BATHYMETRIC SURVEYS IN SUPER-SHALLOW WATER
ASSESSMENT OF THE MAIN CHALLENGES: CASE STUDY OF THE LAGOON OF VENICE, ITALY

Federica Foglini (b), Fantina Madricardo (a), Renato Tonielli (c) and Marzia Rovere (a)

a) ISMAR-CNR, Venice, Italy
b) ISMAR-CNR, Bologna, Italy
c) IAMC- CNR, Naples, Italy

7th GEBCO Science Day 2012 – Salle du Ponant, Monaco, on 2nd October 2012.
OUTLINE

• Introduction
• Motivation
• The challenge of bathymetry in super shallow environments
• The trials with multi beam and interferometric systems
• Comparisons between the two systems
• Results
• Conclusions
The lagoon of Venice is the biggest lagoon in the Mediterranean area with a surface of about 550 km². It communicates with the Adriatic Sea through three inlets. It has an average depth of about 0.8 m.
The typical morphological features are:

- navigation canals (20 m deep at the inlets up to 2 m deep)
- natural tidal channels and creeks (few m to few dm deep)
- tidal flats (often less than 1 m deep)
- intertidal areas
- salt marshes
THE LAGOON OF VENICE IS IN RAPID EVOLUTION:
- salt marsh areas decreased by more than 50% in the last century
- deepening trend in some parts of the lagoon was observed with a net sediment flux exiting from the inlets.

THE NEED OF MONITORING:
- hot spot areas of erosion and sedimentation.
- repeated surveys on some specific hotspots.

BATHYMETRY IS ONE OF THE MAIN FACTOR IN MULTIDISCIPLINARY STUDIES
- Habitat mapping
- Quantitative geomorphology
- Sediment budgets
- Geo-archaeology
THE CHALLENGE OF BATHYMETRY IN THE LAGOON OF VENICE

- Extremely shallow water (~1 m) – Multipath effect and reverberation
- High turbidity – no transparent water

- Current speed (about 1 ms\(^{-1}\) in the Lido inlet and 0.2 ms\(^{-1}\) in the Scanello channel, Northern Lagoon)
- Sound velocity profile variations (variation in salinity and temperature)

- High tide excursion (about 1m) – operational problems and need for tide correction

**Scanello channel svp vs time**

**From Dese to Torcello svp vs space**
THE CHALLENGE OF BATHYMETRY IN SUPER SHALLOW WATER ENVIRONMENTS

POSITIONING – to achieve a high accuracy bathymetry in shallow water the positioning is crucial

DGPS – error about 1m
RTK – error about 5 cm

IN THE LAGOON THE MAIN PROBLEM IS THE DIFFICULTIES IN RECEIVING CONTINUOUS RTK CORRECTION EVERYWHERE

TO SOLVE THIS PROBLEM:

post-processing of position
fixed station
To assess the potential and the limits of acoustic surveys in super-shallow environments we carried out three surveys in the Lagoon of Venice:

- Interferometric sonars (IS) – GeoSwath PLUS GeoAcustics at 500 kHz and 250kHz
- Multibeam echosounder (MBES) – SeaBat 7125 RESON 200 and 400 kHz

These field tests were carried out on the same study area to directly compare the data acquired to find the best instrumental setup for extremely shallow conditions.
Boat equipment with Geoswath plus

GeoSwath Plus 250 / 500 kHz deck unit
GeoSwath 250 kHz v-plate
GeoSwath Plus 500 kHz compact t-plate
Tritech Altimeter PA500 (250 kHz v-plate only)
Valeport MiniSVS
TSS DMS-05 MRU
Hemisphere V101 GPS compass

Weight ~ 16 kg, Swath angle 240°, Max depth ~ 50 m
Real swath coverage ~ 12 time water depth
Boat equipment with Reson 7125

- Multibeam Reson 7125 200-400 kHz
- Laser Scanner Optech HD High Density
- RTK POSITIONING Applanix POS-MV
- DGPS OmniSTAR

Weight ~ 21 kg
Swath angle 140
Max depth ~ 200-400 m
Real swath coverage ~ 6 times water depth
THE TRIALS – INTERFEROMETRIC ACQUISITION AND PROCESSING

- Amplitude filtering
- Statistical filtering
- Binning
THE TRIALS – MULTI BEAM ACQUISITION AND PROCESSING
Scanello GeoSwath 500 kHz

DTM 0.5m
V.E = 5
Scanello Reson 7125 + Laser scanner
RESON vs GEOSWATH 500

DTM 0.5 m
RESON vs GEOSWATH 500 DTM 0.2 m

Reson
Value
High: -0.18
Low: -8.5

GeoSwath
Value
High: -0.17
Low: -15.84
Swath Coverage at 6m water depth
35 vs 55 m
6 x vs 9x
SAN MARCO SQUARE - The Third Column legend or reality?
SURVEY AREAS - DIFFERENT ENVIRONMENTS

TRE PORTI CHANNEL
Treporti channel

Value
High : -2.69
Low : -58.701
CONCLUSIONS

• ASSESSMENT OF THE MAIN CHALLENGES OF BATHYMETRY IN SUPER SHALLOW WATER

Reson 7125
Value

• FIRST COMPARISON BETWEEN THE IS AND MBES.

• MBES IS LESS NOISY AND MORE SUITABLE FOR SMALL TARGET DETECTION

• IS IS MORE EFFICIENT IN TERM OF SEAFLOOR COVERAGE

• BOTH SISTEMS IDENTIFY THE SAME MORPHOLOGICAL FEATURES

• POSITIONING IS CRUCIAL FOR REPEATED SURVEYS AND HIGH RESOLUTION GRID
NEXT STEPS…

BACKSCATTER ANALYSIS AND HABITAT MAPPING

QUANTITATIVE ROUGHNESS ESTIMATION

QUANTITATIVE GEOMORPHOLOGY

COUPLING WITH HYDRODINAMIC MODELS
THANKS FOR YOUR ATTENTION

QUESTIONS?