



THE WATER INSTITUTE  
OF THE GULF™

# Risk Reduction for Water-Based Hazards Latin America & Caribbean

A SUSTAINABLE AND BALANCED WATER  
APPROACH

February 18, 2015

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## Preface

Water is a common element in hazards affecting communities in coastal and deltaic environments emerging from the ocean as storm surges, from the sky as rainfall, or from rivers and streams as floods.

Latin American and Caribbean countries face potentially crippling economic, social, stability and security costs from extreme hazard events, many of which are water-related. These countries need to do more to reduce risks and prepare to respond to likely catastrophes.

While floods account for the greatest number of major events in most Latin American and Caribbean countries, droughts affect the most people and adequate potable water supplies represent a near universal challenge. Therefore, when we refer to water-related hazards, we are concerned not only with floods, hurricanes and storms, but also with water scarcity and access to the food that water generates.

The Latin American and Caribbean region has seen its population grow more vulnerable to natural hazards and the national assets that provide a foundation for economic growth become increasingly exposed to water related threats.

The problems associated with poverty and economic stability are pervasive and are irreversibly aggravated by disasters particularly in impoverished communities of Latin America.

This report followed a consensus building and collaborative planning approach designed to address these realities through applied research for the sustainable and balanced use of water for the development of the Latin American and Caribbean people.



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## Technical Assistance Opportunities

### BACKGROUND

Water is a common element in hazards affecting communities in coastal and deltaic environments emerging from the ocean as storm surges, from the sky as rainfall, or from rivers and streams as floods. Preparing for these impacts is an important element of understanding vulnerability and building community resilience. A variety of approaches can be applied at the community level. By bringing knowledge, experience, tools and best practices for risk reduction, communities can work collaboratively to build capacity that leads to sustainable communities.

Communities in south Louisiana have experienced the impacts of major storms, hurricanes and floods from the beginning of their existence. In recent years, a series of strong hurricanes, the most prominent being Katrina and Rita in 2005, have caused major destruction of homes, businesses and infrastructure. These experiences have led to ongoing efforts to assess and reduce risk, increase resilience and enhance preparedness through planning, protection measures and education. The success stories and lessons learned can be used to define and advance programs that better equip communities in Latin America to sustain their economies and cultures by reducing risk through preparedness and planning.

The Water Institute of the Gulf proposes collaboration among organizations and coastal communities in Louisiana and Latin America (North-South collaboration) that can develop and stimulate the implementation of planning and management tools that reduce community risk and improve resiliency in the face of recurring water-driven hazards and water supply disruptions.

### WATER RELATED HAZARDS AND TECHNICAL ASSISTANCE THEMES

Latin American and Caribbean countries face potentially crippling economic, social and security costs from extreme hazard events, many of which are water-related and must do more to reduce risks and prepare to respond to likely catastrophes. The problems associated with poverty and economic stability are pervasive and are irreversibly aggravated by disasters particularly in impoverished communities of Latin America. While floods account for the greatest number of major events in the most Latin American countries, droughts and illnesses from poor water quality affect the most people. Therefore, when we refer to water-related hazards, we are concerned with not only floods, hurricanes and storms but also the preservation of the quality and quantity of water and access to the food that water generates.

The Water Institute proposes several areas where their experience and tools can be useful in supporting risk reduction on the face of water-related hazards. Each of these can be tailored for application across the full range of urban and rural risks, recognizing the specific challenges associated with water-related hazards within highly urbanized areas and coastal zones.<sup>1</sup>

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<sup>1</sup> Latin America has highly urbanized areas, poor rural areas, rich agrarian areas, semi-arid regions, tropical forest areas and coastal zones that are all challenged by the interaction of environment and human activities.



## 1. Risk Reduction and Communication

A growing body of evidence<sup>2</sup> and experience shows that there are considerable economic and social gains to be made by adopting a proactive approach to risk reduction. Current governments struggle with communicating risk. Risk communication is not simply a process whereby the population accepts the message from the government, but it should effectively synthesize existing information to raise the level of understanding of all those who are involved. A variety of approaches are available to ensure communities receive adequate information within the limits of available science and can proactively participate in a culture of risk reduction.

## 2. Technology and Decision Making

In predicting water-based threats, uncertainty, risk and potential consequences go hand-in-hand with a high-degree of subjective perception by stakeholders. A number of numerical modeling tools are available to support emergency management and hazard preparedness. Understanding and assessing predictive uncertainty is a prerequisite for reducing risk as well as improving the reliability and robustness of emergency management. Training can be provided with a number of coastal and riverine-flooding tools to help managers identify what best meets the needs of their communities.

## 3. Community Engagement

Communities can best learn by becoming engaged from the very beginning in planning for risk reduction. Engagement can help communities to recognize their own capacities and cultivate their capacities to manage risks. It also empowers communities as owners of solutions, building a culture of prevention at the community level. The Institute has experience with various forms of engagement that can be tailored to local needs.

While many governments have recognized the need to establish risk management entities at the highest levels within their administrations, many countries continue to struggle with the development of an integrated program of hazard mitigation and development policies and practices that mesh with local government efforts and that can go hand in hand with the private sector, NGOs and the academy. The technical assistance opportunities identified here can contribute to such programs.

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<sup>2</sup> Vorhies, Francis (2012). The economics of investing in disaster risk reduction. (<http://www.preventionweb.net/posthfa/documents/dreconomicsworkingpaperfinal.pdf>)



## Developing Collaborations

On July 22, 2014, The Water Institute held a planning meeting with USAID/OFDA/LAC and CATHALAC in Baton Rouge, Louisiana, to identify areas of need in Latin America and the Caribbean. A follow up consensus building meeting was held in conjunction with the *II Latin American Forum on Disaster Risk Reduction (LAC-DRR) in Higher Education* in Bogota, Colombia, from November 24 to November 26, 2014.

### PLANNING MEETING OF USAID/OFDA/LAC AND CATHALAC



Figure 1. From left to right: Andres Calderon, Craig Colten, Gonzalo Pulido, Sidney Velado and Charles "Chip" Groat

This initial Latin American and Caribbean concept development meeting was held at The Water Institute of the Gulf headquarters, and the participants were:

- ◆ Charles "Chip" Groat - The Water Institute
- ◆ Craig Colten - The Water Institute
- ◆ Andres Calderon - Senior Advisor to The Water Institute
- ◆ Sidney Velado - USAID
- ◆ Gonzalo Pulido Silva - CATHALAC

From this original concept development meeting with USAID/OFDA/LAC and CATHALAC, The Water Institute sought to work with Latin American partners to develop an ongoing program of collaboration consisting of three related components:

#### 1. Training

The Water Institute intends to host visiting researchers and practitioners to exchange best practices in hazard assessment and risk reduction, and also to send its staff to work with government agencies and educational institutions to further the two-way conversation.

#### 2. Research

The Water Institute intends to initiate joint research projects that will seek to develop tools to measure and assess the risk of hazards and also solutions to water-related hazards that result in risk reduction.





### 3. Outreach

The Water Institute intends to collaborate with Latin American partners to develop effective programs to communicate with at-risk populations and foster risk reduction and sustainable communities.

#### IDENTIFYING POTENTIAL COLLABORATORS

The Water Institute sought to find a selected group of scientists based on their academic credentials and interest of working together in the realm of responsible water use for the betterment of the LAC communities. We will refer to this core group in this document as the LAC Water Network (LAC-WN).

The Water Institute solicited interest from experts from all countries in the LAC region to participate, as part of the LAC-WN, at the *II Latin American Forum on Disaster Risk Reduction (LAC-DRR) in Higher Education* which was held November 24 to 26, 2014.<sup>3</sup> Among the twenty-one researchers interested in participating at this event, The Water Institute invited four researchers to participate. These four researchers were selected based on their outstanding research credentials, their quality of publications and their interest in the creation of the LAC-WN. The selected researchers are as follow:

Name	Country	Institution
André Munhoz de Argollo Ferrão	Brazil	Universidade Estadual de Campinas / Faculdade de Engenharia Civil Arquitetura e Urbanismo / Departamento de Recursos Hídricos
Mário Jorge Cardoso Coelho Freitas	Brazil	Universidade do Estado de Santa Catarina (UDESC) / Programa de Pós-graduação em Planejamento Territorial e Desenvolvimento Socioambiental
Linda Daniele	Chile	Universidad de Chile / Departamento de Geología
Norka Fuentes Gonzalez	Chile	Universidad de los Lagos en Osorno / Laboratorio de Limnología Departamento de Acuicultura y Recursos Agroalimentarios

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<sup>3</sup> Following sections contain more detail about this event.



**Figure 2. Seated from left to right: André Munhoz de Argollo Ferrão, Norka Fuentes Gonzalez, Linda Daniele, Craig Colten, Mário Jorge Cardoso Coelho Freitas and Andres Calderon**

## THE II LATIN AMERICAN FORUM ON DISASTER RISK REDUCTION (LAC-DRR) IN HIGHER EDUCATION

The Latin American and Caribbean regions have seen their populations grow more vulnerable to natural disasters. Its national assets (which are the basis for economic growth) become increasingly exposed to water related threats<sup>4</sup>, and their people face inadequate supply of potable water. The *II Latin American<sup>5</sup> Forum on Disaster Risk Reduction (LAC-DRR) in Higher Education<sup>6</sup>* was held November 24 to 26, 2014.

During the LAC-DRR, The Water Institute of the Gulf presented its capabilities and held the first meeting of a selected group of scientists interested in working together in the realm of responsible water use for the betterment of the LAC communities.

### The LAC-DRR Event

The Red Universitaria de América Latina y el Caribe para la Reducción de Riesgo de Desastres (REDULAC/RRD)<sup>7</sup> invited universities and government representatives to participate in the conference titled “Promoting Communities of Knowledge and Practice.” The event was hosted by the School of Military Engineers, member of the REDULAC Colombia Chapter, and was sponsored by USAID Office of Foreign Disaster Assistance for Latin America and the Caribbean (USAID/OFDA/LAC) and the

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<sup>4</sup> UNICEF (2011). No title provided. ([http://www.unicef.org/hac2011/files/HAC2011\\_4pager\\_TACRO.pdf](http://www.unicef.org/hac2011/files/HAC2011_4pager_TACRO.pdf));

Catherine Cameron, Gemma Norrington-Davies and Dr. Victoria te Velde of Ahulhas (2012). Managing Climate Extremes and Disasters in Latin America and the Caribbean: Lessons from the IPCC SREX Report. ([http://www.ifrc.org/docs/IDRL/-\\_To\\_add/ManagingClimateExtremesLatinAmerica.pdf](http://www.ifrc.org/docs/IDRL/-_To_add/ManagingClimateExtremesLatinAmerica.pdf)); UNEP (2008). Hydropolitical Vulnerabilities and Resilience Along International Waters: Latin America and the Caribbean.

([http://www.unep.org/publications/contents/pub\\_details\\_search.asp?ID=4035](http://www.unep.org/publications/contents/pub_details_search.asp?ID=4035)); Association of American Geographers (2011). Climate change and hazards in the Americas. (<http://www.aag.org/galleries/project-programs-files/ClimateChangeHazards2010.pdf>)

<sup>5</sup> While its name only lists Latin American countries as an area of focus, this forum had full representation and participation of the Caribbean Nations such as the presence of CDEMA at the executive and operational level.

<sup>6</sup> Sponsored by the USAID/OFDA/LAC and UNISDR organizations.

<sup>7</sup> The Disaster Risk Reduction Network of Latin American and Caribbean Universities. (<http://www.redulac.net/>)



United Nations Office for Disaster Reduction (UNISDR). The event had a total of 179 attendees and between 14,000 and 18,000 virtual participants.



Figure 3. Panoramic view of the LAC-DRR Event

The Water Institute held a panel presentation during this event to present its capabilities and to invite attendees to participate of a “Conversatorio,” an open forum dialog about the water challenges of Latin America and the Caribbean and to brainstorm potential solutions to challenges and joint strategies that interested participants could pursue.

The “Conversatorio” was held with twelve experts, two representatives from The Water Institute, four LAC-WN participants and other interested parties that joined us for two hours. Additional participants included:

Name	Country	Institution
Carmen Paz Castro Correa	Chile	Universidad de Chile
Marcela Uribe	Colombia	Universidad Tecnológica de Pereira
Chris Renschler	USA	University at Buffalo (SUNY)
Daniel Arriba Saldramod	USA	Universidad Jorge Tadeo Lozano
Silvia Graciela Quiroga	Argentina	Universidad Nacional de Cuyo
Sidney Velado	USA	USAID/OFDA
Alfonso Fuentes	Guatemala	CSUCA

Participants discussed the water challenges, defined a focus, established key principles, reviewed mutual areas of interest and deliberated next steps. The following section contains the details of this experience.



## Latin America and Caribbean-Water Network (LAC-WN)

### FOCUS

In LAC, people are living in societies that daily face insecurity and social, economic and environmental instability; therefore, the focus of research organizations and educational institutions should be the advancement of knowledge, science and technological innovation for the resilient development of their societies.

*The LAC-WN defined its focus to be the applied research for the sustainable and balanced use of water for the more resilient development of the Latin American and Caribbean people.*

The LAC-WN is a cross-disciplinary network of researchers that are focused on the applied scientific research aimed at the sustainable and balanced use of water for the development of a more resilient LAC region. It provides a focal point for the LAC applied research based and creates opportunities for collaborations with government and academic partners in the LAC region and overseas. All members of the LAC-WN are currently involved in a number of high-impact research projects and public engagement activities.

One of the key objectives of the LAC-WN is to develop outreach activities to promote awareness and multicultural understanding of the use of water. The LAC-WN provides a number of activities which use innovative methodologies to engage with students, teachers and the local and international communities to deliver education, training, social and economic impact through increased awareness and understanding of water as a threat to communities and also as a force of life and prosperity.

### PRINCIPLES

The LAC-WN decided to work on a framework of principles that includes:

#### Transparency

Based on equity considerations, transparency is a cornerstone principle to our approach, ranging from our water research to our own internal conduct within the LAC-WN. Our goal is to promote transparency, integrity and accountability in all we do as an organization.

Transparency is also related to the knowledge we produce, allowing all to have access to the research we create so that we can broaden the bases of understanding regarding the sustainable and balanced use of water and the well-being of our communities. This knowledge will be disseminated through peer-reviewed scientific publications.

The LAC-WN will build partnerships and actively engage with other institutions, communities and governments to deliver education, outreach and applied research on a resource that touches every aspect of life of the LAC region.



## Working in Partnership

We believe in working in partnership with other organizations and existing networks. We believe in supporting the full participation of stakeholders, primarily those in the communities where we work, since resilient communities depend on organization and engagement.

The LAC-WN believes that working in partnerships generates a multiplier effect when each partner, acting in concert with others, becomes more influential and effective and the whole becomes greater than the sum of its parts.

## Sustainability

Sustainable development is as much about risk mitigation, education and economic development as it is about water—our source of life. Sustainability in itself is a complex term that requires a balance of priorities, so it is the process about the informed, educated, healthy, equitable and productive use of water resources. It is about wealth and value creation that generates equality and opportunity, encouraging consumption and production patterns that respect environmental limits, mindful of human rights.

## Balance

The economic and regional development challenges of the LAC region need to be balanced with the wealth of our natural resources—water being the most important one. Rapid and unplanned urbanization in LAC continues stress on our water resources and continues to place our economies and populations at risk.

The balance of economic growth, environmental health and social well-being and water use is paramount. Achieving a balance is not a simple task and involves many dimensions that need to be considered for the long term and healthy development of the Latin American and Caribbean people.

## Functional and Systematic Approach

The systems approach to the management of water is based on general system theory—the theory that says that to understand fully the risk/reward balance of water use requires the understanding of its parts and the interdependence of its parts. This holistic and systematic approach to our applied research allows for the evaluation of frameworks that meet the needs of the people we serve and ensures a balanced use of the resource to satisfy their functional needs and protect their communities from water related risks.

## Applied Research

The LAC-WN follows an action-oriented approach where we transfer knowledge to solve practical problems and we aim to improve human conditions. We utilize academic findings in the form of accumulated theories, knowledge, methods and techniques, for research that can lead to the sustainable and balanced use of water for the development of the Latin American and Caribbean people.

Our research, while applied, follows scientific rigor and sound practice commonly using empirical or measurable evidence that is subject to specific principles of reasoning established within the area of practice and research.



## Addressing Research Disparities

The LAC-WN seeks to increase scientific research in LAC by increasing the number of researchers dedicated to the many areas affecting the use of water in the LAC Region. We believe that through cooperation of scientists across the LAC region and internationally, we can obtain a win-win situation where: (1) we can engage in scientific research projects that allow for transfer of knowledge, science and technology, human and physical resources, to foster the development of scientific understanding in the region and (2) reduce risk and resolve the relevant problems of the region through applied research for the sustainable and balanced use of water for the development of the Latin American and Caribbean people.

Hence, our focus is always two pronged: (1) to foster multidisciplinary research in the LAC (currently only 1 percent<sup>8</sup> of all world investment in research and development goes to LAC) and (2) to reduce the highest threat to the LAC economies in terms of disasters<sup>9</sup> and long term survivability as it relates to its most precious resource—water.

The LAC-WN seeks to also enhance research significance by integrating studies of different regions into projects, allowing for interdisciplinary intra-regional collaboration that is designed to leverage the project similarities or to contrast regional or discipline differences to strengthen our understanding of water in the LAC region.

## Good Practices

We seek to observe good practices that foster the participation of a larger number of institutions in order to enlarge our understanding of water as a resource and hazard in LAC while taking into account diversity and plurality of the many scientific areas, cultures, communities and problems we seek to solve.

This means that we have to establish efficient ways to exchange, disseminate and cooperate in research projects, enhancing the circle of participation among those interests in digital resources. One of our central efforts is to make our data, information, emerging practices and protocols easily accessible to interested parties.

## Approach

Our approach seeks to manage complexity as we recognize the many different factors, competing forces and interdisciplinary interactions affecting the risk reduction, sustainable and balanced use of water for the development of the LAC region. Our projects start by understanding the existing fundamentals, seeking to leverage existing values and fostering collaboration among the actors. Studies become more complex due to an increase in geographic scale as well as with an increase in the amount of data, variables or the number of fields that are involved in the design; however, we start with the basics and build complexity when necessary.

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<sup>8</sup> Andreas Oppenheimer (2008). Latin America's Dangerous Decline. George Washington University – Universaria, Vol. 2, Num. 1, ISSN: 1988-7116. ([http://gcg.universia.net/pdfs\\_revistas/articulo\\_79\\_1206609697358.pdf](http://gcg.universia.net/pdfs_revistas/articulo_79_1206609697358.pdf))

<sup>9</sup> In LAC, from 1980-2010, water related disasters: affected over 90 percent of the population, caused over 70 percent of the deaths and destroyed over 80 percent of the assets. Source: "EM-DAT: The OFDA/CRED International Disaster Database, Universit catholique de Louvain, Brussels, Bel." Data version: v11.08.



Our methodology favors the use of holistic frameworks for the definition and measurement of adherence to our goal of achieving a sustainable and balanced use of water for the development of the LAC region. By using an interdisciplinary and holistic framework that takes into consideration all functional dimensions that affect the water systems, the LAC-WN can establish baselines and monitor spatial-temporal progress of significant dimensions, allowing us to make sound decisions and to continuously monitor and reduce risks.

## Next Steps

### SMALL PROJECT

#### Why Central America?

Human and economic losses stemming from disasters have increased over the past century in the Central American region as a consequence of population growth and unplanned urbanization. In addition to the daily costs paid by economies in Central America, due to operations in unstable countries like Honduras, El Salvador and Guatemala, these economies suffer their greatest price when a disaster hits—as losses due to disasters are twenty times greater (as a percentage of Gross Domestic Product) in developing countries than in industrialized countries.<sup>10</sup>

*The LAC-WN seeks to submit a proposal to enhance the collaboration of the Brazilian, Chilean and North American LAC-WN institutions with institutions of Central America*

Due to its geographic location, Central America is one of the most hazard-prone regions of the world particularly exposed to a wide variety of natural hazards including floods, tropical storms and hurricanes, earthquakes, landslides, droughts and wildfires – with frequent recurrence. With its mountainous terrain and complex river basins, landslides, flooding and water-related disasters are very common. Every year the region suffers from literally hundreds of small- and medium-scale events that collectively cause more damage and disruption than the larger events; therefore, risk reduction efforts scaled for frequent, small-scale events, are not able to meet the challenges presented by larger events

In the last thirty years, seventy major disasters and more than ninety smaller scale events were registered by the U.S. Agency for International Development, Office of U.S. Foreign Disaster Assistance (USAID/OFDA).<sup>11</sup>

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<sup>10</sup> Luis Flores Ballesteros, May, 2010, Who's getting the worst of natural disasters?, (<http://54pesos.org/2008/10/04/who's-getting-the-worst-of-natural-disasters/>)

<sup>11</sup> Inter-American Development Bank, May 1999, Reducing Vulnerability to Natural Hazards: Lessons Learned from Hurricane Mitch. A Strategy Paper on Environmental Management ([http://www.iadb.org/regions/re2/consultative\\_group/groups/ecology\\_workshop\\_1.htm](http://www.iadb.org/regions/re2/consultative_group/groups/ecology_workshop_1.htm))



Central America regularly suffers disastrous losses spawned by natural events—Hurricane Mitch (1998) being the greatest disaster in the region in the past 200 years, in which Honduras and Nicaragua were the most severely affected.

### Why the Caribbean?

The Caribbean countries and territories are located from Suriname, just 2° above the equator, to the Bahamas, whose northward extension is roughly 5° north of the Tropic of Cancer, the same latitudinal extent that provides the conditions of warm, moist air and clockwise Coriolis force required for the formation of tropical depressions, storms and hurricanes; and from Belize to the west at 89° longitude to Barbados in the Eastern Caribbean located at 59° W longitude.<sup>12</sup> These same meteorological conditions are also shared by many of the neighboring Gulf of Mexico countries and cause most of the deaths and damages in the Caribbean region.<sup>13</sup>

Flooding – often caused by tropical cyclone activity and often itself provoking landslides – is one of the most common natural hazards in the region and the most widespread hazard occurring within the CDEMA participating states,<sup>14</sup> with approximately 88 percent of countries experiencing flooding events in the five-year period preceding 2001.<sup>15</sup>

Adverse natural events are responsible on average for losses equivalent to more than 2 percent of the Caribbean region's annual gross domestic product (GDP).<sup>16</sup> While this is a long-term average, individual adverse natural events such as hurricanes can result in major losses overnight. In 2004, four hurricanes (i.e., Charley, Frances, Ivan and Jeanne) wreaked havoc on a number of small Caribbean islands and caused combined losses in excess of US \$4 billion.<sup>17</sup> In 2008, Hurricanes Gustav, Hanna and Ike battered the nations of Cuba, the Dominican Republic and Haiti within mere weeks of each other.

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<sup>12</sup> Dr. Barbara Carby, 2011, The University of the West Indies Mid-Term Review of the Caribbean Implementation of the Hyogo Framework for Action (HFA), ([http://www.unisdr.org/files/18197\\_203carby.caribbeanimplementationoft.pdf](http://www.unisdr.org/files/18197_203carby.caribbeanimplementationoft.pdf))

<sup>13</sup> Dr. Barbara Carby (2011). The University of the West Indies Mid-Term Review of the Caribbean Implementation of the Hyogo Framework for Action (HFA). ([http://www.unisdr.org/files/18197\\_203carby.caribbeanimplementationoft.pdf](http://www.unisdr.org/files/18197_203carby.caribbeanimplementationoft.pdf))

<sup>14</sup> Anguilla, Antigua, Bahamas, Barbados, Belize, British Virgin Islands, Dominica, Grenada, Guyana, Jamaica, Haiti, Monsterrat, St Kitts and Nevis, Saint Lucia, St Vincent and the Grenadines, Suriname, Trinidad and Tobago and Turks & Caicos Islands.

<sup>15</sup> Organization of the American States (OAS) (2002). Issues Paper: Climate Change and Disaster Management Prepared by the Caribbean Disaster Emergency Response Agency for ADAPTATION TO CLIMATE CHANGE IN THE CARIBBEAN DISASTER RISK MANAGEMENT BRAINSTORMING WORKSHOP. (<http://www.oas.org/macc/Docs/DisasterIssues.doc>)

<sup>16</sup> The aggregate economic losses incurred by the small island states of the Caribbean Basin as a result of storms during the period 1979 – 2005 is estimated at US \$16.6 billion (in current value), or US \$613 million annually.

<sup>17</sup> World Bank Catastrophic, Risk Insurance Facility, Financing for Relief and Development, International Aid and Trade. publication IAT03-13/3.





## Project Goals

1. To challenge the research divide that exists between institutions in Central America and Caribbean, and those institutions forming the LAC-WN, allowing participants to: become more integrally linked to international research networks, become active partners in knowledge accumulation and capacity enhancement, participate in international research exchanges, and pursue joint research publications in scientific peer reviewed journals.
2. To reduce impacts from the greatest threat to the Central America and the Caribbean economies in terms of disasters and long-term survivability as it relates to its most precious resources— people and water. To be active contributors to reduce hazard risk and to build resilient communities through a more sustainable and balanced use of water.

This proposal seeks to identify a source of funding to cover the cost of the following:

1. Each of the following institutions will identify a research area of interest and will host the visit<sup>18</sup> of a Central American or Caribbean researcher of their selection, to work on a mutual research project:
  - 1.1. Universidade Estadual de Campinas / Faculdade de Engenharia Civil Arquitetura e Urbanismo / Departamento de Recursos Hídricos (Brasil)
  - 1.2. Universidade do Estado de Santa Catarina (UDESC) / Programa de Pós-graduação em Planejamento Territorial e Desenvolvimento Socioambiental (Brasil)
  - 1.3. Universidad de Chile / Departamento de Geología
  - 1.4. Universidad de los Lagos en Osorno / Laboratorio de Limnología del Departamento de Acuicultura y Recursos agroalimentarios (Chile)
  - 1.5. The Water Institute of the Gulf (USA)
  - 1.6. Note: This is not an exclusive list as other universities in the USA and LAC will also be invited to collaborate.
2. This exchange opportunity will be advertised across the Central American and Caribbean network of higher-learning institutions and entities interested in water related research.
3. The LAC-WN hosts will select the best candidates for the exchange.
4. A one to two week research exchange will take place.
5. Three months after the research exchanges have taken place, all exchange participants will be invited to present the results of their collaborative effort to a multidisciplinary panel of researchers composed of LAC-WN participants, others selected researchers and guests.
  - 5.1 During this event participants will present their work and will have the opportunity to receive a multidisciplinary review of their work.

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<sup>18</sup> One week visit of the Central American or Caribbean researcher to the host country is anticipated.



5.2 During this event participants will have the opportunity to juxtapose their project against different community resiliency frameworks to better identify their functional contribution to water resiliency in the LAC region.<sup>19</sup>

5.3 Data and metadata utilized for the research will be openly shared with others and recommendations on how to integrate this data with data from other studies will be discussed.

5.4 Participants will be provided the opportunity to submit papers, book chapters, or other academic publications detailing their research.

A special edition of the *Revista Labor & Engenharia* [ISSN: 2176-8846] journal will be dedicated to this project.<sup>20</sup>

### Potential Sources of Funding

- ◆ USAID Office for Foreign Disaster Assistance for Latin America and the Caribbean Grant
- ◆ NSF Directorate of Biological Sciences Research Coordination Network Grant
- ◆ NSF Sustainability Research Networks Competition

### MEDIUM PROJECT

The focus of the “Converstatorio” was to define a first project as a pilot for the group. The group will use the opportunity of the first project to further define its structure and operation. The following is just a framework for potential next projects to pursue and this framework will be refined during the implementation of the Small Project listed above.

### Medium-Comparative Studies

As the significance of national boundaries increasingly gives way to larger water systems, so the potential salience of comparative and trans-regional research in water is increased. For example: Water can serve as the basis for organizing comparative studies of ecosystems exhibiting differing degrees of urbanization, watersheds could also spatially organize the hierarchically scaled linkages by which the human/water model can be applied.

Here are some of the potential steps that were defined by the group in the selection, definition and approach to take on a medium size project:

1. Find similar watersheds, inventory of potential watersheds and their characterization.
2. Is there existing data?
  - Knowing that there is good data helps since, these data can be leveraged toward the project.
3. Is the community interested?

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<sup>19</sup> C. Colten, J. Hay, and A. Ginacarlo (2012). Community resilience and oil spills in coastal Louisiana. *Ecology and Society* 17(3): 5. (<http://dx.doi.org/10.5751/ES-05047-170305>)

<sup>20</sup> Participants will also be encouraged to publish in scientific and applied research peer-reviewed journals, books and other academic publications.



- Community resilience becomes an emergent cultural value when the local stakeholders effectively support projects and projects tend to thrive with engaged communities.
4. What is the key water issue?
    - The team understands that not all water related problems can be resolved; however, identifying the primary root cause of the water problem and developing holistic solutions that can be adopted by the communities with generate the most value.
  5. Watershed management, management of extremes?
    - A management strategy that does not take into account the connections of all factors and takes a holistic approach to managing the extremes that end up causing the most community damages, is a failed strategy. While planning for catastrophes is not the goal of this activity, communities need to understand how extreme events can affect their well-being and protect against these more frequent events.
  6. What is the best model, has someone else used this model?
    - Having the collaboration and technical assistance opportunities through a North-South collaboration, with a multidisciplinary team, the identification of a proven model is a key success factor and an advantage of our collaborative approach.
  7. Economic benefit?
    - Clearly governments and communities will gravitate to economic benefits; however, losses are generally not as strong an attractor as benefits. Having a holistic framework with the tools to evaluate economic benefits increases project success.
  8. What management approaches?
    - A well-trained, competent and motivated local community is critical to a good management of their own resources. This is achieved through multiple dissemination, training and capacity building tools that foster the responsible management of their resources.
  9. Monitoring of indicators?
    - From biological, to flow, flood levels and technology driven monitoring, communities need to keep the finger in the pulse of their resources.
  10. Legal framework and policy are also part of a responsible use of shared community resources and are also to be taken into consideration for a medium size project.

## LARGE PROJECT

A larger study would offer a holistic view on the functional balance of the interactions of water and humans for a specific region, bringing all disciplines into consideration under a holistic framework of evaluation that would include key factors such as Population and Demographics, Environmental/Ecosystem, Organized Governmental Services, Physical Infrastructure, Lifestyle and Community Competence, Economic Development and Social-Cultural Capital in the context of water.



## Appendix A: LAC-WN Bios



ANDRÉ MUNHOZ DE ARGOLLO FERRÃO

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- Professor “Livre Docente“ at the Water Resources Department of “FEC-Unicamp”,
- Ph.D. Architecture and Urbanism, M.Sc. Agricultural Engineering.
- Professor Livre Docente do Departamento de Recursos Hídricos da Faculdade de Engenharia Civil, Arquitetura e Urbanismo, da Unicamp. Doutor em Arquitetura e Urbanismo pela FAU-USP, Mestre em Engenharia Agrícola pela Feagri-Unicamp, Engenheiro Civil, Arquiteto e Urbanista. Tem experiência nas áreas de engenharia de empreendimentos sustentáveis, com ênfase em tecnologia e gestão de processos, sob o enfoque do “pensamento complexo;” atuando principalmente nos seguintes temas: planejamento e projetos de ordenação territorial, arquitetura rural, patrimônio e paisagem cultural, projeto arquitetônico, técnicas construtivas, materiais alternativos e tecnologia apropriada.

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**Áreas de Interés:** Tengo interés por las 3 Areas / I have interest in the 3 Áreas

- Reducción de Riesgos y la Comunicación: YES
- Tecnología y la Toma de Decisiones: YES
- Participación de la Comunidad: YES



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- Voluntary permanent professor of the Post-graduation Program in Territorial Planning and Social-environmental Development, at the University of the State of Santa Catarina (UDESC) of Brazil. Visiting professor of UDESC (2010-2013). Retired professor of the University of Minho (UM). Graduated in Biology (University of Porto, Portugal), MSc, PhD (UM, Portugal) and Postdoctoral (Federal University of Santa Catarina, UFSC, Brazil) in Education.
- Teaching of signatures and modules of postgraduate and undergraduate degrees both in Portuguese universities (Trás-os-Montes and Alto Douro, Madeira and Lisbon Classical) and Brazil (UFSC, Federal of Tocantins and UDESC). Research activity in: Risk Disaster Management; Education (Science Education, Environmental Education and Education for Sustainability, Education for Risk Management, Intercultural Education, Supervision and Training and Educational Mediation); Environment (Environmental Management and Environmental Mediation), Territorial Planning (People and Community Participation). Author of books, book chapters and articles in both national and international journals. Coordination and participation in Scientific and Organizing Committees of National and International Congresses. Supervisor of more than thirty masters dissertations and PhD theses.
- Member of several juries of Masters and PhD. Member of several Centres and Research Groups. Overall coordination, executive coordination and/or participation in projects, some of them funded by development agencies and public institutions in Portugal and Brazil, particularly in the field of reduction/management disaster risks (prevention of environmental disasters: educational strategies and public participation; Drought in Western Santa Catarina: diagnosis and resilience; Municipal Instruments Risk Management, Contingency Plans and Community Plans Risk Management). Member of the Editorial Board of the Journal of Ecotourism and reviewer of the Journal of Pedagogical Studies (Brazil) and Portuguese Journal of Education (Portugal). Member of several national and international organizations. Director of the Peneda-Geres National Park (PNPG), equivalent to General Sub-director and Chairman of the Board of Directors of the Development of the Regions of PNPG Association, Portugal (2000-03). Coordinator of the team responsible for the revision process of the Managing Plan of PNPG and the PNPG group in the preparation of the Managing Plan of Caniçada reservoir. General Secretary of the Biologists Association of Portugal and President of its Northern Section (1998-2000).
- Advisory and coordinating advisory bodies to government processes, including the preparation of respective technical and scientific reports (creation and management of the Protected Landscape Area of the Horn Nozzle (1998/99), EIA of Hydropower Development Sela (1998) EIA and the High Speed Train (TGV) in Northern Portugal. Member of the team that made the mural exposition for the showroom of Araucárias National Park, SC, Brazil. Advising and coordinating of environmental mediation for companies (AES Tietê, managing of the reservoirs edges). Participation in international projects such as advice for greening the curriculum of ISE-UniCV (Cape Verde), curriculum development of the 3rd cycle in Timor-Leste (UNICEF funding) and specialized training of staff in higher education Angola (Secretary of State for Higher Education of Angola) Methodologies for



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#### **Áreas de Interés:**

- Reducción de Riesgos y la Comunicación
- Tecnología y la Toma de Decisiones
- Participación de la Comunidad
- Urbanización

#### **Publicaciones:**

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NORKA FUENTES GONZALEZ

*DOCTOR EN CIENCIAS NATURALES (Dr. rer. nat.), BIÓLOGO MARINO Y LIMNÓLOGO*

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**Ocupación Actual:** profesor Asociado del departamento de Acuicultura y recursos agroalimentarios de la Universidad de los Lagos en Osorno. Investigación y docencia.

### **TITULOS Y GRADOS**

- Licenciado en Biología Marina
- Biólogo Marino
- Universidad Austral de Chile, Valdivia, Enero 2000
- Doctor en ciencias naturales (Dr. rer.nat), Mención Limnología y Ecología
- Universidad de Konstanz, Alemania, Julio 2010

### **EXPERIENCIA EN DOCENCIA**

- 2014- Clase del caso CELCO en río Cruces. Complejidad en ecosistemas límnicos del curso “Contaminación” del magister en Ciencias, mención Producción, Manejo y Conservación de Recursos Naturales
- 2014- Clase en Doctorado en Ciencias Sociales de la Universidad de los Lagos, modulo de Economía, territorio y medioambiente.
- 2013-2014- Profesor responsable de curso electivo para estudiantes del magíster en ciencias, mención Producción, Manejo y Conservación de Recursos Naturales “Evaluación ambiental y caracterización de ecosistemas límnicos”
- 2013- Profesor responsable de curso electivo de doctorado “Herramientas para la caracterización y Evaluación de ecosistemas epicontinentales”
- 2011-2013- Clases de “Ecosistemas límnicos” en módulo Recursos hidrobiológicos, del Curso “Tópicos y Métodos Avanzados para el Manejo de Recursos Naturales.
- 2011-2012- Participación en modulo “Hidrología” del curso Dinámica del medio natural.
- 2010-2011-2012-2013-2014- Profesor Responsable de las Cátedras de Limnología, Botánica Acuática, Tópicos en la Biología Marina y Modulo de Contaminación
- 2011-2012-2013- Participación en módulo magister en Ciencias, mención Producción, Manejo y Conservación de Recursos Naturales “Ecosistemas continentales”
- 2010-2011-2012-2013- Dirección de prácticas y seminarios de título Universidad de los lagos, pregrado y postgrado.
- 2002-2003- Curso de Verano de zooplancton de Agua dulce para estudiantes de Biología de La Universidad Técnica de Munich TUM, Instituto de Limnología, Iffeldorf. Profesional responsable.

### **PUBLICACIONES**

- PINO, M & FUENTES, N. 2002. Origen de metales pesados en la cuenca del río Valdivia, En: Revista interna de SERNAGEOMIN. Pto. Varas.250 pp.
- FUENTES, N., 2010. Analyse des allochthon eingetragenen Fluß-Sestons und der autochthonen Primärproduzenten in der Nahrungskette des Bodensees mit Hilfe stabiler (15N, 13C) isotope. Dissertation, Universität Konstanz, 169S. Konstanzer Online-Publikations-System (KOPS) URN: <http://nbn-resolving.de/urn:nbn:de:bsz:352-opus-122263> URL: <http://kops.uni-konstanz.de/volltexte/2010/12226/>



- TOBAR, C. RAU, J. IRIARTE, A. VILLALOBOS, R. LAGOS, N. CURSACH, J. DIAZ, C. FUENTES, N. and A. GANTZ 2012. Composition, diversity and size of diatoms consumed by the Andean flamingo (*Phoenicoparrus Andinus*) in Salar de punta negra, Antofagasta, Region Northern, Chile. *Ornitología Neotropical* 23: 243–250.
- FUENTES, N. GÜDE, H. WESSELS, M. and D. STRAILE, 2013. Allochthonous contribution to seasonal and spatial variability of organic matter sedimentation in a deep oligotrophic lake (Lake Constance). *Limnologia*, 43:122–130.
- FUENTES, N. GÜDE, H. STRAILE, D. 2013. Importance of Allochthonous Matter for Profundal Macrozoobenthic Communities in a Deep Oligotrophic Lake. *Int. Rev. Hydrobiol.* 98: 1–13.
- CONTRERAS, H. DUARTE, C. JARAMILLO, E. and N. FUENTES 2013. Morphometric variability in sandy beach crustaceans of Isla Grande de Chiloé, Southern Chile. *RBMO*, 48:487-496.
- TOBAR, C. RAU, J. FUENTES, N. IRIARTE, GANTZ A. SUAZO, C. CURSACH, J., SANTIBAÑEZ, A. & JORGE PÉREZ-SCHULTHEISS. 2014. Diet of the Chilean flamingo *Phoenicopterus chilensis* (Phoenicopteriformes: Phoenicopteridae) in a coastal wetland in Chiloé, Southern Chile. *Rev. chil. hist. nat.* 87:1-15.

### **PARTICIPACIÓN EN CONGRESOS NACIONALES E INTERNACIONALES**

- FUENTES, N. & PINO, M. Variación temporal y espacial de la concentración de metales pesados en el estuario del río Valdivia. XV Jornadas de Ciencias del Mar, Mayo 2000, Valparaíso, Chile (presentación Oral).
- FUENTES, N. GÜDE, H. DIETMAR, S. Uso de isótopos estables  $\delta^{13}\text{C}$  en estudios limnológicos del lago Konstanz, Alemania. IV Congreso de la Sociedad Chilena de Limnología., Santiago de Chile, 2007 (Miniconferencia).
- GÜDE, H. FUENTES, N. TRAUNSBURGER, W. WESSEL, T. 2007. Einfluss allochthoner und autochthoner Sedimentation auf benthische Lebensgemeinschaften des Bodensees. Deutsche Gesellschaft für Limnologie (DGL) – Tagungsbericht 2006 (Dresden), Werder 2007 (Miniconferencia).
- FUENTES, N. GÜDE, H. DIETMAR, S. Allochthonous organic carbon supply : a significant source of nutrition for littoral and profundal benthic animal communities of Lake Constance ? Symposium The Role of Littoral Processes in Lake Ecology Hegne (Lake Constance), Germany January 29 to 31, 2010 (conferencia).
- FUENTES, N. GÜDE, H. DIETMAR, S. Análisis del seston fluvial alóctono y de los productores primarios autóctonos, en las redes tróficas del lago Constanza, con la ayuda de isótopos estables ( $\delta^{15}\text{N}$  und  $\delta^{13}\text{C}$ ). VII Congreso de la Sociedad Chilena de Limnología., Villarrica, Octubre 2010 (Miniconferencia)
- GÜDE, H. FUENTES, N. STRAILE, D. WESSEL, T. Contribution of allochthonous organic matter to sedimentation and benthic food-webs in lake Constance: Evidence from stable isotopes. 5th International Limnogeological Congress, 31 August -3 September 2011, Konstanz, Germany (Exposición oral).
- FUENTES, N. & GOMÉZ, L. Perturbación natural de dos ecosistemas lóticos (ríos GolGol y Nilahue) producto del evento eruptivo del complejo volcánico Puyehue-Cordón Caulle, Chile. XI Congreso de la Sociedad Chilena de Limnología., Antofagasta, Octubre 2012 (Exposición Oral).
- C. TOBAR, J. RAU, J. CURSACH, J. VILUGRÓN, A. GANTZ & N. FUENTES. Abundancia poblacional y dieta del flamenco chileno “*Phoenicopterus Chilensis* en un humedal marino de Chiloé. XXXII Congreso de Ciencias del Mar Punta Arenas, octubre 2012.
- GOMÉZ, L. & FUENTES, N. Evaluación de la Integridad Ecológica del río GolGol, posterior al evento eruptivo del complejo volcánico Puyehue-Cordón Caulle, Chile. XI Congreso de la Sociedad Chilena de Limnología., Antofagasta, Octubre 2012 (Exposición Panel).



- C. TOBAR, A. SANTIBAÑEZ, J. RAU, N. FUENTES & C. DÍAZ. Caracterización invernal del fitoplacton estuarial en un humedal marino de Chiloé, sur de Chile. XXXIII Congreso de Ciencias del Mar., Antofagasta, Mayo 2013 (Exposición Panel).
- FUENTES, N. CRUCES, F. & J. RAU. Importancia de los Subsidios Continentales sobre la Abundancia y Diversidad del Fitoplancton en la Bahía de Caulín, Chiloé. XIII Congreso de la Sociedad Chilena de Limnología., Santiago, Octubre 2014 (Exposición Oral).
- LEIVA, G., FUENTES, N. & S. ZELADA. Variación estacional del índice biótico para lagos (LBI: Vernaux et al. 2004) en la caracterización ecológica del Lago Rupanco, Chile.
- XIII Congreso de la Sociedad Chilena de Limnología., Santiago, Octubre 2014 (Exposición Oral).
- NUÑEZ D. & N. FUENTES. Estado de conocimiento de los ríos de Chile. XIII Congreso de la Sociedad Chilena de Limnología., Santiago, Octubre 2014 (Exposición Oral).

### **EXPERIENCIA PROFESIONAL**

- 2012 Vigente- Evaluación ambiental de la piscicultura Rupanco. Proyecto Universidad de los Lagos- Unidad de producción Acuicola UPA. Proyecto interno ULA-UPA.
- 2014- Terrestrial subsidies for aquatic food webs of an oligotrophic, northern Patagonian lake- Evidence from stable isotope composition. Proyecto FONDECYT de Iniciación 11140471 (En concurso).
- 2011-2014- Núcleo de Investigación Universidad de los Lagos. BIODÉS. Conservación de la biodiversidad de aves acuáticas y desarrollo sustentable en ecosistemas productivos sometidos a usos tradicionales. Investigador Asociado.
- 2014-2015- Codirección, investigador en proyecto FPA del Ministerio de Medio Ambiente, Monitoreo de la biodiversidad de aves y mamíferos marinos del AMCP-MU (Área Marina Costera Protegida- Múltiples Usos) Lafken Mapu Lahual.
- 2012- Estudio preliminar de las variables bióticas y abióticas de los lagos Ranco, resultado del evento eruptivo del cordón Caulle. Director e Investigador principal. Proyecto interno ULA.
- 2011- Proyecto FONDEF D09I1256 “La dieta viva de artemia: un recurso local estratégico para la sustentabilidad de la acuicultura chilena”. Investigador asociado.
- 2009- Consultoría de evaluación ambiental de las condiciones del fondo de las áreas geográficas de uso intensivo por la Salmonicultura en la Región de Los Lagos, zona de estero de Reloncaví, Calbuco y Chiloé Sur. Ministerio de Economía - IFOP. Jefe de Proyecto.
- 2009- Asesoría técnica en proyectos de teledetección vinculados a eventos de marea roja en Chile. EOMAP GmbH & Co, Alemania.
- 2006-2007 - Asesoría técnica en proyectos de teledetección en Europa. EOMAP GmbH & Co, Alemania
- 2004-2009- Bodensee-Untersuchung-Seeboden. Abschlußbericht für die Projektträger Internationale Gewässerschutzkommission für den Bodensee und IIIA Alpenrhein Bodensee. Coinvestigador.
- 2004-2010- Analyse der Nährstoffflüsse der autochthonen Primärproduzenten und des Flußsestons in der Nahrungskette des Bodensees mit Hilfe stabiler (15N, 13C) Isotope. Dissertation zur Erlangung des akademischen Grades des Doktors der Naturwissenschaften (Dr. rer. nat.) an der Universität Konstanz Mathematisch-Naturwissenschaftliche Sektion Fachbereich Biologie. Proyecto de Doctorado.
- 2002-2003- Analyse stabiler Isotope von Stickstoff und Kohlenstoff auf der Ebene der Primärproduzenten als Basis zum Studium des Nahrungsnetzes innerhalb eines komplexen Seensystems (Osterseen, Oberbayern). Investigador principal.
- 2001- Mollusken als Umweltindikatoren. Proyecto de doctorado, Instituto de Geología de la TUM Technische Universität München. Doctorante (Doctorado inconcluso por muerte de profesor guía).
- 2000-2001- Origen de metales pesados en la cuenca del río Valdivia. Convenio Marco SERNAGEOMIN – UACH. Coinvestigador.



- 2000- Mediciones de Gas Metano en el campus Isla Teja de la Universidad Austral de Chile. UACH. Asistente de terreno.
- 2000- Estimación de la contaminación ambiental en el sistema del estuario del río Calle Calle y Valdivia, Chile, debido a el sistema de las aguas residuales de la Universidad Austral. Campus Teja, Valdivia. Declaración Ambiental RILES UACH. Asistente de laboratorio.
- 1999- Estimación de la contaminación ambiental en el sistema estuarial de los ríos Calle Calle y Valdivia, Chile. Convenio UACH-FRIVAL. Asistente de laboratorio.
- 1998-2000- Variación Temporal y Espacial de la Concentración de Metales Traza en el Estuario Medio y Superior del Río Valdivia. Tesis de Biología Marina. Biblioteca UACH.

#### **CURSOS DE ESPECIALIZACIÓN**

- 2007- Curso de Ecología Microbiana. Aplicación de la técnica PCR para identificación de microorganismos. Universidad de Chile.
- 2006- Curso de Inglés. Fachhochschule en Munich, Alemania.
- 2002- Curso de Isótopos estables. Aplicación del método de Isótopos para resolver problemas ecológicos. Universidad Técnica de Munich, TUM Alemania.
- 2001-2002- Curso de alemán. Goethe Institut de Freiburg, Alemania

#### **MIEMBRO DE SOCIEDADES CIENTIFICAS- REVISOR**

- Miembro de la sociedad de Limnología de Chile (SOCHLIMO)
- Revisor de revista ISI- Limnologica



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