Primary Topic: Measurements Techniques in the Coastal Zone
Secondary Topic: Morphodynamics of Reef-lined or Carbonate Coasts
Student Paper Contest

A STEP BY STEP METHODOLOGY TO ASSESS CORAL REEF RUGOSITY BY PHOTOGRAMMETRY

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1. Introduction

Healthy coral reefs present the most complex structures found in coastal areas. Besides its ecological importance, this environment offers co-benefits in wave dampening and coastal protection (Harris et al., 2018). Rugosity is often used to characterize physical complexity, in order to monitor structural change or implemented into hydrodynamic numerical modeling experiments. Fine scale datasets are needed to extract coral reef rugosity. However, most methods are either very expensive and difficult to implement or invasive and inaccurate. Photogrammetry is a non-invasive and effective method but implies a strict data collection and processing. Here we present a step by step cost effective methodology to extract coral reef rugosity using photogrammetry from in situ data acquisition to data analysis.

2. Field site

Anse-des-Salines is a reef-lined beach located on the eastern shore of Grande-Terre Island in Guadeloupe Archipelago (France) in the Lesser Antilles. The reef system consists of an approximatively 200 m wide reef flat bounded by a narrow yet very shallow crest of 15 m wide and almost 0 m depth at low tide (Figure 1a). The reef is composed of mixed dead and living coral colonies of branching and encrusting corals with notable macro-algae coverage. The reef flat shows two principal areas of coral development at both extremes forming complex chaotic structures of about one meter in height and several meters in width. The center is mainly composed by sand and smooth inert bedrock. The frontreef presents characteristic “spur and groove” structures in depth ranging from two to height meters.

3. Instruments and methodology

Several representative patches of 15 m x 15 m have been selected (Figure 1a). Each corresponds to a specific coral reef assemblage of the reef flat or the front reef. Thus 4 classes are identified: (1) front reef spurs and grooves, (2) reef flat current oriented reef, (3) reef flat chaotic highly developed reef (4) reef flat chaotic mildly developed reef.

Targets (ground control points), 2D and 3D scale bars and calibrated cubes were disposed into the patches (Figure 1b). On each patch, a set of pictures covering the whole patch was taken with a consumer grade Olympus TG-6 following a strict sampling strategy with equally spaced transects in both directions and two view angles (nadir and 30°).

Raw images were then processed in © Agisoft Metashape software to obtain a 3D point cloud and © CloudCompare software to extract a rugosity value for each patch, which may be extrapolated to the whole site with respect of corresponding classes.

4. Results and discussion

The spatial resolution obtained on every patch is less than 1 cm and the overall coverage exceed 95% of the surface of the patches (with most holes located in complex shadowed areas) highlighting the robustness of the methodology and photogrammetry capacity to reproduce coral reef structure. The aim of the methodology is to be at an affordable expense specifically adequate to reef flats and front reefs which are difficult to monitor because of the shallowness (from 0.5 to 8 m in our experiment) and the hydrodynamic (wave shoaling/breaking and currents) of such environments.

The step by step methodology including the choice of representative patches, complete pictures sampling strategy, two options of referencing and scaling, images alignment or dense cloud building will be developed in the full version of the article.

The choice on formulation on rugosity calculation and values obtained on patches and extrapolated to the whole site will also be developed, as well as a discussion on the way to implement this very detailed rugosity map into hydrodynamic and morphodynamic numerical models.

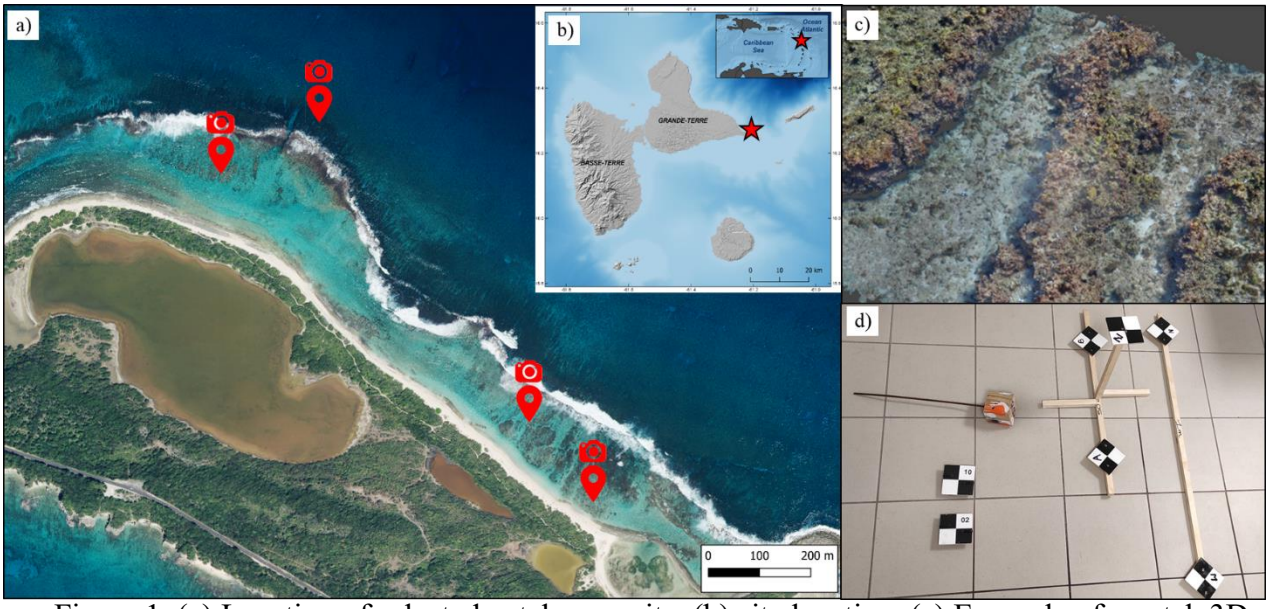

Figure 1. (a) Location of selected patches on site, (b) site location. (c) Example of a patch 3D point cloud, (d) example of targets and scale bars and calibrated cube used in the field.

References

Harris, D. L., Rovere, A., Casella, E., Power, H., Canavesio, R., Collin, A., Pomeroy A., Webster J.M., Parravicini V., 2018. Coral reef structural complexity provides important coastal prot ection from waves under rising sea levels. *Sci. Adv. 4*:eaao4350. doi: 10.1126/sciadv. aao43 50.