

NARRATIVE QUARTERLY REPORT

(JANUARY–MARCH) 2026

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, Lic. Daniela Martínez Ortiz (PhD candidate), Eng. Alex Rivera Rivera (PhD candidate), MSc. Luis Abel Rodríguez de Torner (PhD candidate), Dr. Aramis Rivera Denis, Eng. Orestes Chávez Linares, Dr. Dayaris Hernández.

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

Task 1. Detecting and addressing vulnerabilities in the Physics building that endanger the project



Fig. 1 — Trying to reduce the vulnerability of the premises associated with the ARES project using our own means.

Photo taken March 17, 2026, one day after intruders broke into the Faculty of Physics building. From left to right: PhD candidate Daniela Martínez-Ortiz, student Patricia Altshuler, and master's student Marlon Mederos. (Photo: E. Altshuler)

Work has been underway to eliminate vulnerabilities in the Physics building on the University of Havana's hill campus, where multiple windows in very poor condition — due to termite damage — make it easy for potential intruders to get in. This is a VERY SERIOUS situation. Action began with letters to the Dean of Physics, who in turn informed the Rector of the University of Havana; a second, more detailed letter followed, specifying the value of the assets to be protected. However, these actions have not yet resulted in concrete measures. The situation escalated when, on March 16, 2026, a BURGLARY occurred in the Physics building: the intruder forced a termite-infested window at the back of the building, as well as a door, and got inside. Although the project's assets were not affected on this occasion (the Photovoltaics Laboratory was), the intruders were literally at the door of our laboratories. Faced with inaction despite repeated warnings about the vulnerability of the premises assigned to the project, a group of professors and students (Daniela Martínez-Ortiz, Marlon Mederos, Patricia Altshuler, and Ernesto Altshuler) took minimal security measures with the materials available: (a) three of the most vulnerable windows were boarded up with 5 mm acrylic sheeting from the project (Fig. 1); (b) hardware and padlocks (also from the project) were fitted to the two main doors; (c) the hinges of another door were reinforced; and (d) the refrigerator and microwave oven purchased with ARES funding were moved to a less vulnerable room. These measures are INSUFFICIENT to eliminate the premises' vulnerabilities, but it would be HIGHLY IRRESPONSIBLE not to take steps to protect the investment of more than \$100,000 in equipment and tools due to arrive in Cuba in April 2026 as part of the ARES project.

Task 2. Drafting the purchase list, and managing assets acquired with project funding

Just a few days ago, news arrived that the first container from Brussels has been released and is due to arrive at the port of Mariel (Cuba) in April 2026. Its contents are to be installed in the premises mentioned under Task 1, as planned for the project. During the last quarter, constant negotiation continued with suppliers of specialized equipment for the second container from Belgium and the second shipment from Panama; PhD candidate Alex Rivera has played an essential role in this. Efforts also continued to have the project's electric tricycle donated to the University of Havana by its (temporary) owner, Ernesto Altshuler — requiring the professor to visit the vehicle registry office (VEDCA) once again to obtain another original of the tricycle's title, since the original was kept by that institution when the vehicle was first registered. It is contradictory that, in order to make the donation, the vehicle must first be registered and then an original of its ownership document is required — a document that is surrendered precisely when the vehicle is registered. This only wastes time and resources; we strongly recommend that this system be replaced in the future by one that follows the rules of logic.

Task 3. Continued instrumentation for in situ measurements

Over the period, no further communication tests could be run between the equipment mounted on the Havana Bay buoy and the shore, because (a) constant blackouts in the Geocuba area have severely hampered the work, and (b) the small boat used to access the buoy was "lent to the Port of Mariel indefinitely." This is a hard blow to the project in its original form. We have therefore temporarily switched to an emergency plan, in which the water-quality sensor equipment will be used in situ, but not mounted on the buoy — instead placed at the edge of the bay. This tactic

preserves the essence of the project, if not part of its original strategy; we hope this is a temporary situation.



Fig. 2 — PhD candidate Daniela Martínez-Ortiz working with the professional spectrophotometer acquired with ARES funding, at the Zeolite Engineering Laboratory, March 30, 2026.

PhD candidates Alex Rivera and Daniela Martínez, with the participation of Dr. Aramis Rivera and Dr. Dayaris Hernández, made notable progress on two key fronts: (a) design and construction of several portable spectrophotometer prototypes for in situ marine water-quality measurements; (b) characterization of those prototypes using dyes, comparing their results against those obtained with the professional spectrophotometer acquired with ARES funding (Fig. 2); (c) design and construction of a portable microscope prototype incorporating artificial intelligence, for in situ marine water-quality measurements. In addition, Physics graduate Marlon Mederos continued tests, both in the lab and in Havana Bay waters, on measuring salinity wirelessly. The LoRa system has not yielded good results, so testing continues with a VNA (Vector Network Analyzer) system; tests continue to progress, though without definitive or publishable results yet.

Task 4. Preliminary experiments on the dynamics of solid contaminants in a wave channel



Fig. 3 — Preliminary studies of the migration of floating solid waste. The wave generator is to the right of the photo (out of frame), and the artificial beach (in blue) is on the left. During the experiment, the can moves toward the beach at an average speed that depends on its asymmetry. Left: the empty channel. Right: the can partway through its drift toward the beach.

PhD candidate Luis Abel Rodríguez and Dr. E. Altshuler built a new experimental setup to film the movement of empty beer cans floating in a wave channel. Our preliminary observations indicate that the cans' asymmetry is a critical parameter determining the average speed at which they move toward the artificial beach (that is, toward the shore, in real life). These are preliminary observations that still need to be systematized. PhD candidate Luis Abel Rodríguez traveled to the Université Libre de Bruxelles starting March 1, 2026, and began characterizing the artificial beach in the wave channel he had designed there. Third-year Physics student René Ariel Delgado Peña has become

involved in the work carried out in Cuba.

Task 5. Academic exercises carried out by the PhD candidates involved in the Project

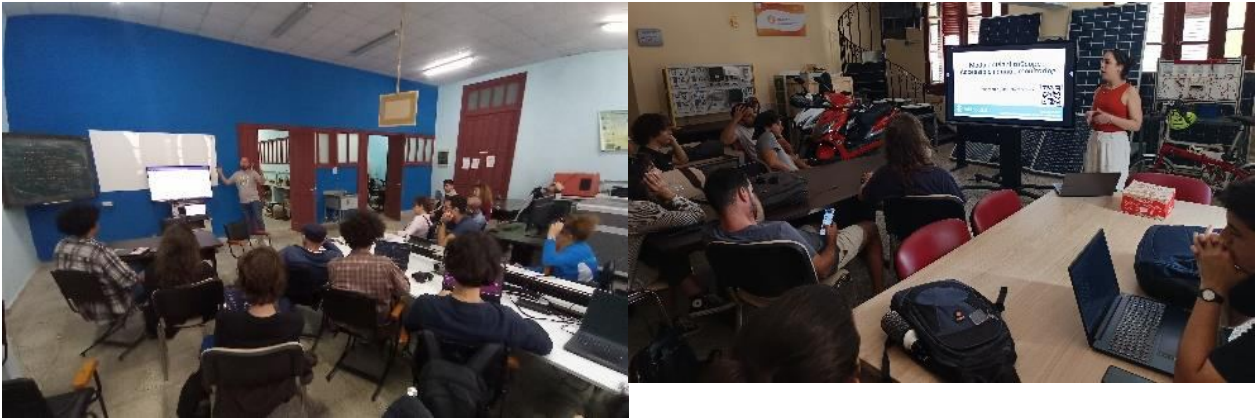


Fig. 4 — Seminars by PhD candidates Luis Abel Rodríguez (February 23, 2026) and Daniela Martínez-Ortiz (March 16, 2026).

PhD candidates Luis Abel Rodríguez, Daniela Martínez-Ortiz, and Alex Rivera each gave a doctoral seminar at the Center for Complex Systems of the Faculty of Physics, on February 23, March 16, and March 23, 2026 respectively (see Fig. 4). More than five PhD holders attended each seminar. In addition, all of the PhD candidates took part in writing a review article on the in situ measurement of marine water quality, to be submitted for publication within days; they are also working on two further articles.

Task 6. Continued research in the social sciences

During the quarter, 87 surveys on the expectations and needs of Casablanca residents were completed, addressing the doctoral thesis's first specific objective. Social-science PhD candidate Mayelín García began her stay at the Université Catholique de Louvain-la-Neuve on February 23, and has held meetings with her Belgian co-supervisor, Florence Degavre. Using the PRISMA method, she is drafting the thesis's theoretical chapter and the theoretical groundwork for a scientific article. She has also taken part in seminars presenting the progress of research under way at the host university, addressing topics of mobility, housing conditions, and access to basic services, and has presented her project to the host university's scientific community, receiving feedback within a group of doctoral candidates working across the social, economic, and technological dimensions.

Sincerely,

Dr. C. Ernesto Altshuler

Project director, Cuban side