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

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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

INTRODUCTION

-The lagoon of Venice is the biggest lagoon in the Mediterranean area with a surface of about 550 km^2

-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

MOTIVATION

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:

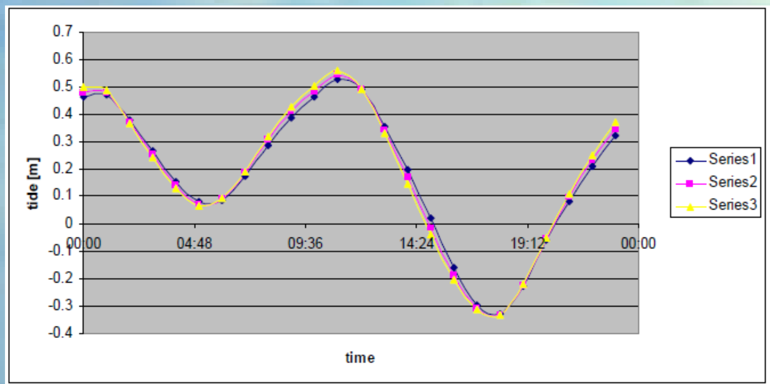
- hot spot areas of erosion and sedimentation.
- repeated surveys on some specific hotspots.

BATHYMETRY IS ONE OF THE MAIN FACTOR IN MULTIDISCIPLINARY STUDIES

- Habitat mapping
- Quantitative geomorphology
- Sediment budgets
- Geo-archaeology

THE CHALLEGE OF BATHYMETRY IN THE LAGOON OF VENICE

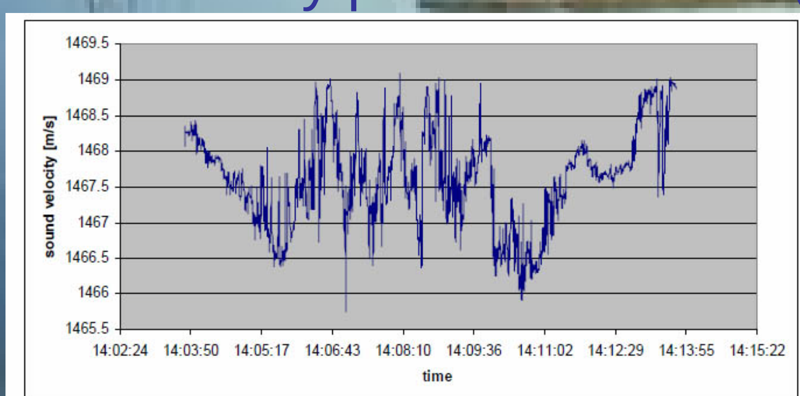
- Extremely shallow water (~1 m) – Multipath effect and reverberation
- High turbidity – no transparent water



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

•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)



Scanello channel svp vs time

From Dese to Torcello svp vs space

THE CHALLEGE OF BATHYMETRY IN SUPER SHALLOW WATER ENVIROMENTS

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 CONTINUOS RTK CORRECTION EVERYWHERE

TO SOLVE THIS PROBLEM:

post-processing of position

fixed station

THE TRIALS WITH MULTI BEAM AND INTERFEROMETRIC SYSTEMS

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

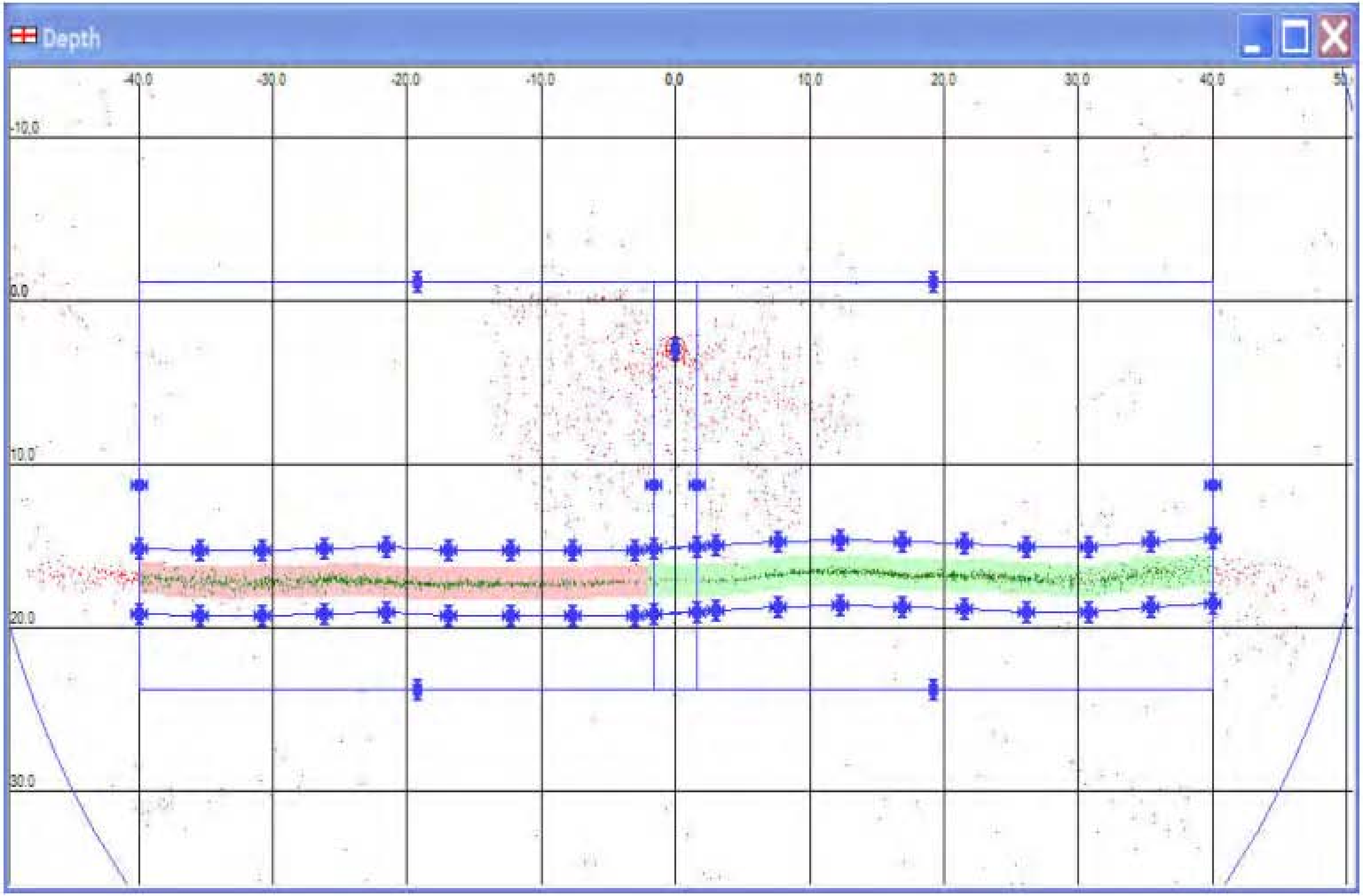
Boat equipment with Reson 7125

Weight ~ 21 kg
Swath angle 140
Max depth ~ 200-400 m
Real swath coverage ~ 6 times water depth

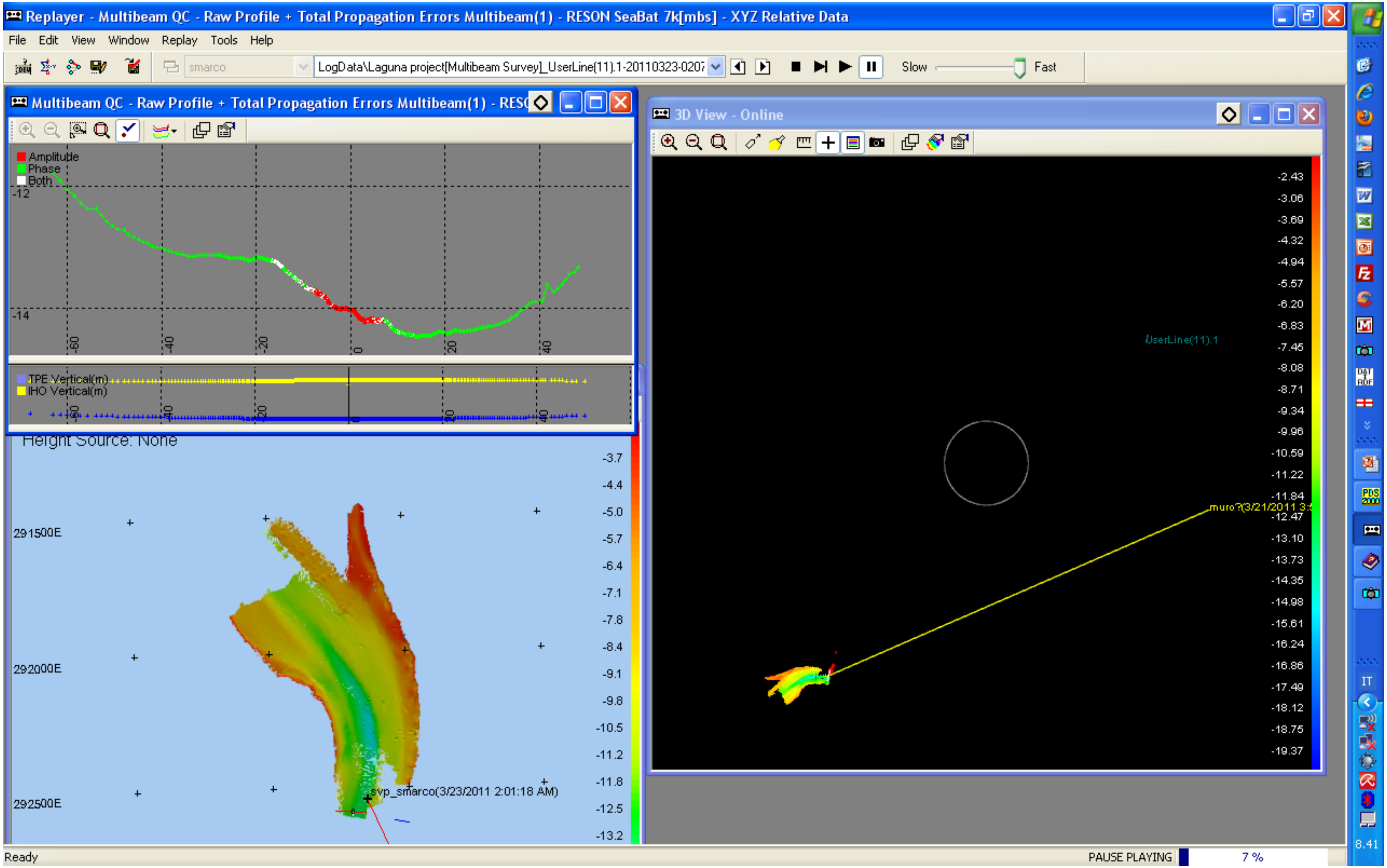
Multibeam Reson 7125 200-400 kHz
Laser Scanner Optech HD High Density
RTK POSITIONING Applanix POS-MV
DGPS OmniSTAR

THE TRIALS – INTERFEROMETRIC ACQUISITION AND PROCESSING

- Amplitude filtering
- Statistical filtering
- Binning

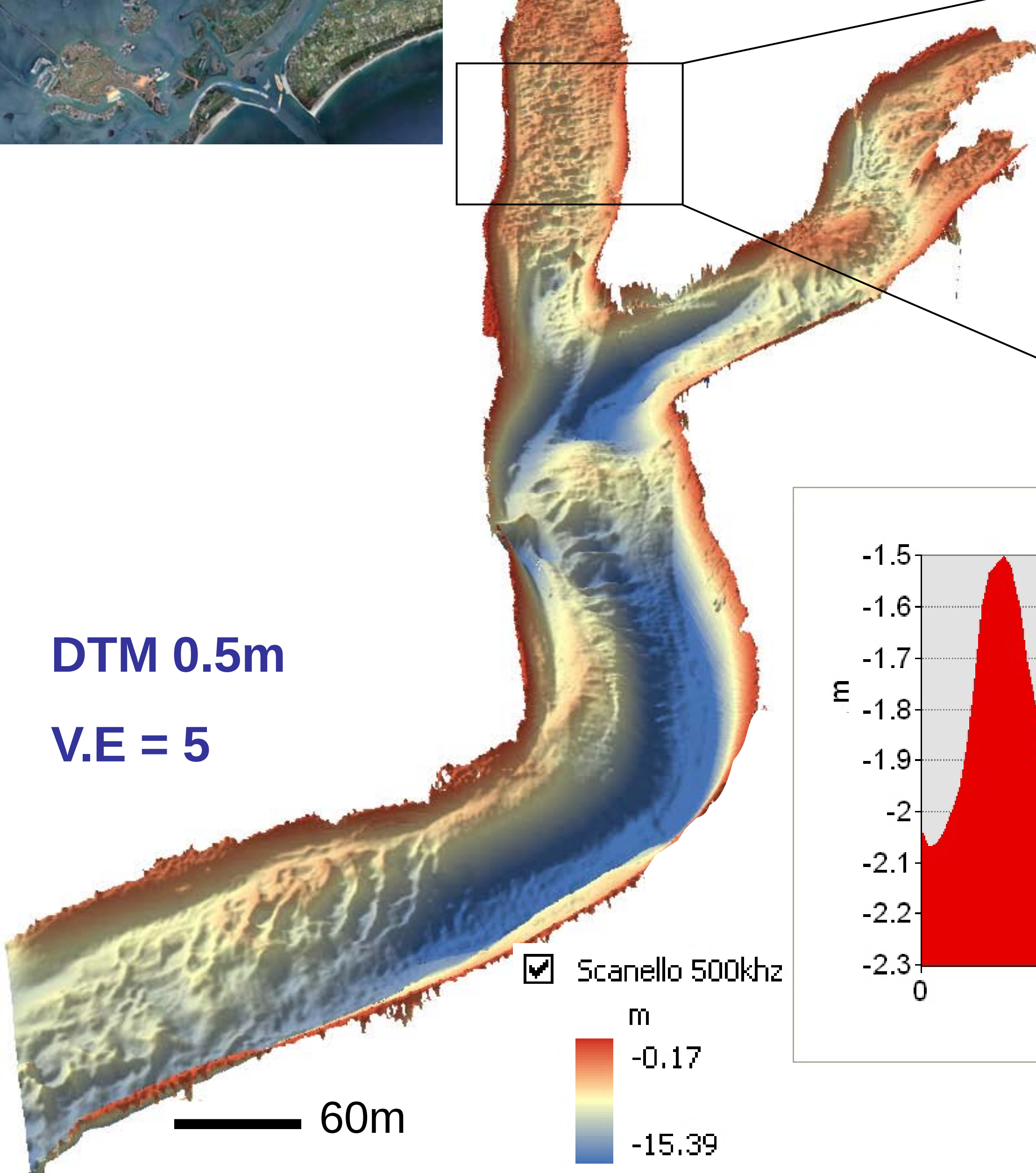


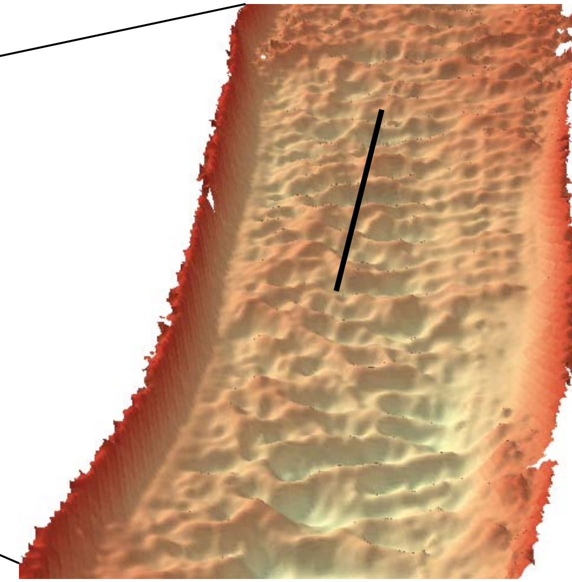
THE TRIALS – MULTI BEAM ACQUISITION AND PROCESSING

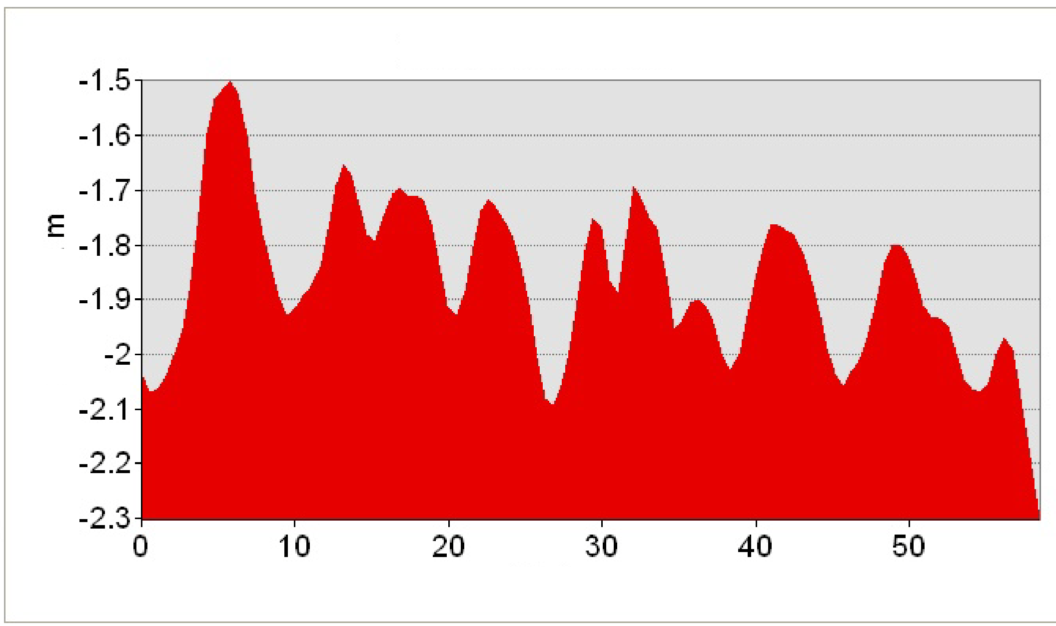


SURVEY AREAS-DIFFERENT ENVIRONMENTS

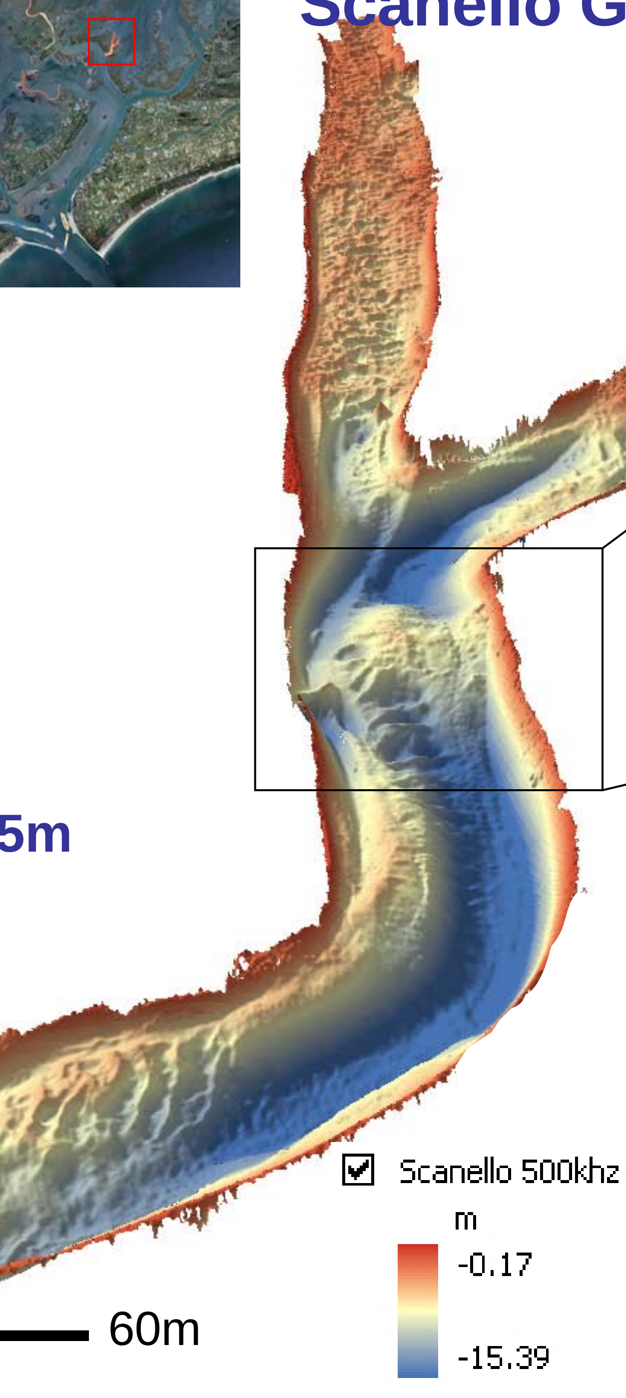
Scanello GeoSwath 500 kHz

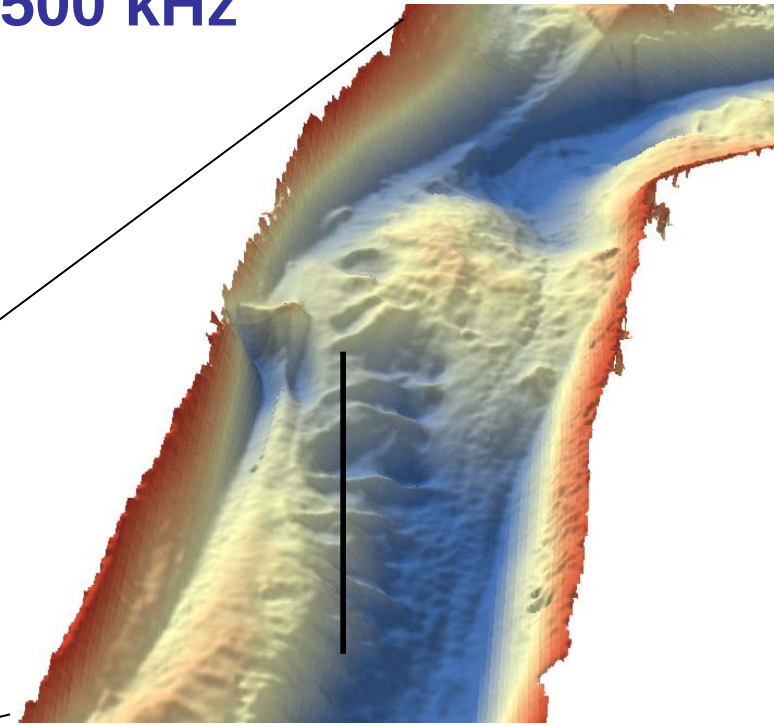






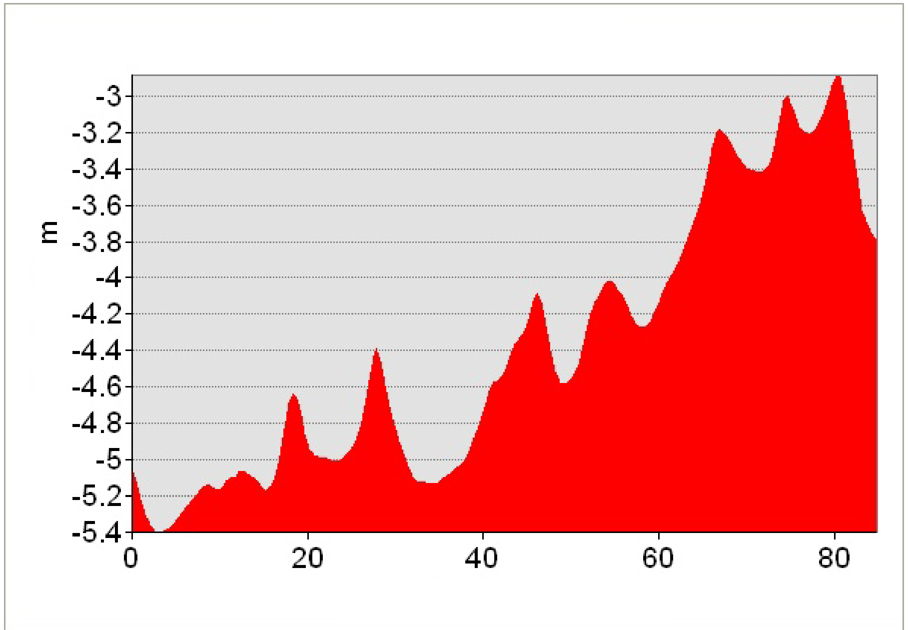
Scanello GeoSwath 500 kHz



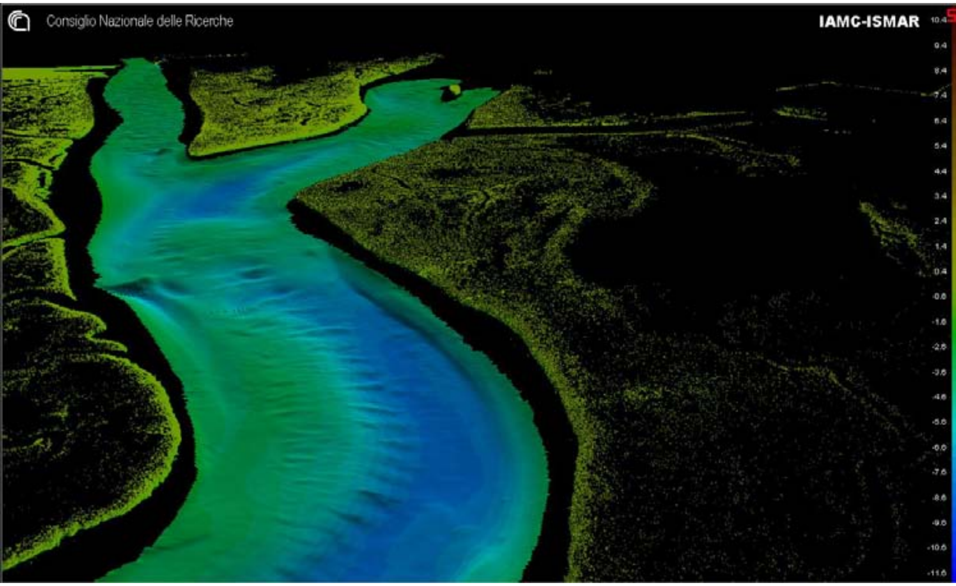


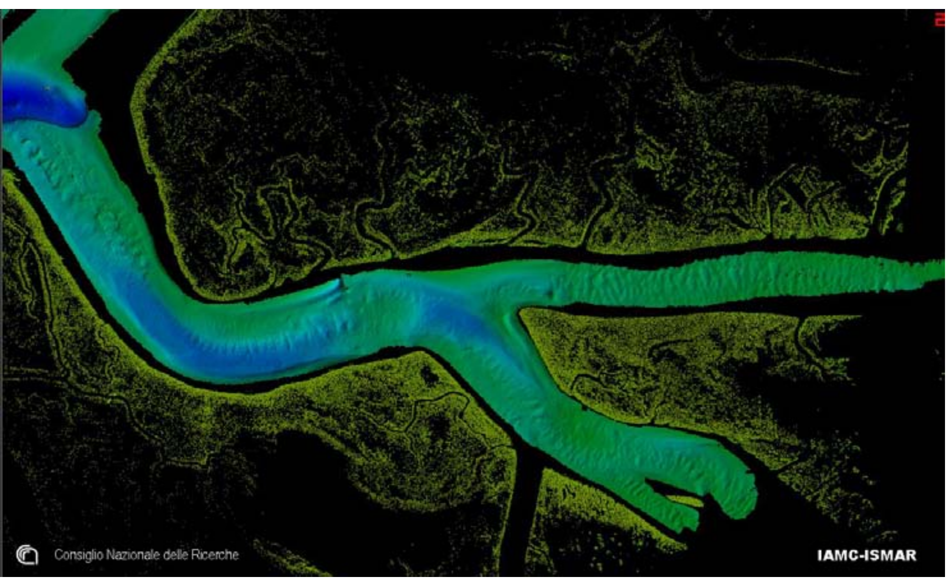
DTM 0.5m

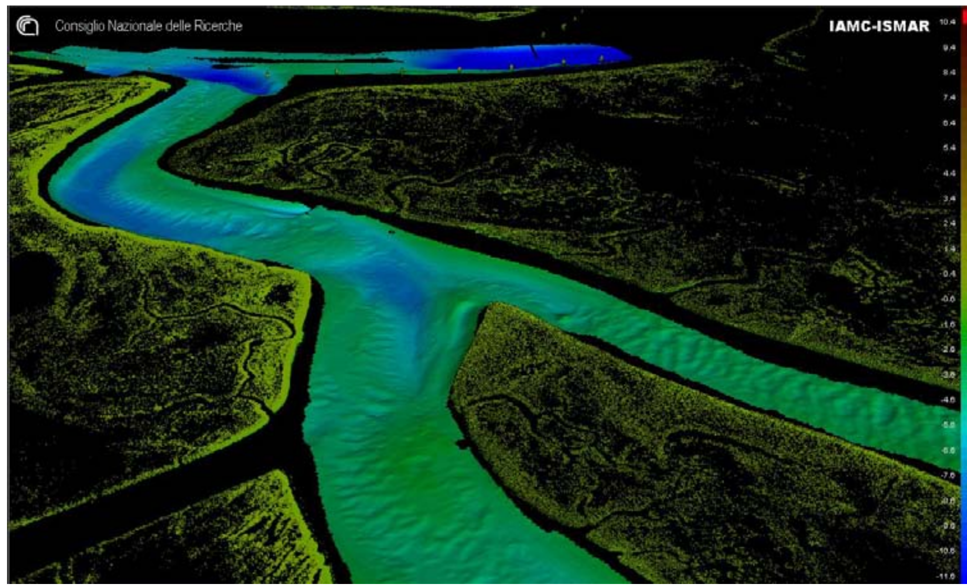
V.E = 5



Scanello Reson 7125 + Laser scanner

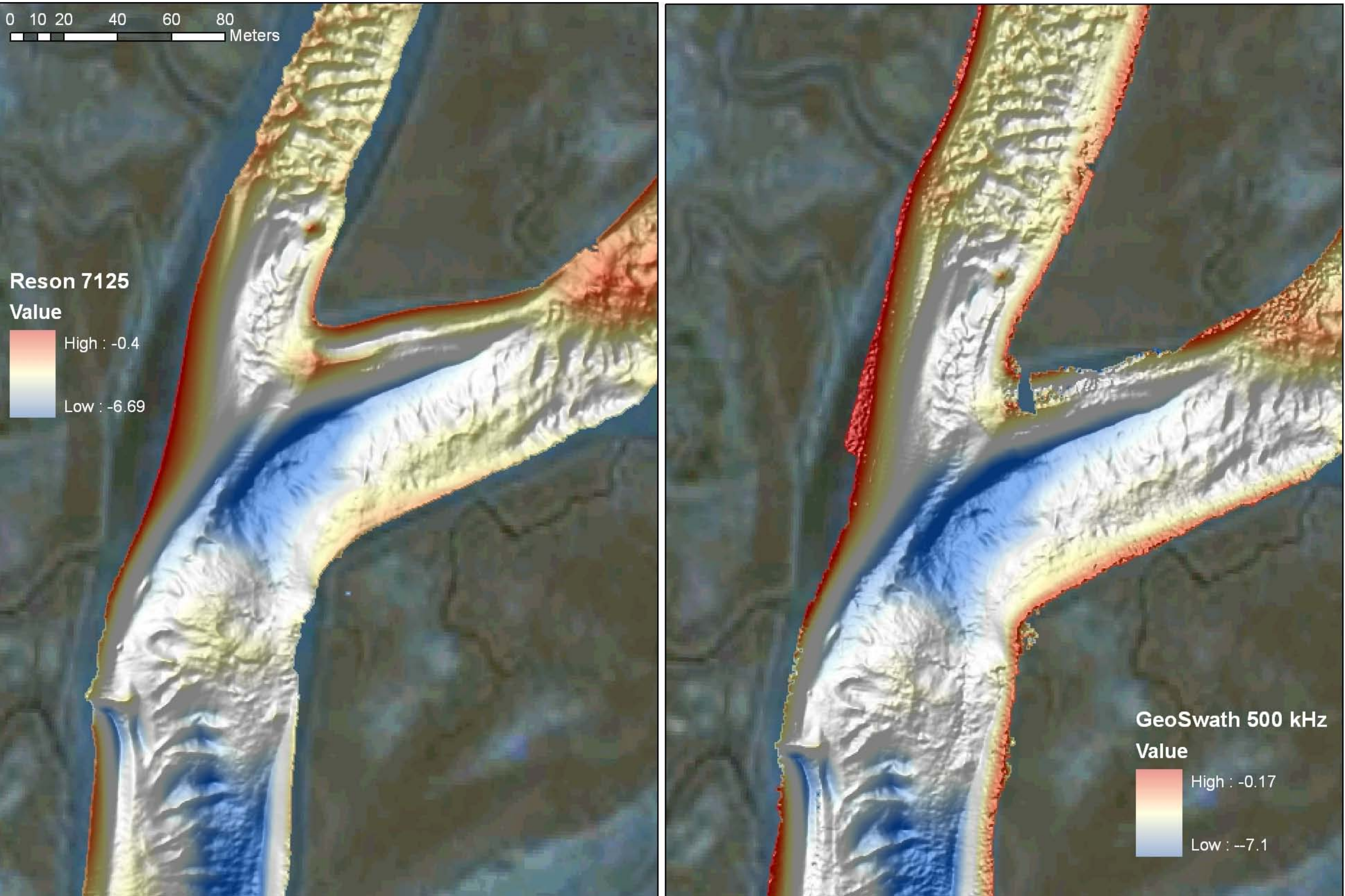




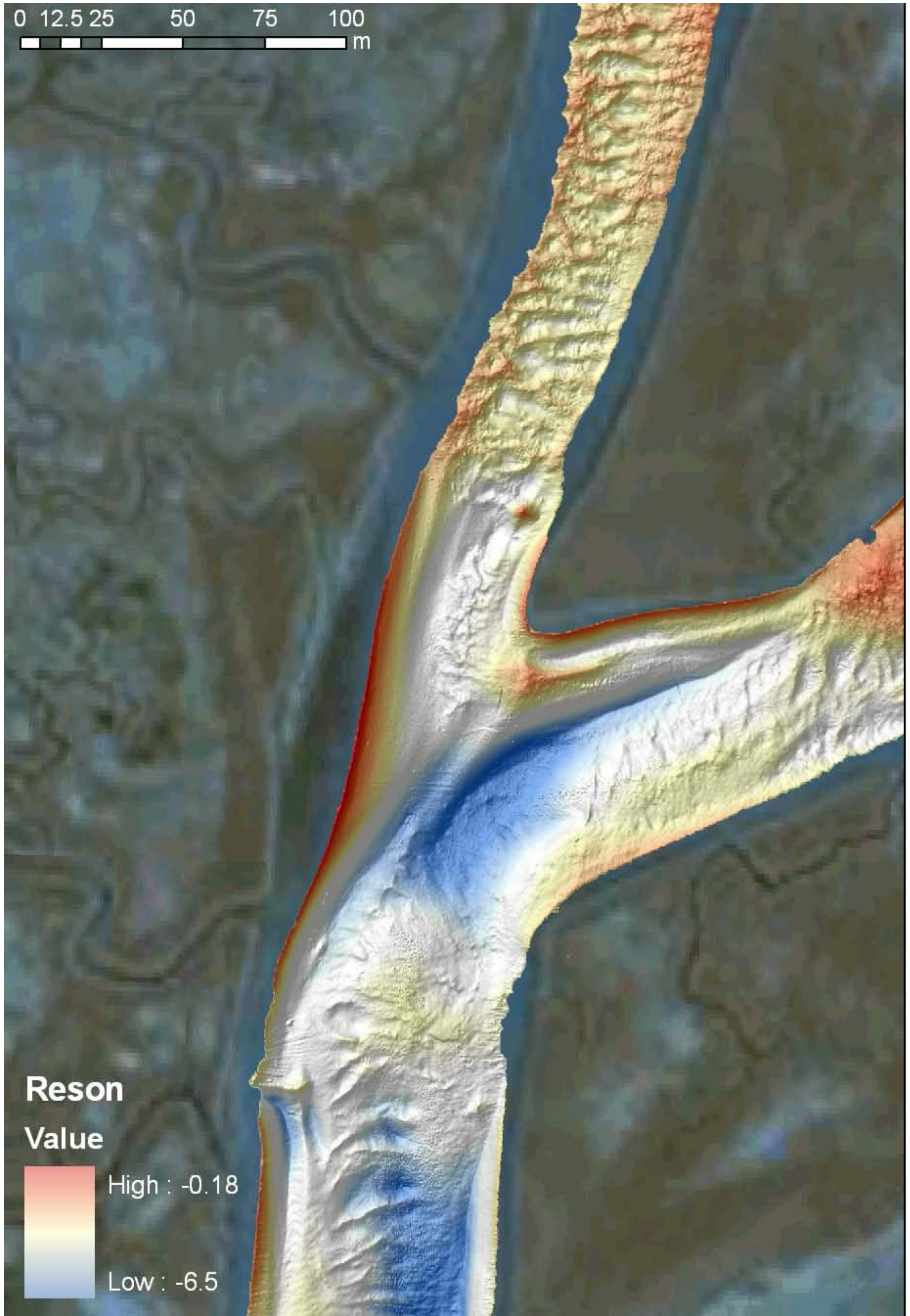


RESON vs GEOSWATH 500
DTM 0.5 m

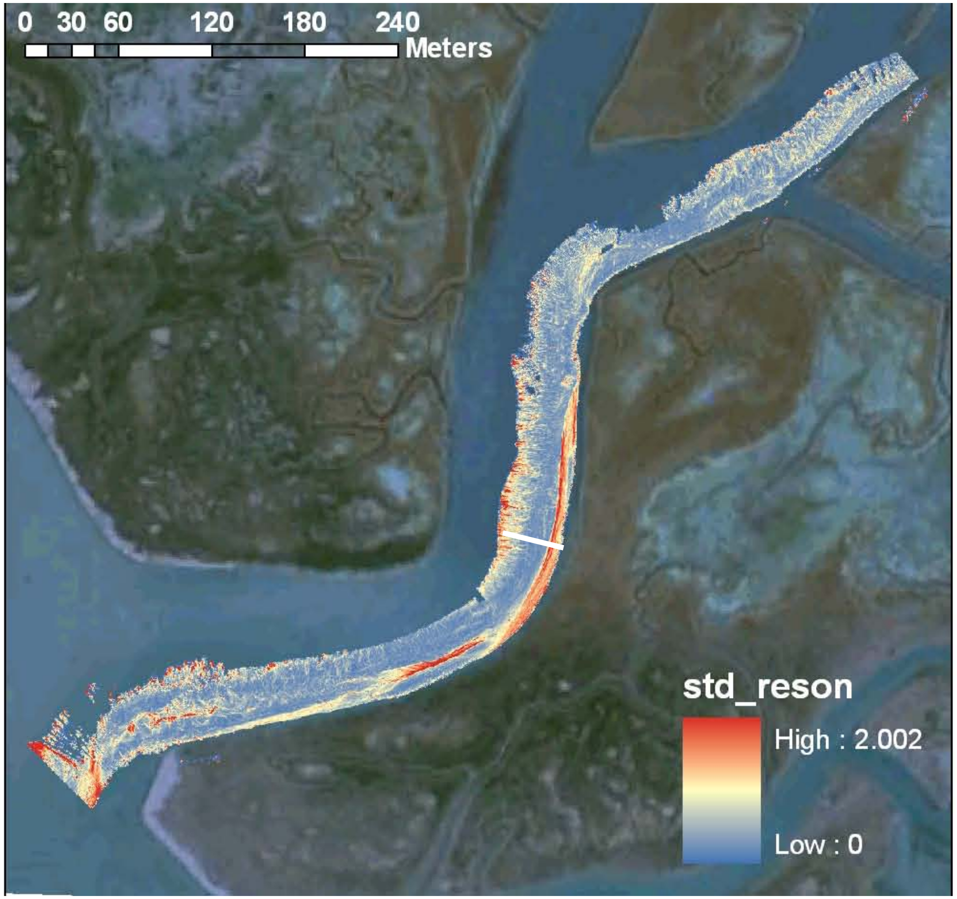
RESON vs GEOSWATH 500
DTM 0.5 m



RESON vs GEOSWATH 500 DTM 0.2 m

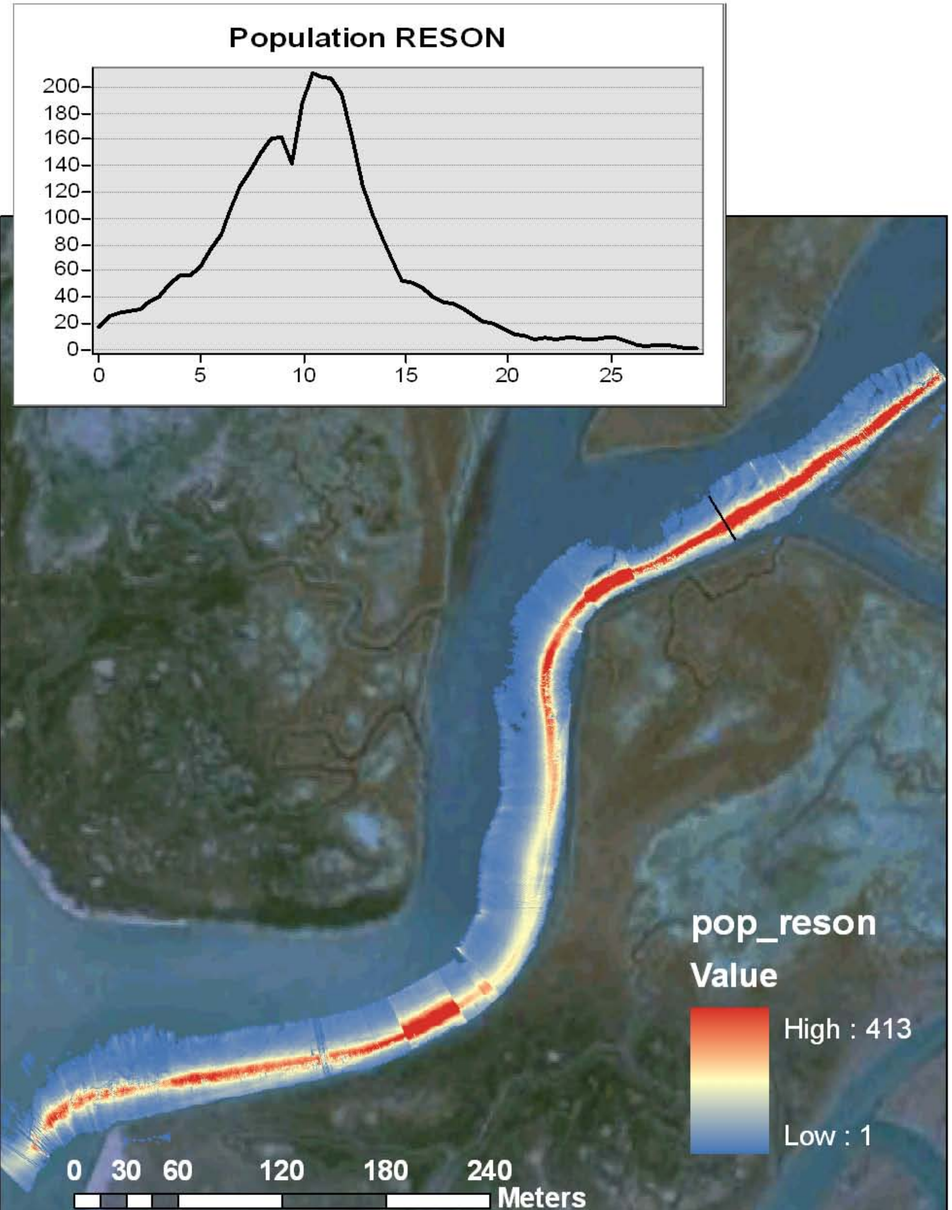


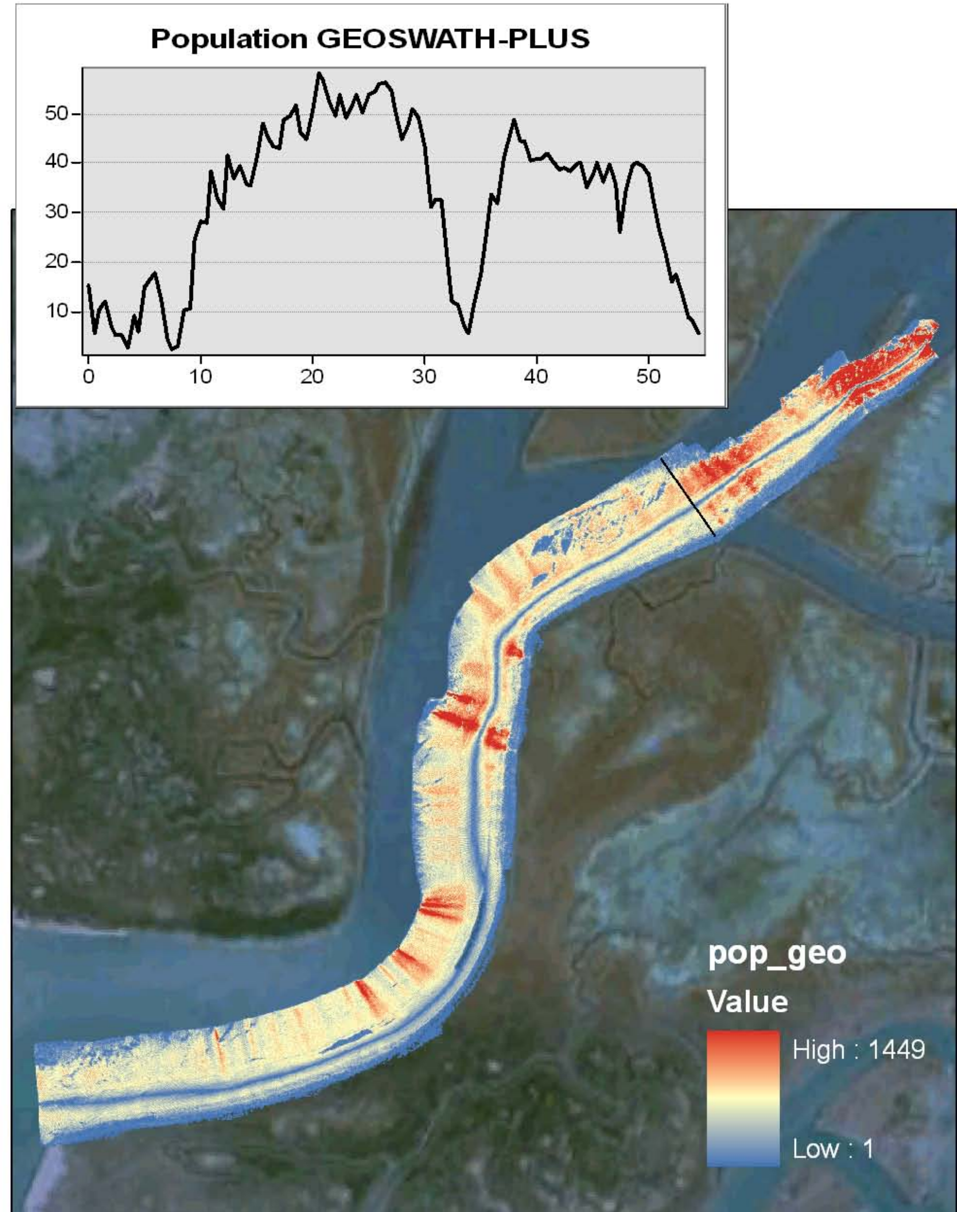
RESON vs GEOSWATH 500
STD



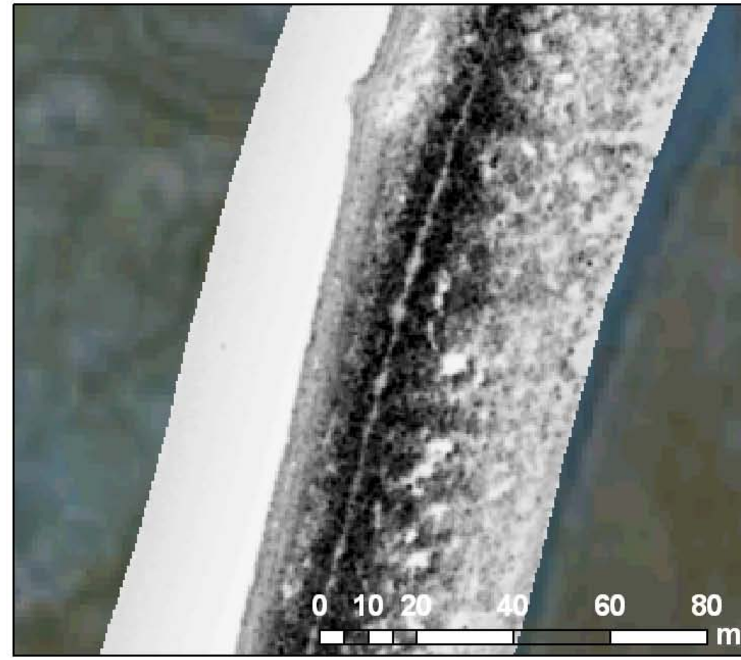
Swath Coverage at 6m water depth
35 vs 55 m
6 x vs 9x

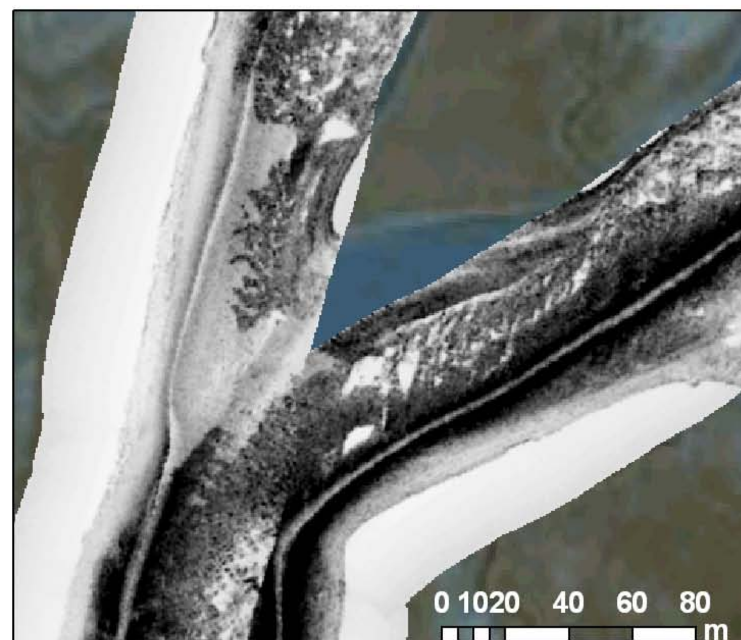
RESON vs GEOSWATH 500 kHz POPULATION



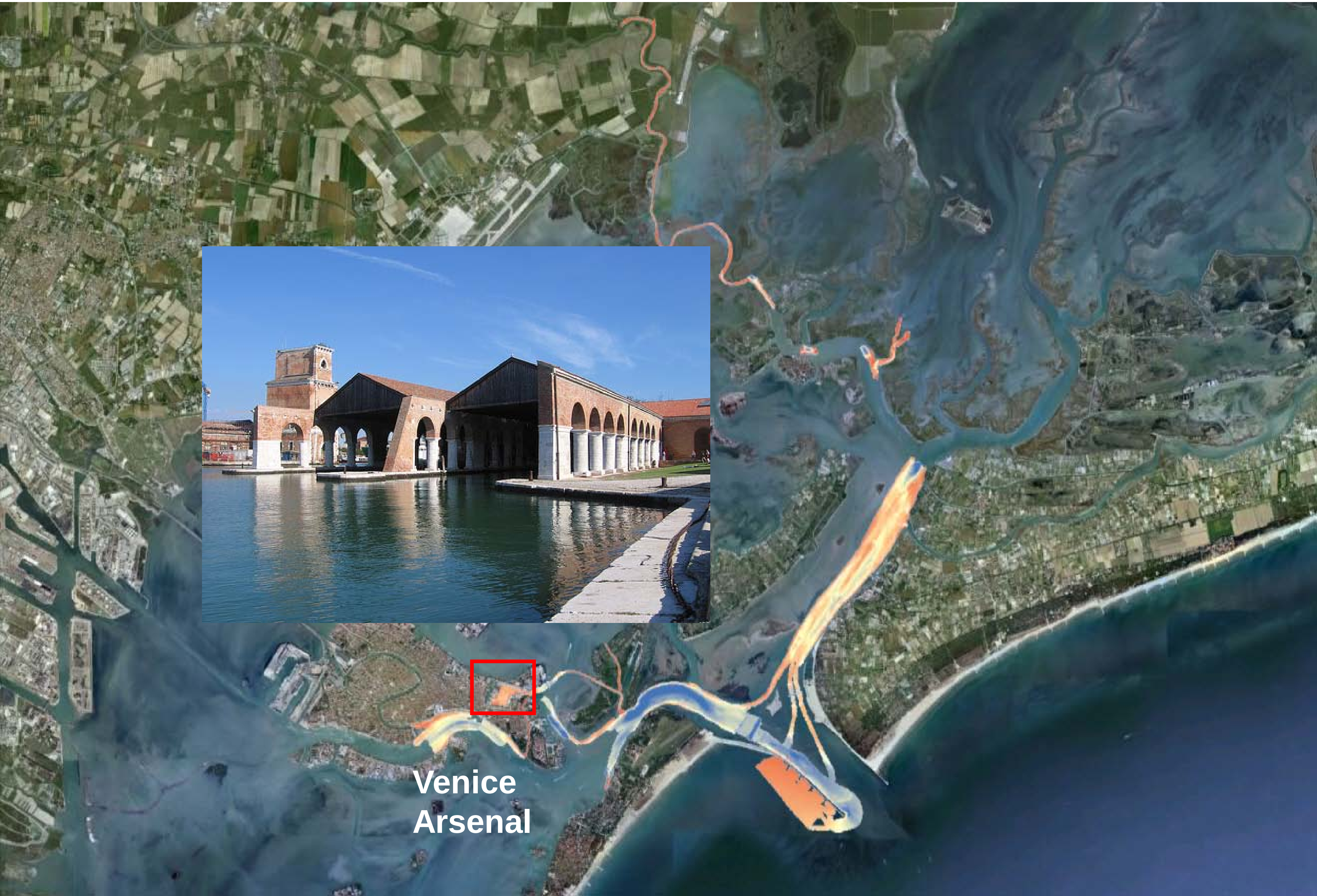


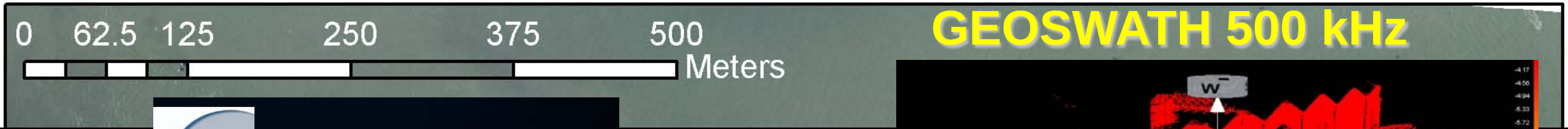
GEOSWATH 500 kHz - Backscatter



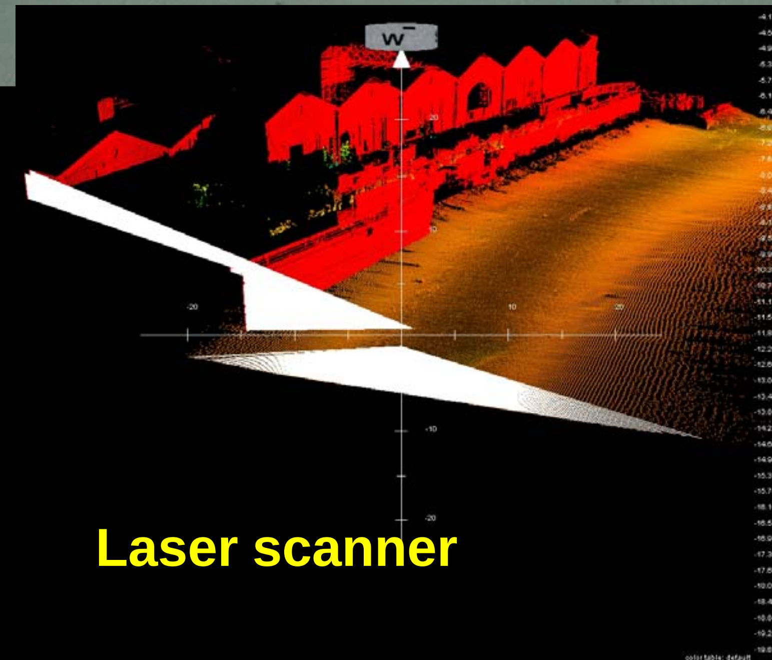


SURVEY AREAS - DIFFERENT ENVIRONMENTS





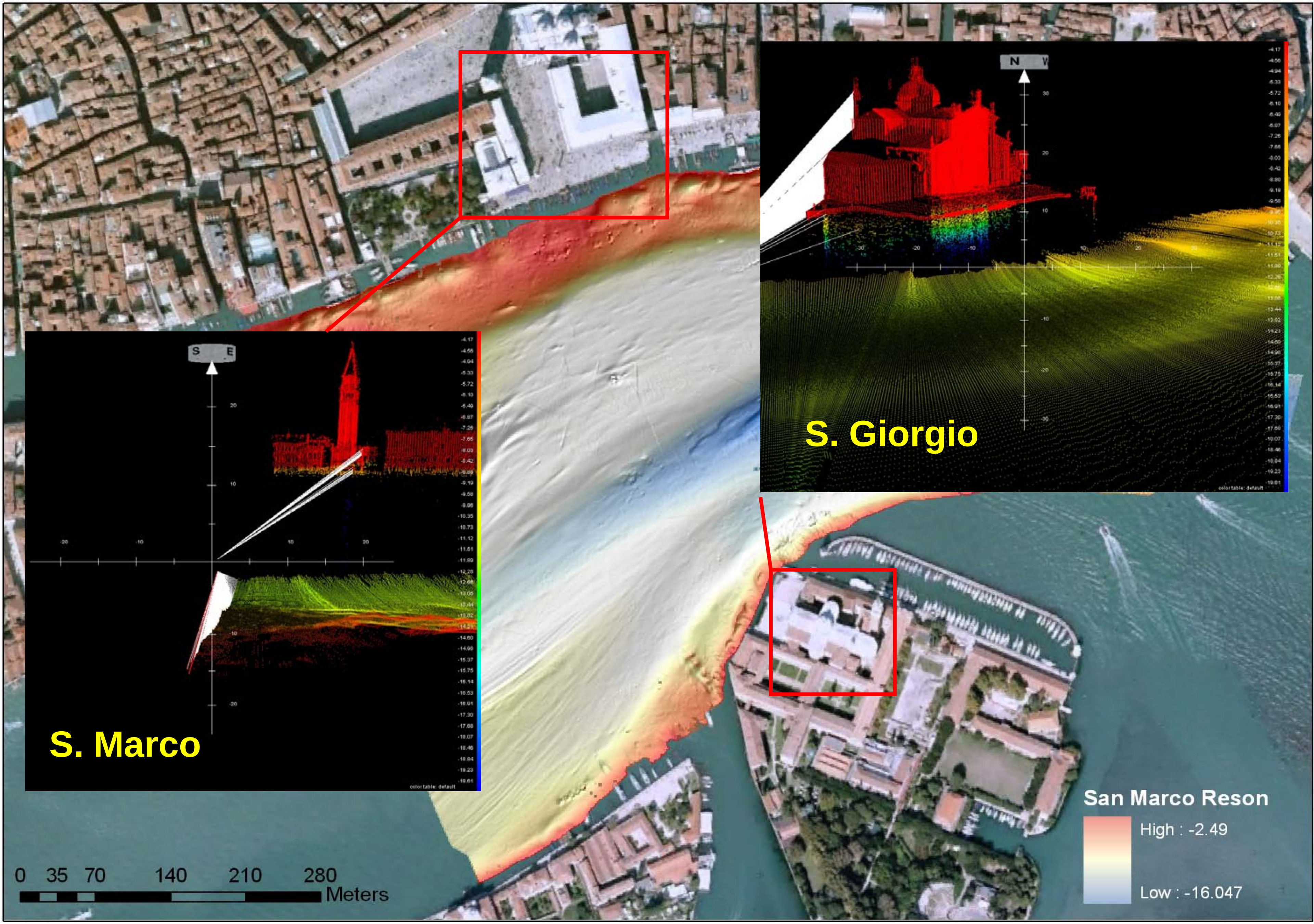
GEOSWATH 500 kHz



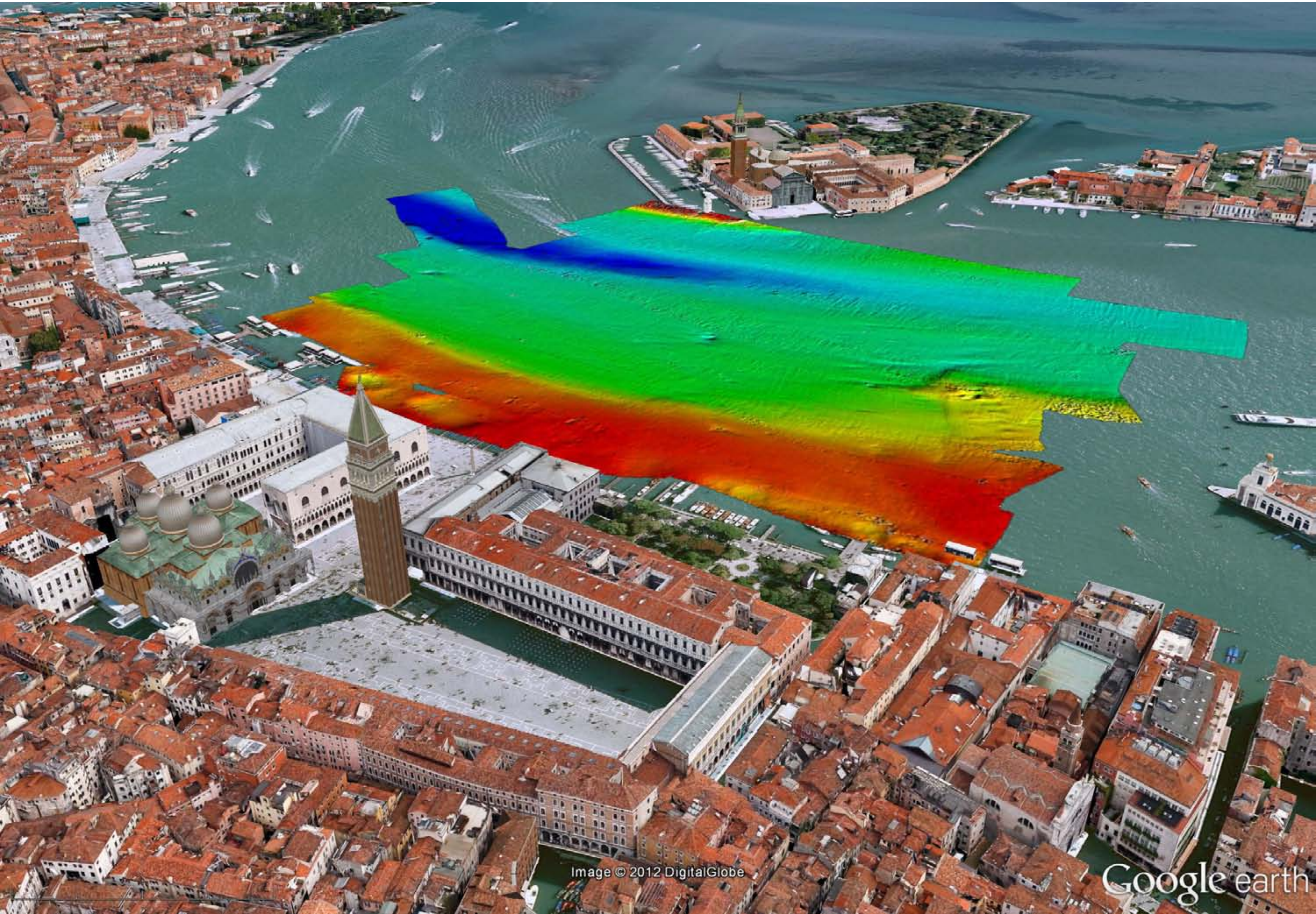
Laser scanner

SURVEY AREAS - DIFFERENT ENVIRONMENTS

RESON 7125


S. Giorgio
S. Marco
San Marco Reson
High : -2.49
Low : -16.047
0 35 70 140 210 280
Meters

SAN MARCO SQUARE - The Third Column legend or reality?



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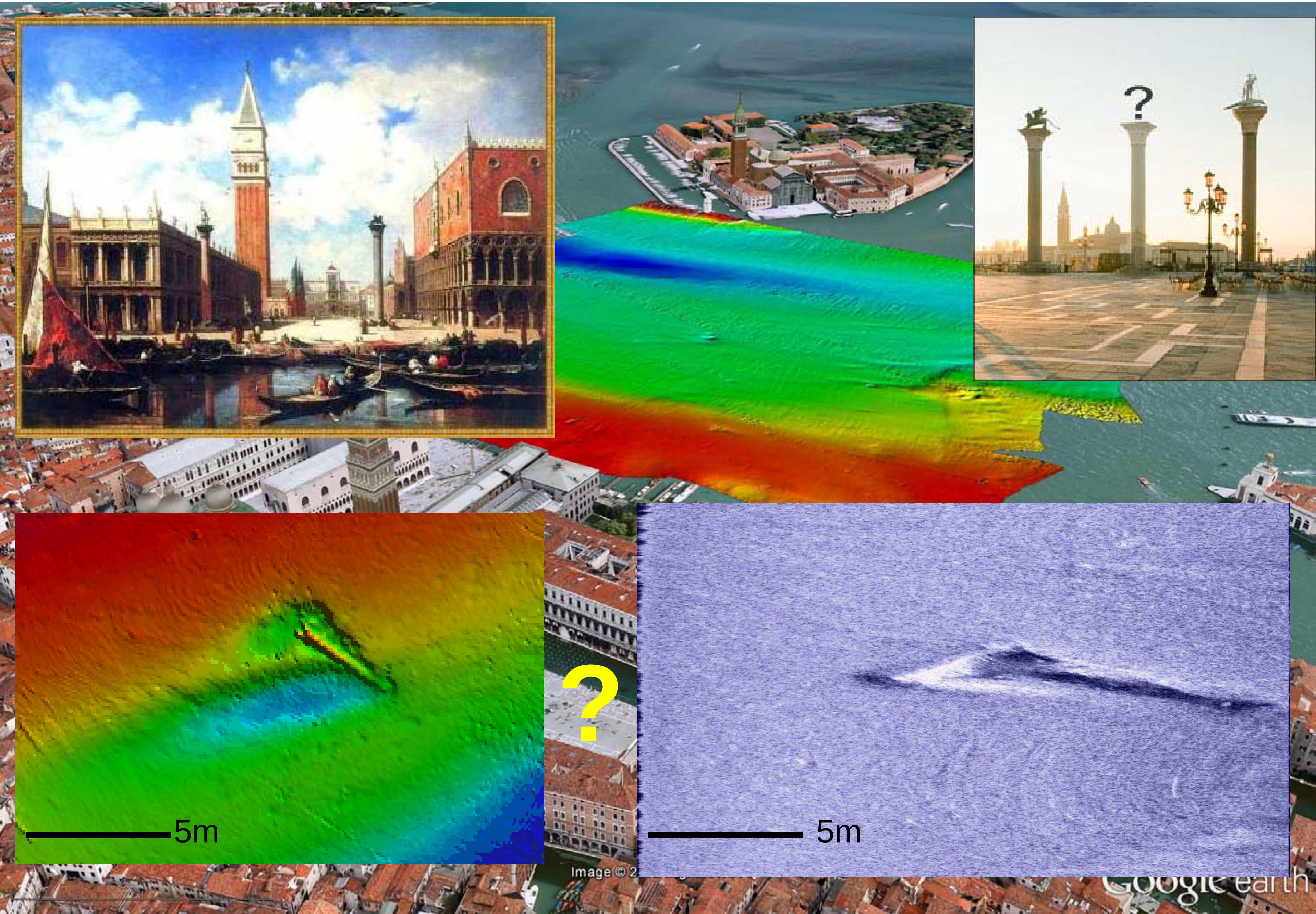
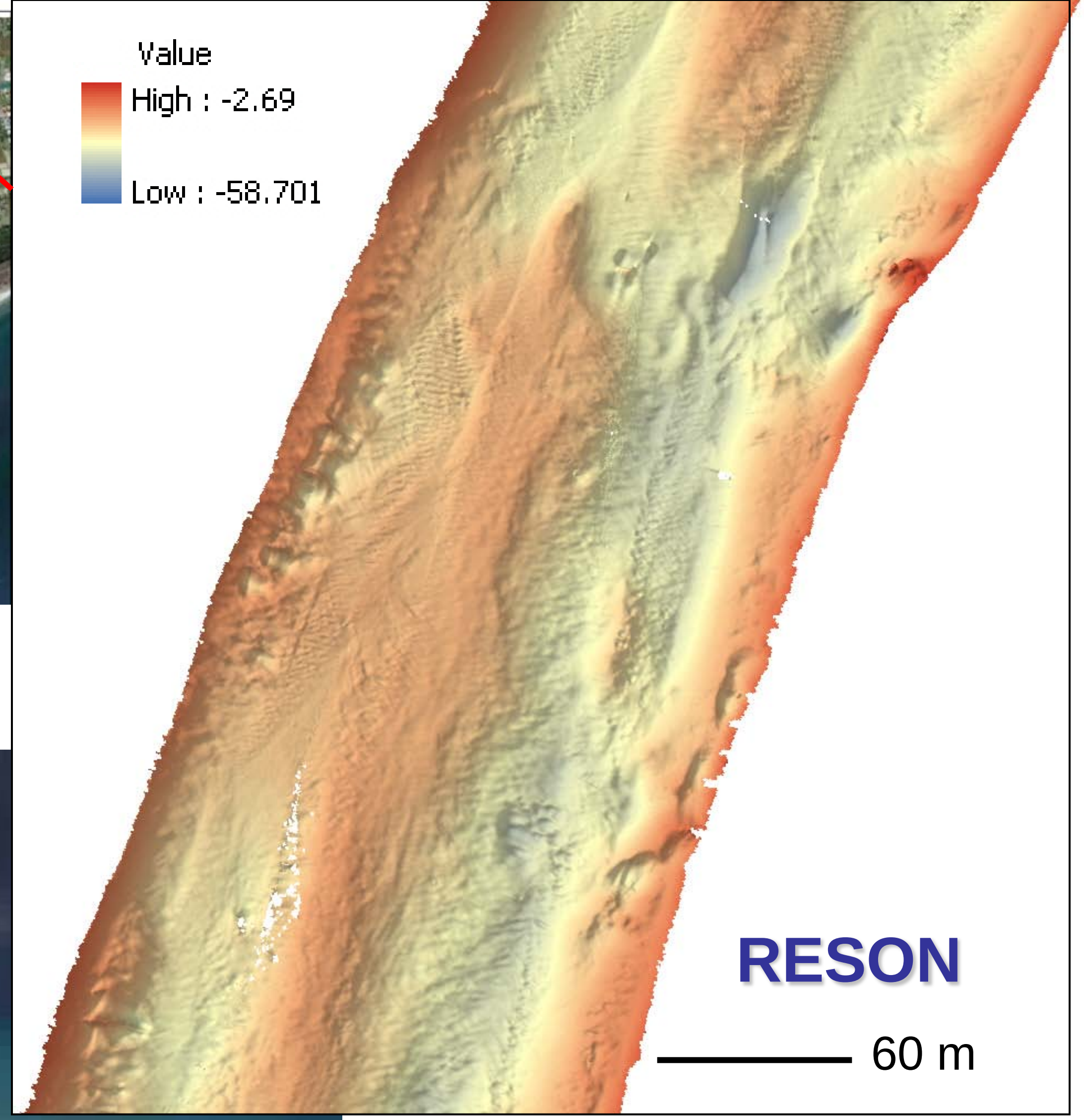
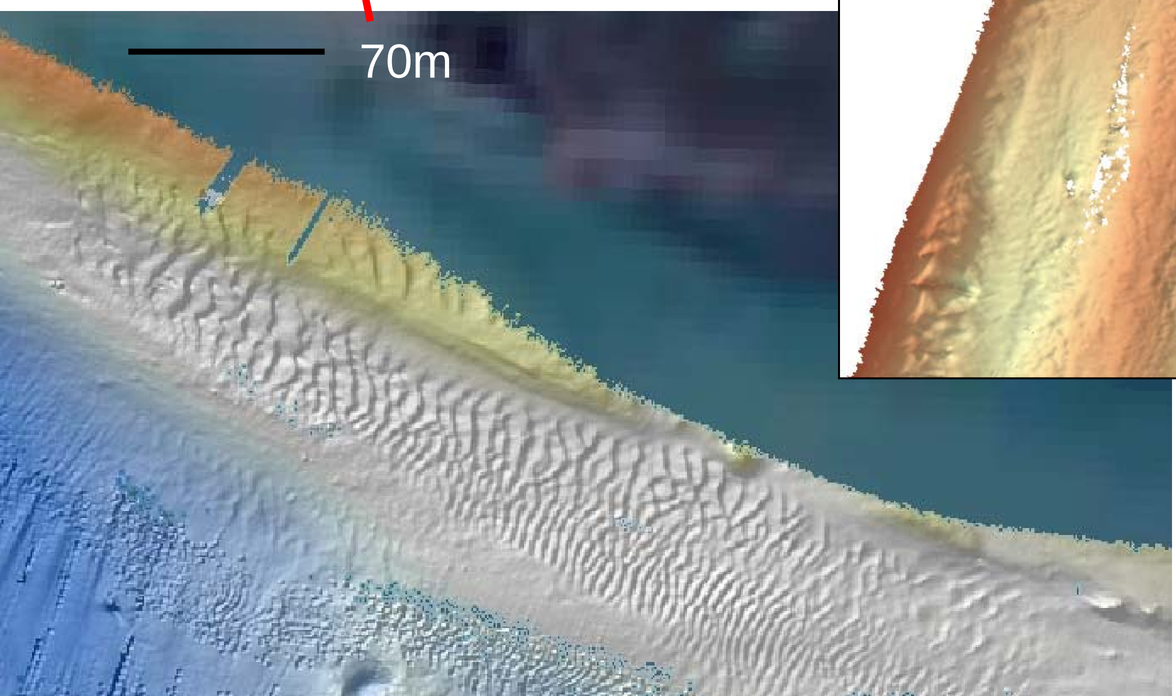


SURVEY AREAS - DIFFERENT ENVIRONMENTS

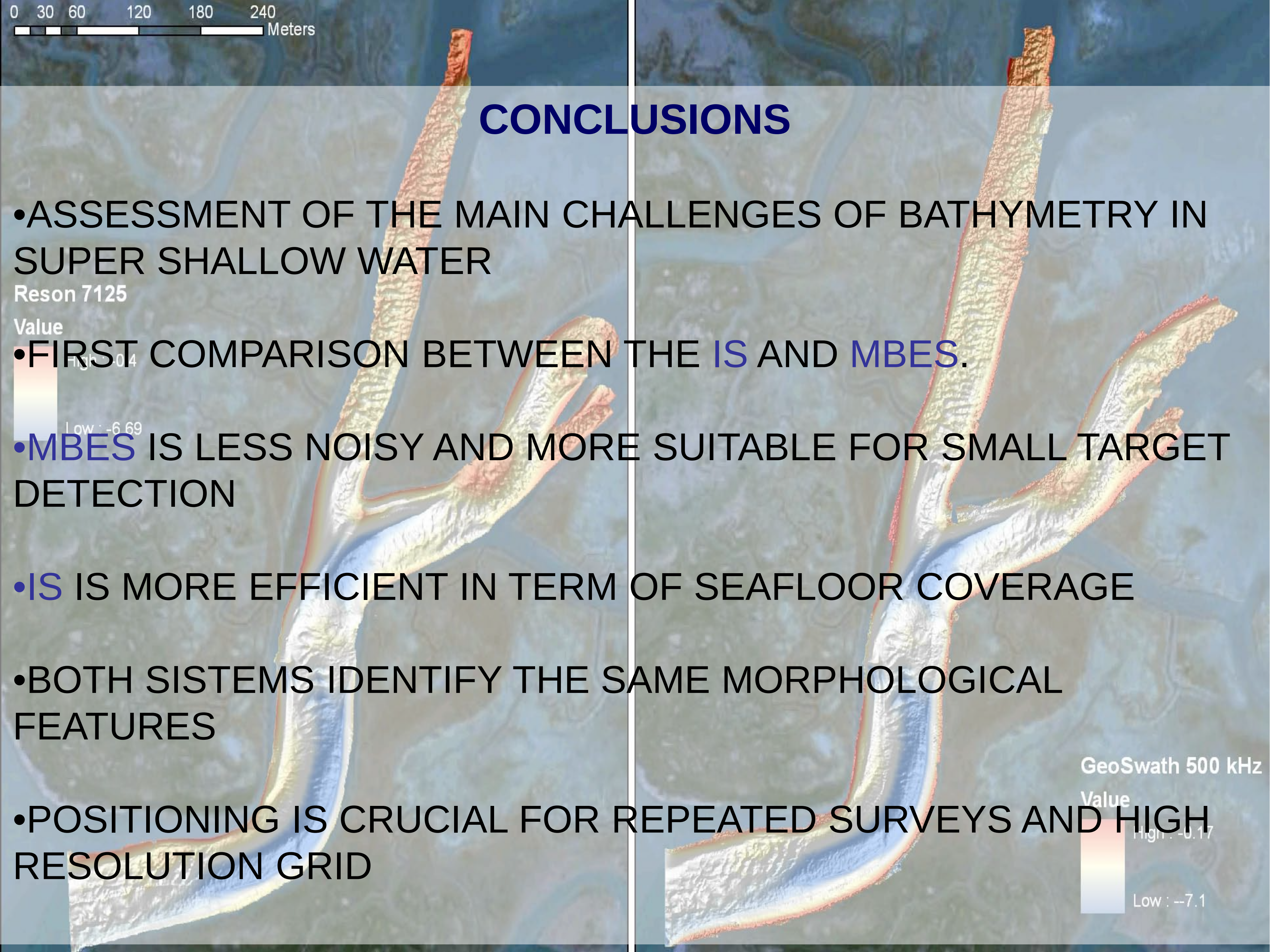

60m
GEOSWATH 250 kHz
Mose
m
High : -3.49
Low : -12.77
lagunatot
High : -0.653
Low : -100.105
0 255 510 1,020 1,530 2,040 2,550
Meters
RESON
0 45 90 180 270 360 450
Meters

SURVEY AREAS - DIFFERENT ENVIRONMENTS



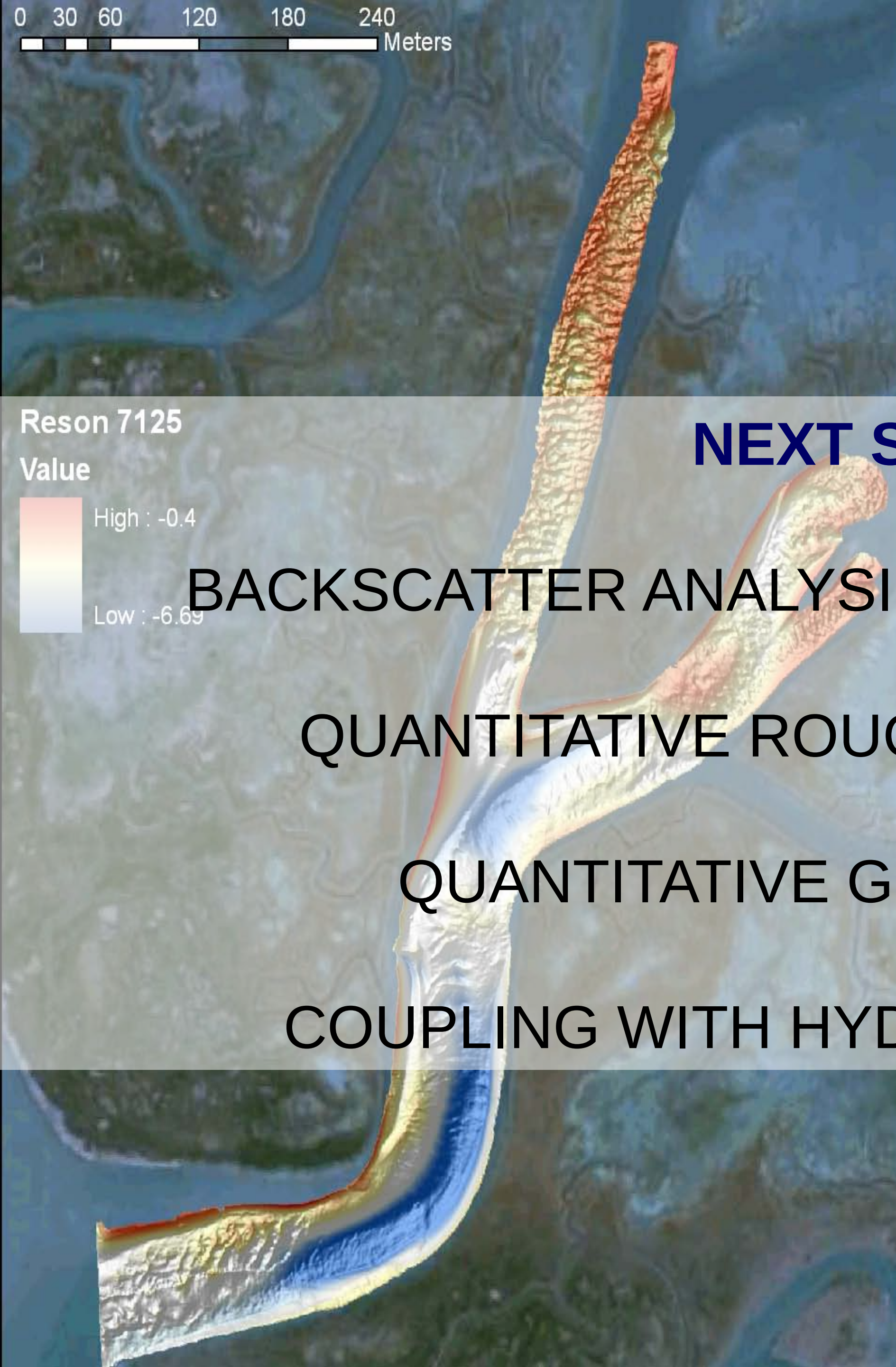


Treporti channel



CONCLUSIONS

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



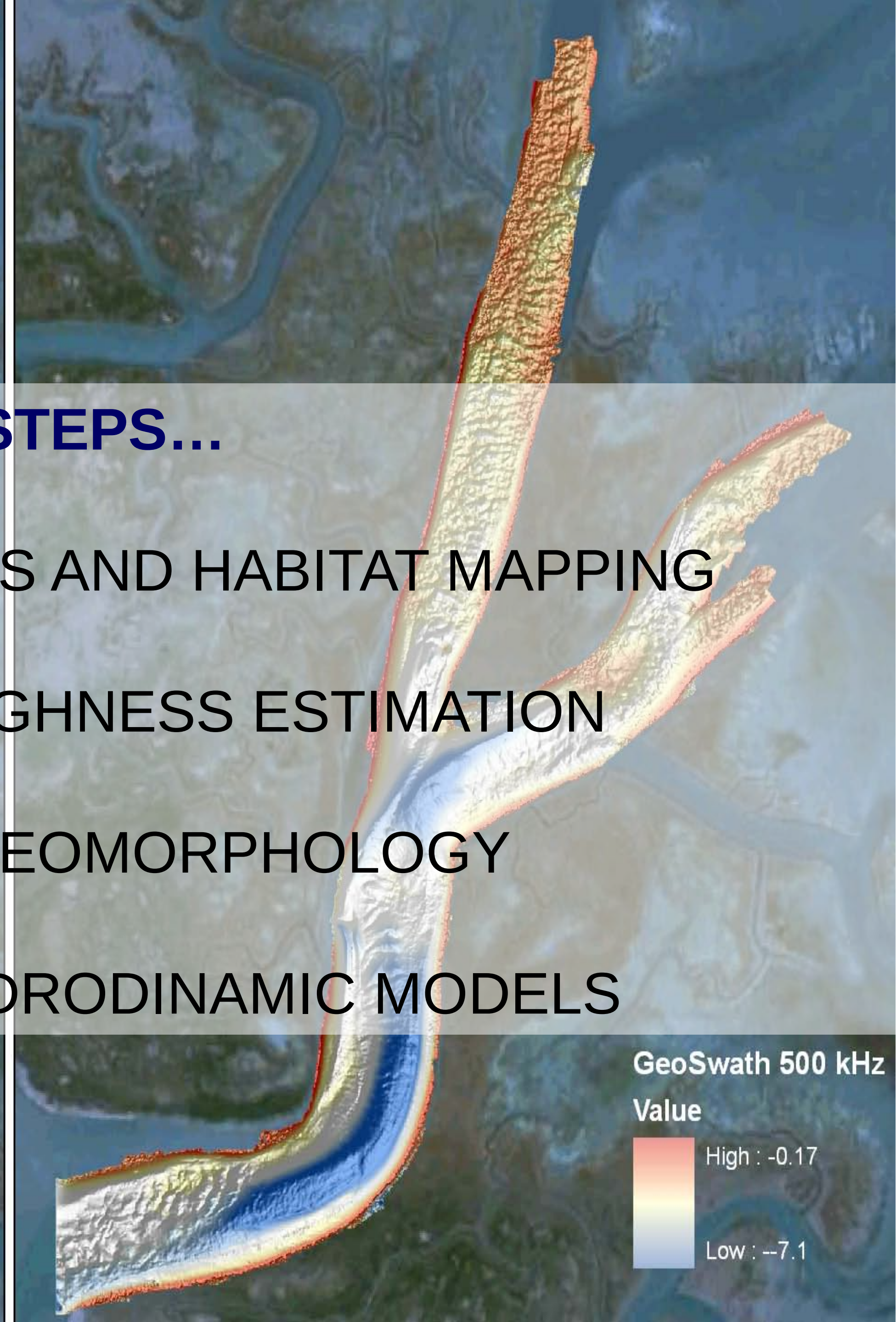
NEXT STEPS…

BACKSCATTER ANALYSIS AND HABITAT MAPPING

QUANTITATIVE ROUGHNESS ESTIMATION

QUANTITATIVE GEOMORPHOLOGY

COUPLING WITH HYDRODINAMIC MODELS



THANKS FOR YOUR ATTENTION

QUESTIONS?