



eWORKING WEEK 2021 20-25 JUNE
SMART SURVEYORS FOR LAND
AND WATER MANAGEMENT
CHALLENGES IN A NEW REALITY

Bathymetry Modelling from Altimeter-Based Gravity and Satellite Multispectral Images in the North Adriatic

Ljerka Vrdoljak, ljerka.vrdoljak@hhi.hr

Jelena Kilić Pamuković, jelena.kilic@gradst.hr



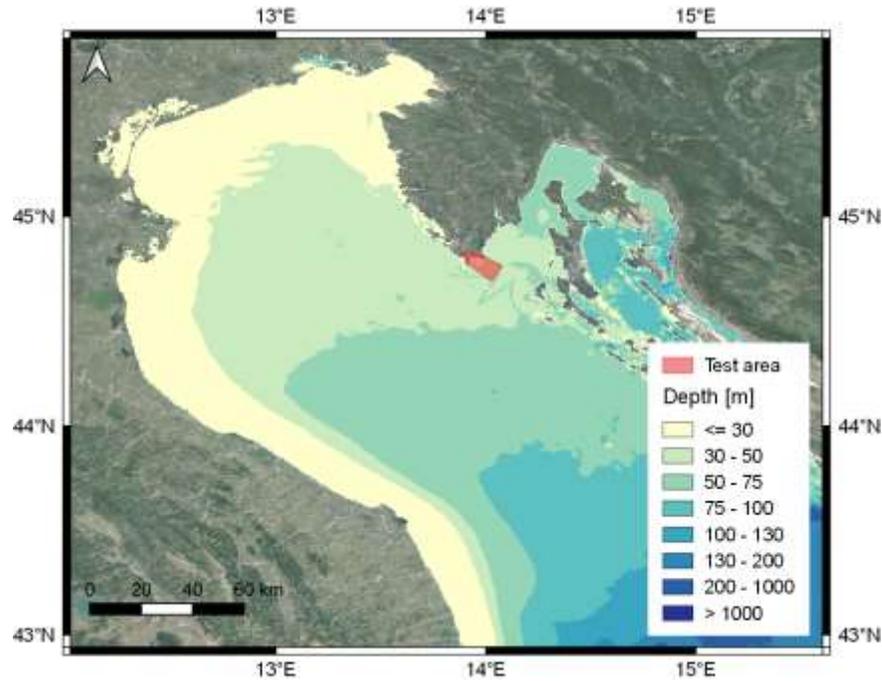
Introduction

- Bathymetry supports all marine activities



BATHYMETRIC METHODS				
Acoustic methods	Lidar	Remote sensing methods (EM spectrum)		
Pros: High quality data (IHO standard + high resolution)	Cons: Time and/or money consuming especially in shallow areas	SDB	Gravity	SAR radar
		Pros: Time and money efficient		
		Cons:		
		Depth limitation (up to 30 meters)	Resolution and accuracy	Depth limitation (10 m to 70 m)

Study Area – Medulin Bay, North Adriatic

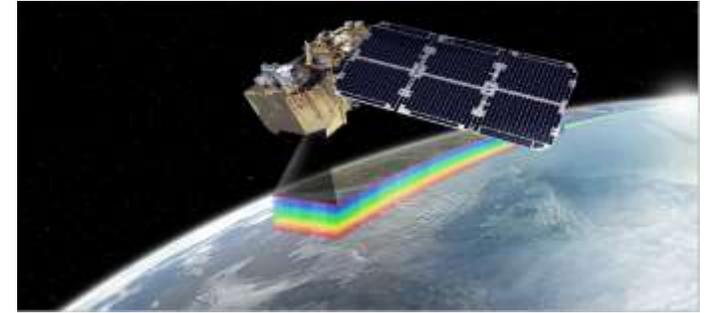


- Shallow area with depth up to 50 meters

Data – Publicly available online

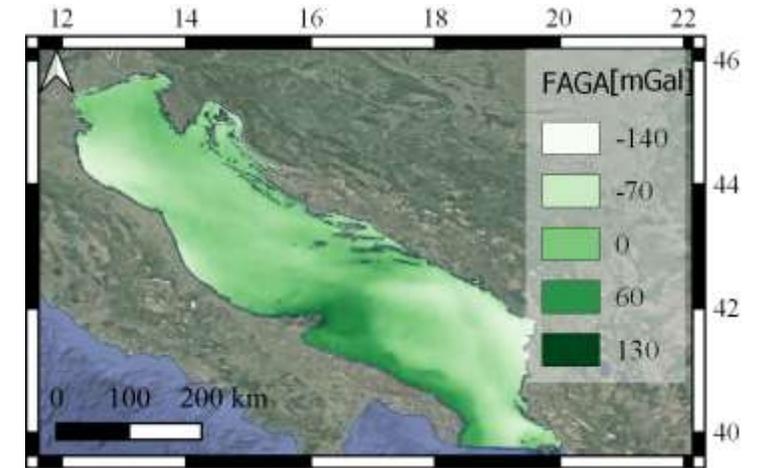
Multispectral Satellite Images

- Landsat 8 and Sentinel 2



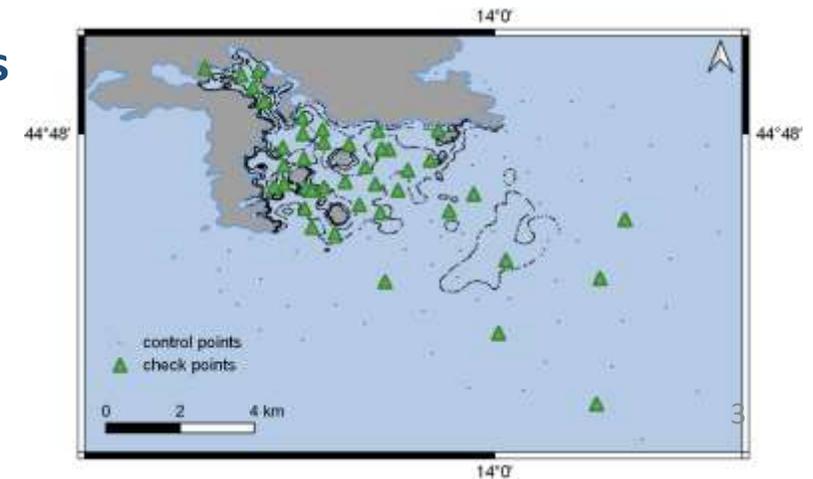
Satellite Altimetry-Derived Gravity Anomalies

- Smith and Sandwell Free Air Gravity Anomalies V29.1



Control and Check Soundings

- Coastal nautical chart Pula – Kvarner 100-16



Combined Algorithm for Bathymetry Prediction

Bathymetry estimation methods

Multispectral Satellite Images

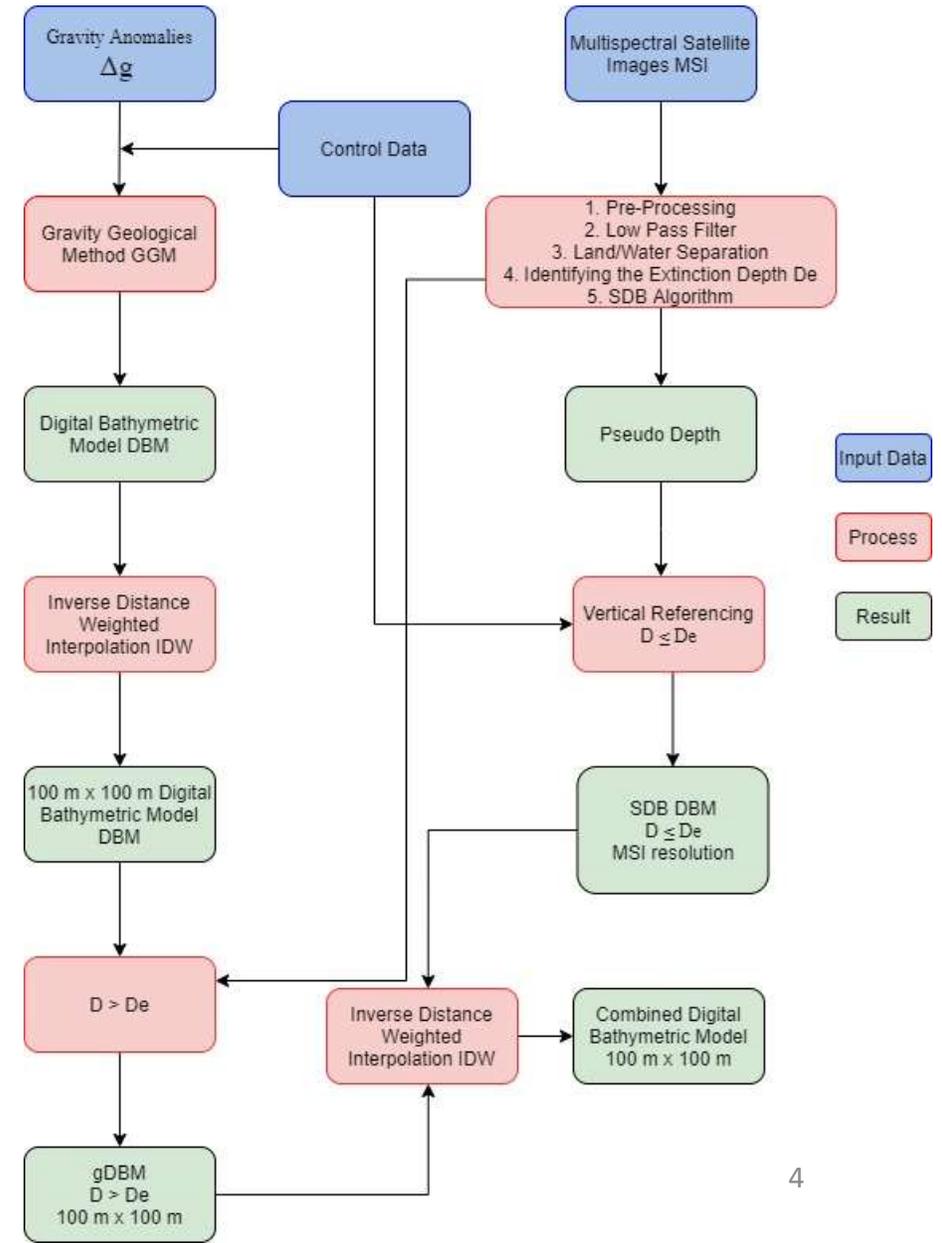
Empirical Bathymetry:
Log Ratio Model
Stumpf algorithm
 Blue and Green band

$$D = m_1 \left(\frac{\ln(L_{obs}(\lambda_i))}{\ln(L_{obs}(\lambda_j))} \right) - m_0$$

Gravity Anomalies

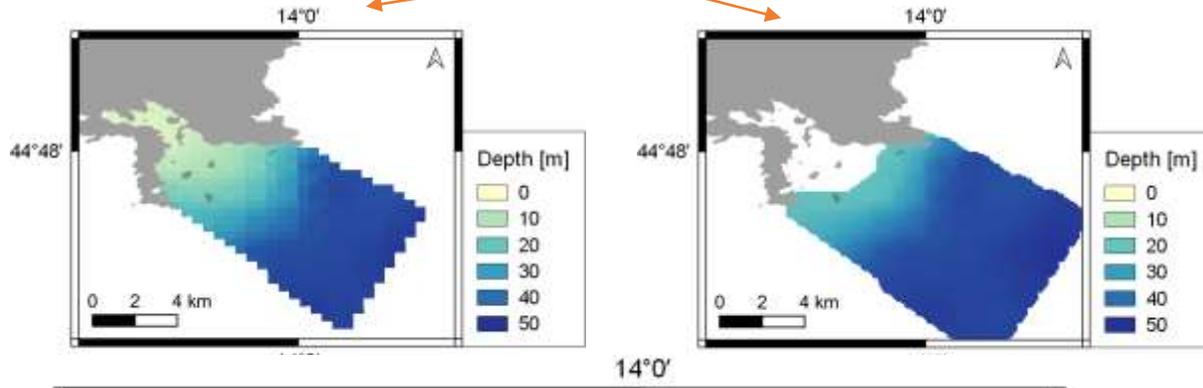
Gravity Geologic Method GGM

$$D(i) = \frac{g_{short}(i)}{2\pi G \Delta \rho} + D$$

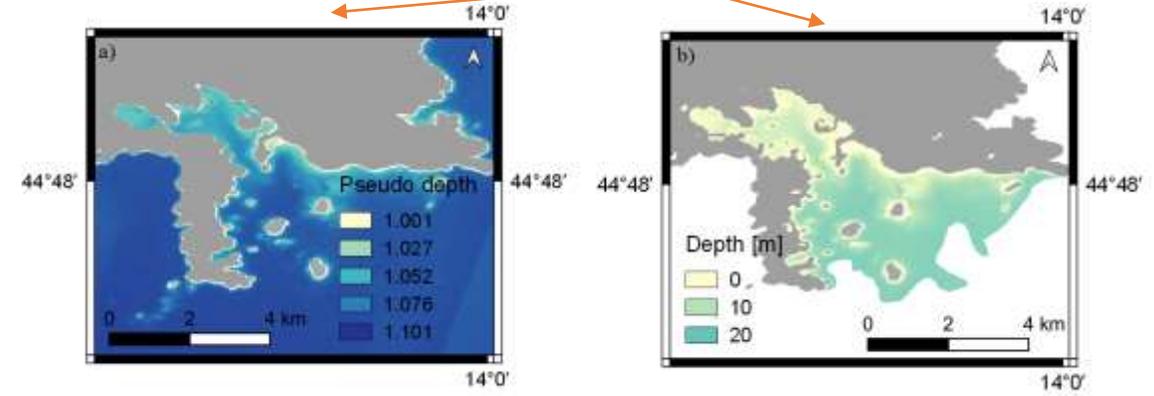


Results

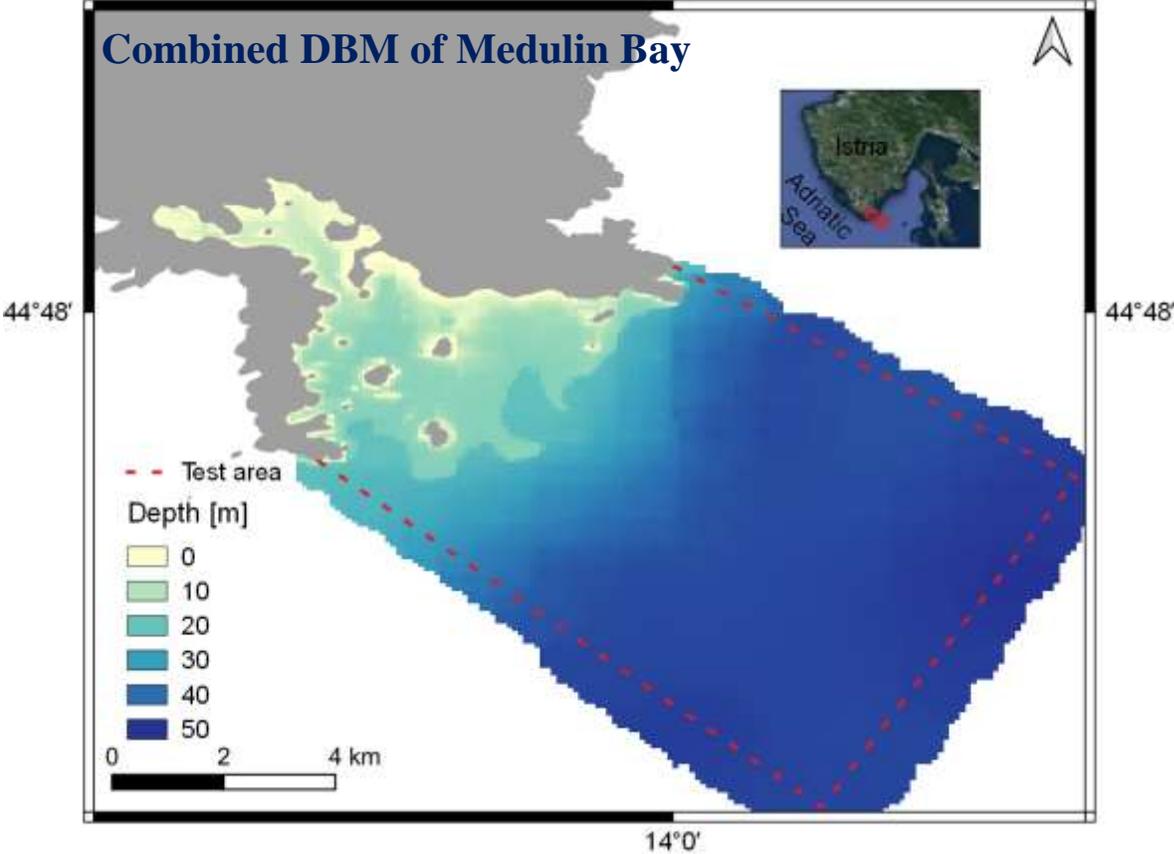
GGM



SDB



Combined DBM of Medulin Bay



DBM	RMSE [m]	Correlation coefficient
LANDSAT 8*	4.45	0.75
SENTINEL 2*	2.58	0.91
gDBM (GGM)	6.64	0.92
CDBM (GGM_SDB)	4.73	0.97

* Shallower than 20 meters

Conclusion

As compared to traditional bathymetric methods, satellite remote sensing methods are **cost and time effective**.

Topography of the seafloor in the Medulin bay and adjacent sea area with depths up to 50 meters in the North Adriatic was modelled using the **combined algorithm for bathymetry prediction**.

Model was validated using the chart soundings.

As compared to Landsat data, Sentinel bathymetry had better resolution and correlation with chart data.

Bathymetry derived from gravity was augmented with Sentinel data in areas shallower than 20 meters in a combined bathymetric model with 100 meters resolution.

Correlation of Combined bathymetric model was 0.97 and RMSE was 4.73 meters. **Quality of bathymetric model was improved** by augmenting the model estimated from gravity with satellite derived bathymetry.

A nautical chart of the Medulinski Zaljev area, showing depth contours, navigational markers, and various geographical features. A semi-transparent blue overlay covers the right side of the chart. The text "Thank you for your attention!" is centered over the chart in a large, bold, dark blue font. The chart includes labels for various locations such as Pomerski, Premanturski, Luka Medulin, U Bijeca, Rt Kasteja, U Lokvica, LEVAN (11), LEVANIJE (15), U Lovica, Rt Marlera, U Kuvišeja, Rt DeBELA, Sika, C BI(2) 5s 8m 4M, B BI 8s 21m 9M, U Polje, U Njive, Pliè Kršine, Pliè Veliki batun, Pliè Konjina, Pliè Fenera, FENERA, Rt Kamenjak, Crveno, and Bijelo. Depth contours are shown in meters, and various navigational symbols like buoys and lights are present. The text "MEDULINSKI ZALJEV" is visible in the center of the chart.

Thank you for your attention!