Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XL

Tipping points in marine ecosystems

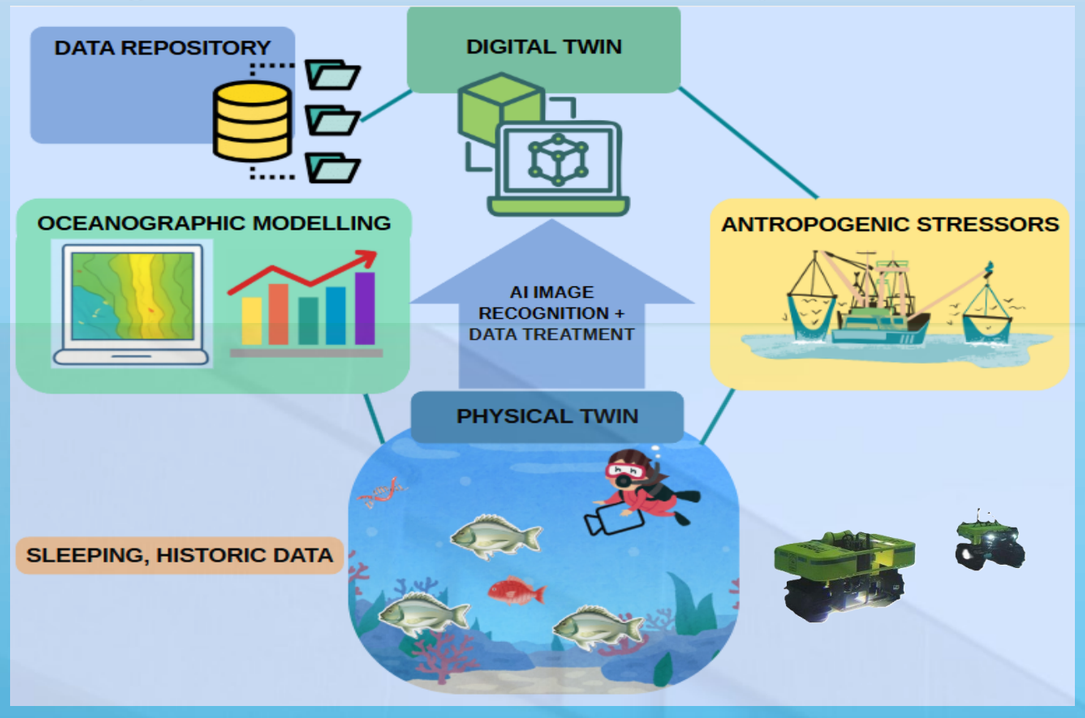
PhD Student: Alessandra Kostantchouk

Laboratorio di Biologia ed ecologia marina, DiSVA

Tutor: Prof. Roberto Danovaro

Introduction & Aims

Tipping points in marine ecosystems represent critical thresholds leading to significant and often irreversible changes, altering the ecological balance and the ecosystem services[1]. The drivers of such changes include climate change, pollution, overfishing, and habitat degradation. The Digital Twin of the Ocean (DTO) is gaining popularity as a technological tool for monitoring and predicting changes in environmental systems.

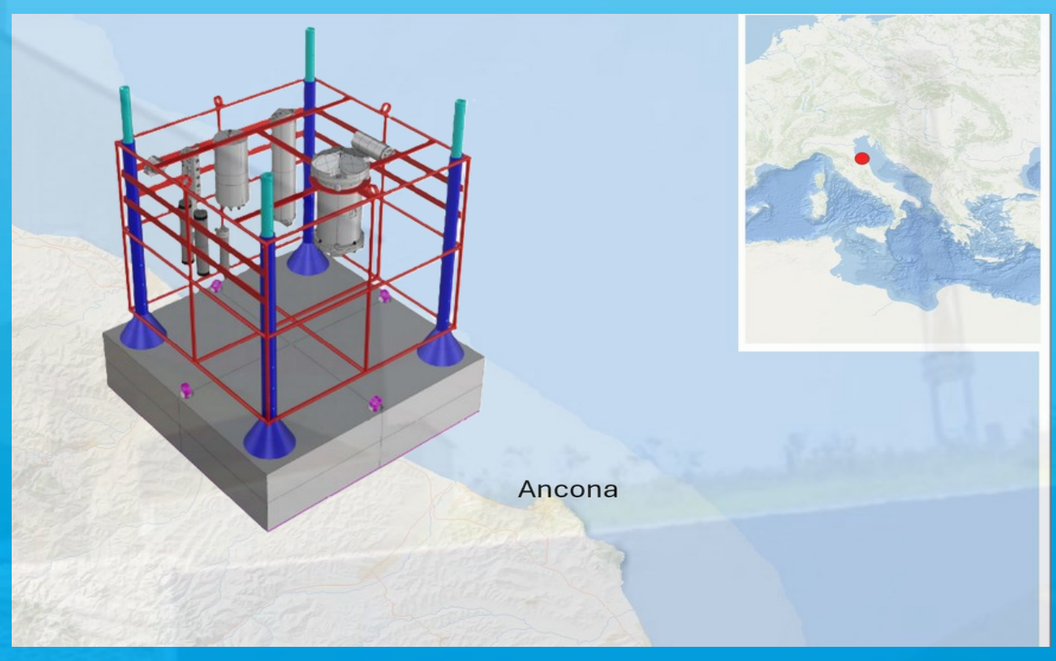


The **main objective** is to determine the effects of climate and anthropogenic stressors on the ecological processes and biodiversity.

Target species: seascape and fish biodiversity (Sparidae family which comprises many large and mobile species that are targeted by recreational and commercial fisheries) in the Mediterranean. Drivers: temperature, littering and noise, fishing pressure and any other stressor [2].

Methods

- Deployment of autonomous platforms for real-time monitoring, 2 miles off the coast of Fano, Italy (including AUVs, crawlers).
- Analysis of spatial and temporal environmental changes based on satellite Copernicus data and in-situ sensors.
- Animal classification and counting using AI tools.
- Multiparametric data analysis to establish cause-effect relationships between biological variables and the habitat conditioning through multivariate regression modelling



Expected results

- Develop a data processing pipeline to quantify key ecological indicators for monitoring the health and status of benthic ecosystems.
- Create a Digital Twin model of the marine ecosystems in the study area, integrating multi-source data.
- Enable real-time simulation and visualization of ecosystem dynamics, offering immediate insights into environmental changes.

References:

1. IPCC (2001), Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Watson, R.T. et al. (eds.), Cambridge University Press, Cambridge, United Kingdom, and New York
2. Bariche, M., Bilecenoglu, M., Goren, M., Harmelin-Vivien, M., Mouine, N., & Pollard, D. (2023). *Overview of the conservation status of the marine fishes of the Mediterranean Sea*. IUCN.