USE OF MULTIBEAM ECHOSOUNDER TO DETECT TERRAIN CHANGES A ROUND TWO ARTIFICIAL REEFS (WESTERN ADRIATIC SEA, ITALY)

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Abstract

Since the end of eighties, Senigallia and Portonovo, on the Western Adriatic Sea, host two artificial reefs at a depth of about 10 m. After about sixteen years from their construction, they were monitored through a multibeam echosounder to assess sea-bottom morphology and terrain changes around the structures. The bathymetric system was proved a very advanced geophysical instrument able to detect the distribution of artificial reefs and the location of every single unit. 3-D visualizations of the study areas showed clearly movements of the single units and subsidence of the reefs, above all the central zone.

Key-words: multibeam echosounder, artificial reefs, sea-bottom, Adriatic Sea

Introduction

During the last thirty years, fourteen artificial reefs were built-up along the Western Adriatic coast at a depth ranging from 11 to 15 meters. In the present work the artificial structures of Senigallia and Portonovo were considered after about sixteen years from their construction to observe how they altered in the time, as well as the effects on sea-bottom morphology due to the whole reef and on terrain changes around individual reef units. High-resolution seabed maps of artificial reefs created with data from a multibeam echosounder (MBES) were previously performed in Taiwan in 1998 (1;2).

Materials and Methods

Senigallia reef was built-up at 12 m depth, about 1.2 nm offshore, on a sandy-muddy seabed far from natural hard substrates. The reef was constructed in 1987 and consists of 29 pyramids, each made of five 2-m cubic concrete blocks, and twelve concrete cages (6x4x5 m) for shellfish culture placed in a rectangular arrangement. Portonovo reef was deployed in 1988 in Portonovo Bay (Conero Promontory), 0.5 nm offshore on sandy bottom at 12 m depth. It consists of 87 pyramids and 36 cages arranged in three oasis of the same type as Senigallia reef and 100 m far from each other. The main difference between the two reefs is their geographical position: Senigallia reef is an open area, exposed to winds between NW-SE and currents that run parallel to the shoreline in the same direction, while the Portonovo reef is more protected from winds and currents due to the indented coastline of the promontory.

In 2002 the two artificial reefs were investigated through the Kongsberg-Simrad MBES EM-3000 system to evaluate terrain changes around the structures. The system mounted on research vessel M/N *Tecnopesca II* belonging to ISMAR–CNR of Ancona, meets all standards suggested by International Hydrographic Organization (3).

EM-3000 operated at a frequency of 300 kHz, with an angle of 120° along six survey lines at a distance of 30 m from each other. To obtain detailed depth information the vessel speed was 3-6 knots.

Recorded data were processed using Simrad Neptune and Roxar C-Floor software. The first one allowed applying the post-processing steps: the "cleaning" of the navigation and the tidal corrections. Processed depth soundings from EM-3000 system were available as ASCII xyz files. Their processing using C-Floor was the next step to obtain 3D images of the reefs.

Results and Discussion

The geometric structure of both reefs and how the terrain around concrete blocks was changed were illustrated using sun-illuminated option (Fig. 1). Darker areas just around the single units evidenced a certain subsidence of the terrain, followed by lighter boundary that represented the bank of removed substrate. These terrain movements caused in some cases the instability of the pyramids inducing the upper block falling.

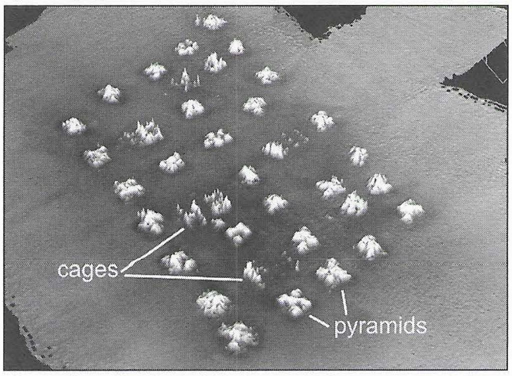

Fig. 1. Sun-illuminated 3D image of Portonovo artificial reef.

Regarding the complete bathymetric coverage of the two artificial reefs, it was possible to observe the sinking of the whole sea-bottom under the structures and particularly strong subsidence in the central zone of the areas. This vertical movement and the amount of it were also confirmed through cross sections along the longer side of the reefs. It was clearly evident from the profiles that the central areas were about 1 m deeper than the surrounding terrain (Fig. 2).

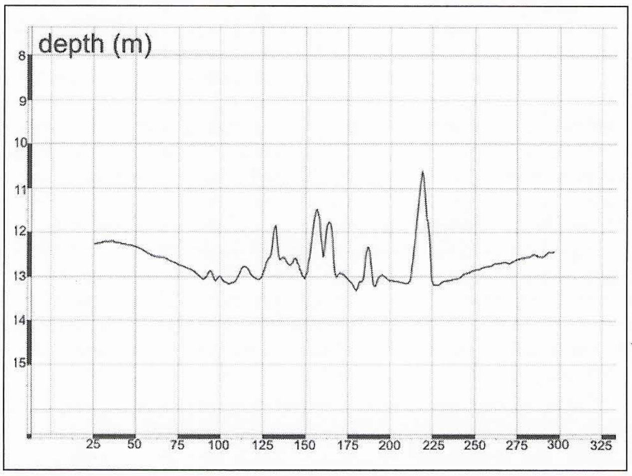

Fig. 2. Profile of a cross section along the whole length of Senigallia artificial reef.

Conclusions

The results showed that EM-3000 system was an efficient instrument not only to delimit the extension of artificial reefs but also to identify single units and to assess their spatial movements and subsidence. In fact, in both study areas, it allowed to point out a scouring of some concrete blocks that composed the pyramids and certain subsidence that occurred around the single pyramids or cages. In addition, EM-3000 enabled also to show a subsidence in the whole areas that hosted the artificial structures. It was likely that the close settlement of one pyramid or cage with the other made the reef as a single large structure that changed currents direction and wave motion, acting in this way on the bottom and inducing this significant alteration of the entire seabed morphology.

References

1 - Shyue S., 1998. Preliminary study on the distribution of artificial reefs by using multibeam echo sounder. Proceedings of OCEANS'98 – IEEE/OES*:* 1144-1148.

2 - Shyue S. and Yang K., 2002. Investigating terrain changes around artificial reefs by using the multibeam echo sounder. *ICES Journal of Marine Science,* 59: S338-S342.

3 - IHO Standards for Hydrographic Surveys, 1998. Special Publ., 44. 25 p.