



Young Scientist Ambassador Programme (YSAP) Mission Report



Ambassador: Dr Lahcen Elyoussfi

Member of the Global Young Academy GYA (2017-2022)

Head of the Environmental Engineering Department

EST of Khénifra, Sultana Moulay Slimane University, Morocco

Member of the research team of Environment and Natural Resources management

Member of the research laboratory of Biotechnology and sustainable development of Natural Resources management

Young Affiliate of the African Academy of Sciences

Coordinator the Working Group of Agriculture, Food Security and Nutrition Sciences of Affiliates of the African Academy of Sciences



Host: Dr Alex Godoy-Faúndez

Member of the Global Young Academy GYA (2015-2020)

Honorary Doctor from UW-Green Bay

Director, Sustainability Research Center and Strategic Resource Management (CiSGER)

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Research Associate, [FONDAP WARCAM](#) / [Earth Engineering Center](#) at Columbia University

Coordinator United Nations Sustainable Development Solutions Network [SDSN Andes](#) for Chile

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Dates: 30 October to 10 November 2019

Country of Origin: Morocco

Country of Destination: Chile

Objective

Fostering research and scientific collaboration between Alex and Lahcen in the field of Water Food Energy Nexus and to create bridges (Science ambassadors) in Sciences and Higher Education between Morocco and Chile.

Brief

GYA member Alex Godoy-Faúndez, Director of Centro de Investigación en Sustentabilidad y Gestión Estratégica de Recursos and Associate Professor from the Facultad de Ingeniería at Universidad del Desarrollo, Santiago, Chile, hosted a GYA Young Scientist Ambassador Programme (YSAP) mission in November 2019. GYA member Lahcen Elyoussfi, a professor of EST of Khénifra, SUTLAN Moulay Slimane University, Morocco, met research scholars and professors in Chile to discuss ways to develop future collaborative research.

Lahcen delivered talks to undergraduate students about the water-energy-foods security nexus in Morocco and its relation with SDGs. He also visited the research group working on-demand water at Universidad de Concepción to discuss the possibility of future research collaboration and academic exchanges between Chile and Morocco.

As a key outcome of the mission, Lahcen started a joint research timeline with Alex and Diego Rivera (Universidad de Concepción) on WEF nexus. Lahcen invited Alex to visit Morocco as well as a keynote speaker and steering committee for e-conference about WEF nexus. Both are also planning to publish together on issues related to WEF nexus between both countries and continents.

Research Background

The current challenges in a climate change framework are mainly related to the rational use of natural resources, the determination of their valuation as environmental services and the need to reduce the impacts generated from their extraction, use or consumption, and those produced in the conversion to goods and services, discharges, air emissions, and wastes. These externalities ultimately affect economic systems, socio-demographics, legal frameworks, and political environments. The convergence of these systems requires research to focus on how to deliver solutions for particular problems balancing social and environmental dimensions. In this framework, Sustainability Science probes interactions between global, social, and human systems, the complex mechanisms that lead to degradation of these systems, and concomitant risks to human well-being.

In this context, engineering must provide solutions to the challenges we face as a society, including water scarcity and contamination, energy generation, food security, and waste generation, among many others, each of which are putting pressure on economic and production systems, and political frameworks. The interrelation between these variables reflects their convergence, demanding the engineering sciences incorporate tools from the social sciences to contribute to the resolution of numerous conflicts, defined today as socio-environmental conflicts.

Today, energy and water systems are physically interconnected, and there are interlinkages between food production/waste generation and water and energy systems. On the other hand, waste management practices have been changing with most wastes being sent to sanitary or hazardous landfills (post-consumption or food waste) instead of traditional poorly managed landfills; but, there is still little recovery of waste materials. So, creating a circular economy on an urban, regional, and country-level needs to understand the link between production and consumption, based on the usage of natural resources (water and energy) and food/wastes as an indicator of the inefficiency of a linear economy.

The interlinkages are named Nexus, and this approach to environmental resource management provides a holistic view to realizing the material and energy fluxes inside a system. "The Nexus Approach to environmental resources management examines the inter-relatedness and interdependencies of environmental resources and their transitions and fluxes across spatial scales and between compartments. Instead of just looking at individual components, the functioning, productivity, and management of a complex system are taken into consideration" (UNU-FLORES, 2017). Therefore, Water, Energy, and Food/Waste Nexus approach focuses on determining the fluxes cross-spatial scales and between water, energy, and Food/waste. In this way, it provides an opportunity for policy harmonization between the energy and water supply and food/waste management and nexus-based adaptation to current environmental challenges and conflicts. Therefore, understand this Nexus could be a pivotal step to develop strategies to design a Sustainable Water Use Securing Food Production, including the food supply chain and the end of the pipe, waste disposal.

The Nexus in Chile is evident. Chile is facing substantial water problems. During the years of 2010 to 2016, the Andean State was hit by a so-called megadrought (Garreaud et al. 2017). Following a business-as-usual strategy, Chile would be one of the five countries in the world suffering of the highest water stress in 2040, according to the World Resource Institute (2015). Beneath human consumption, the economic development concentrating on natural resources and export is causing this high demand on surface and groundwater (Valdés-Pineda et al. 2014). Additionally, energy production represents significant water demand in Chile as hydropower plants produce 28% of Chilean energy (Open Energy, Ministry of Energy, <http://www.energia.gob.cl/energias-renovables>). As Chile is one of the fastest-growing economies in Latin America, energy demand is expected to grow roughly 8% by 2020. (International hydropower Association, 2017). Waste flow in Chile presents an enormous opportunity for the reclamation of materials, generating energy, and lowering water and resource stress through various conversion techniques. On the one hand, these flows link industrial production with its raw materials, water, and energy consumption, and, on the other hand, households that convert goods and services into waste while consuming water and energy. Hence, new models based on material flow are needed to assess the amount of potential energy and material recovery.

Since it is evident that conceptualizing water and energy systems and the food/waste flow in agriculture, industry, and rural-urban systems as a single system are needed, this project suggests to mutually investigate on the questions of (a) what are the trends and future risks in energy and water sector, (b) how much energy production out of municipals waste and wastewater would be possible in different geographical regions and cities and (c) what are the water consumption reduction and wastewater reuse options. By this, it will explore the systematic interlinks of the water-energy-food/waste described above and investigates (d) how can the conceptualized system be remodeled from a linear economy to a circular one.

Morocco and Chile historically have had minimal scientific contact. Right now, Dr. Lahcen El Youssfi has been working on Water Food Energy Nexus in Morocco and Africa. His expertise could be beneficial to transfer to Chile due to similar weather conditions. The joint project's overall goal is to establish an international research network with a particular focus on agriculture systems, water, and energy. The scientific objective of this project is the development of the Water-Energy-Food/Waste Nexus approach to creating a framework for the circular economy and integrated management of water, energy, and food/waste in Chile and Morocco.

YSAP Activities Overview

1. Presentation of research projects
 - a. Conceptualizing a social-ecological system of Water-Energy-Food/Waste in case of Chile-Morocco,
 - b. Developing a system approach to Water-Energy-Food/Waste Nexus,

- c. Identifying the current system boundaries and current system conditions using Scale Analysis and Material Flow Analysis,
- 2. Second week
 - a. Data gathering and big data analysis
 - b. Define a timeline to apply to projects
 - c. Define an exchange program for students between countries

As a YSAP ambassador, Dr Lahcen Elyoussfi was visiting Santiago of Chile at the same time that Chile was suffering social uprisings. He had several meetings with researchers at Sustainability Research Centre & Strategic Resource Management (CiSGER in Spanish), School of Engineering at Universidad del Desarrollo. After meetings, Lahcen and Alex drew a timeline to work together based on collaboration on research and goals to apply to funds with a focus on water-energy-food security nexus.

Lahcen was giving teaching to undergraduate students about the Water-Energy-Food Security nexus. He mentioned the relationship between climate and smart strategies applied to crops in the Mediterranean region at different basins. Moreover, he shared his experience working on farms in different watersheds, explaining why it is critical to understand the relation to climate, crops, and food security. He mentioned that the UN SDGs framework could be useful to drive the research on agro-business.



Lahcen had the opportunity to visit Valparaiso, a world heritage city on the coast. He could understand how the geography in Chile can change within a few kilometers between coastal lines and Andean mountains. Further, Lahcen and Alex had long conversations about the food supply chain and its challenges to face the impacts of climate change.



The second week, Lahcen traveled to Chillán City to meet with research partners at Universidad de Concepción. The host was Dr Diego Rivera, who introduced him to the demand water research group. Lahcen and the group discussed that they could drive their research to compare differential approaches to fight climate change impacts such as drought and flooding. Their goal could be fixed to understand the water-energy-food security nexus on specific shared crops between both countries looking for best practices and technologies.

Field and Lab visits: Irrigation engineering, intelligent technology, 3D print and Censoring.



Finally, Lahcen had dinner at the Moroccan embassy in Chile. The ambassador is a university professor and was interested in developing the exchange programme of scholars and students between Morocco and Chile and Latin America and Africa.



YSAP Follow-up Events:

- Participation of Alex in the organizing committee of the “First International E-conference of interdisciplinarity and Sustainable Development Goals” that was held online on 25 April 2020. On the other hand, Alex participated with an interesting Keynote speech on “Sustainability Sciences and Higher Education” at the opening of the E-conference.
https://www.estk.ac.ma/ESTK/index.php?option=com_content&view=article&id=327:interdisciplinary-in-higher-education-and-sdgs&catid=2:uncategorised
- Alex is part of the organizing committee “International E-Conference on Climate Nexus perspectives: Food Water and Biodiversity” that will be held on 4 June 2020 (online) and will be giving a keynote speech and chairing a panel at the conference.
- Partnership between Alex and the E-sustainability of the Universidad del Desarrollo as partner of the conference the “First International E-conference of interdisciplinarity and Sustainable Development Goals” and the “International E-Conference on Climate Nexus perspectives: Food Water and Biodiversity” with the research team and the Higher School of Technology of Khenifra, Sultan Moulay Slimane University, home institution of Lahcen and colleagues. The logo of the GYA will be used during these events.



<https://estk.ac.ma/ESTK/55-actualites/328-climate-nexus-conference-june-2020>

- Participation of Diego Rivera, from the University of Concepcion and collaborator of Alex as Keynote speaker at the “International E-Conference on Climate Nexus perspectives: Food Water and Biodiversity” that will be held on 4 June 2020 and it's first form of collaboration/creation of the network between Alex' colleagues and Lahcen's colleagues.
- Collaboration on editing the book of proceeding of the organized conferences “International E-Conference on Climate Nexus perspectives: Food Water and Biodiversity”

YSAP Follow-up Plans

The visit in Chile permitted the creation of good communication and reinforced the collaboration between Alex and many teams of the Universidad del Desarrollo and Universidad del Concepción especially the E-sustainability Lab and the Water Research Center. The future collaboration concerns:

- Alex and/or colleagues to visit Morocco in 2021
- Co-publish papers and book chapters related to Water Food Energy Nexus in Chile, Morocco, Latin America and Morocco;
- Co-organize events;
- Exchange of Scholars between the concerned institutions in Morocco and Chile;
- Constitute research consortiums in order to participate in international research calls;
- Activate communication with policy makers to encourage collaboration in science and higher education between Morocco and Chile; Latin America and Africa.