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Video camera to monitor microtidal fringing reef beaches : Lesson from a year of observation in Reunion Island

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Since 1994, the dynamics on the fringing reef beaches of Reunion Island have been the subject of observation and monitoring. The Hermitage study site is supported by the French coastal observation service SNO DYNALIT (Service National d'Observation) labeled by the CNRS INSU (Institut des Sciences de l'Univers – National Institute of Sciences of the Universe). The instrumentation associated with this observatory has evolved towards the acquisition of bi-annual DTM (digital terrain model) by unmanned aerial vehicles such as drones and beach profile surveys by DGPS (Digital Global Positioning System). However, the increasing need to further understand the coastal change and to improve the models that will help planning what our future coast will be, imply obtaining different time scales datasets documenting the evolution of coastal forms and processes. Several sites across the world make use of video cameras to study short-term and long-term coastal dynamics. This study is the first experiment in the context of a fringing reef microtidal beach.

A shore-based video station was installed at the Hermitage study site in December 2019. The video station comprises a video camera fixed on the roof of the lifeguard station, and a Raspberry Pi connected to a hard-disk and the internet. The station provides raw ultra-high definition (3840*2160 pixels) videos with H265 encoding which are sent via the internet to a server. The study period is from February 2020 to January 2021. After the preprocessing phase, three types of images are created every 10 minutes from 6 a.m. to 6 p.m.: (i) instantaneous images, (ii) cross-shore time stacks, and (iii) 10-min time exposure images. The images are then rectified and georeferenced using DGPS control points and photogrammetry methods from literature. Finally, the data obtained from the different processes are compared to actual topographic and climate databases (Wave Watch 3 and Candhis). An OSSI pressure sensor is used to obtain water levels, wave dynamics and parameters in the fringing reef. Data from the pressure sensor is also used as a means to calibrate the camera for beach profile detection.

The first results of this year of observation allowed us to assess the possibilities, constraints and limitations of such a tool on a microtidal fringing beach. For instance, in literature the possibilities of obtaining water levels and bathymetric datasets with the camera have been demonstrated. In our case, in a microtidal fringing reef, the tidal range is not suitable for such

studies. Also, the presence of vegetation, such as filaos (*Casuarina equisetifolia* L.), reduces the width of the shore studied. The comparison of the one-year video-derived tidal harmonics components with that of the SHOM (Service hydrographique et océanographique de la Marine) dataset, showed that the amplitudes of the M2 and S2 tidal components in the fringing reef is half the amplitudes at the Pointe des Galets station, located at about 20 km from the study site, with a difference in phase of -0.09 and 0.63 degrees respectively. Although the study site was judged to be stable in literature, we found that the foreshore profile shows variations in the range of 20 cm. For the studied period, the MTR (Mean Tidal Range), which is the difference between the mean high water and mean low water levels, was 0.20 m. The FTR (Full Tidal Range), which is the difference between the higher and lower water level, was 0.48 m. Maximum submersions were observed on 8th July 2020 during a Southern Ocean swell event, where water reached a maximum of 3 m high on the beach, which translates to the flooding of the beach on a distance of 30 m crossshore. In summer, the MTR was 0.18 m and the FTR was 0.45 whereas in winter, the MTR was 0.21 m and the FTR was 0.51 m. At a given water level in the fringing reef, it has been observed that the proxy used as the mean shoreline varies within a range of 1.73 m horizontally. Very low frequency waves have also been observed.

Eventually these results will help better our comprehension of the coastal dynamics in fringing reefs, especially in microtidal environments. Research into the use of low-cost and continuous measurement equipment is important to ensure that observatories are accessible to as many people as possible (including developing countries) and remote sites where the occurrence of morphogenic forcing has a high occurrence. Such data may help in better decision-making in regards to coastal management.