

Mapping Technologies and Monitoring Techniques in Coral Reef Environments

13-21 February 2024

III edition

Official Report

*MaRHE Center, Magoodhoo
Faafu Atoll - Republic of the Maldives*

Sponsored by:



FOREWORD



Foreword

Why this workshop?

Coral reefs are a complex and productive ecosystem that encompasses the highest biodiversity of any marine ecosystem. They are unique as they depend on a strong interaction between geomorphic and ecological processes. Investigating the formation and morphological change of coral reefs and reef-associated landforms contributes to a deeper understanding of a number of geomorphological, environmental and ecological issues, such as sediment and nutrient transport processes, larval dispersion mechanisms, estimation of their carrying capacity as habitat, etc. Moreover, it is crucial to improve coral reef conservation with a view of changing environmental conditions resulting from an increased stress by both anthropogenic and climate changes. To date, we have lost most of the global coral reef systems worldwide due to several impacts, such as overfishing, coastal development, sedimentation, marine-based pollution (e.g. plastic pollution).

Until less than a decade ago, geomorphological mapping in coral reef environments was carried out using satellite data ground-truthed by field studies. Because of this, geomorphological mapping lacked a 3D representation at high spatial resolution. As a consequence, geomorphological and habitat mapping, together with monitoring investigations, were challenging topics. Nowadays, detailed mapping of coral reef environments is possible thanks to the use of both acoustic equipment (e.g. Multibeam Echosounder - MBES) and Uncrewed Aerial Vehicles (UAVs or drones), thus we are able to map, study and plan monitoring actions to be carried out to preserve such productive ecosystems.

The III Edition of the Mapping Technologies and Monitoring Techniques in Coral Reef Environments represents an opportunity to gain hands-on experience on data acquisition and post-processing techniques by using different equipment, focusing on the importance of cutting-edge monitoring techniques for mapping coastal and nearshore environments.

Foreword

About the workshop - history

During the first edition of *Mapping Technologies in Coral Reef Environments* in 2019, the main goal was to provide an overview of the most advanced technique used to collect elevation data in coral reef environments and to integrate multi-scale elevation datasets to obtain seamless Digital Terrain Models (DTMs).

The III Edition of this practical training, as well as the past II edition, is called **Mapping Technologies and Monitoring Techniques in Coral Reef Environments**, and it also aims at providing advanced knowledge on how to plan and carry out multi-scale and multi-sensor monitoring activities in nearshore environments.

This course entailed an overview of the most advanced techniques used to collect remote sensing data in coral reef environments (e.g. UAVs and MBES) and to ground-truth them (Photogrammetry). We presented post-processing procedures for both MBES data (Bathymetry and Backscatter) and UAV imagery (Structure from Motion - SfM), other than data interpretation thanks to the use of GIS toolboxes (ArcMap).

Lessons were held at the *Marine Research and High Education Center (MarHE Center)* of the University of Milano-Bicocca in Magoodhoo Island, Faafu Atoll, which is about three hours by speedboat from Malé airport.

Field activities were carried out either on land, or on board a traditional Dhoni (wooden sailing vessel), or in snorkelling.

Practical activities included the use of dedicated software for processing collected data and performing their integration and interpretation.

THE TEAM



The Team

The University of Milano- Bicocca, Italy

The workshop was coordinated by Dr. Luca Fallati and Ph.D candidate Andrea Giulia Varzi, with the help of Ph.D candidate Luca Marino and Dr. Beatrice Ruggeri.

Luca Fallati is a Researcher in the *Department of Earth and Environmental Sciences (DISAT)*. His research is mainly focused on marine geomorphology and habitat mapping in coastal and submarine environments, with a particular focus on innovative remote sensing technologies for multi-scale approach in changing environments, together with underwater photogrammetry and reconstruction of 3D models for immersive Virtual Reality (VR) scenarios.

Andrea Giulia Varzi is a Ph.D candidate in the DISAT. Her scientific interests are towards geomorphological and habitat mapping, together with habitat and restoration suitability models. Her research is focused on the “white ribbon” area, the land-sea continuum, to define a reference workflow to integrate high resolution multi-scale and multi-source geospatial datasets for creating seamless models to bridge the gap.

Luca Marino is a Ph.D candidate in the DISAT. He as well is focused on habitat and geomorphological mapping of seagrass and coral reef environments. In particular, his interests lie in creating models capable of automatically classify seabed features by using machine learning techniques (e.g. GEOBIA) to support restoration programmes.

Beatrice Ruggeri is a post-doc in the *"Riccardo Massa" Department of Human Sciences for Education*. She is currently working in collaboration with the NBFC - National Biodiversity Future Centre and MaRHE Center on a project entitled "For the Sustainable Use of Biodiversity in the Indian Ocean. Protocols and Guidelines for SIDS", with a focus on land reclamation processes in the Maldives. Her research focuses on developing guidelines for biodiversity conservation in small island states.

PARTICIPANTS



Participants

People from all the World!

13  PARTICIPANTS



China Seychelles
United Kingdom Croatia
USA Saudi Arabia Canada
Germany Mexico
Italy

4 Continents



CANADA: Sandra Rain Moore; **CHINA:** Sheng-wen Horng; **CROATIA:** Nora Markezic; **GERMANY:** Patrick Oswald; **ITALY:** Margherita Scala, Federico Sidoli; **MEXICO:** Karla Paola González Martínez; **SAUDI ARABIA:** Ibrahim Alhawsawi; **SEYCHELLES:** Dillys Karine Pouponeau; **UNITED KINGDOM:** Megan Emily Bartlett; Joseph Plant; **USA:** Karen Lindsay Angle; Anna Michelle Zuke.

STRUCTURE and CONTENTS



Structure and Contents

What happened

9 **DAYS**
INTENSIVE
Workshop

Drone
Activities



Field TRIPS

10⁺

Snorkelling
Activities

LECTURES

The course consisted of a series of frontal lessons and field activities for a total of more than 70 hours of training. It was coordinated by researchers with experience in the use of aerial drones (UAVs) and underwater instruments (MBES) to perform coastal and seafloor mapping (bathymetric and habitat) together with photogrammetry techniques.

After completion of this training course, participants were able to:

1. plan drone surveys with the ground station software;
2. performe the survey and georeference the obtained models with GPS ground control points;
3. recognise main carbonate producers in coral reef environments;
4. collect terrestrial and submarine topographic/bathymetric data using different technologies (UAV, MBES, photogrammetry);
5. process MBES bathymetry and backscatter with specific software (Qimera, FMGT);
6. process imagery data with Structure from Motion (SfM) algorithms to build orthomosaics and/or 3D models (Agisoft Metashape);
7. create geomorphological and habitat maps (ArcMap).

Structure and Contents

Daily program

DAY 1

- Arrival at Malé International Airport, Maldives
- Transfer by speedboat to MaRHE Center, Magoodhoo Island
- Welcome in Magoodhoo island
- Dinner
- Briefing on the next day's activities

DAY 2

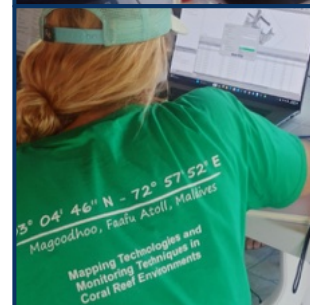
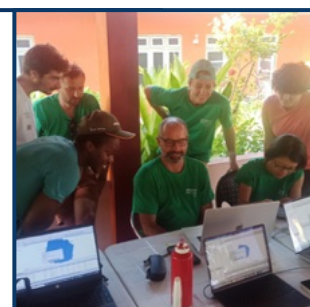
- Field Activity: Snorkelling and water confidence
- Laboratory Session: Group division and software installation
- Lunch
- Classroom Session: Coral Reef environments
- Classroom Session: Remote sensing data retrieval
- Classroom Session: UAV introduction
- Field Activity: UAV equipment
- Dinner

DAY 3

- Classroom Session: How to plan a UAV survey
- Classroom Session: GPS and georeferencing
- Laboratory Session: UgCS software
- Laboratory Session: UAV survey planning
- Lunch
- Laboratory Session: UAV survey planning
- Classroom Session: SfM software (Agisoft Metashape)
- Classroom Session: OBIA software (eCognition)
- Field Activity: UAV data acquisition
- Dinner

DAY 4

- Classroom Session: Best practices for underwater photogrammetry
- Field Activity: UAV/underwater photogrammetry data acquisition
- Laboratory Session: UAV/underwater photogrammetry data processing
- Lunch
- Laboratory Session: UAV/underwater photogrammetry data processing
- Field Activity: UAV/underwater photogrammetry data acquisition
- Dinner



Structure and Contents

Daily program

DAY 5

- Field Activity: Underwater photogrammetry
- Laboratory Session: Underwater photogrammetry processing
- Lunch
- Field Activity: Underwater photogrammetry
- Laboratory Session: Underwater photogrammetry processing
- Classroom Session: Acoustic survey in shallow waters (MBES)
- Laboratory Session: MBES survey planning (Qinsky)
- Dinner

DAY 6

- Field Activity: MBES/UAV/underwater photogrammetry data acquisition
- Lunch
- Field Activity: MBES/UAV/underwater photogrammetry data acquisition
- Classroom session: MBES data processing (Qimera)
- Laboratory Session: MBES data processing
- Dinner

DAY 7

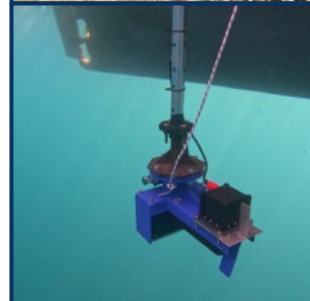
- Travel to Gynnantuga
- Field Activity: MBES data acquisition
- Lunch
- Field Activity: UAV/underwater photogrammetry data acquisition
- Travel to MaRHE Center
- Laboratory Session: Group working time
- Dinner
- Briefing on the next day's activities

DAY 8

- Laboratory Session: Group working time
- Lunch
- Laboratory Session: Group working time
- Classroom Session: Final presentations
- Dinner
- Boduberu

DAY 9

- Transfer by speedboat to Malé, Maldives
- Arrival at Malé International Airport, Maldives



PARTICIPANTS' EVALUATION



Participants' Evaluation

What they think about it

Results from the anonymous evaluation using a scale from 1 to 10.

In the scale, 1=poor and 10=excellent.

The results were derived from 10/13 feedback:



Participants' Evaluation

What they appreciated the most

Pretty much everything!

Many many thanks for everyone who worked hard to put the workshop together, provided all the lectures and software needed, combined learning with lots of fun and local cultures.

Really love every aspect of the workshop!

"Interacting with locals"

"Hands on learning"

The collaborative and open nature!

It really helped me to learn how to use the software and the data collection skills without feeling any pressure

"Multibeam acquisitions!"

The opportunity to put theoretical knowledge into practice

and

work with people with different backgrounds and experiences

"Learning about the Ocean and Maldives"

A warm THANK to you all!



Stay Tuned for the Next Edition!