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Predicted mapping of seabed sediments based on MBES backscatter and bathymetric data: A case study in Joseph Bonaparte Gulf, Australia using Random Forest Decision Tree

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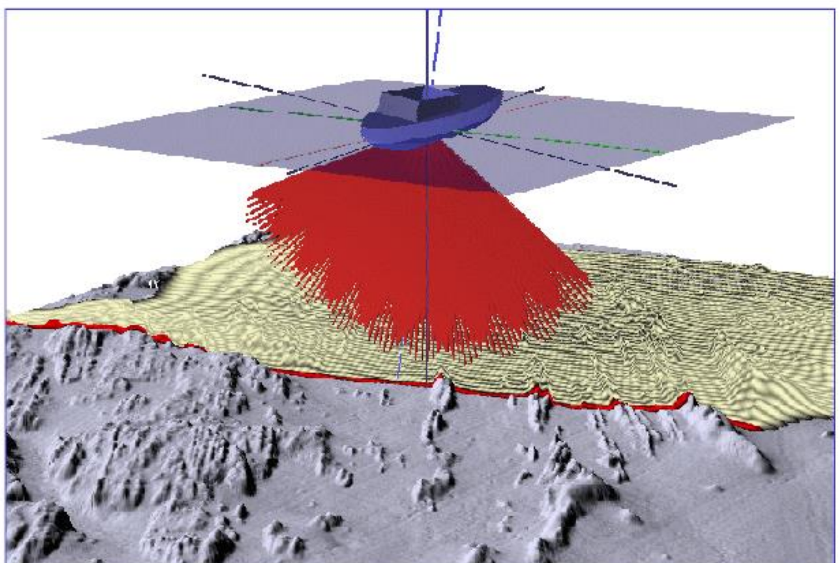
Introduction

To obtain seabed information …

- Traditional Technique
- Seabed sampling
  - Grab
  - Core



more efficiently and accurately….

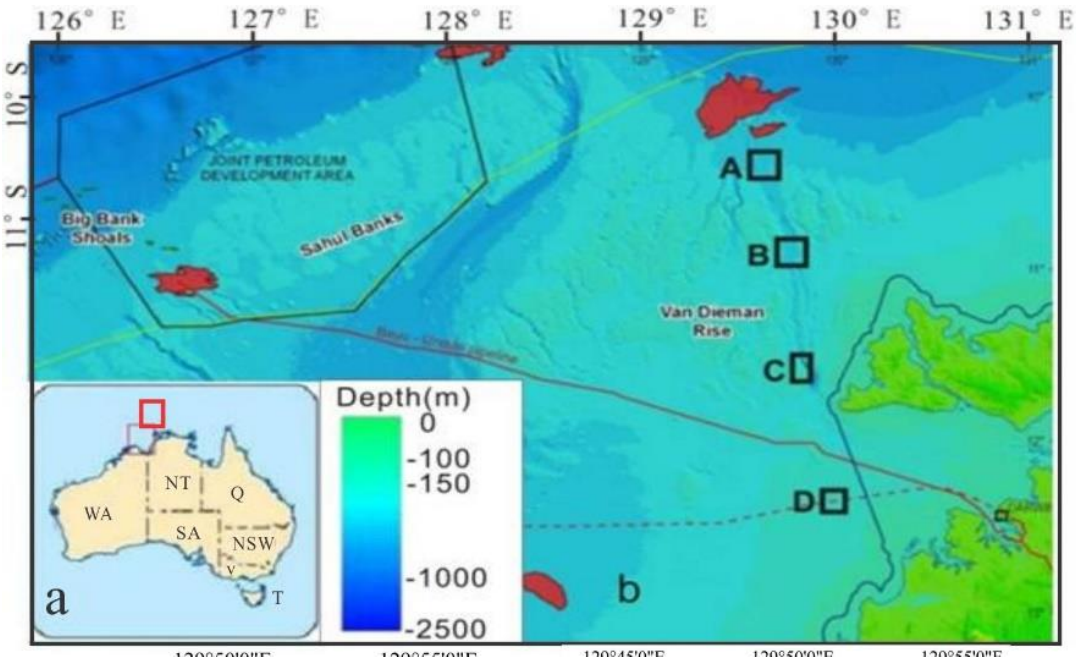
- More Recent Techniques
- Acoustic Remote Sensing
  - Single beam
  - Side Scan
  - Multibeam
  - Sub-bottom profiler
- Optical Remote Sensing
  - Under-water camera
  - Satellites and airborne sensors
  - Lidar

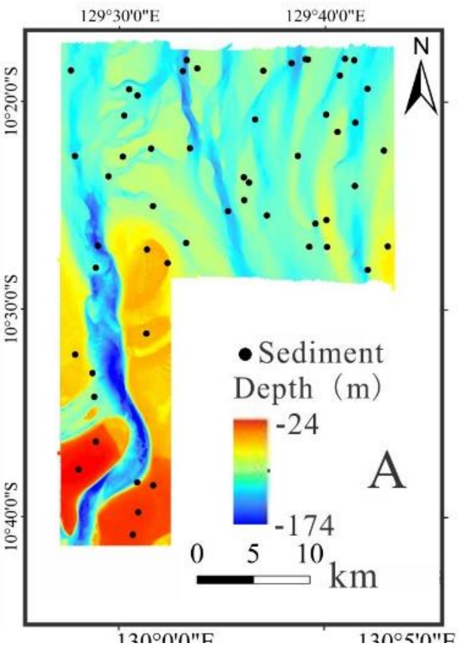
Study Aim and Objectives

- Aim: Investigate the full potential of multibeam data in predictive mapping of seabed properties and types

- Objectives:
  - Prediction of individual sediment properties
    - %Gravel
    - %Mud
    - %Sand
    - MGS: Mean Grain Size
  - Classification of sediment types

Study area





A geomorphologically complex area as a case study: Joseph Bonaparte Gulf, Australia

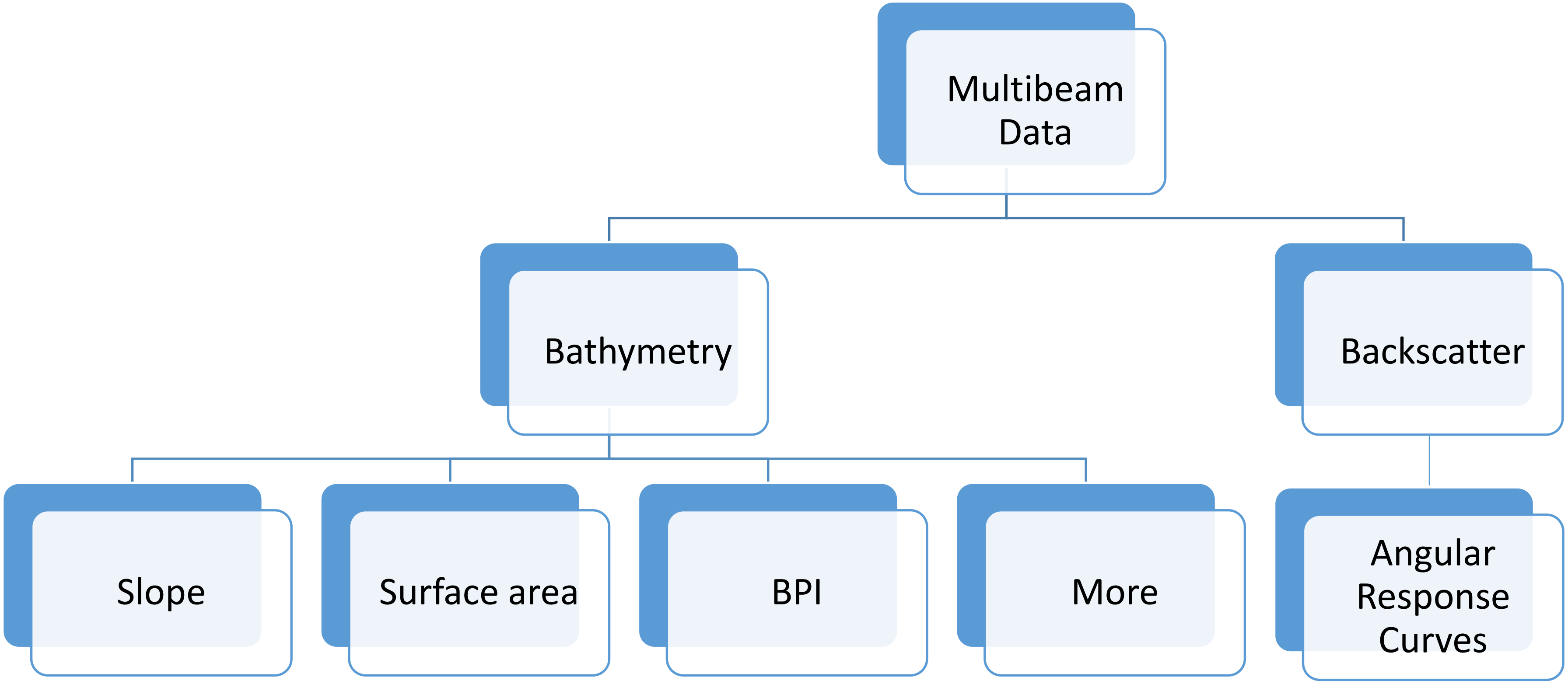
Data collection: 54 sediment samples; 880 km^2 multibeam bathymetry and backscatter data

Methods

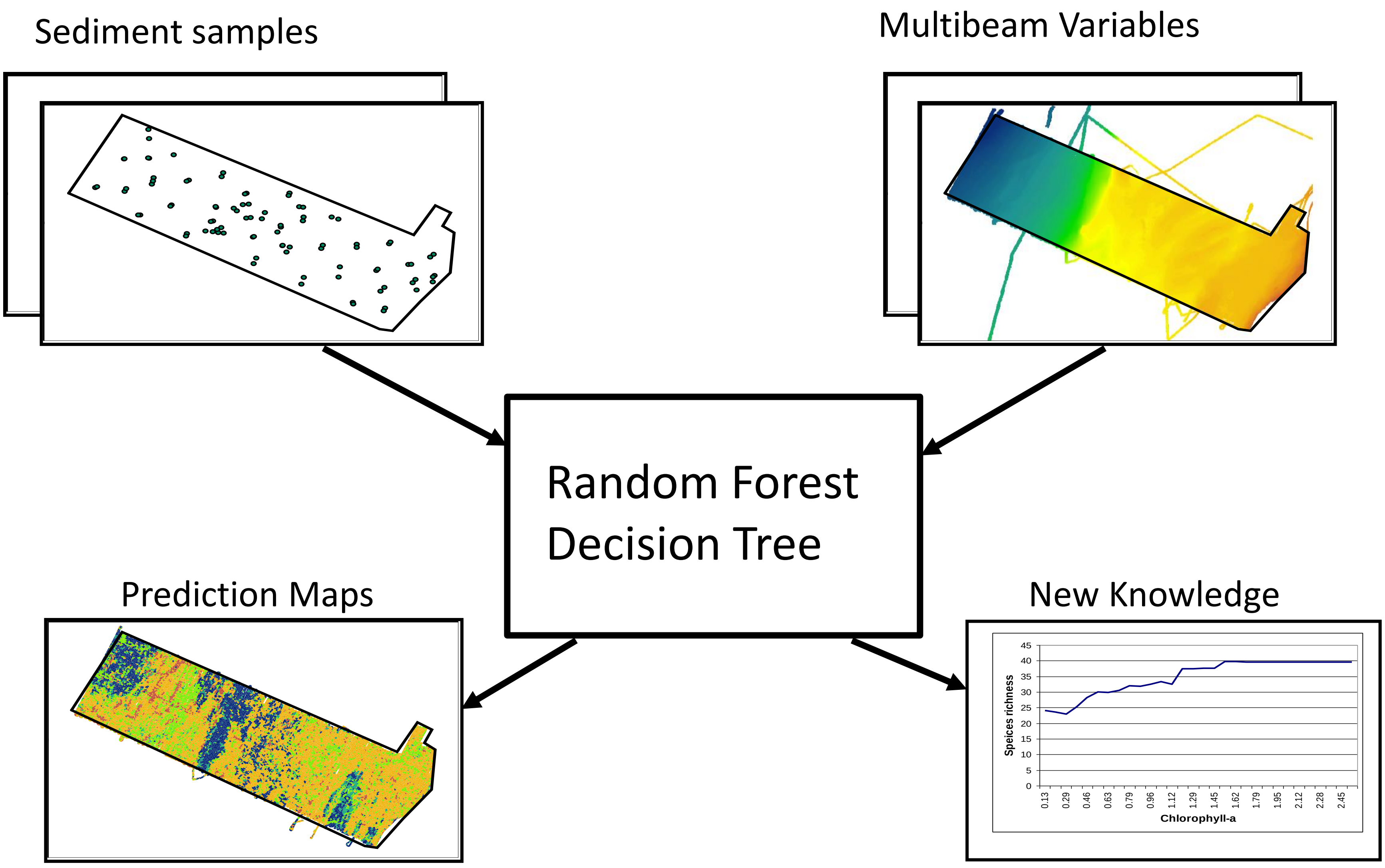
- Explanatory Variables
  - Two combinations
    - Angular Response Curves (ARCs)
    - Bathymetry, derived data and angular Response Curves (Bathys and ARCs)
- Target Variables
  - Sediment properties
  - Sediment types
- Modelling Technique
  - Random Forest Decision Tree

Methods

Multibeam Derived Data



Methods—Workflow



Results

- Prediction—sediment properties

Characteristic parameters of Bathys and ARCs for predicting sediment properties

- Prediction of %gravel : BIA15, BIA34and depth
- Prediction of %mud : BIA13, BIA 21 and depth
- Prediction of %MGS: BIA14, BIA24 and depth

Characteristic parameters of ARCs for predicting sediment properties

- Prediction of %gravel : BIA15, BIA18 and BIA34
- Prediction of %mud : BIA13 and BIA 21
- Prediction of %MGS: BIA14, BIA48, BIA25, BIA33 and BIA22

Characteristic parameters of Bathys and ARCs

Iterations	%gravel (R^2)	%mud (R^2)	MGS (R^2)
Initial experiment	15° (0.57)	13° (0.39)	14° (0.76)
1st	Depth (0.74)	Depth (0.53)	Depth (0.82)
2nd	34° (0.77)	21° (0.57)	24° (0.852)
3rd	48° (0.65)	16° (0.56)	48° (0.849)

Characteristic parameters of ARCs

Iterations	%gravel (R^2)	%mud (R^2)	MGS(R^2)
Initial experiment	15° (0.57)	13° (0.38)	14° (0.76)
1st	18° (0.66)	21° (0.46)	48° (0.82)
2nd	34° (0.68)	17° (0.45)	25° (0.84)
3rd	27° (0.65)	—	33° (0.85)
6th	—	—	22° (0.86)
7th	—	—	27° (0.85)

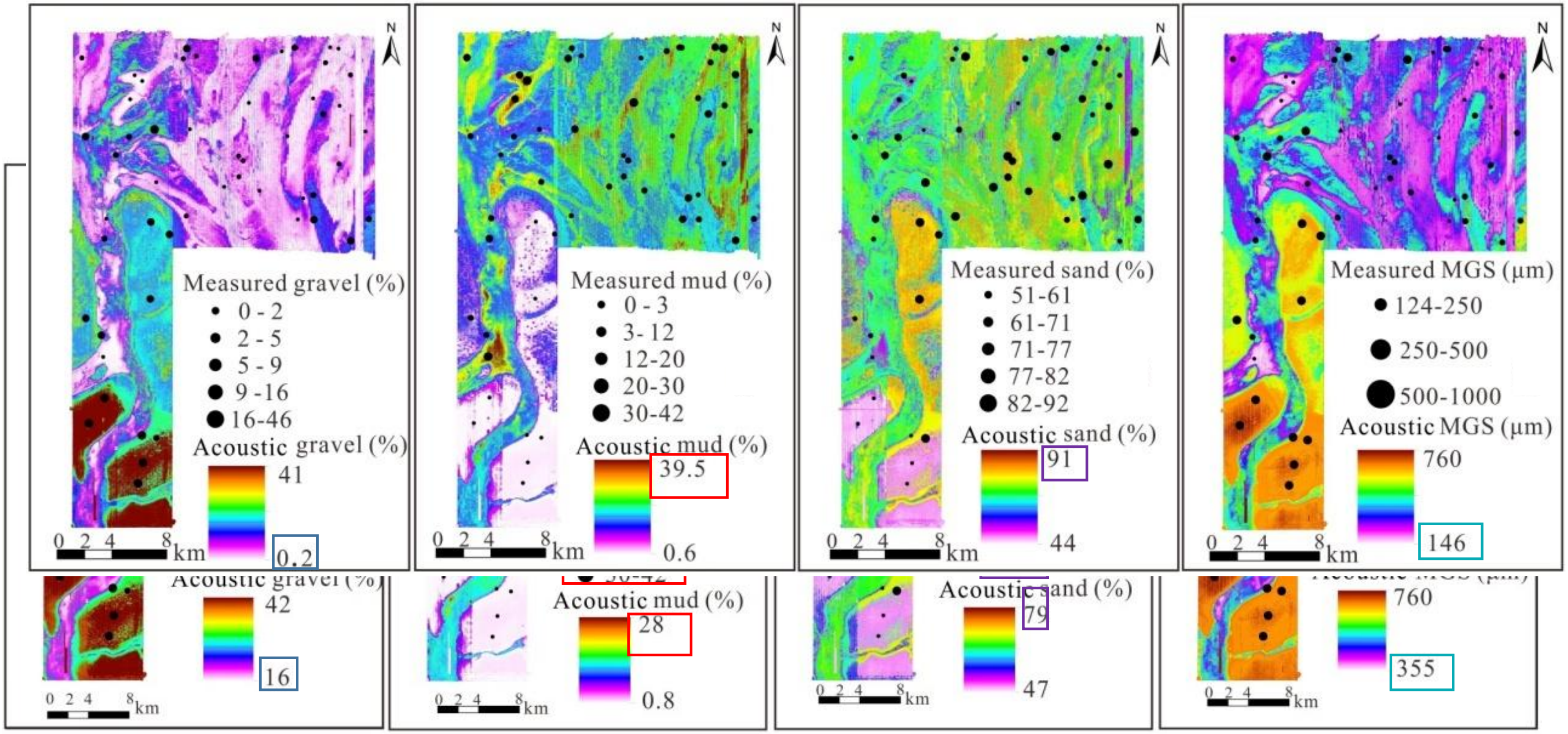
BIA15 was backscatter intensity at incidence angle of 15°

Results

- Mapping—sediment properties

Using Bathys in addition to ARCs, the difference between predicted and measured sediment properties are smaller.

ARCs and Bathys as the explanatory variables, the mapping of sediment properties

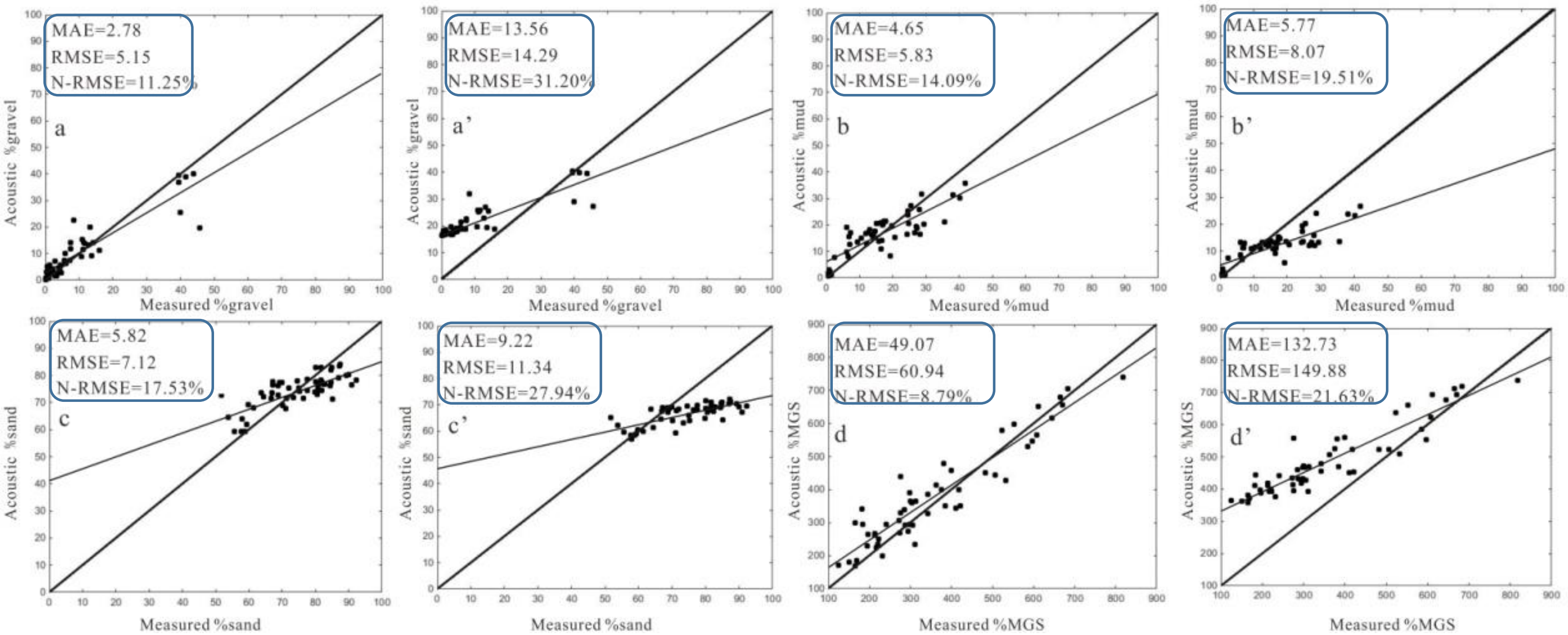


Results

- Accuracy evaluation—sediment properties

R square、MAE、RMSE and N-RMSE

Fig a-d: ARCs and Bathys
Fig a'- d': ARCs
Using Bathys in addition to ARCs, the prediction performance of sediment properties are improved.



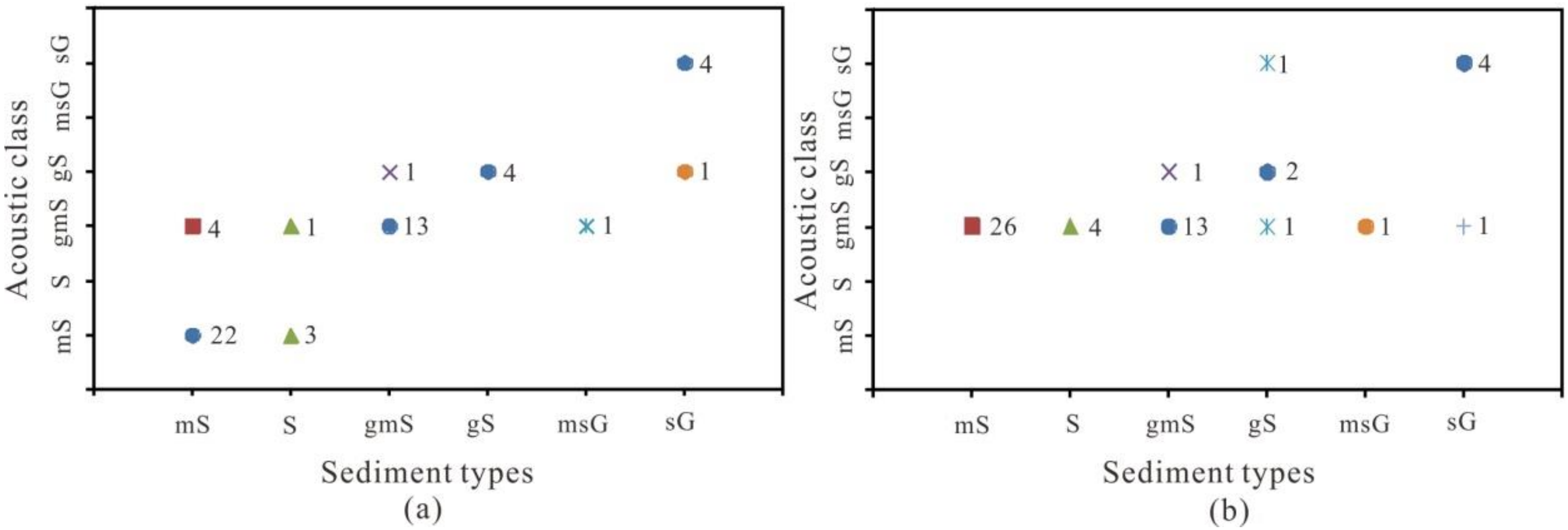
Results:

- Classification—sediment types

Accuracy evaluation： overall accuracy and Kappa

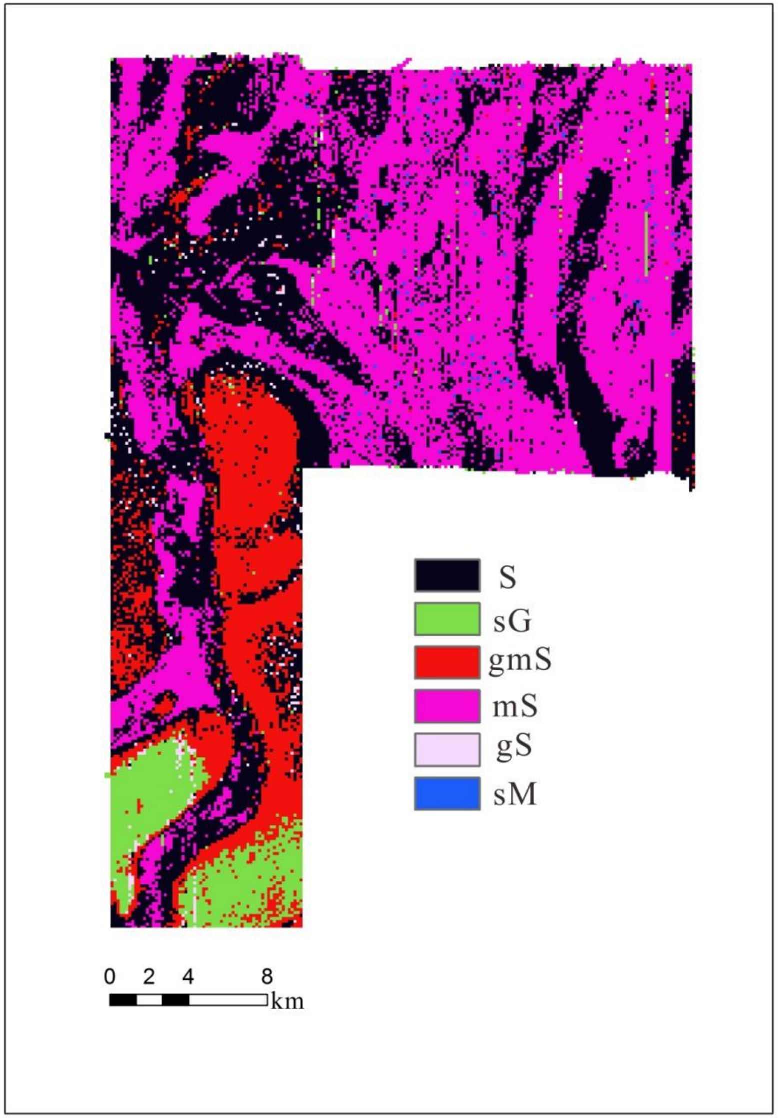
ARCs and Bathys (Fig.a)
overall accuracy:79.63%;
Kappa:0. 70

ARCs (Fig.b)
overall accuracy:35.18%;
Kappa:0.15



Results

- Mapping—sediment types



Mainly distributed sediment types:
—Sand;
—sandy gravel;
—gravelly muddy sand;
—muddy sand.

Conclusions

- Full potential of multibeam data was demonstrated by using combined backscatter and bathymetry information, because using multibeam bathymetry data in addition to backscatter data improved the sediment prediction performance.
  - The prediction performance achieved a ~10% improvement for %gravel and %mud by the assessment of R square.
  - The prediction performance achieved a ~45% improvement for sediment types by the assessment of the overall accuracy, a 0.55 improvement by the assessment of Kappa.

Thanks for listening!