión del agua de la cuenca o territorio correspondiente. Los verbos empleados enfatizan actividades subordinadas a la Comisión Nacional del Agua, pero no definen en sentido estricto ninguna facultad para que el consejo de cuenca pueda decidir algo por sí mismo. De esta manera a pesar de ser un órgano dominado por funcionarios federales, la ley no le asigna al consejo de cuenca la responsabilidad de la gestión del agua de la cuenca.

## LAN 2004

En 2004 se reformó la Ley de Aguas Nacionales y se modificaron sustancialmente las disposiciones relativas a los consejos de cuenca. Esta nueva ley define a los consejos de cuenca como:

Órganos colegiados de integración mixta, que serán instancia de coordinación y concertación, apoyo, consulta y asesoría, entre la Conagua, incluyendo el Organismo de Cuenca que corresponda, y las dependencias y entidades de las instancias federal, estatal o municipal, y los representantes de los usuarios de agua y de las organizaciones de la sociedad, de la respectiva cuenca hidrológica o región hidrológica (LAN art. 3, fracc. XV) (SEMARNAT, 2004)

La nueva definición hace énfasis en la concurrencia entre los diferentes ámbitos de gobierno y la sociedad civil organizada en el seno de los consejos de cuenca, pero como órgano colegiado de “coordinación, concertación, apoyo, consulta y asesoría”. No se trata por lo tanto de una agencia ejecutiva o un encargado de la gestión. Los consejos no son órganos de gestión, sino más bien cajas de resonancia u órganos consultivos. La autoridad administrativa del agua sigue recayendo en el Ejecutivo Federal quien delega esta función en la Comisión Nacional del Agua. La LAN 2004 en todo caso instruye que se promueva la participación de los usuarios y la descentralización de funciones “dentro del marco legal vigente” (LAN 2004 arts. 4 y 5). Hay que apuntar además, que esta nueva versión de la LAN declara de utilidad pública “la gestión integrada de los recursos hídricos, superficiales y del subsuelo, a partir de las cuencas hidrológicas en el territorio nacional, como prioridad y asunto de seguridad nacional” (art. 7, fracc. 1). Existe una tensión evidente en estas disposiciones que por un lado mantienen íntegra la centralización pero fomentan la descentralización; concentran funciones de gestión pero promueven la coordinación y la participación; declaran de utilidad pública la gestión integrada del agua, que es un enfoque que promueve la gestión local a nivel de cuenca, pero mantienen todo el poder en la instancia federal centralizada. La LAN de 2004 aclara también que los consejos de cuenca no están subordinados a la Comisión Nacional del Agua ni a los organismos de cuenca (art. 13), sin embargo, los preside y ocupa las principales posiciones dentro de él.

La LAN 2004 modifica la estructura interna de la Comisión Nacional del Agua y crea los organismos de cuenca, que son ahora los encargados de la gestión integrada de los recursos hídricos a nivel regional. Estas nuevas dependencias dan la apariencia de ser descentralizadas con jurisdicciones regionales relacionadas con las cuencas hidrológicas; sin embargo, la ley les da una autonomía muy acotada y sus jurisdicciones comprenden múltiples cuencas y grandes regiones en varios estados. La definición que se da de los organismos de cuenca es que son: “unidades técnicas, administrativas y jurídicas especializadas, con carácter autónomo que esta Ley les confiere, adscritas directamente al Titular de la Comisión” (art. 12 bis 1). La tensión es clara entre la autonomía y el estar adscritos directamente al titular, dos atributos que se contradicen.

En cuanto a su composición interna, los Consejos de Cuenca se integran por un presidente, un secretario técnico y vocales, con voz y voto, que representen a los tres órdenes de gobierno (federación, estados y municipios), a los usuarios del agua (agrícolas, público-urbanos, industriales, pecuarios, acuícolas y de servicios) y a las organizaciones de la sociedad. Ya no se da mayor preeminencia a los representantes del gobierno federal y se busca un mayor equilibrio entre los tres ámbitos de gobierno y los representantes sociales. Se menciona que los representantes de las entidades federativas son los mismos titulares del gobierno estatal, quienes pueden nombrar representantes. Asimismo, la LAN de 2004 establece que los vocales representantes de la sociedad civil, que pueden ser usuarios del agua o representantes de organizaciones ciudadanas, deben de ser cuando menos el 50%. Es importante señalar, sin embargo, que los representantes de los organismos de agua potable y

saneamiento, aunque generalmente son entidades de los gobiernos municipales, para los propósitos de esta ley son considerados como usuarios sociales. Asimismo, los representantes de los gobiernos estatales y municipales deben de ser cuando más el 35%. De este modo, los representantes del gobierno federal serían solo alrededor del 15%. Sin embargo, el representante de la Conagua fungirá siempre como Secretario Técnico del consejo con voz y voto y la presidencia recaerá, al menos en su etapa inicial, en el Director General de la Conagua.

Figura 2. Integración del Consejo de Cuenca según la LAN 2004

Sector	Vocales	Representación y proporción
Gobierno	Gobierno federal	SEMARNAT, SHCP, SEDESOL, ENERGÍA, ECONOMÍA, SALUD, SAGARPA (7 entidades). Aproximadamente 15%.
	Gobiernos estatales y municipales	No más de 35%.
Sociedad	Usuarios y organizaciones ciudadanas	Incluye a los organismos operadores de agua potable y saneamiento. Al menos el 50%.

Fuente: LAN 2004 con modificaciones.

Por lo que respecta a las funciones o tareas encomendadas a los consejos de cuenca, éstas aumentan en número y temas pero todas se mantienen en el espacio ya mencionado de la “coordinación, concertación, apoyo, consulta y asesoría”; los verbos predominantes entre las funciones asignadas son: contribuir, participar, promover, coayudar, colaborar, impulsar, auxiliar y apoyar. En cambio no incluye verbos como gestionar, decidir, asignar, sancionar o planear. Por lo tanto, en este rubro no hay avance en las facultades de los consejos ni se les empodera para que realicen funciones de gestión o administración del agua de sus cuencas. La integración de los consejos, dirigida y controlada por la Comisión Nacional del Agua, así como las funciones subordinadas y complementarias que se le asignan contrastan con las recomendaciones de la LAN 2004 en los artículos 14 y 14 bis del capítulo siguiente titulado “Organización y participación de los usuarios y de la sociedad” en donde, en pocas palabras, se exhorta a la Comisión a promover y facilitar la participación de la sociedad en la planeación, toma de decisiones, ejecución, evaluación y vigilancia de la política nacional hídrica” (art. 13 bis). O sea que aquí sí se refiere directamente a la participación de los usuarios en la gestión del agua, pero solo a nivel de exhortación, sin dar ningún instrumento ni responsabilidad concreta a los usuarios.

En cuanto a los cambios y nuevos énfasis que esta ley hace en la integración de los consejos de cuenca con respecto al reglamento de 1994, el transitorio segundo de la LAN de 2004 señala que: “En tanto se expiden los reglamentos derivados de la presente Ley, quedan vigentes las disposiciones del Reglamento de la Ley de Aguas Nacionales, en todo lo que no contravenga lo dispuesto en el presente Decreto y la Ley que contiene”. O sea que esta ley actualiza y prevalece sobre los contenidos del reglamento anterior sin derogarlos, sino que más bien los complementa.

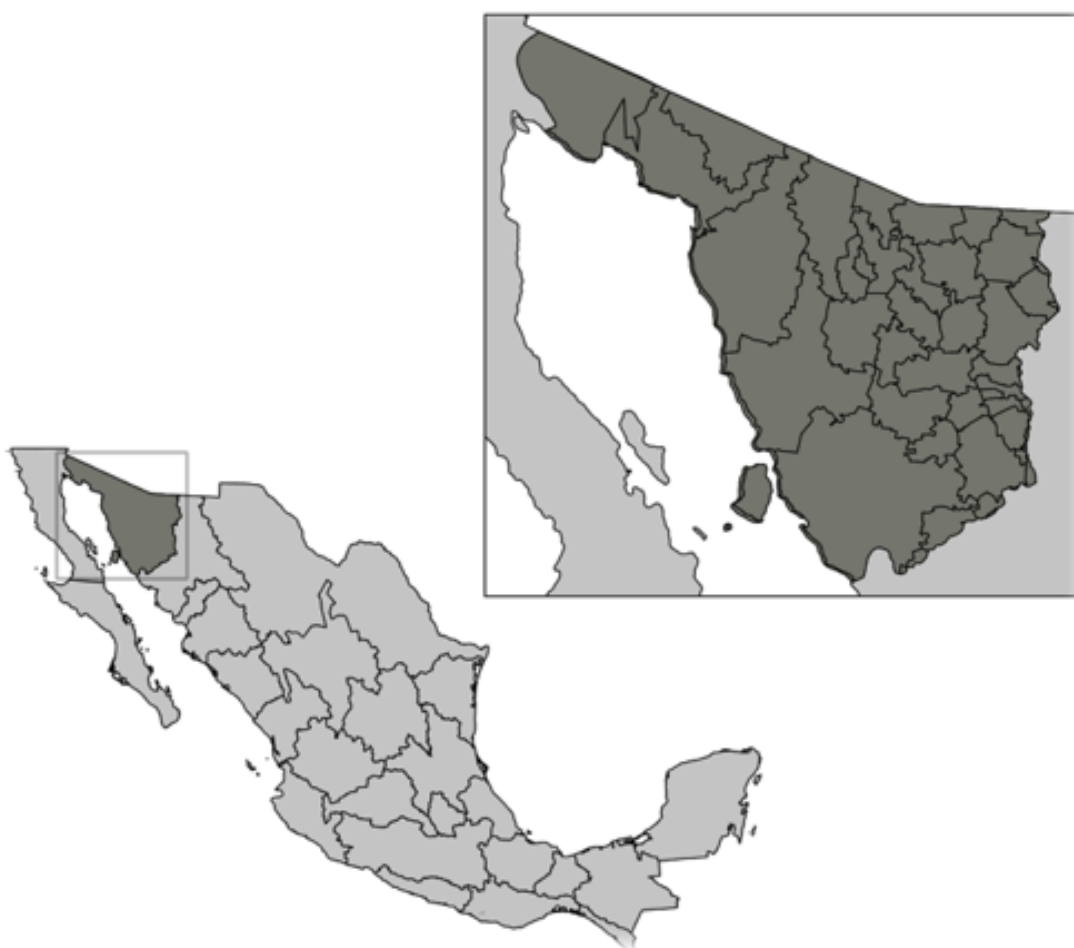
### **El caso del Consejo de Cuenca del Alto Noroeste**

El Consejo de Cuenca del Alto Noroeste (CCAN) fue constituido el 13 de marzo de 1999 en la ciudad de Hermosillo, Sonora, en una reunión de alto nivel a la que asistieron el director general de la Comisión Nacional del Agua y el gobernador de Sonora y varios presidentes municipales y a la que asistió como invitado especial el gobernador de Chihuahua. El punto dos del acta constitutiva señala que este consejo está integrado por: un presidente que es el Director General de la Comisión Nacional del Agua, el titular del poder ejecutivo del Estado

de Sonora, un vocal representante de los usuarios del uso agrícola, un vocal del uso público urbano, un vocal del uso industrial, un vocal del uso pecuario y el secretario técnico que es el Gerente Regional Noroeste de la Comisión Nacional del Agua. Se trata en total de siete miembros, de los cuales dos son del gobierno federal, uno del estatal y los restantes cuatro son del sector de los usuarios. Todos ellos asistieron a esta reunión y firmaron el acta (Comisión Nacional del Agua, 1999). Es importante señalar que en el acta constitutiva no aparecen los representantes de otras dependencias federales, ni de otros sectores de la sociedad civil. Esta integración muestra diferencias relevantes con lo previsto en el marco legal.

En cuanto al área territorial del CCAN, el acta constitutiva, en su anexo dos, señala que la jurisdicción del consejo comprende un área estimada en 100,887 km<sup>2</sup> ubicada en 40 municipios de la esquina noroeste del estado de Sonora. A pesar de que el marco legal señala que la jurisdicción de los consejos será con base en cuencas, el acta constitutiva del CCAN no las menciona, y establece la jurisdicción territorial basada en la división política de los municipios (Comisión Nacional del Agua, 1999). Es importante señalar que el área geográfica del CCAN comprende tres cuencas de los ríos Sonoyta, Concepción y Sonora. Se trata de un área desértica en la que los primeros dos ríos son corrientes efímeras que solo corren en la temporada de lluvias (que son pocas) y permanecen secos la mayor parte del año (Dunbier, 1968, pág. 74). En cambio, el río Sonora nace en la sierra, recoge más agua y es un poco más constante y con más corriente que los anteriores. Se trata entonces de un área muy extensa donde el agua es un recurso escaso y con una problemática variada.

Figura 3. Territorio y división municipal de la jurisdicción del CCAN.



Fuente: Elaborado por Alejandro Navarro con base en datos de Conagua.

Después de la creación del CCAN y en un proceso descendente de arriba hacia abajo, se establecieron varios organismos auxiliares para la participación social en las cuencas, subcuencas y acuíferos comprendidos dentro de la extensa área territorial de este consejo. Así en el acta del 19 de septiembre de 2003, se acuerda “la integración de los Comités Municipales de Playas Limpias de Puerto Peñasco y Bahía de Kino, como Organismos Auxiliares”. Posteriormente, en el acta del 10 de noviembre de 2006, “se reconoce como órganos auxiliares a la Comisión de Cuenca del Río Concepción, a la Comisión de Cuenca del Río Sonora, así como a los Comités Técnicos de Aguas Subterráneas de los Acuíferos El Zanjón, Río San Miguel y Mesa del Seri-Victoria” (Conagua-OCNO, 2017).

### **Las minutas de las reuniones de trabajo**

Este trabajo está basado principalmente en la revisión y estudio de las actas levantadas de las sesiones del Consejo de Cuenca del Alto Noroeste. Éstas son documentos electrónicos que fueron proporcionados por la Conagua.

Con ligeras variaciones, las actas constan de los siguientes elementos: 1) una portada o encabezado que identifica el documento, por ejemplo “Minuta de la décima primera reunión de trabajo del Grupo de Seguimiento y Evaluación del Consejo de Cuenca del Alto Noroeste; 2) lugar y fecha en donde se menciona la ciudad que generalmente es Hermosillo, Sonora, la fecha con día, mes y año, así como el lugar en donde lleva a cabo el evento que generalmente es un hotel. Después vienen las partes con números romanos que son: I. Antecedentes, II. Intervenciones, en donde se mencionan los nombres de los asistentes y sus cargos, III. El motivo de la reunión, IV. El orden del día con los puntos o temas que se abordaron y quienes los exponen, V. El desarrollo de la reunión que consiste en una breve relatoría de las participaciones, VI. Acuerdos y cierre del acta. Al final aparecen las firmas de los principales participantes en la reunión.

Se consiguieron, en diferentes entregas y fuentes, todas las actas de las reuniones del CCAN desde su instalación el 19 de marzo de 1999 hasta la del 23 de noviembre de 2017 con la cual se cerró el período de estudio de este trabajo. Las actas se revisaron y se ordenaron a fin de evitar duplicados o detectar faltantes. Se trabajó un total de 73 actas o minutas.

De acuerdo con su propia identificación, de los 73 documentos estudiados, 61 minutas corresponden a reuniones ordinarias del grupo de seguimiento y evaluación (GSE). Los doce restantes corresponden a los siguientes tipos: la primera es el acta constitutiva, hay 1 reunión extraordinaria, 2 son de asambleas de usuarios, 6 son reuniones de la comisión de operación y vigilancia (COVI) y 2 son denominadas simplemente como “sesiones del consejo”. Al indagar sobre las diferencias entre los tres últimos tipos de sesiones, se nos aclaró que el GSE corresponde a la etapa en que el consejo era presidido por el Director General o el Gerente del organismo de cuenca de la Conagua, el cual cambió de nombre a COVI cuando en las últimas sesiones la presidencia pasó a manos de un usuario. La sesión extraordinaria tuvo como motivo el recibir “comentarios y observaciones sobre la versión preliminar del Programa Nacional Hidráulico y la propuesta de inversiones 2002 para el Noroeste”. Por su parte, las asambleas de usuarios son las reuniones en las que se eligen o aprueban a nuevos representantes de los diferentes sectores de usuarios. La siguiente información y estadísticas están derivadas del estudio de las actas.

### **Número de sesiones y asistencia a las reuniones del consejo**

A partir de su instalación en marzo de 1999 y hasta diciembre de 2017, cuando concluye el período estudiado para este trabajo, el CCAN tuvo un total de 73 sesiones formales en un total de 19 años. Esto significa un promedio de 3.84 veces por año. El año en que más reuniones se sostuvieron fue el 2000 con nueve reuniones. Los años con menos reuniones fueron el 2003, el 2009 y el 2010 en las que hubo dos reuniones en cada año.



En general, si se observa la gráfica de las reuniones por año, se aprecia una tendencia a la baja en el número de reuniones anuales hasta el año 2014 y un ligero repunte en los años 2015 y 2016.

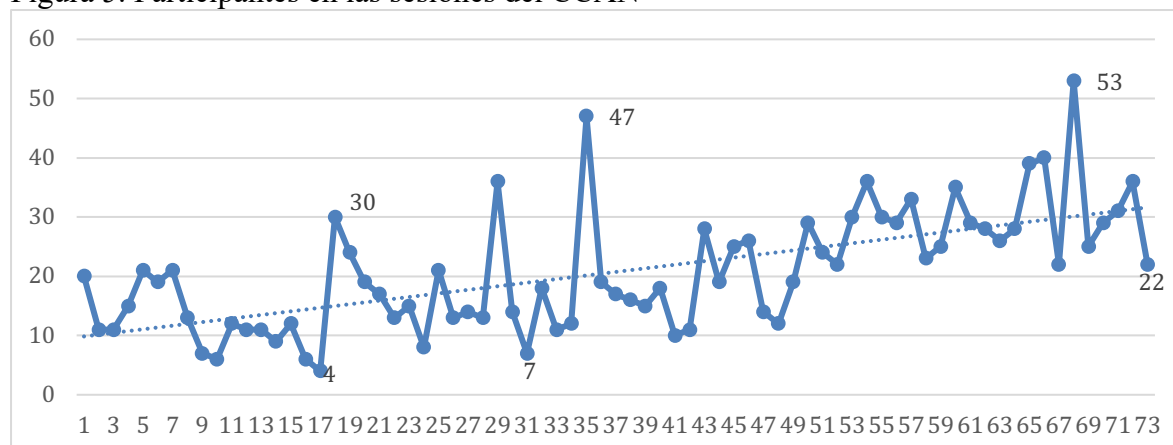
Figura 4. Número de reuniones por año



Fuente: Elaboración propia con base en las actas del CCAN

En lo que se refiere a la asistencia, o más exactamente a los participantes registrados en las actas, se tiene que en las 73 reuniones realizadas, el promedio de asistentes fue de 20.7. La reunión en la que hubo más participación fue la número 68 (28 de septiembre de 2016) en la que hubo 53 participantes. Después de esa, le sigue la número 35 (22 de noviembre de 2006) en la que, según la minuta, hubo 47 asistentes. En cambio la sesión con menor participación fue la número 17 (20 de marzo de 2002) en la que sólo hubo 4 asistentes. En general, se aprecia una tendencia a la alza en la asistencia a las sesiones del CCAN.

Figura 5. Participantes en las sesiones del CCAN



Fuente: Elaboración propia con base en las actas del CCAN

Por otra parte, si analizamos las instituciones que han participado por medio de representantes, se observa que la única que asistió a las 73 sesiones es la Comisión Nacional del Agua, que es la institución organizadora y cuyo representante ha presidido las reuniones. Después, la siguiente institución con mayor número de asistencias es la Comisión Estatal del Agua (CEA) o su antecesora la Comisión de Agua Potable y Alcantarillado del Estado de Sonora (Coapaes), que conjuntamente tuvieron un total de 53 asistencias, es decir asistieron al 73% de las reuniones. Le sigue de cerca la representación de los usuarios cuya asistencia fue a 50 reuniones, es decir el 66%. Otras instituciones que asisten con cierta regularidad son: los comités técnicos de aguas subterráneas (COTAS) 51%, la Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) 38%, la Secretaría de Agricultura, Ganadería, Pesca y Alimentación (SAGARPA) 37%, la Secretaría de Desarrollo Social, la Universidad de Sonora y la Comisión Nacional Forestal (CONAFOR) 29% cada una, los comités locales de usuarios con 26%, la Procuraduría Federal de Protección al Ambiente (PROFEPA) 21% y los

usuarios de comités locales 19%. Hay otros organismos o representaciones que han asistido esporádicamente (menos de 14 sesiones del total de 73) entre los que destacan: organizaciones de la sociedad civil, la Comisión de Ecología y Desarrollo Sustentable del Estado de Sonora (CEDES). Además, está una larga lista de diversos tipos de organismos e instituciones que han asistido en algunas ocasiones, entre estos se encuentran: instituciones académicas como la Universidad Estatal de Sonora y El Colegio de Sonora y otras; presidentes municipales como el de Caborca, Nogales y Altar; organismos operadores de agua de diferentes municipios de región geográfica del consejo, y muchas otras dependencias de diferentes niveles de gobierno y organizaciones de la sociedad civil que solo han asistido a menos de diez reuniones en los 19 años del período de estudio.

Figura 6. Entidades que asisten a las sesiones del CCAN

Entidad	Asistencias	%
Comisión Nacional del Agua (CONAGUA)	73	100%
Comisión Estatal del Agua (CEA, antes COAPAPES)	53	73%
Vocales Representantes de Usuarios	50	68%
Comités Técnicos de Aguas Subterráneas (COTAS)	37	51%
Sría. Medio Ambiente y Recursos Naturales (SEMARNAT)	28	38%
Sría. Agricultura, Ganadería, Des. Rural, Pesca y Alimentación (SAGARPA)	27	37%
Secretaría de Desarrollo Social (SEDESOL)	21	29%
Universidad de Sonora	21	29%
Comisión del Río Concepción	21	29%
Comisión Nacional Forestal en Sonora (CONAFOR)	21	29%
Procuraduría Federal de Protección al Ambiente (PROFEPA)	15	21%
Usuarios de los Comités Locales	14	19%
Comisión de Ecología y Desarrollo Sustentable (CEDES)	12	16%

Fuente: Elaboración propia con base en las actas del CCAN

Como puede observarse la asistencia de los representantes diferentes de la Conagua es bastante irregular y variable. La más asidua es la representación del Gobierno del Estado por medio de las dos comisiones de agua que han existido en el período. Es de observar asimismo que los vocales gubernamentales federales, como la SAGARPA y las secretarías de energía, economía y salud, que ocupan un lugar preeminente en el diseño legal de los consejos de cuenca, tienen poca presencia en las reuniones.

Otro punto relevante a observar es quién preside las sesiones del CCAN. Como ya se mencionó, la primera sesión de instalación del CCAN fue presidida por el Director General de la Conagua, que es quien la LAN prevé como presidente de los consejos de cuenca. Sin embargo, después de la primera sesión de instalación, el Director General no ha vuelto a asistir a ninguna otra sesión. Todas las demás sesiones han sido presididas por personal de la Conagua. Las actas muestran que las sesiones son organizadas y presididas indistintamente por alguno de tres funcionarios de la Conagua que son:

- Gerente Regional o Director General del Organismo de Cuenca del Noroeste,

- Subgerente Regional de Programas Rurales y Participación Social o Coordinador de Atención a Emergencias y Consejos de Cuenca, y
- Jefe de Proyectos de Consejos de Cuenca.

Aunque el Gerente Regional es el suplente formal para presidir el Consejo de Cuenca, en aproximadamente la tercera parte de las sesiones no asistió y fue representado por el subgerente o por los otros funcionarios en la presidencia y coordinación de la sesión por un subgerente o por otros funcionarios de la Conagua. Incluso la sesión del 13 de agosto de 2005 contiene un acuerdo que dice: “solicitar al gerente regional que asista a las sesiones”. Está claro entonces el predominio y dependencia que el consejo de cuenca tiene con respecto a la Conagua y la poca participación de las otras dependencias federales. Es de observar, además, que las partes más interesadas y con asistencia más frecuente, aunque con pocas facultades legales, son los representantes del gobierno estatal y de los diferentes sectores de usuarios.

### El financiamiento del consejo

En lo que respecta al financiamiento del CCAN, desde el año 2008, la Conagua y la CEA firman anualmente un convenio con el objeto de “conjuntar y promover acciones y recursos para incidir en la gestión integrada de los recursos hídricos en el ámbito del Consejo de Cuenca del Alto Noroeste, mediante el fortalecimiento de su gerencia operativa” (CEA, 2013). La cantidad aportada por estas dependencias ha variado a lo largo de los años; en el año 2008 sumó en total 1,300,000 pesos que es el monto más elevado que ha recibido. En el resto de los años, la cantidad ha variado entre un millón y 1,260,000 pesos. Sin embargo, en año 2017, el monto total aportado descendió a solo 670,000 pesos. Como se puede apreciar, la tendencia de las aportaciones es hacia la baja (Conagua-CEA, 2008-2017).

Figura 7. Financiamiento de la Conagua y la CEA al Consejo de Cuenca del Alto Noroeste

Año	Aportación Conagua	Aportación CEA	Presupuesto CCAN
2008	650,000	650,000	1,300,000
2009	500,000	650,000	1,150,000
2010	500,000	650,000	1,150,000
2011	600,000	600,000	1,200,000
2012	400,000	600,000	1,000,000
2013	530,000	600,000	1,130,000
2014	600,000	600,000	1,200,000
2015	630,000	630,000	1,260,000
2016	500,000	500,000	1,000,000
2017	335,000	335,000	670,000

Fuente: elaboración propia con datos extraídos de los Convenios entre Conagua y CEA, 2008-2017.

Por medio de estos convenios se asignan fondos financieros al CCAN a fin de que sufrague tanto su gasto corriente como la realización de estudios. Así, por ejemplo, el convenio firmado el 31 de enero de 2014 le asigna un total de \$1,200,000 pesos, de los cuales 600 mil son aportados por la Conagua provenientes del Ramo 16 del Presupuesto Federal y otros 600 mil son aportados por la CEA provenientes de recursos propios. De acuerdo al anexo técnico

de dicho convenio, la aportación de la Conagua se destina a rubros de gasto corriente como: 300 mil pesos para honorarios, 92 mil para pago de arrendamiento, 60 mil para servicios de capacitación, y 44 mil para servicios de traslados y viáticos, además de otros gastos menores en combustibles, equipamiento y mobiliario, acceso a Internet, y otros servicios básicos. Por su parte, los 600 mil pesos que aporta la CEA son destinados a “estudios y proyectos, así como a actividades operativas que autorizadas en el seno del Comité Técnico de Seguimiento y Evaluación”.

Con base en estos convenios, en 2014 se encargó un estudio titulado “Identificación de diques y repesos de uso industrial, pecuario y agrícola, para efectos de su uso sustentables e impacto ambiental en el Río Sonora”. Asimismo, en 2015, se realizó otro estudio denominado “Evaluación de la calidad toxicológica del agua suministrada a la ciudad de Hermosillo”. En 2016, se encargó el estudio “Proyecto Ejecutivo para la construcción de obras de infiltración para la recarga artificial del acuífero Mesa del Seri-La Victoria”. La gerente informa asimismo que el CCAN no ha contado con fondos provenientes de otras fuentes ni se ha cobrado ningún tipo de cuotas a los usuarios (Mercadante, 2017).

Como se puede observar, el CCAN es enteramente dependiente de la Conagua y de la CEA para su sostenimiento y los montos recibidos pueden considerarse precarios y escasos para lograr el objetivo del Consejo que según el acta constitutiva es: “Formular y ejecutar programas y acciones para la mejor administración de las aguas nacionales, el desarrollo de la infraestructura hidráulica y de los servicios respectivos y la preservación de los recursos de la cuenca” (Acta Constitutiva de 1999).

### **Fortalecimiento institucional del CCAN**

Desde su instalación en 1999, el CCAN ha ido evolucionando y agregando algunos nuevos elementos orientados a fortalecerlo como organización y a aumentar su capacidad institucional. Entre las acciones de este tipo está primeramente la de contar con gerente, es decir con un empleado permanente encargado llevar sus asuntos, así como de contar con un local u oficina que sea la sede del CCAN. De este modo, el grupo de seguimiento y evaluación del CCAN acordó el 3 de octubre de 2007 la instalación de la gerencia operativa y es a partir de ese año que el gobierno del Estado se comprometió a aportar recursos para su operación.

Otra acción de fortalecimiento fue la aprobación de un reglamento interior. Después de revisar el modelo de reglamento proporcionado por la Conagua en 2010 y de lanzar en 2012 una convocatoria para hacer comentarios y modificaciones a la propuesta de documento, el 7 de marzo de 2013, el CCAN aprobó sus propias *Reglas de Operación y Funcionamiento*. De este modo, el CCAN formalizó su organización y procedimientos internos y cuenta con un reglamento interno.

De este modo, el CCAN desde 2008, cuenta con un gerente, con los fondos aportados por la Conagua renta un local que le sirve de oficina para atender sus asuntos, y desde 2013 cuenta con un reglamento propio.

### **Acuerdos y agenda de trabajo**

Por último, una tarea central de este artículo es la revisión de los acuerdos plasmados en las actas de las sesiones del CCAN. Ahí se puede observar el tipo de asuntos que se tratan y dar seguimiento a algunos asuntos abordados. Un asunto interesante, por ejemplo, es el asunto de creación de un centro de información y consulta sobre el agua (CICA) de las cuencas de los ríos Sonora, Concepción y Sonoyta que se planteó desde la primera sesión de instalación. El proyecto de creación del CICA buscaba contar con un instrumento moderno y eficaz para reunir información sobre el agua en apoyo de los diversos usuarios de las cuencas y acuíferos del Alto Noroeste. Para ello se destinó incluso un local en el edificio de la Unión Ganadera del Estado (Mendivil Corral, 2007). Este asunto se trató en las sesiones desde el año 2000

hasta el 2004; se conformó una comisión y hubo avances menores, pero finalmente no se realizó la conformación de dicho centro y el CCAN no ha contado con dicho servicio de información y consulta.

Otro asunto similar al anterior fue la creación de una página *Web* del CCAN que se trató en las sesiones del 16 de marzo de 2000 y del 6 de julio de 2001. Sin embargo, dicha página *Web* nunca se concretó y cuando menos hasta el año 2017 el CCAN ha carecido de dicho recurso.

Por otra parte, al amparo del CCAN y de los recursos que aportan la Conagua y la CEA se han realizado estudios de los acuíferos, el monitoreo de la calidad del agua en Puerto Peñasco, el manejo sostenible del agua en la Costa de Hermosillo y la adecuación de los Derechos de Agua (Salmón, 2006). Sin embargo, éstas son acciones que se pueden atribuir más propiamente a la Conagua que el CCAN como tal.

Otro ejemplo del papel que juega el CCAN en la gestión del agua de sus cuencas es el bajo perfil de su participación en la respuesta y atención a la contingencia del derrame tóxico en el río Sonora el 6 de agosto de 2014 (Gobierno de la República, 2015), que ha sido considerado el más grave desastre ecológico de Sonora (Greenpeace, 2014). La siguiente reunión del CCAN se llevó a cabo hasta el 17 de diciembre de 2014 y ahí, entre varios otros, se asientan los siguientes acuerdos (Conagua-OCNO, 2017):

- El GSE se da por enterado del informe realizado por el Ing. Julio López Hernández [de Conagua], sobre los principales hechos y acciones realizadas por la CONAGUA y otras dependencias, en atención de la contingencia presentada en el río Sonora por derrame de sustancias tóxicas, provenientes de la Mina Buenavista del Cobre en Cananea, Sonora.
- Se refrenda el acuerdo de la 51 reunión de GSE del CCAN, que se refiere a integrar el proyecto de restauración hidrológica para la cuenca del río Sonora dentro del programa de gestión del CCAN
- Se buscará concretar una reunión entre el CCAN con los diputados que conforman la comisión para la contingencia del río Sonora y la comisión Sonora para la contingencia ambiental río Sonora, para que éstas rindan un informe sobre la planeación de la remediación total de la contingencia.

Cómo puede verse, el CCAN no participa directamente en la atención a la contingencia, sino que es solamente una especie de caja de resonancia o ente validador de las acciones de la Conagua. En esta contingencia, todos los presidentes municipales y usuarios de agua del río Sonora se organizaron y realizaron multitud de reuniones y gestiones, pero no lo hicieron a través del CCAN.

En un ejercicio de clasificación de los acuerdos registrados en las actas de sesión hasta el año 2015 se obtuvo que de un total de 240 acuerdos tomados, solo 30 (el 12.5%) se relacionan

directamente con la gestión del agua, mientras que los 210 (87.5%) acuerdos restantes se refieren más bien a asuntos administrativos y de organización interna.

La revisión de los acuerdos apunta entonces a que las sesiones del CCAN se han dedicado a atender asuntos administrativos y muy poco a la gestión del agua de la cuenca; además, tampoco se ocupa de conflictos como la escasez de agua en Hermosillo, el racionamiento o tandeo del servicio de agua potable o la contaminación del río Sonora.

Esta conclusión es similar a la planteada por Sánchez Meza (2008) respecto a ineficacia y falta de operatividad del consejo de cuenca del río Sonora para atender los graves problemas abordados en las sesiones de trabajo del Grupo de Seguimiento y Evaluación, y a la expuesta por Parra y Salazar (2017) en relación a la capacidad limitada del CCAN para desenvolverse conforme a los principios de la GIRH.

### **Reflexión final**

Retomando los componentes del concepto de capacidad institucional que propusimos en los primeros apartados de este trabajo podemos revisar los diferentes elementos de la capacidad institucional del Consejo de Cuenca del Alto Noroeste (CCAN).

Primeramente, en cuanto a la autoridad legal, los consejos de cuenca no son autónomos sino órganos dependientes de la Conagua. Su falta de autonomía se aprecia en su misma composición formal ya que, al menos en su período inicial, el Director General de la Conagua fungió formalmente como su presidente; asimismo el secretario técnico es el director del organismo de cuenca correspondiente. Entonces al menos en su período inicial, el consejo de cuenca no estuvo presididos por usuarios, sino por funcionarios de gobierno. Asimismo, las facultades de los consejos de cuenca, definidas tanto en la LAN (art. 13 bis 3) (SEMARNAT, 2004) y en el Reglamento de la LAN (SEMARNAT, 2014) (en su artículo 13), no asignan facultades o autoridad directa para la gestión, administración o planeación de la cuenca. Por los verbos que se utilizan (contribuir, concertar, conocer, promover) estas facultades son más bien de apoyo a la Conagua y no asignan responsabilidad ejecutiva sobre la cuenca. Por ello, los consejos de cuenca son a lo sumo órganos consultivos orientados a convalidar o a ser caja de resonancia de la agenda de la Conagua. Por ello, resulta engañoso equiparar a los consejos de cuenca de México con los consejos u organizaciones de cuenca de otros países que son responsables de la planeación y gestión del agua de sus cuencas (Cap-Net - UNDP, 2008) (Huitema & Meijerink, 2014).

Otra observación es que el liderazgo del consejo de cuenca reside en la Conagua y su composición es fuertemente gubernamental ya que formalmente tiende a prevalecer la representación de las dependencias federales y la coordinación con el gobierno estatal, más que los asuntos de los usuarios relacionados con los derechos de agua.

En lo que se refiere a la representación, participación y asistencia de los usuarios del agua, las minutas y los acuerdos indican que los usuarios tienen deseos de participar, plantear propuestas y realizar acciones relacionadas con la gestión de la cuenca. Sin embargo, al no tener los consejos autoridad ejecutiva para decidir estos asuntos, se pierden incentivos para participar de manera más efectiva.

En lo referente a las finanzas y sostenimiento económico, el CCAN depende de las aportaciones que le hacen conjuntamente la Conagua y el gobierno del Estado y a lo largo de los años sus aportaciones han tendido a disminuir. En este sentido, el CCAN tiende a ser entonces una dependencia gubernamental.

Por último, la revisión de las actas de las sesiones mostró que la participación de los usuarios es reducida y que en las agendas y temáticas abordadas tienden a prevalecer los asuntos que no están directamente relacionados con la gestión del agua de la cuenca, sino con la información y la aprobación de asuntos más amplios propuestos por la Conagua.

En resumen, la creación y existencia del Consejo de Cuenca del Alto Noroeste constituye ciertamente un avance con respecto a la nula participación de los usuarios y de los gobiernos locales que existía anteriormente en la gestión del agua, pero esta participación está todavía distante de lo que puede considerarse como la participación efectiva de los usuarios en la planeación y gestión del agua de la cuenca. El vaso de la participación social en la gestión del agua puede verse medio lleno o medio vacío; medio lleno en el sentido de que representa un avance, pero no es suficiente; y medio vacío en el sentido de que muestra todas las deficiencias de las políticas verticales (de arriba hacia abajo), de la centralización de la Conagua, mucha rigidez y acartonamiento en las formas y sus procedimientos están todavía alejados de despertar la energía, la innovación y el capital social que significa la participación social de abajo hacia arriba. En pocas palabras, los consejos de cuenca en México en general, y el Consejo de Cuenca del Alto Noroeste en particular, carecen de capacidad institucional para la gestión del agua de sus cuencas y más bien son órganos complementarios de la Comisión Nacional del Agua que es la dependencia federal que efectivamente está encargada de la gestión de las cuencas y mantiene el centralismo de la política hídrica en México.