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## The contribution of acoustic seafloor mapping techniques to outlining coral reef geomorphology: A case study in the Republic of Maldives (Magoodhoo Reef – Maldivian Archipelago)

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Optical remote sensing data coupled with a dense network of field surveys have historically played a crucial role in geomorphological mapping of coral reef environments. Recently this field has undergone a major upgrade thanks to the integration of new advanced methods such as LiDAR, AUV-based and close-range digital photogrammetry and acoustic remote sensing techniques, which are able to investigate the deeper components of this complex geomorphic system. The new detailed maps can produce seamless digital elevation model (DEM) of coral reef environments, by integrating the elevation datasets acquired by the combination of the mentioned survey techniques.

In our work, a harmonised geomorphological map is generated for the Magoodhoo reef, which borders the southwestern discontinuous marginal rim of a subcircular atoll (i.e. Faafu Atoll) of the Maldivian archipelago. In its north-eastern sector the reef consists of a cusped reef joined to an almost closed ring reef to the south-west, where Magoodhoo Island is located. The map was generated from the analysis of Sentinel data, orthomosaics and 3D optical models generated by the application of SfM techniques to UAV images, as well as bathymetry and backscatter intensity measurements. The latter were collected down to a depth of up to 120 m along the oceanward margin of the atoll's rim, and to a depth of roughly 60 m along the lagoonward margin. Direct observations were also performed using an observational ROV on the forereef and within the lagoon, and video-transects on the reef flat.

The oceanward margin shows steep terraced slopes that reveal a complex history of late Pleistocene/Holocene sea level oscillations, while the backreef slopes (toward the lagoon) are generally more gentle, although at places can show abrupt escarpments and overhangs. The lagoon submarine landscape is distinctly featured by patch reefs of variable shapes (from circular to sub-elongated) and dimensions (from few meters to 30m high). Their distribution is clearly controlled by the surface circulation pattern, regulated by the pass that borders the reef to the

west. Towards the deeper edge of the mapped sector of the lagoon floor, where patch reefs are totally absent, intriguing small-scale depressions have been detected instead. The regular circular and concave shape calls for their interpretation as pockmarks, but their origin is still unknown due to the lack of core samples and geochemical analysis in the area. New data are actually needed to precisely outline the sedimentary environments that feature Faafu Atoll and its inner lagoon. Nevertheless, the obtained geomorphological map and the mapped landforms shed new light and a more complete understanding on the processes that drive morphological changes of the entire Magoodhoo reef.