



# 3D Underwater Mapping from Above and Below

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## Integrating 3D Reconstruction and AR for Enhancing Visitor Experience in Submerged Heritage Sites

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# CONTEXT



## From the 2001 UNESCO Convention

### Article 2.5.

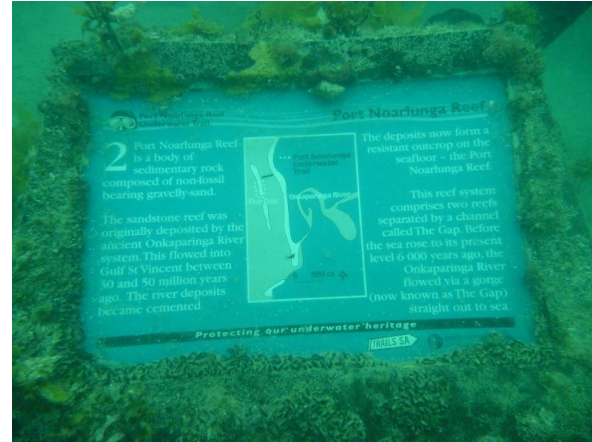
*The preservation in situ of underwater cultural heritage shall be considered as the first option before allowing or engaging in any activities directed at this heritage.*

## From the Rules of the Annex to the Convention

### Rule 24.

*The conservation programme shall provide for the treatment of the archaeological remains during the activities directed at underwater cultural heritage, during transit and in the long term. Conservation shall be carried out in accordance with current professional standards.*

# MOTIVATIONS



- Reduced visibility
- Biological colonization
- Limited spatial awareness
- Underwater communication difficulties

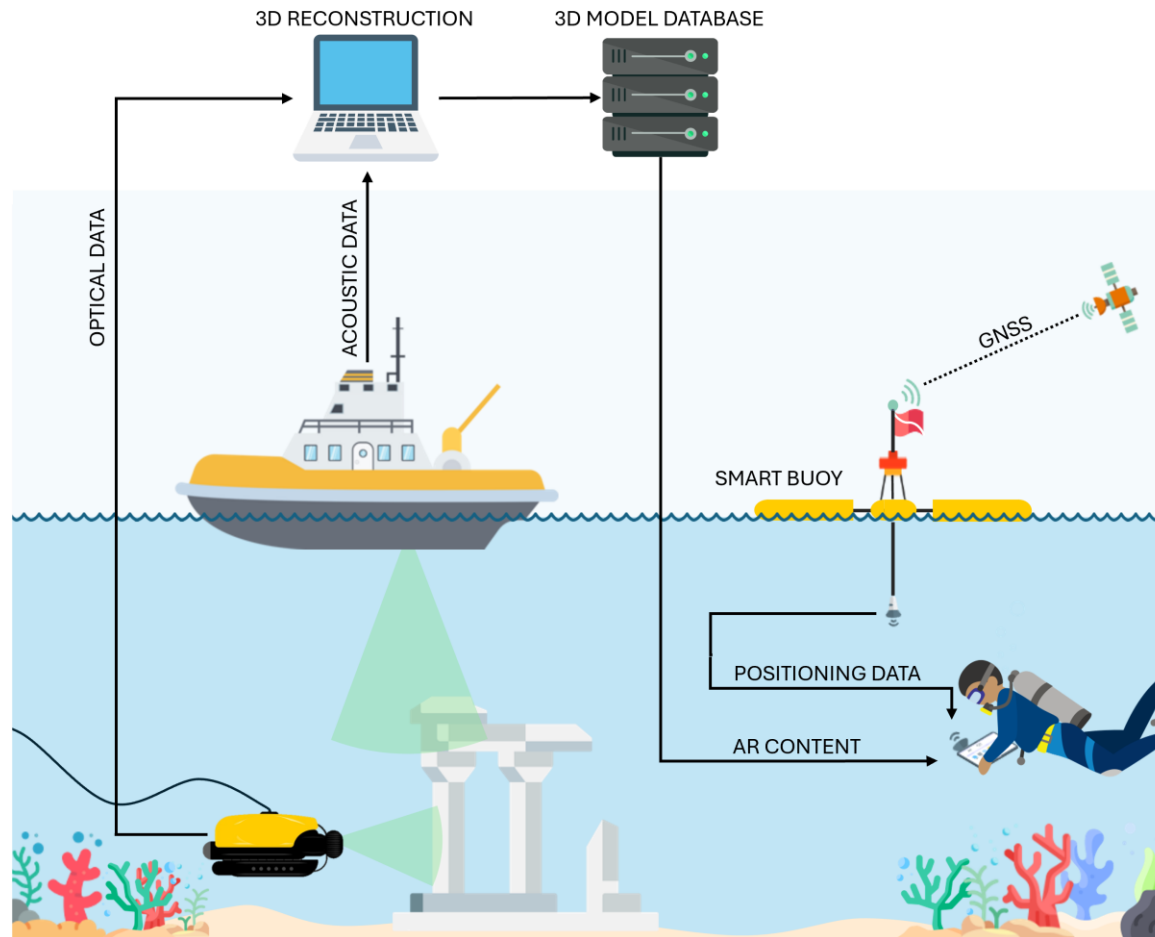
# GOAL

Design and development of an integrated Underwater Augmented Reality (UWAR) system enabling real-time, site-specific interpretation for recreational divers through 3D reconstruction and thematic annotation.

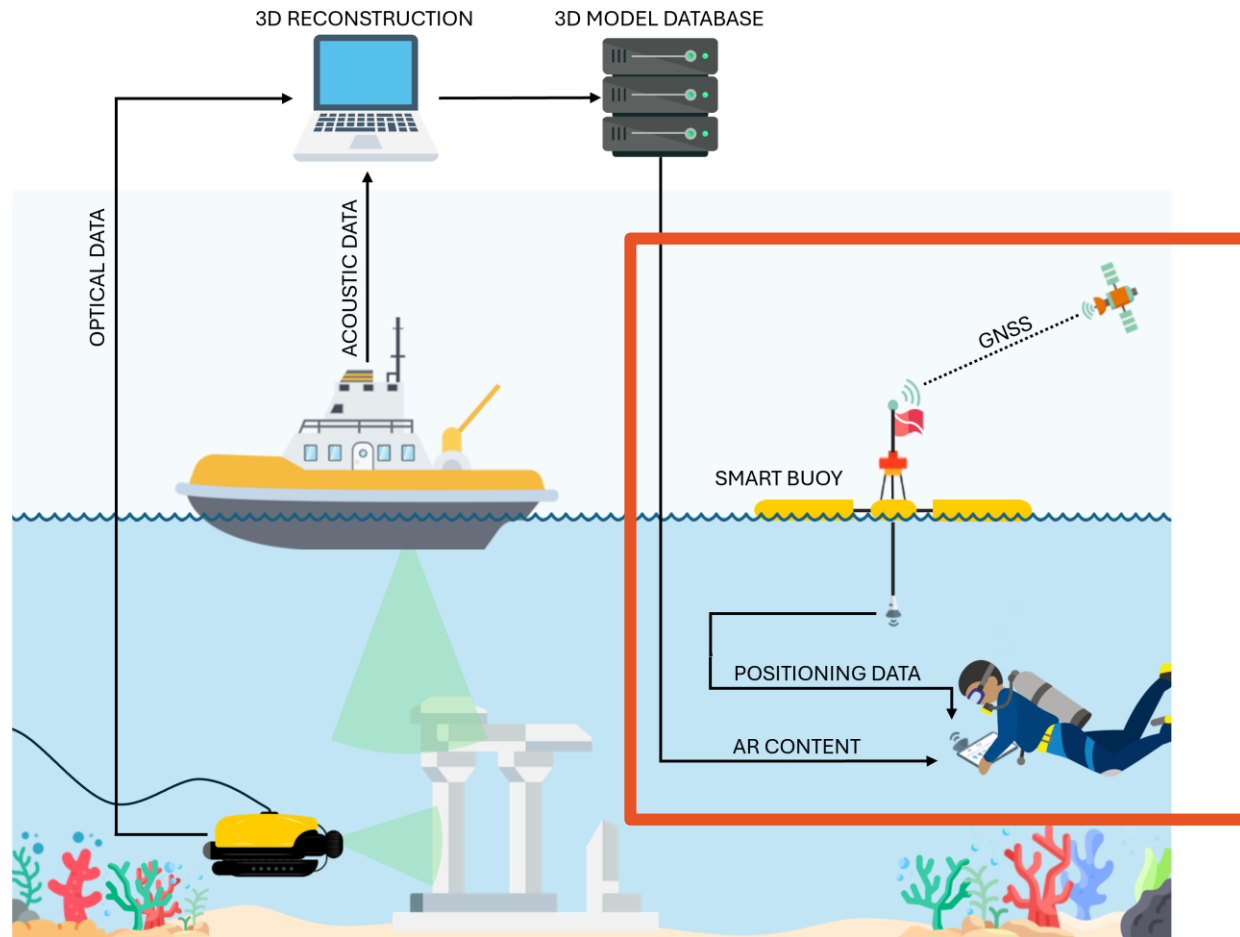
## Main features:

- Real-time underwater localization
- AR content delivery
- 3D Opto-acoustic reconstruction

# UNDERWATER AUGMENTED REALITY SYSTEM



# UNDERWATER AUGMENTED REALITY SYSTEM



# BACKGROUNDS

Over the past decade, the team has successfully developed UWAR systems through European projects like VISAS, BLUEMED and iMARECULTURE, which demonstrated positive results in real underwater settings by enhancing diver orientation and user experience with innovative technologies.

VISAS - 2018



iMARECULTURE - 2019



## Open challenges:

- Need for faster, cheaper and more accurate acoustic localization
- Improve ergonomics (reduce size, increase screen contrast, etc.)

# AUGMENTED DIVING SYSTEM

Integrated system for diver-surface communication and positioning.

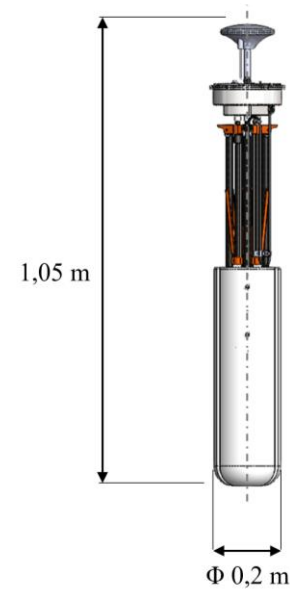
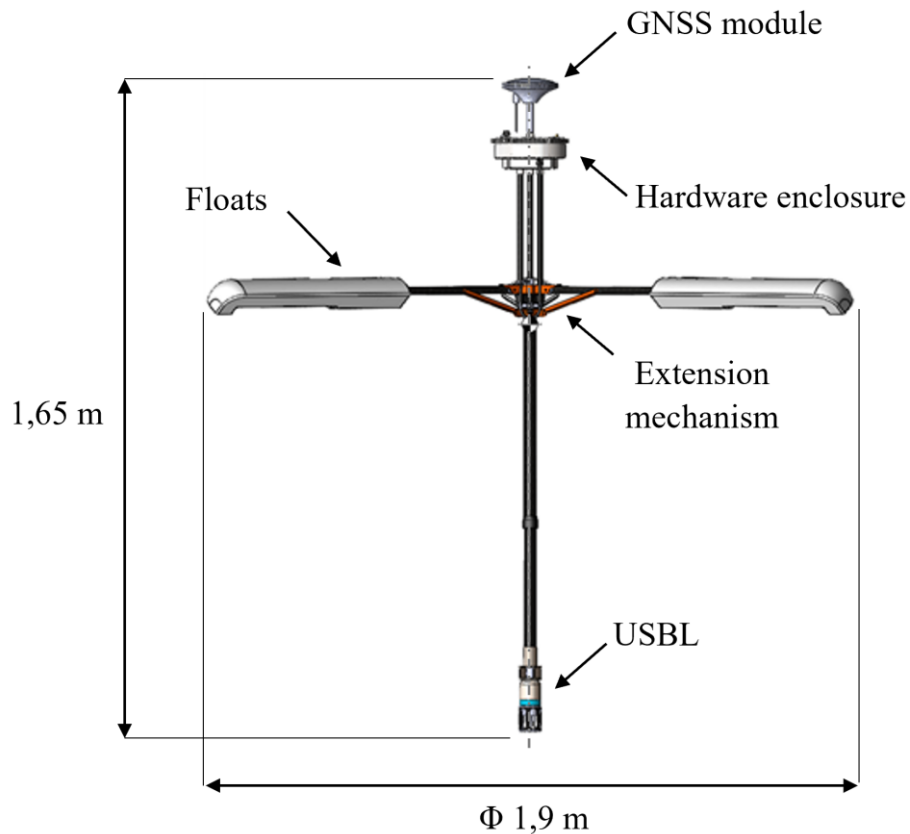
The system consists of:

- A **smart buoy** equipped with a GNSS receiver and an acoustic transducer
- An **underwater tablet** with a built-in acoustic receiver



# SMART BUOY

Features an expansion mechanism that ensures compactness during transport and optimal protection for the sensors. This design enables rapid deployment and enhanced portability.



Specifications	Details
Weight	6.8 Kg
Buoyancy	10 Kg
Battery Life	6 hours

# UNDERWATER SMARTPHONE

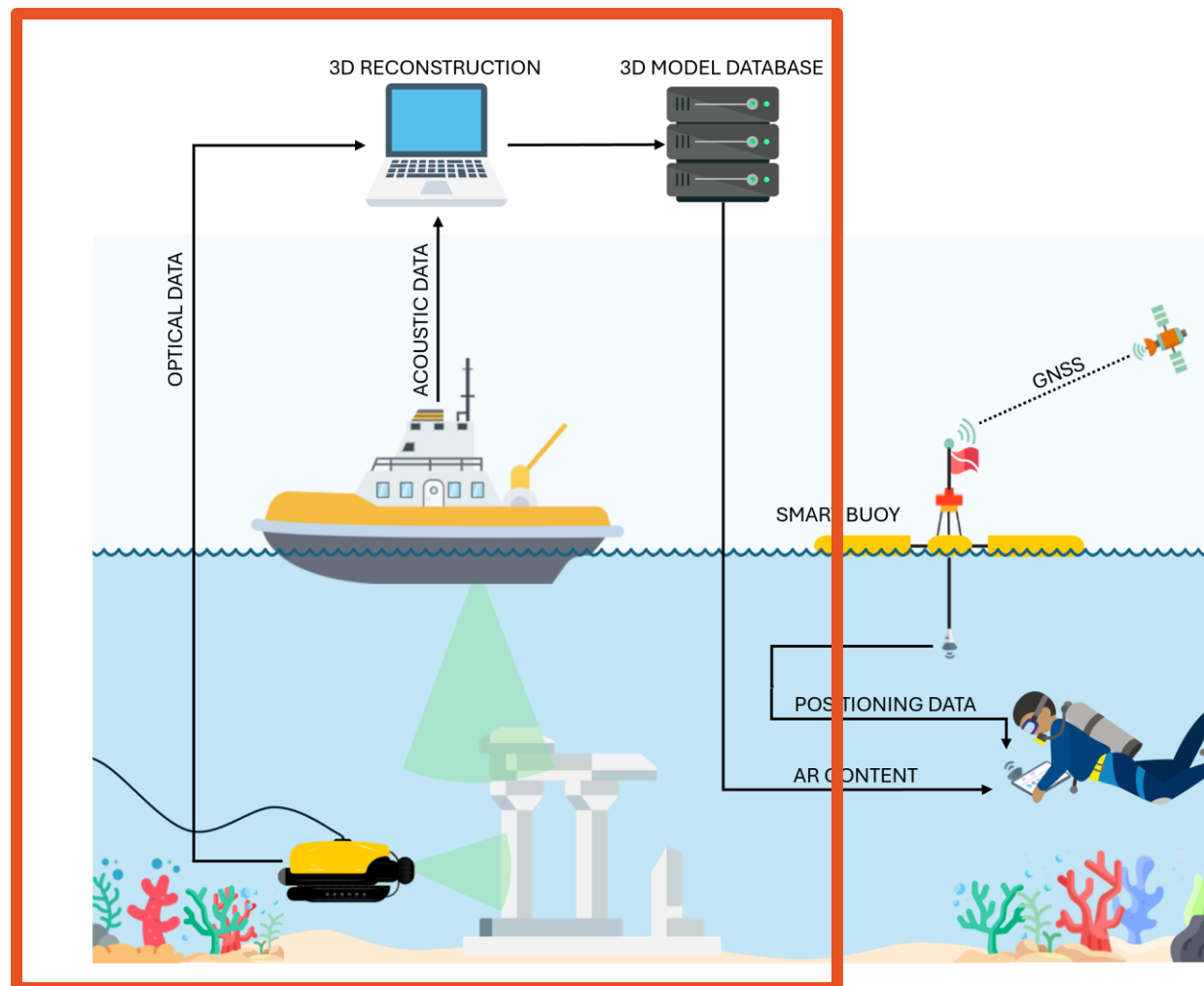


Android Smartphone

Easydive Leo3 Smart case

Specifications	Details
Dimensions	250 x 125 x 65 mm
Weight	2.4 Kg
Buoyancy	0.4 Kg
Depth max	150 m

# UNDERWATER AUGMENTED REALITY SYSTEM



# BENGALA SHIPWRECK

The wreck of the steamship Bengala lies at a depth of 26 to 29 meters, approximately 1500 meters off the coast of Capo Rizzuto (Crotone, Italy). The vessel sank in 1889 after striking a submerged reef during adverse sea and wind conditions.

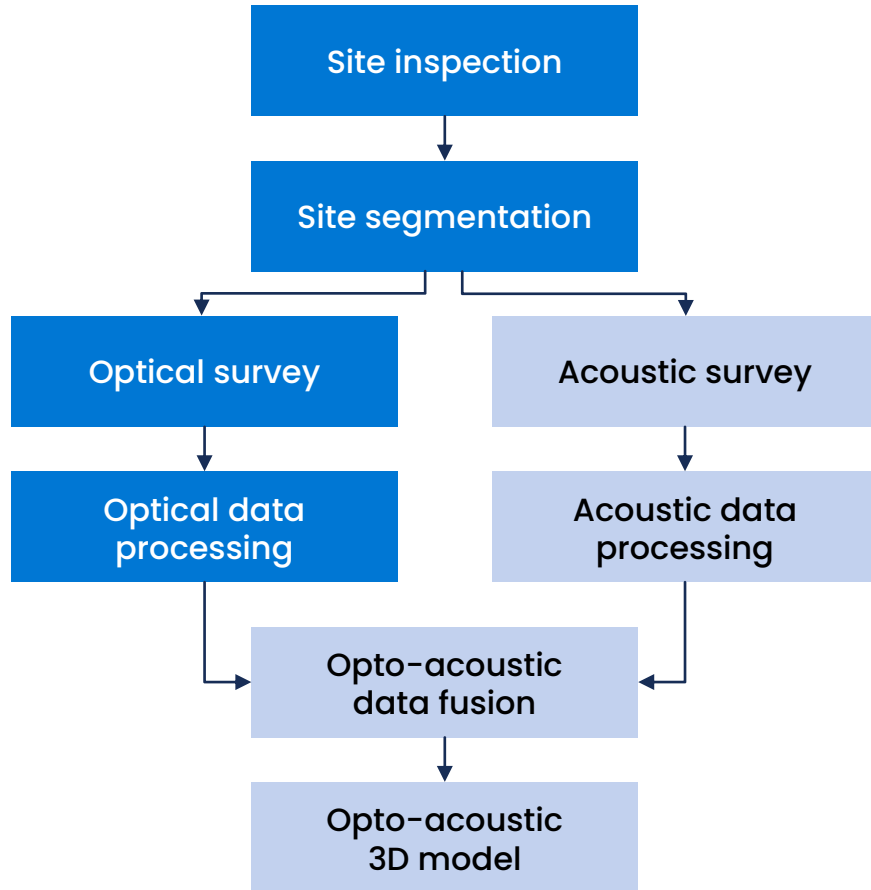
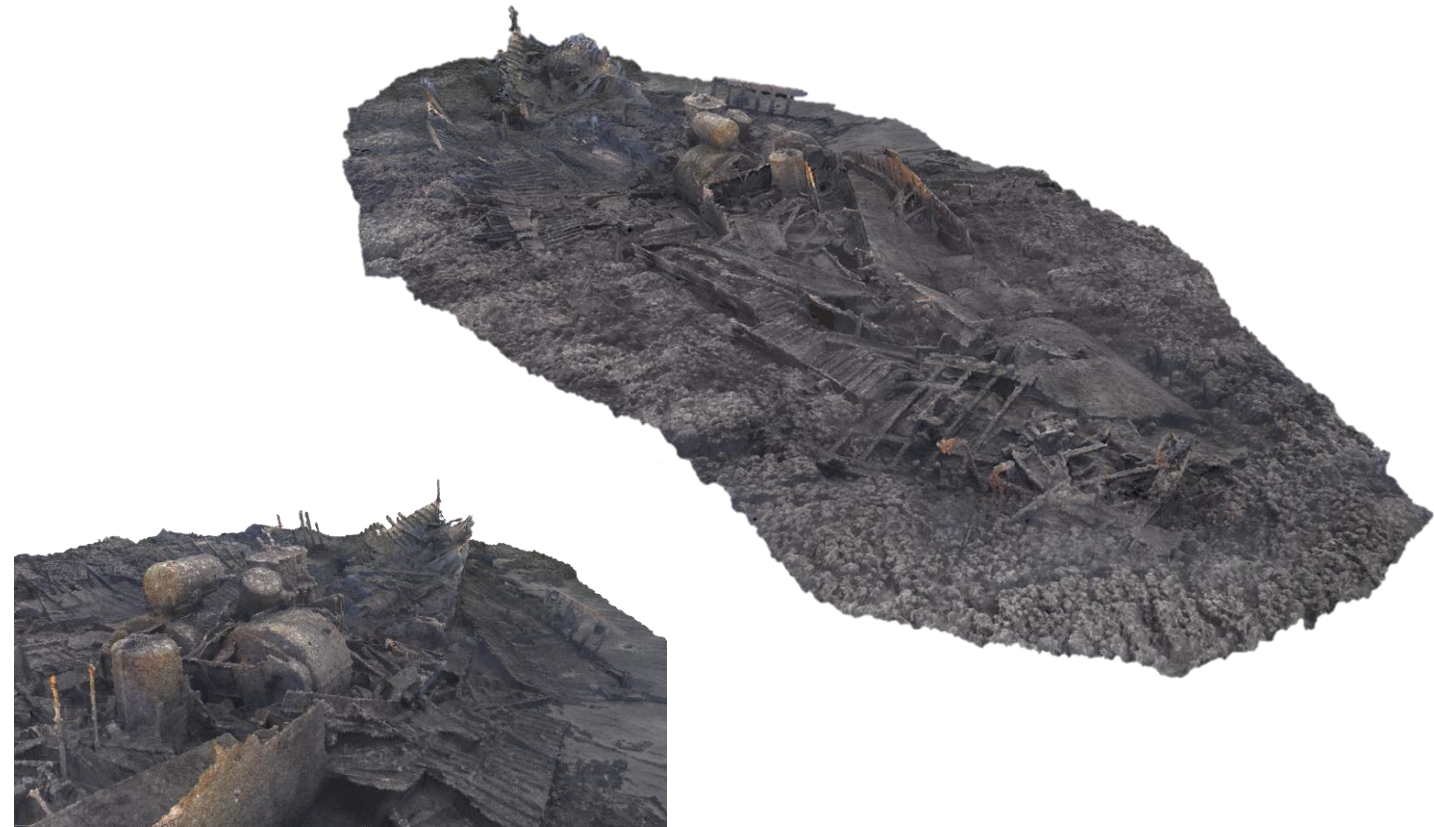


Coordinates: 38°53'50,32"N 17°7'12,89"E

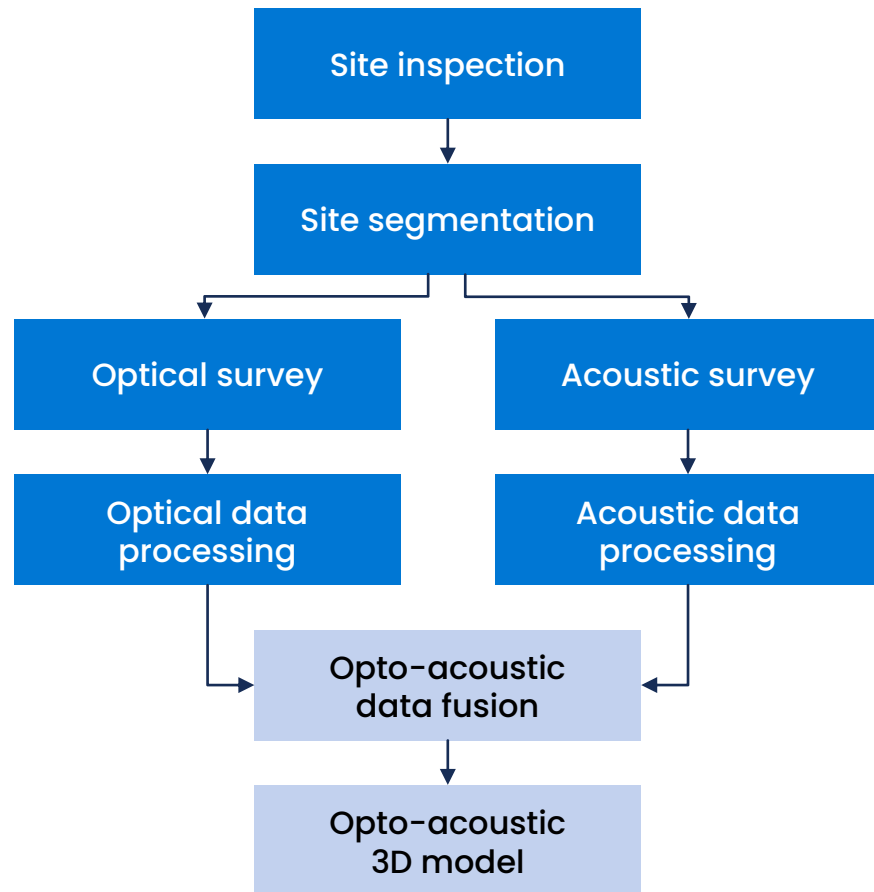


# OPTO-ACOUSTIC 3D RECONSTRUCTION

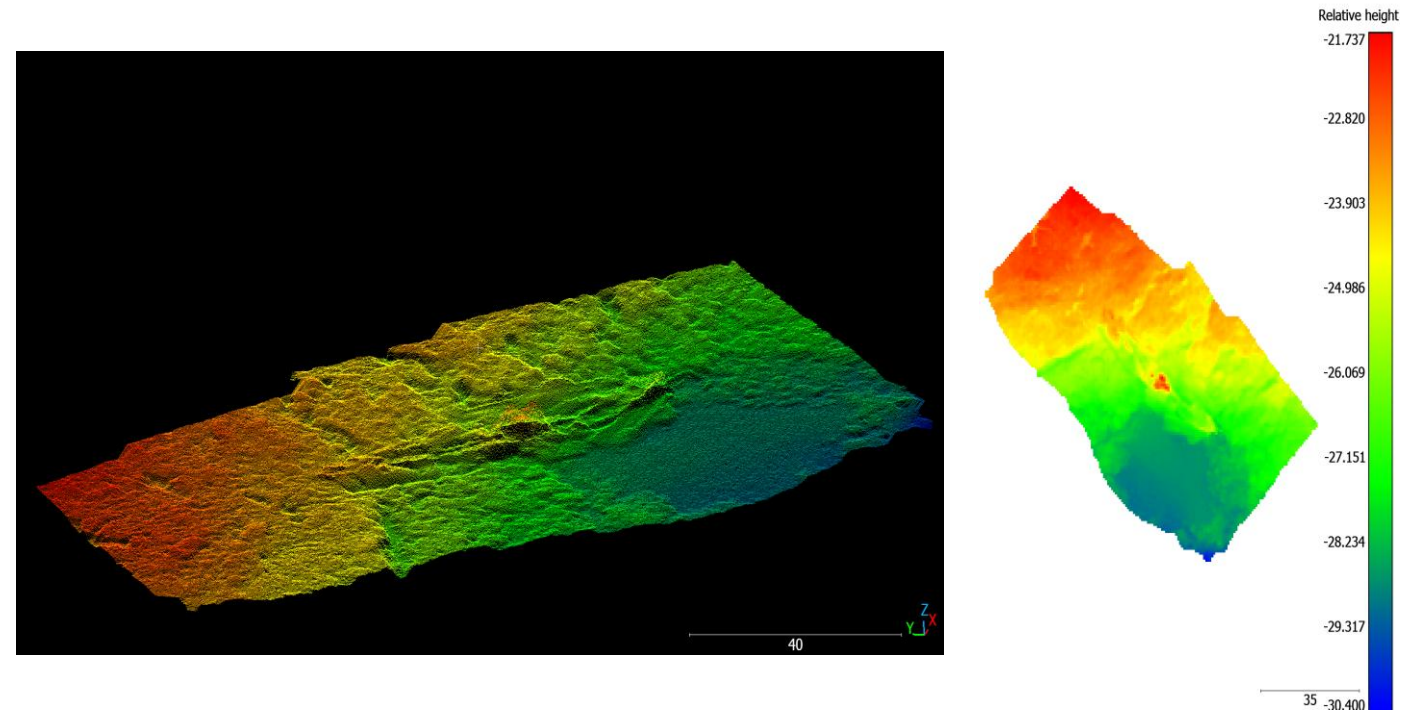
Orthophoto of the Bengala shipwreck site



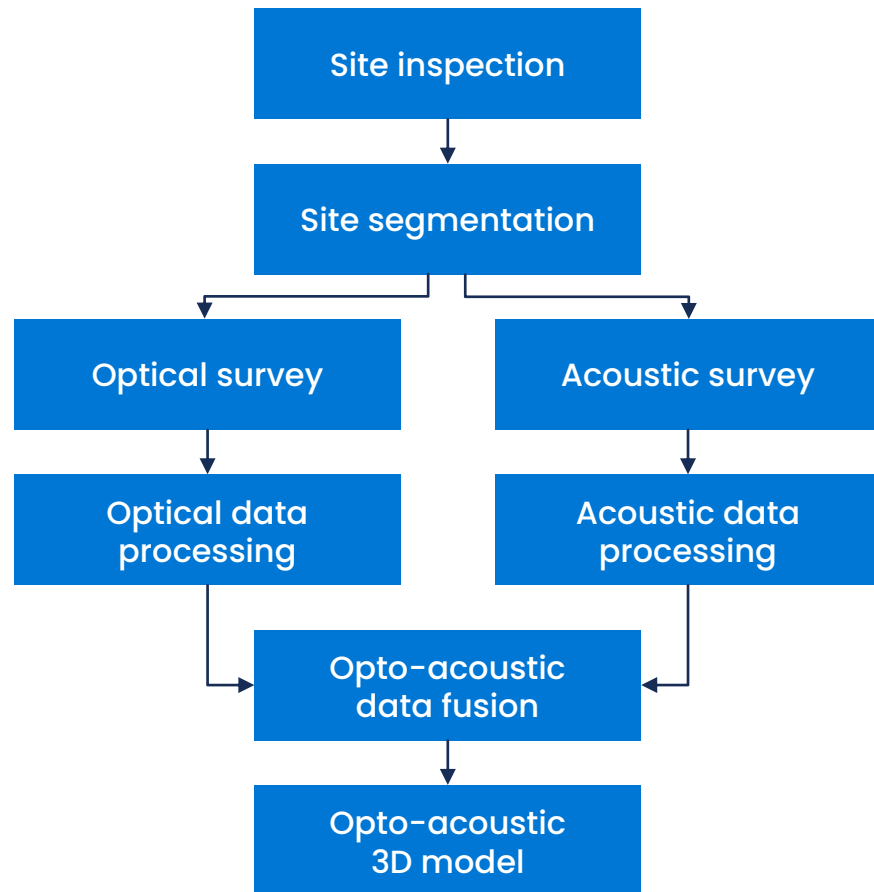
# OPTO-ACOUSTIC 3D RECONSTRUCTION



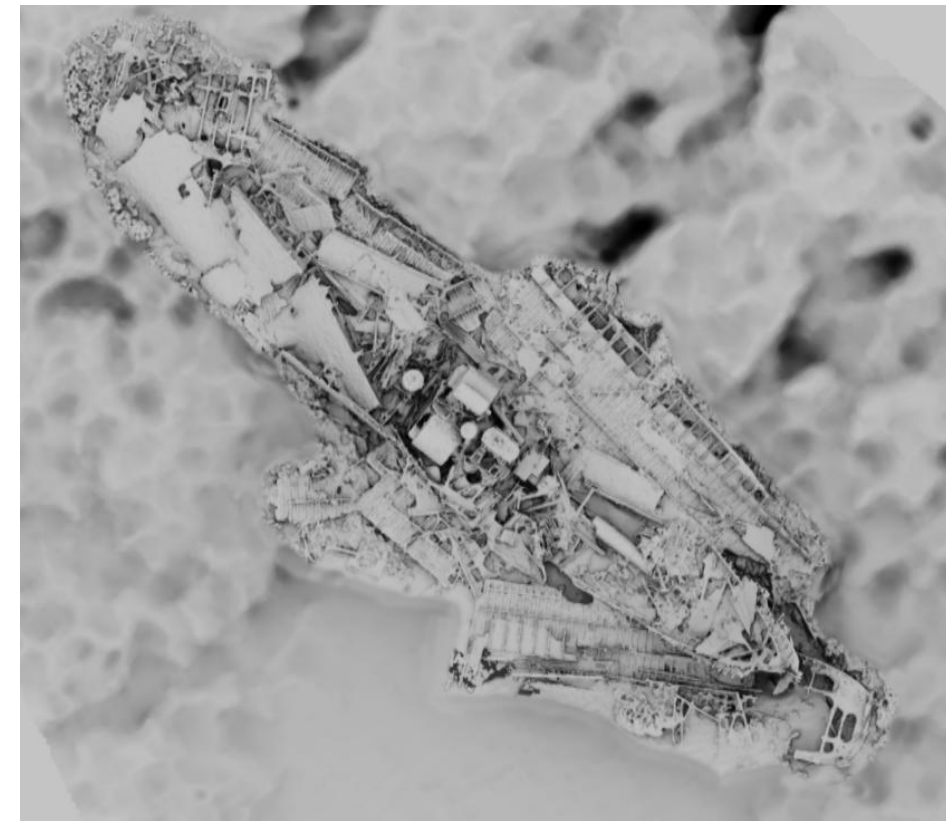
Bathymetric map of the Bengala shipwreck site



# OPTO-ACOUSTIC 3D RECONSTRUCTION



Multiresolution 3D model of the site



# HYPOTHETICAL 3D RECONSTRUCTION







# CONCLUSIONS

- Developed a portable UWAR system for real-time, site-specific interpretation of underwater archaeological sites.
- Combined optical photogrammetry and acoustic bathymetry to produce accurate, georeferenced 3D models.
- Enabled interactive AR experiences through thematic annotation and spatially anchored POIs.
- Designed an infrastructure-free deployment setup, supporting flexible use and future collaborative features.



**Future work** includes system optimization, collaborative features, and user studies on educational and emotional impact.

# ACKNOWLEDGEMENTS

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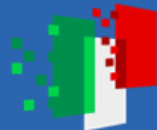
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# THANKS FOR YOUR ATTENTION



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DIPARTIMENTO DI **INGEGNERIA**  
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