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3D reconstruction of coral reef morphology using UAV, acoustic sonar and very high resolution satellite images: interests and limits of an integrated approach for natural hazards studies (Takapoto Atoll, French Polynesia).

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Geometrical characterisation of coral reefs in 3D has become a necessary primary step for numerous modelling studies (e.g. hydrodynamics, marine submersion, ecological habitat). Needed resolution varies from metric to centimetric scales, but available high resolution data are often sparse or unavailable especially in remote islands such as in South Pacific. This study explores the interests of combining different sources of imagery to reconstruct, at a very fine resolution scale, a full topo-bathymetric 3D transect of the eastern portion of Takapoto Atoll, Tuamotus Archipelago, French Polynesia. Aerial images were acquired using a drone (unmanned aerial vehicle) for topographic survey, an echosounder for ground-truth bathymetry, and very high resolution multispectral satellite images for integration of the both previous datasets. Aerial images were georeferenced using implemented ground targets, located with a Differential GPS. 3D model of geomorphic structures were reconstructed at very fine scale (5-10 cm), allowing mapping of geomorphic and sedimentary structures (e.g. cyclonic ridges, reef boulders, overwash deposits). Sediment volumes were quantified using 3D models and compared to satellite images' analysis. Drone images failed to retrieve bathymetry mostly due to sun glint over water surface. Satellite-based spectral information robustly predicted bathymetry in a 0.5-25 m range using depth soundings and ratio transform modelling (R2=0.94, RMSE=0.17 m). Drone-based topographic and satellite-based bathymetric surface models were connected in a seamless landscape model. Limitations and perspectives of this novel fusion methodology are discussed in an integrated vision of the coral reef landscape, and its interests for natural hazard studies (marine submersion, coastal erosion) are discussed.