

Abstract #: 1211

EROSION PROCESS IN THE CARIBBEAN SANDY BEACHES

José Luis Juanes, Institute of Marine Sciences. juanesjoseluis4@gmail.com
Colin Peter Jack, Association of the Caribbean States. cjack@acs-aec.org
Miguel Izquierdo, Inversiones GAMMA S. A. alvarez.miguel@gmail.com
Vladimir Caballero, Inversiones GAMMA S. A. vladycaballero@gmail.com
Pavel Morales, Inversiones GAMMA S. A. pavmordiaz@gmail.com

1. INTRODUCTION

Beach erosion is a widespread phenomenon on Caribbean beaches, with rates of coastline retreat between 2.2 and 0.5 m/year and higher reports in some areas. Different investigations indicate the combination of natural and anthropogenic causes and highlight the current influence of climate change related sea level rise. It is recorded as a generalizing trend the landward displacement of the beach profile, with sand transfer above the dunes and sand bars in a process that fits better the model proposed by Dean and Maurmeyer (1983) than the recognized model by Brunn (1962). Photos 1 and 2 show an example of the occurrence of this process.



Photo 1. Transport of sand from the beach to the lagoon. Cayo Frago. North Coast of Cuba Cayo Frago. 2010



Photo 2. Sand transported to lagoon from the beach. Cayo Frago. North Coast of Cuba. June 2010.

With the aim of deepening this research, and considering the environmental and socio-economic importance of the impact of beach erosion in the countries of the region, the Association of Caribbean States (ACS), in collaboration with the International Collaborative Agency of the Republic of South Korea (KOICA) and the Korean Institute of Oceanic Science and Technology (KIOST), have been developing since 2017 the project: "Impact Assessment of Climate Change on the Sandy Shorelines of the Caribbean. Alternatives for its control and resilience" (Sandy Shoreline) with the participation of 9 countries: Antigua and Barbuda, Costa Rica, Cuba, Dominican, Guatemala, Haiti, Jamaica, Panama and Trinidad and Tobago.

The project includes the following components:

- 1: Establishment of focal point network.
- 2: Creating institutional and human resource capacities in dealing with the erosion process.
- 3: Establishment of regional erosion monitoring network.
- 4: Preparing beach rehabilitation projects and monitoring beach erosion process
- 5: Writing a Beach Rehabilitation manual with scientific and engineering criteria that respond to the special features of the Caribbean coastal region.
- 6: Hosting the first conference on the preservation of beaches in the Caribbean region.

The project was conceived for execution between 2018 and 2022 but with travel restrictions due to covid-19 virus, resulted in the extension of the project until September 2023.

2. PROGRESS OF THE PROJECT UNTIL JULY 2022

With regard to the training component, the delivery of the postgraduate course on Coastal Processes and Beach Methodological Criteria for Beach Recovery and training in sedimentology techniques can be highlighted. This training activity was repeated to 40 specialists from the 9 countries in Panama in 2018 and as part of the executive projects developed in Antigua and Barbuda, Panama and Trinidad and Tobago in 2021-2022. The specific objectives of the course were as follows:

1. Define the concepts of coastal zone and coastal processes.
2. Evaluate the methodological importance of the analysis of the sedimentary balance of the coastal system in the investigation of the processes of erosion of beaches.
3. Evaluate the scope of morphological and sedimentological indicators for the determination of net coastal drift and direct and indirect methods for estimating coastal transport.
4. Analyze the concept of beach as a morphodynamic

element of coastal systems and identify the natural and anthropic causes of the erosion process.

5. Evaluate the scope of legal and engineering measures for the control of erosion processes.

6. Analyze the process of decision, design, execution, of an Artificial Beach Nourishment project.

For the establishment of the erosion process monitoring network, a protocol was prepared for the selection of beaches, as well as the location and requirements of a monitoring station. For the selection of the beaches, the following elements were proposed:

1. That the beaches were spread along the entire extension of the coasts of the country.

2. That natural beaches and beaches with anthropic activity (facilities on the dune, mining, etc) were included.

3. That beaches formed by terrigenous, biogenic or oolitic sands were included.

4. That beaches protected by reef barriers or cays and beaches without natural protection were included.

5. That beaches with different structures back beach (cumulative terrace, dune, coastal lagoon, cliff, etc.) were included.

Based on the protocol applied, the Focal Points have prepared progress reports in the establishment of the monitoring network and results of the behavior of the beach profile.

Member State	No. Beaches Monitored
Antigua Barbuda	6
Costa Rica	4
Cuba	35
Dominican Republic	4
Guatemala	Pending
Haiti	1
Jamaica	7
Panama	3
Trinidad & Tobago	54

Table 1: shows Overview of Beaches Monitored as part of the Sandy Shorelines Project.

Regarding the Beach Rehabilitation Projects fieldwork has been successfully completed at Runaway Beach, St John's Antigua & Barbuda, and Bonasse Beach, Cedros Trinidad & Tobago in June 2022. The project at Viento Frio Beach in Panama was completed in October, 2021. The ACS consultant CITMA/GAMMA, Cuban company is currently preparing the final reports for the projects.

The executive projects were conceived under the following basic principles:

1. Study the functioning of the coastal system to correctly identify the causes of erosion.

2. Evaluate regulatory and management measures to eliminate or minimize the anthropic causes of erosion.

3. Reduce to the indispensable the use of hard engineering solutions.

4. Assess the reconstruction of the natural conditions of the beach with the application of artificial beach nourishment and adaptation based on ecosystems.

CITMA/GAMMA, used this approach in Cuba as can be seen in Photos 3 and 4 evidence of the effectiveness of the application of these principles on Varadero beach, Cuba.



Photo 3. Dune designed to protect the hotel to cope with extreme erosive events and sea level rise. IberoStar Hotel. Varadero Beach. July 2015.



Photo 4. A few days after the passage of Hurricane Irma. IberoStar hotel. Varadero Beach. Effective dune protection. Sept. 2017.

With regards to the Beach Rehabilitation Manual, the following title has been proposed:

“Manual for the Protection and Rehabilitation of Caribbean Beaches” with the following content:

Scientific-environmental topics

1. Describe coastal processes that govern the development of shorelines and particularly beaches. (Geological, Hydrodynamic, Sediment Transport, Meteorological and Chemical).

2. Characterize the particularities of the coastal systems of the Caribbean region, pointing out the differences between the systems of the continental zone of the islands.

3. Offer methodological and conceptual criteria for the interpretation of the causes of erosion allowing the correct distinction between the natural causes of the anthropic causes.

4. Offer methodologies for monitoring erosion and conducting research on the dynamic processes of beaches (field and laboratory techniques, remote sensing and drones, radars, video cameras, wave sensors, currents, sediment samplers, among others).

5. Offer and recommend software for information processing and storage, and running mathematical models.

Management and planning of the beaches

1. The behavior of the occupation and expansion of economic activities on the beaches is analyzed, highlighting the importance of tourism activity for island states and the threat posed to the conservation of beaches by the development models followed to date.

2. Emphasis will be placed on the need to conceive the protection of Caribbean beaches through the application of regulations and management programs that contribute to eliminating or minimizing the anthropic causes of erosion.

Engineering actions for the control of erosion

1. International experience in the application of coastal actions to mitigate erosion will be addressed under the approach of minimizing the use of actions that physically or aesthetically impact the natural conditions of the beaches. Emphasis will be placed on the fact that the effectiveness of a solution depends first of all on the correct identification of the causes of erosion.

The basic rules for the design of the different types of hard actions will be offered.

2. The basic rules for the design artificial beach nourishment project will be included.

3. Evaluations of other unconventional solutions will be offered.

The manual will include a section of "Lessons Learned" and "Good Practices" in which the three executive projects prepared in Antigua and Barbuda, Panama and Trinidad and Tobago will be included as Case Studies.

As a conclusion to the Sandy Shoreline project, work is being done on the preparation of the First Conference on Protection and Maintenance of the Caribbean Beaches, under the slogan "Science and technology for beaches protection against Climate Change", which will take place in June, 2023. The objective of the conference will be to promote the exchange and discussion about the best practices to guarantee the conservation of the Caribbean beaches to face the effects of Climate Change and the models of tourism development that occur in the region.

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