

NARRATIVE QUARTERLY REPORT

(JANUARY–MARCH) 2025

Project — In situ monitoring of water quality in Cuban bays: creating and promoting the use of scientific tools

Participating institutions

- University of Havana (UH)
- Université Libre de Bruxelles (Belgium)

Cooperating institutions

- Center for Environmental Research and Transport Management (CIMAB)
- ESPOLETA Tecnologías (SME)

Other collaborating institutions

- José Antonio Echeverría Technological University of Havana (Cujae)
- Havana Bay State Management Group
- Université Catholique de Louvain

Project coordinators

Cuban side: Dr. C. Ernesto Altshuler Álvarez

Foreign side: Dr. Denis Terwagne

Participants — Dr. Geydis Fundora Nevot, Dr. Florence Degavre, Dr. Stamatios Nicolis, Dr. Alexandre Campo, MSc. Lázaro Martínez Ortiz, Eng. Alex Rivera Rivera, MSc. Luis Abel Rodríguez de Torner, Dr. Aramis Rivera Denis, Eng. Orestes Chávez Linares.

Duration — Five years

General objective — To provide the Cuban scientific-social ecosystem with a set of tools that enables in situ monitoring of water-quality parameters in Cuban bays, in a sustainable way and connected to local communities.

Specific objectives

- Design and build a wave channel at the Faculty of Physics, UH
- Design and build a buoy prototype
- Set up a server with a website to receive data from the buoys and from the community
- Establish a methodology for using the buoys
- Train the corresponding human resources

Fulfillment of the quarterly objectives

Objective 1. Start of receiving first-year purchases, and drafting the second-year purchase list

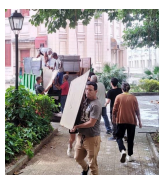


Fig. 1 — Professors and students unloading the shipment. On February 21, 2025, 4.5 tons of acrylic sheets from

China were unloaded at the Faculty of Physics of the University of Havana (Photo: M. T. Pérez).

During the last quarter, the acrylic sheets from China were successfully cleared from the Port of Mariel and transported to the Faculty of Physics of the University of Havana, needed for two purposes: (a) building the wave channel, and (b) operating the digital fabrication laboratory. It should be noted that transport from Mariel to the Faculty of Physics was contracted by the University of Havana, and that the 4.5 tons of acrylic sheets were manually unloaded from the truck into our laboratories thanks to the collaboration of professors and students of the Faculty of Physics, whether or not associated with the Project. Three 3 mm-thick white acrylic sheets were delivered to CIMAB on March 18, 2025. Although it was not possible to receive other Project-related equipment and materials, work continued on the complex permits needed to clear from Customs a box containing an alarm system for our laboratories, which remains held there. During the last quarter, constant negotiation was carried out with suppliers of specialized equipment, such as a UV-visible spectrophotometer, a high-speed camera, water-recirculation systems for the wave channel, and others.

Objective 2. Continued instrumentation of the buoys, and wave-channel design



Preparations to board a buoy inside Havana Bay, March 24, 2025. From left to right: Alex Rivera, Daniela Martínez, José A. Amado-Ojito, Alexandre Campo, and Stamatios Nicolis. (Photo: E. Altshuler)

Throughout the period, multiple tests were run on the buoys' LoRa-based communication system, involving PhD candidates Alex Rivera, Daniela Martínez, and Luis Abel Rodríguez, along with other collaborators such as Raciél Pupo-Santos (Espoleta Tecnologías). On-land communication tests were carried out using a transmitter placed in a garden at the Faculty of Physics of the University of Havana (powered by a photovoltaic panel), sending data (e.g., temperature) to a receiver in a Faculty laboratory. The experiment ran successfully until the entire garden setup was stolen at around 10 pm on a Saturday. On December 20, 2024, with the participation of Eng. José A. Amado-Ojito, an analogous system was installed on a buoy in Havana Bay located about 150 meters from the nearest shore, but on January 16, 2025 the temperature sensor's cable was found apparently cut with a knife, disabling the rest of the buoy's electronics. The whole system was reinstalled on the same buoy on March 24, 2025, but a few hours later communication between the buoy and the land-based receiver was lost, possibly due to a power outage (this new installation included a message attached to the buoy asking fishers to help look after the installed equipment). Work is now under way on a more robust electronics and communication system, resistant to power outages and vandalism. As side objectives, the spectrometric characterization of commercial light-emitting and light-detecting diodes was carried out, for use in a spectrophotometer to be placed, at a more

advanced stage of the project, on the buoys. Silicone and copper-particle coatings were also designed and deposited on glass to investigate their potential for preventing biological fouling on the submerged parts of the buoys; this work involved PhD candidate Daniela Martínez, as well as Aramis Rivera (IMRE) and Dayaris Hernández (IMRE). Tests in Havana Bay to evaluate the effectiveness of these coatings are planned for the coming months.

During his second stay at the Université Libre de Bruxelles starting in February 2025, PhD candidate Luis Abel Rodríguez tested more effective ways to build medium-sized channels, investigating a variety of adhesives and assembly systems. He also began testing video-based characterization of the wave profile generated in that channel, with the collaboration of Dr. Fresnel Forcade (IMRE, University of Havana), and continued contributing to the project's complex purchasing process.

Objective 3. First steps in developing a wireless sensor for seawater conductivity

Physics graduate Marlon Mederos ran tests, both in the lab and in Havana Bay waters, on the possibility of using LoRa signal-reception strength as a wireless measure of water conductivity/salinity. The goal is to avoid the standard method of using metal electrodes in direct contact with the water, which would require a high level of maintenance. Preliminary tests have not yet produced conclusive results.

Objective 4. Academic exercises carried out by the PhD candidates involved in the Project

PhD candidate Daniela Martínez presented the seminar "A proposal of biological tools for the in situ monitoring of water quality in Cuban bays" at the Center for Complex Systems on February 24, 2025. PhD candidates Daniela Martínez, Alex Rivera, and Mayelín García gave seminars on their doctoral research topics during a virtual meeting with Cuban and Belgian participation, held on January 23, 2025.

Objective 5. Mission of Stamatios Nicolis and Alexandre Campo to Cuba (March 15–25, 2025)



Discussing an experiment at the Center for Complex Systems. José Pereiro (background) explains to Stamatios Nicolis (left) and Alexandre Campo (right) his experimental setup for the controlled growth of bacterial colonies, March 21, 2025. (Photo: E. Altshuler)



Group photo of the third workshop associated with the ARES Project (Faculty of Physics, University of Havana,

March 18, 2025). (Photo: Faculty of Physics)

Professors Stamatios Nicolis and Alexandre Campo, of the Université Libre de Bruxelles, visited Cuba from March 15 to 25, 2025. The stay had a packed agenda: the professors gave a seminar on March 17 at the Center for Complex Systems of the Faculty of Physics, took part in a workshop on March 18, and visited Havana Bay on March 24, 2025, where they helped set up sensors and communication equipment on a buoy in the bay. They also visited the University of Havana's projects group, led by Marianela Constantén, and held working meetings with PhD candidates Alex Rivera (Espoleta Tecnologías), Daniela Martínez (Center for Complex Systems, UH), and Mayelín García (CIMAB), as well as with Geydis Fundora (FLACSO, UH), Aramis Rivera (IMRE, UH), Dayaris Hernández (IMRE, UH), Alfredo Reyes (Faculty of Physics, UH), José Pereiro (Faculty of Biology, UH), Alejandro Lage (Center for Complex Systems, UH), Orestes Chávez (Espoleta Tecnologías), Raciél Pupo-Santos (Espoleta Tecnologías), and Marlon Mederos (InSTEC, UH).

Objective 5 (bis). Holding the international "PhD Kick-off" workshop within the ARES project "In situ monitoring of water quality in Cuban bays: creating and promoting the use of scientific tools"

The workshop included a presentation by PhD candidates Alex Rivera, Daniela Martínez, and Mayelín García on their current and future activities within the ARES project. Members of the Center for Complex Systems, of Espoleta Tecnologías, of CIMAB, of FLACSO, and of the University of Havana's projects group also took part. The workshop, held in English, also included a final discussion session.

Objective 6. Continued progress in social-science research

During this quarter, exploratory work began with key actors in Casablanca, through several exchanges with the President of the local Popular Council and the fishing unit. Research techniques were designed, including interviews with key informants from the geographic community, the scientific community, and the entrepreneurial community; an observation guide; focus groups with fishers and with children and adolescents from the community's schools; and document analysis — all validated in an interdisciplinary workshop (see description above). The intentional, typological sample was set up and two interviews began to be applied. A content analysis was carried out of the community's 2021–2026 cultural and environmental diagnostics, to identify the needs and expectations of actors involved in the project. Work began on a repository of CIMAB and "Félix Varela" Center research and project results, to systematize practices related to education, communication, monitoring, and environmental sanitation in Havana Bay from the 1990s to the present, so as to have a baseline for promoting further innovations from the processes generated by the project, and to identify the social conditions behind the processes of appropriation and social innovation.

Sincerely,

Dr. C. Ernesto Altshuler

Head of the Complex Systems Laboratory, Center for Complex Systems, Faculty of Physics
University of Havana.



A fisher at work in Havana Bay, March 24, 2025. (Photo: A. Campo)

