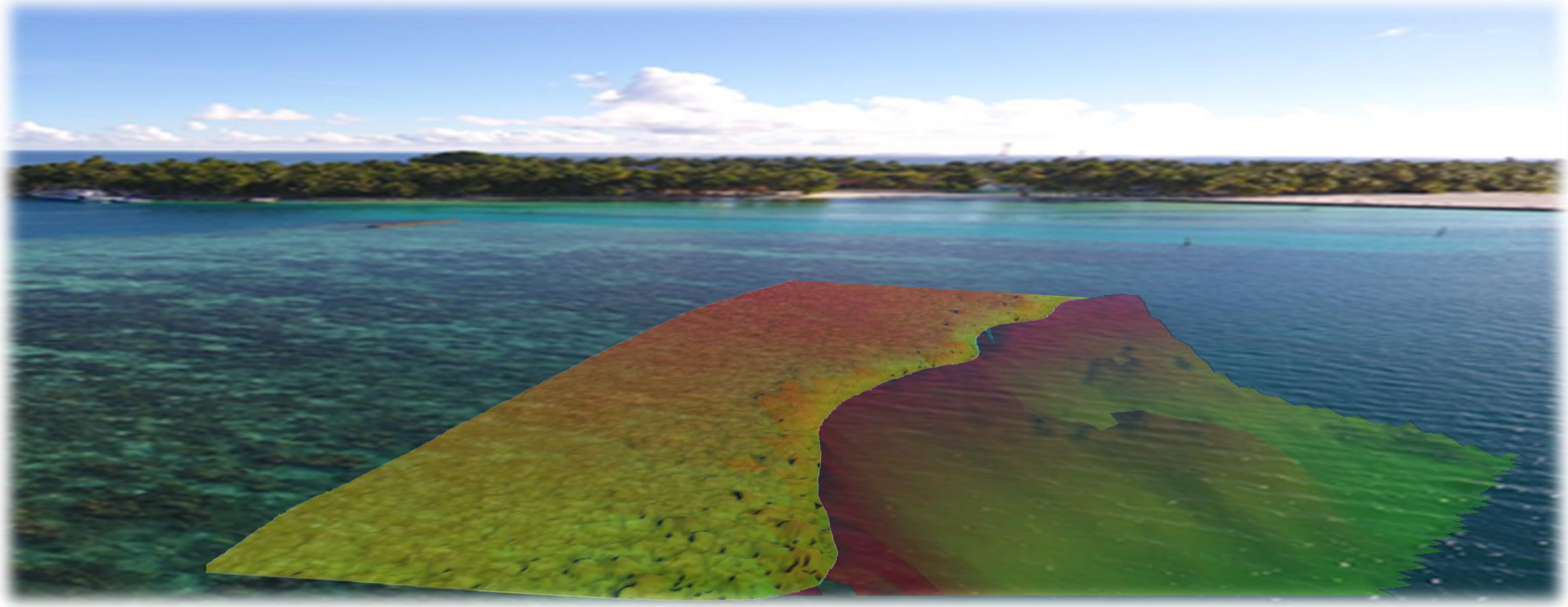
Integrating acoustics and photogrammetry-based 3D point clouds for the generation of a continuous bathymetric model in coral reef environment.



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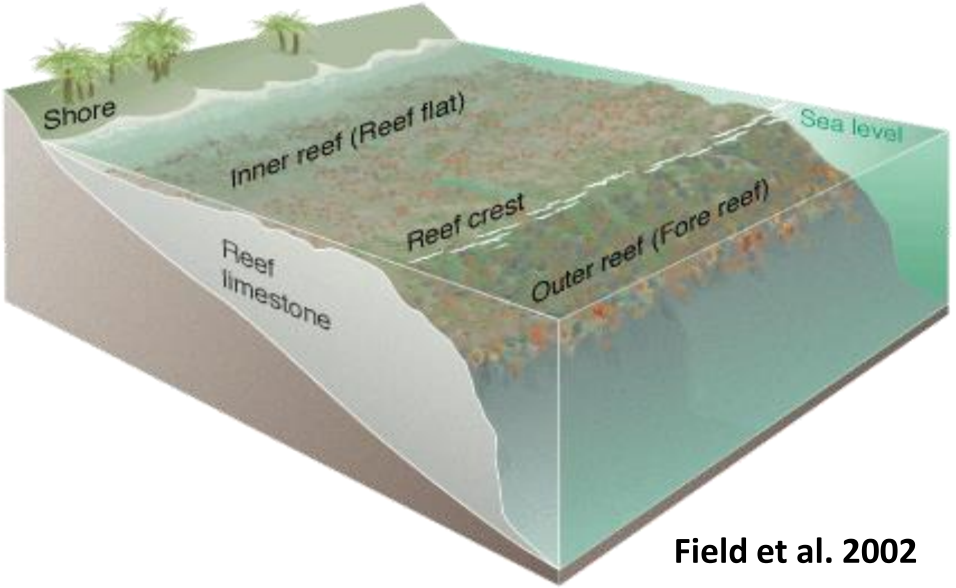
Introduction

Geomorphological mapping in coral reef environments, as for all coastal landforms, needs a fine-scale topography (emerged and submerged) as a tool for a better understanding of geomorphological changes and for planning informed management measures.

Especially because of their complex topography, traditional mapping methods lacked of a continuous 3D representation of coral reef landforms at high resolution, across all their extension, with the deeper lagoon regions included.

- Multibeam echosounder systems, presents difficulties due to the considerable extension of very shallow areas (i.e. reef flat and reef crest areas).
- Airborne Bathymetric LiDAR remains quite expensive.
- Satellite-derived bathymetry provides bathymetry products at a coarser spatial resolution compared to traditional acoustic surveying and bathymetric LiDAR.



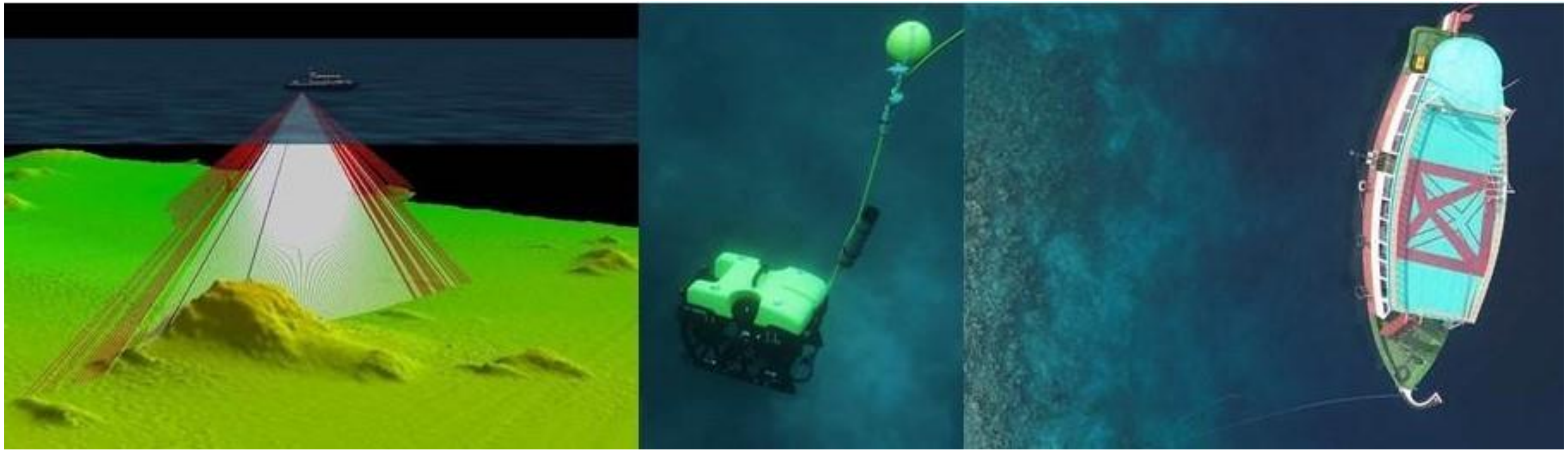
Field et al. 2002

Aim of the works

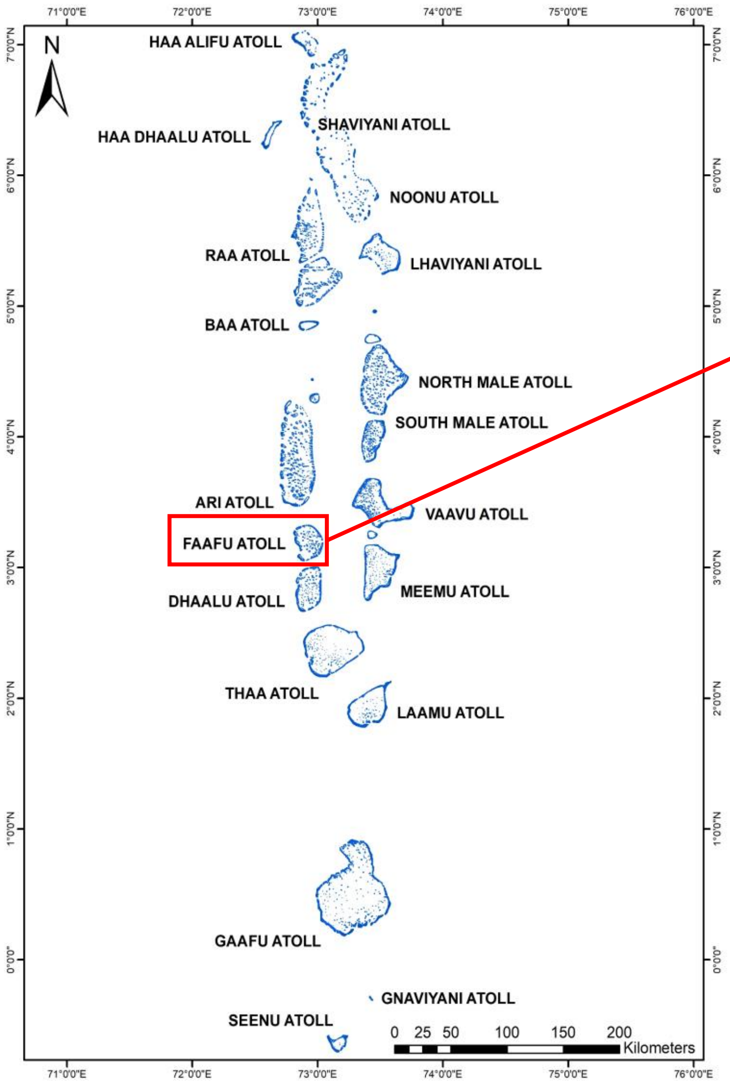
Reconstruction of an harmonized and continuous fine-scale DTM generated in coral reef environments from multiple sensors, using multibeam echosounder-based depth measurements and 3D point clouds obtained applying *Structure from Motion* (SfM) technique to UAV imagery.

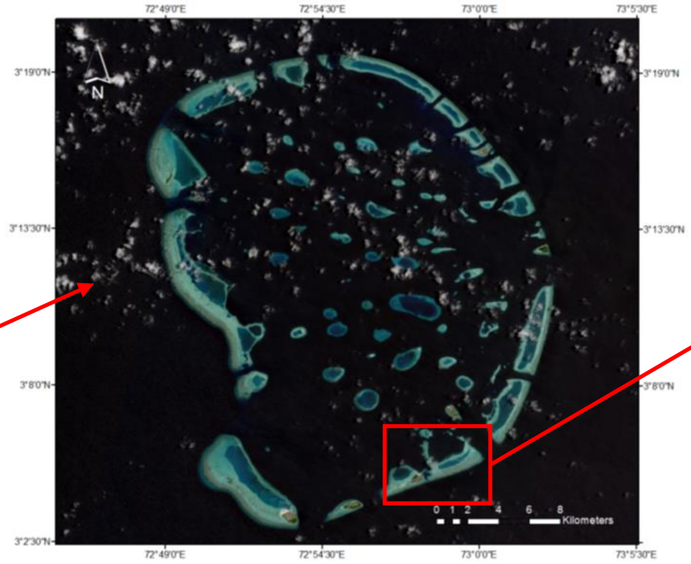
Data source

Data were collected during the 1st Mapping Technologies in Coral Reef Environments Training Course (10-19th March 2019) organised by the **IAG Submarine Geomorphology Working Group** in collaboration with MaRHE centre – Magoodhoo, Faafu Atoll, Republic of Maldives.

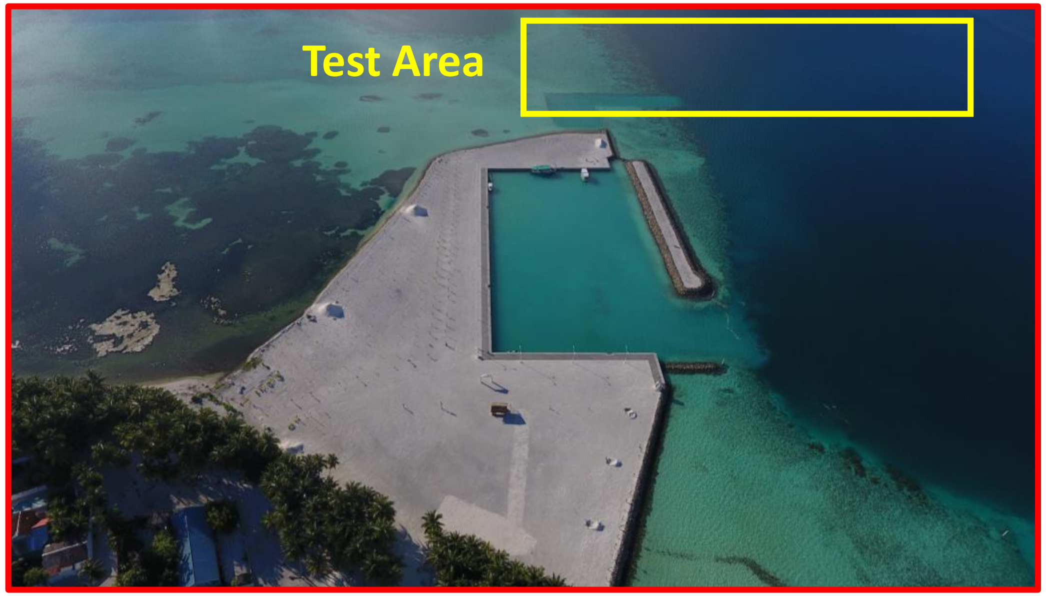


Study Area



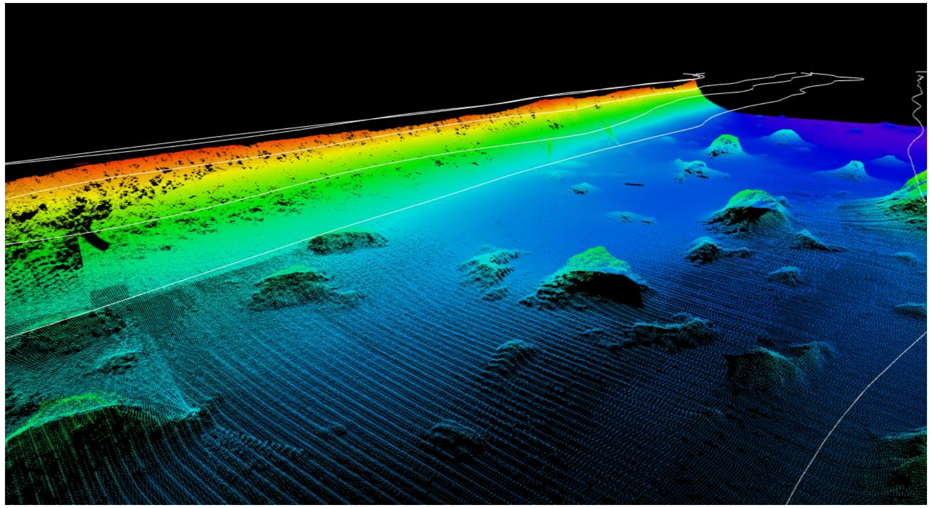


Magoodhoo Island

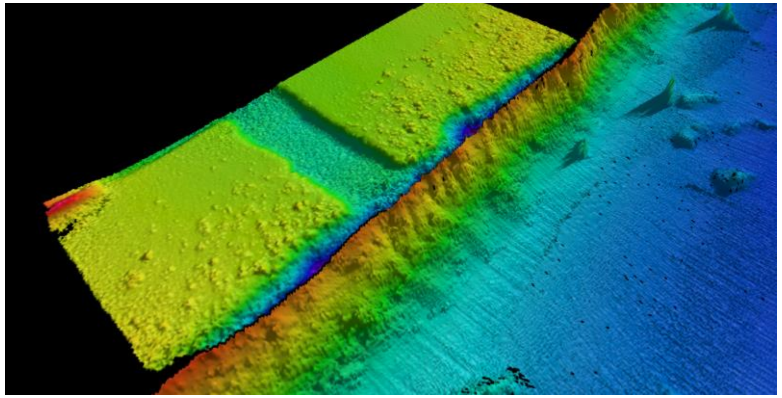


Materials and methods

Bathymetric data



Teledyne Reson 8125, multibeam echosounder



MBES Calibration

MBES Survey

MBES Processing

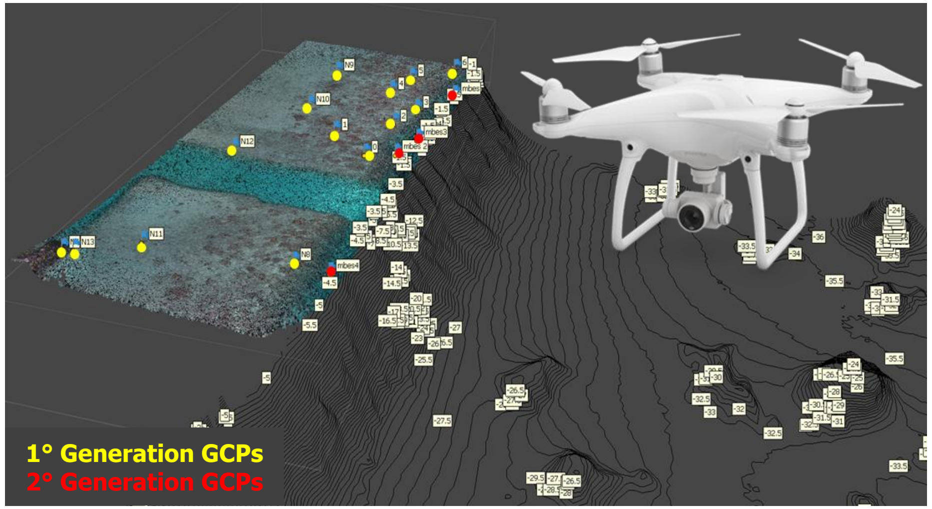
MBES DTM

DTM overlapping

Final merged DTM

UAV SfM data

DJI Phantom 4, consumer grade drone



1° Generation GCPs

UAV Survey

SfM Processing

UAV DTM

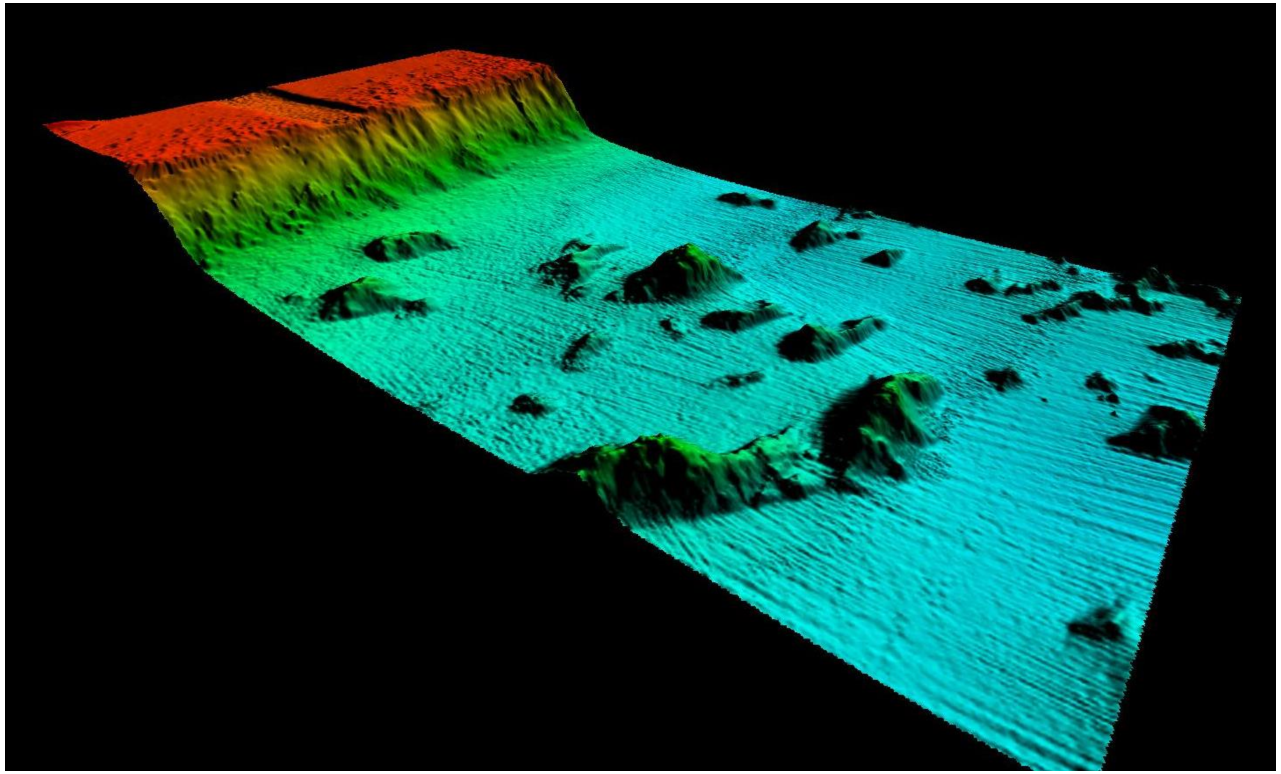
2° Generation GCPs

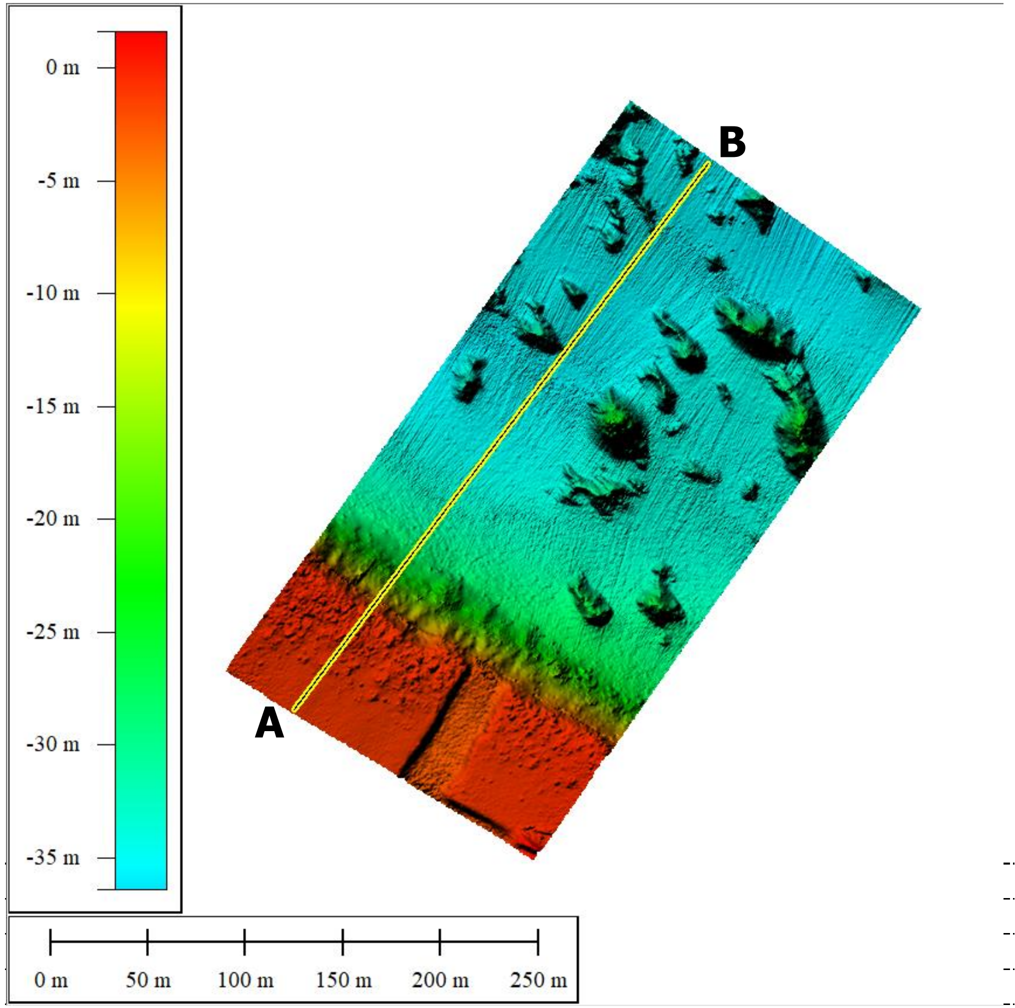
SfM Processing

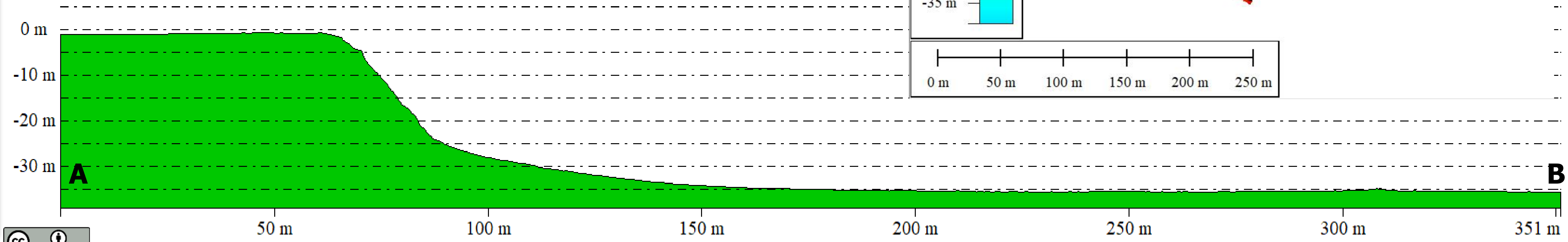
Tide calibrated UAV DTM

3D model result

Final merged DTM







Discussion

Model quality assessment:

1. the accuracy of multibeam bathymetric model, because of the methods itself (sound speed correction, IMU sensor and tide) and based on the International Hydrographic Organization (IHO 2008) standards for hydrographic, remains higher than the SfM model.

2. Accuracy of GCPs was measured before and after second generation GCPs.

3. Residual error per coordinate in 3D space result 0.64m with the first generation GCPs, and 0.84m after the second generation GCPs.

4. Residual DTM was then calculated and show an increasing difference in depth on the model boundary, in particular main differences occurs in the east zone, where second generation GPCs were used to calibrate the deepest area.

Conclusions

The proposed methodology lead thus to the generation of a continuous DTM, based on the integration of two dataset, where the more accurate data at lower resolution (i.e.: bathymetric data with a 0.50m grid cell size) drove the calibration of high-resolution photogrammetry-based 3D point clouds.

The critical point is represented by the need to develop effective and standardized technique for improving the accuracy of bathymetric data derived from the UAV-based 3D point clouds.

Thank you for your attention!