



EVENT REPORT

# Green Adaptation Strategies for Water Security in the Central American Dry Corridor

Nicoya, Costa Rica, 26 March 2019

# EVENT REPORT

Workshop

## **Green adaptation strategies for water security in the Central American dry corridor**

### **Co-organized by:**

Mesoamerican Center of Sustainable Development of the Dry Tropics (CEMEDE) and the Water Resources Center for Central America and The Caribbean (HIDROCEC) of the National University of Costa Rica (UNA).

Research Group INOWAS at the Department of Hydrosociences of the Technische Universität Dresden (TUD), Germany

Nicoya, Costa Rica  
26 March 2019

## About this report

This document contains the report of the workshop entitled “Green adaptation strategies for water security in the Central American dry corridor” organized in Nicoya, Costa Rica, on 26 March 2019. The workshop represented the official kick-off meeting of the bilateral German - Costa Rican project “Facilitation of green adaptation techniques for reduction of seasonal water scarcity in Costa Rica”.

Photo cover: Brasilito beach in Guanacaste province of Costa Rica (Photo: Serena Caucci)

## Acknowledgement

The project is funded by the German Ministry of Education and Technology (BMBF) and the Ministry of Science, Technology and Telecommunications in Costa Rica (MICITT).



## Report compiled by

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Dresden, November 2019

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# Welcome address

The Chorotega Regional Campus of the National University of Costa Rica serves as host for this important event named " Green adaptation strategies for water security in the Central American dry corridor ".

More than two and a half decades ago, the United Nations adopted 22 March as World Water Day in recognition of the importance of this resource for life. There's no life without water. We agree on this and the need for conservation, development and good use of water resources. When I was in elementary school, teachers considered the water as inexhaustible resource. Today we know that this is not the case and that we must be aware of the importance of its rational use. Our university, and our campuses in particular, has been working on this task. Teaching, research and transfer activities contribute to the generation of knowledge for the best use of this vital resource.

That is why today I am pleased to see the theme water at this seminar, where we will have a large panel of national and international experts on managed recharge of aquifers, global implications and water security in coastal areas, adaptation of global circulation models for temperature, runoff and precipitation in Central America, saltwater intrusion and its implications, impact of droughts and projections of climate change scenarios, water security methodologies and methodologies for water governance.

*La Sede Regional Chorotega de la Universidad Nacional de Costa Rica sirve de anfitriona para esta importante actividad denominada "Estrategias de adaptación verdes para la seguridad hídrica del corredor seco centroamericano".*

*Hace más de dos décadas y media se adoptó por parte de la ONU el 22 de marzo como el Día Mundial del Agua en reconocimiento a este recurso como el más importante para la vida. Sin agua no hay vida. Estamos de acuerdo en esto último y en la necesidad de la conservación, el desarrollo y el buen uso de los recursos hídricos. Cuando estudiaba en la escuela primaria los maestros incluían al agua dentro de los recursos inagotables. Hoy sabemos que esto no es así y que debemos hacer conciencia de la importancia de su uso racional. Nuestra universidad, y nuestra Sede en concreto, ha venido trabajando en esa tarea. Desde la docencia, la investigación y la extensión se aporta al conocimiento para el mejor aprovechamiento de este vital recurso.*

*Es por eso que hoy me complace ver la temática a este seminario, donde contaremos con un amplio panel de expertos, nacionales e internacionales sobre los siguientes temas: recarga gestionada de acuíferos, implicaciones mundiales y seguridad hídrica en zonas costeras, adaptación de modelos de circulación global de temperatura, escorrentía y precipitación para Centroamérica, intrusión salina y sus implicaciones, impacto de las sequías. Impacto de sequías y proyecciones de escenarios de cambio climático, metodologías de seguridad hídrica y metodologías para gobernanza del agua.*

**Víctor Julio Baltodano Zuñiga**, Dean  
Sede Regional Chorotega, National University of Costa Rica (UNA)

# Setting the stage

## General context of environmental management in Costa Rica

Costa Rica is a water-blessed country with abundant rainfalls oscillating annually between 1,300 and 7,500 mm. A full set of measures and policies made Costa Rica globally famous for the success of its environmental protection efforts. This ecological commitment ranked the country on top of Latin American and Caribbean countries on the protection of human health and ecosystems. In 2015, the country also achieved 99% of its energy generation from renewable sources, an important milestone in its plan to go carbon neutral by 2021. But this highly privileged status on environmental protection received serious challenges when regarded from the perspective of sustainable water management. One of the main issues of concern relates to the high rainfall seasonality in the North Pacific Region, which increases dramatically the pressure on available freshwater resources. While some issues are currently being addressed at national level, at regional level the country is facing increased pressure from pollution of surface water, from seasonal water scarcity (for example in the Pacific insular communities) and from saltwater intrusion in north-western coastal areas such as Guanacaste province, which are exposed to an increased urban development and concentrated tourism.



*During the dry season, the local communities living on the islands of the Nicoya peninsula are severely affected by freshwater scarcity (photo: CEMEDE)*

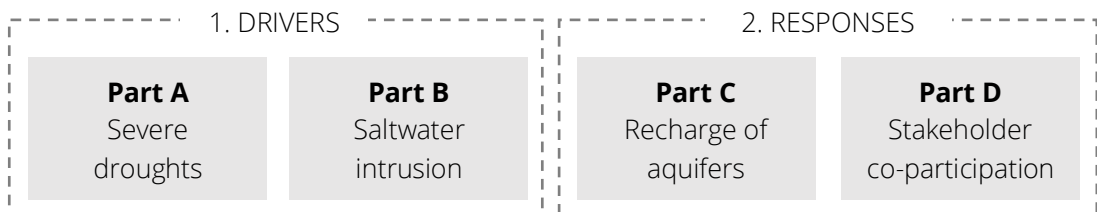
Moreover, the country's unique ecosystem is very vulnerable to changes in climate patterns, with shorter rainfall events and longer midsummer droughts expected to severely affect the replenishment of renewable water sources, so much needed for the country's vital ecosystem services such as hydropower generation and eco-agricultural production. To achieve a long-term resilience, Costa Rica needs a major swift in its common strategy of basically reacting to problems as they come along to a more precautionary approach for conservation and sustainable management.

# German – Costa Rican research collaboration on water resources management

To address these challenges, a new German – Costa Rican collaboration project entitled “Facilitation of green adaptation techniques for reduction of seasonal water scarcity in Costa Rica” was kicked-off in March 2019 with financial support from the German Federal Ministry of Education and Research (BMBF) and the Ministry of Science, Technology and Telecommunications in Costa Rica (MICIIT). On the Costa Rican side, the project is implemented by the Universidad Nacional Costa Rica (UNA) through its regional centres: the Water Resources Center for Central America and The Caribbean (HIDROCEC) and the Mesoamerican Center of Sustainable Development of the Dry Tropics (CEMEDE). The objectives of the 30-month collaboration project are to understand Costa Rica’s water-related challenges in vulnerable communities and to identify and test adaptation options for coping with water scarcity.

## Project kick-off workshop

To kick-off the project, UNA and TUD jointly organised an international workshop that took place at the CEMEDE main campus in Nicoya, Costa Rica, on 26 March 2019. The aim of the workshop was to promote a space for information and discussion on green adaptation strategies for water security in the Central American dry corridor, with emphasis on Costa Rica’s Guanacaste region, and exchange experiences on adaptation and intervention strategies at international level. The workshop included four parts divided in two blocks: 1) Drivers leading to water scarcity; and 2) Technical and non-technical interventions.



Workshop structure and main sessions



Group photo with the participants of the workshop “Green adaptation strategies for water security in the Central American dry corridor” organised by researchers from Universidad Nacional Costa Rica and Technische Universität Dresden, Germany, in Nicoya, Guanacaste peninsula, on 26 March 2019 (photo: CEMEDE).



# Climate change

The changes in climate patterns became obvious over the past decade and the impacts on different aspects of the society are multifold. Researchers from the University of Costa Rica discuss the mechanisms that cause droughts in the Central American Dry Corridor and the implications of climate variability on regional aridity and water scarcity.

INVITED SPEAKERS:

**HUGO HIDALGO LEÓN** | Centre for Geophysical Research, University of Costa Rica (CIGEFI-UCR), Costa Rica  
Research results related to aridity and drought in the Central American Dry Corridor

**ERIC JOSÉ ALFARO MARTÍNEZ** | Centre for Geophysical Research, University of Costa Rica (CIGEFI-UCR), Costa Rica  
Climate scenarios and impacts of droughts and other hydrometeorological events in the Central American Dry Corridor

# Research results related to aridity and drought in the Central American Dry Corridor

HUGO HIDALGO LEÓN

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Severe and sustained droughts are part of the natural variability of the Central American Dry Corridor and Guanacaste. It is important to emphasize that although trends in precipitation in the sub-region in general are not significant, trends in temperature in recent years have caused increases in the aridity of the region. It should be noted that the spatial variability of aridity is high from year to year. The conditions that cause droughts in the Dry Corridor are warming and low pressure in the Tropical Pacific along with high pressure and cooling in the Caribbean. In this presentation, the authors analyzed the mechanisms responsible for a significant fraction of climate variability in the Central American Dry Corridor. Their results indicated that El Niño Southern Oscillation is not the only process that influences the climate of the Central American Dry Corridor, but that also the Caribbean Low Level Jet (representing the Trade Winds) is an important characteristic of the aridity and recurrence of droughts in this sub-region. The authors also discovered that severe and sustained droughts in the Corridor have a periodicity of about 10 years. The low-frequency process that may be related to these decadal variations is a low-frequency version of the Caribbean Low Level Jet.

# Climate scenarios and impacts of droughts and other hydrometeorological events in the Central American Dry Corridor

ERIC JOSÉ ALFARO MARTÍNEZ and PAULA MARCELA PÉREZ BRICEÑO

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*Dr. Eric José Alfaro Martínez and Ms. Paula Marcela Pérez Briceño (UCR, Costa Rica) explain the climate scenarios and the impacts of droughts and other hydrometeorological events in the Central American Dry Corridor*

Predicting rainfall during April-May-June (AMJ), as the first peak of the rainy season in the Central American isthmus, is very important since it has been observed that more or less humid conditions during AMJ tend to be preceded by early or late starts of the rainy season. A late onset of rainfall, for example, followed by drier than normal conditions during MJ and by a subsequent period of intense summer or heatwave, can significantly affect key socioeconomic sectors in the isthmus such as hydropower generation, drinking water supply or agriculture. In this presentation, data from 162 rainfall stations were used to construct predictive models for MJ as the first peak of the rainy season, using Canonical Correlation Analysis (CCA). The aspects to predict during MJ are rainfall accumulation and the Normalized Precipitation Index (NPI) in Central America. The sea surface temperature (SST) anomalies observed in the  $63^{\circ}\text{N} - 10^{\circ}\text{S}$  and  $152^{\circ}\text{E} - 15^{\circ}\text{W}$  domain were used as predictors. The CCA models, using the SST anomalies in February, show a good predictive ability of the accumulations and the NPI during MJ, in an important region of Central America. The results showed that warmer (cold) conditions in the eastern equatorial Pacific SST anomalies, along with colder (warmer) conditions in the North Tropical Atlantic during February, tend to be correlated with drier (wet) periods during the next MJ bimester in virtually the entire isthmus. This suggests that the SST could modulate rainfall during MJ in Central America by influencing the position of the Inter-Tropical Convergence Zone and the magnitude of trade winds.

# Closing address

The forum held in the Tempisque auditorium of the Nicoya Campus of the National University generates a rich experience to learn about alternatives for integrated water resource management. It is a priority at a time when climate variability maintains high levels of impact in the Mesoamerican Dry Tropic region, and the need to proactively address the water security of coastal and island communities in the province of Guanacaste, Costa Rica is demonstrated.

In Costa Rica, the province of Guanacaste is the area that has the driest conditions, however it maintains a dynamic growth of tourism and residential development. The foregoing generates pressures for access and availability of water, especially in the coastal strip that concentrates the majority of the country's tourist activity.

Thus, the meeting of national and international experts around the water issue generates greater confidence that we will know how to conduct scientific research that allows us to address the challenges that arise in the region with the generation of scientific knowledge.

For the Mesoamerican Center for the Development of the Dry Tropics (CEMEDE) it is a pleasure to have the accompaniment of prestigious institutions at national and international level. We especially thank the Technische Universität Dresden (TUD), Germany, through the support of the Department of Hydrosciences and the INOWAS Research Group.

To all national participants who are also a strategic part of the challenges that are presented to us, including the Costa Rican Institute of Aqueducts and

*El foro llevado a cabo en el auditorio Tempisque del Campus Nicoya de la Universidad Nacional genera una rica experiencia para conocer alternativas de gestión integrada del recurso hídrico. Resulta prioritario en momentos en que la variabilidad climática mantiene altos niveles de afectación en la región del Trópico Seco Mesoamericano, y queda demostrada la necesidad de atender de manera proactiva la seguridad hídrica de las comunidades costeras e insulares de la provincia de Guanacaste, Costa Rica.*

*En Costa Rica, la provincia de Guanacaste es la zona que posee las condiciones más secas, sin embargo mantiene una dinámica de desarrollo turístico y residencial en crecimiento. Lo anterior genera presiones por el acceso y disponibilidad de agua, sobre todo en la franja costera que concentra la mayoría de la actividad turística del país.*

*Siendo así, el encuentro de expertos nacionales e internacionales alrededor del tema hídrico genera mayor confianza de que sabremos generar investigación científica que permita atender los desafíos que como región se presentan y se debe responder con la generación de conocimiento científico.*

*Para el Centro Mesoamericano de Desarrollo del Trópico Seco (CEMEDE) es grato contar con el acompañamiento de instituciones de prestigio a nivel nacional e internacional. De manera especial agradecemos a la Universidad Técnica de Dresde (TUD), Alemania, a través de acompañamiento de Departamento de Hidrociencias y de Grupo de Investigación INOWAS.*

*A todos los participantes nacionales que también forman parte estratégica en los retos que se nos presentan, entre ellos al*

Sewers (AyA), and the Center for Water Resources for Central America and the Caribbean (HIDROCEC), as well as researchers and administrative staff of the CEMEDE of the National University, Costa Rica: together we will know how to find the answers to improve the living conditions of the population and contribute in knowledge and innovation to future generations.

I am looking forward to welcome you in our next events and hope for more joint activities and support.

*Instituto Costarricense de Acueductos y Alcantarillados (AyA), y al Centro de Recursos Hídricos para Centroamérica y el Caribe (HIDROCEC) y a los investigadores y administrativos del CEMEDE de la Universidad Nacional, Costa Rica: entre todos sabremos encontrar las respuestas para mejorar las condiciones de vida de la población y aportar en conocimiento e innovación a las futuras generaciones.*

*Los esperamos en los próximos eventos y que siempre mantengamos las acciones de articulación y apoyo conjunto.*

Cordially / *Cordialmente,*

**Juan Carlos Picón Cruz**

Director, CEMEDE

Universidad Nacional, Costa Rica

# Annexes

**Annex 1** | Team of experts

**Annex 2** | Workshop agenda

**Annex 3** | Event photos

## Annex 1 | Team of experts

(in alphabetical order)



**ALFARO CHINCHILLA, Carolina**, M.Sc.

Researcher, Waste Management Laboratory (LAGEDE), National University of Costa Rica (UNA)

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Ms. Alfaro works at the School of Chemistry where she teaches various courses related to cleaner production and environmental chemistry. Her research work is oriented to demonstrate and improve alternative water sanitation systems, especially in the tropical conditions. She is interested in the transfer of technical and scientific knowledge that allows the appropriation of sanitation technologies by users in small communities.



**ALFARO MARTÍNEZ, Eric José**, PhD

Deputy Director, Centre for Geophysical Research (CIGEFI), University of Costa Rica (UCR)

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Dr. Alfaro is Full Professor at the School of Physics, University of Costa Rica, teaching since 1989. His interest areas include climatology, ocean-atmosphere interaction, meteorology, physical oceanography and multivariate statistical models. Dr. Alfaro has special interest in the statistical assessment of seasonal predictions from numerical model outputs, related also with climate change; and their comparison with the observed data in the Mes-oamerican region.



**BALTODANO ZÚÑIGA, Victor Julio**, PhD

Dean, Chorotega Regional Headquarters, National University of Costa Rica (UNA)

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Dr. Baltodano has a M.Sc. in Business Administration and a Doctorate in Social Sciences. He is the Dean of the Chorotega Regional Headquarters, National University of Costa Rica (UNA).



**HIDALGO LEÓN, Hugo**, PhD

Director, Center for Geophysical Research (CIGEFI),  
University of Costa Rica (UCR)  
email: hugo.hidalgo@ucr.ac.cr

Dr. Hidalgo currently works at the Departamento de Física Atmosférica, Oceánica y Planetaria, University of Costa Rica (UCR) and has over 20 years of experience in hydrology. His research interests are in meteorology, hydrology and climatology. He is the director of the Center for Geophysical Research (CIGEFI) and a member of the Costa Rican Academy of Sciences (ANC).



**JUNGHANNS, Ralf**, Dipl.-Ing.

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Technische Universität Dresden (TUD)  
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Mr. Junghanns works with the Research Group INOWAS at the Technische Universität Dresden (TUD) as full-stake software engineer and groundwater modeler. He is the main IT developer of the web-based INOWAS platform and is fluent in several programming languages.



**PÉREZ BRICEÑO, Paula Marcela**, M.Sc.

Centre for Geophysical Research (CIGEFI),  
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Ms. Pérez Briceño has a Bachelor in Geography (2011) from the University of Costa Rica and a Master in Integrated Coastal Zone Management (2017). She is currently teaching in the field of Hydrological Engineering at the Chorotega Campus, National University, School of Geography (Rodrigo Facio Campus) and Environmental Health (Guanacaste Campus), University of Costa Rica. She is a researcher at the Center of Geophysical Investigations (CIGEFI-UCR), where she has conducted studies related to the impact of disasters before extreme hydrometeorological events in terms of risk management. She has several publications and has participated in national and international congresses.



## Annex 2 | Workshop agenda

**Date:** 26 March 2019. **Location:** CEMEDE-UNA, Sede Regional Chorotega

Time	Activity	Speaker
09:00-09:15	Welcome address	<b>Víctor Julio Baltodano Zuñiga</b> , PhD. Dean. Sede Regional Chorotega, UNA
09:15-09:45	Presentation of projects: Facilitation of green adaptation techniques for the reduction of seasonal water scarcity in Costa Rica (GREAT) and CADICO-DTR	<b>Andrea Suárez Serrano</b> , PhD. General Coordinator of HIDROCEC-UNA, Sede Regional Chorotega.
09:45-10:15	Managed aquifer recharge (MAR) as a tool for sustainable groundwater management	<b>Catalin Stefan</b> , PhD. Head of Research Group INOWAS, Department of Hydrosociences, Technische Universität Dresden
10:15-10:35	<i>Refreshments</i>	
10:35-11:05	Research results related to aridity and drought in the Central American Dry Corridor	<b>Hugo Hidalgo León</b> , PhD. Director of the Centre for Geophysical Research (CIGEFI), UCR.
11:05-11:45	Is seawater intrusion by over-extraction of groundwater even worse than we expected?	<b>Marc Walther</b> , PhD. Junior Professor of Contaminant Hydrology. Department of Hydrosociences, Technische Universität Dresden
11:45-12:15	Case studies of saltwater intrusion in Costa Rica	<b>Roberto Ramírez Chavarría</b> , PhD. Director of Research and Water Management, SENARA
12:15-12:45	Discussion	
12:45-13:45	<i>Lunch break</i>	
13:45-14:15	Climate scenarios and impacts of droughts and other hydrometeorological events in the Central American Dry Corridor	<b>Eric Alfaro Martínez</b> , PhD. Deputy Director of the Centre for Geophysical Research (CIGEFI), UCR. <b>Paula Pérez Briceño</b> , M.Sc. School of Geography, Sede Chorotega, UCR
14:15-14:45	Opportunities for managed aquifer recharge in Costa Rica	<b>José Pablo Bonilla Valverde</b> , PhD. AyA.
14:45-15:15	Transdisciplinary approach to complex water-related management: stakeholder assessment and analysis for Costa Rica	<b>Serena Caucci</b> , PhD. Researcher in Sanitation and the Water-Soil-Waste Nexus. Institute for Integrated Management of Material Fluxes and of Resources, United Nations University
15:15-15:35	<i>Coffee break</i>	
15:35-16:15	Discussion panel	
16:15-17:00	Conclusions	<b>Juan Carlos Picón Cruz</b> , PhD. Director CEMEDE-UNA, Sede Regional Chorotega <b>Pável Bautista Solís</b> , PhD. Researcher CEMEDE-UNA, Sede Regional Chorotega

# Annex 3 | Event photos



