ESA CYBER ITALY Coastal Digital Twin

Digital Twin costieri a supporto della valutazione del rischio e dei piani di adattamento

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ASI, InfoDay IRIDE, 16.04.25



DT#3 SCOPE OF WORK



The project aims to prototype and evolve a DIGITAL TWIN (DT) for monitoring and managing Italian coastal areas.

MAIN OBJECTIVES:

- **Scenario simulation**: implementation of simulation tools to evaluate scenarios related to storm surges, flooding, coastal area restoration, and the planning of Nature-Based Solutions (NBS).
- Impact assessment models: tools to evaluate the effects coastal environment and communities.
- **Interactive applications**: development of digital tools enabling users to modify variables (scenarios) and simulate outcomes for effective strategic planning.
- Geographical customization: adaptation of digital solutions to the specific characteristics of the selected Italian areas.

AREAS OF INTEREST (AOI):

- Emilia-Romagna (RIMINI) with proposed focus on coastal erosion and water quality
- Puglia (MANFREDONIA-ZAPPONETA) with proposed focus coastal flooding and barrier management

AOI n.1: Coastal erosion and water quality in the Rimini

2017

User's (e.g. coastal planners) questions:

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How can we redesign the rigid barriers to be more effective? Which is the optimal design for restoration of coastal land and marine ecosystems through NBS? What is the impact of the Marecchia river mouth and how can we dimprove water quality?





Challenges: Subsidence; sea level rise, coastal erosion, water quality Socio-economic assets: Tourism, port, coastal cities development

2024

AOI n.2: MANFREDONIA-ZAPPONETA AREA 🧼 💩 🖕 📀 📀 esa coastal erosion, water quality and extreme events







User's (e.g. coastal planners) questions:

- How can we prevent the impacts of extreme events on coastal erosion and flooding?
- Can we remove the barrier without affecting coastal erosion or how best to adapt the height/distance?
- Which is the optimal design for restoration of coastal land, transitional and marine ecosystems?



Challenges: coastal erosion; sea level rise, open sea and transitional water role, water quality, extreme events **Socio-economic assets**: Tourism, port. Adaptation solution to be sought: How do I decrease wave energy at the coasts and where do I restore seagrass habitat? The Civitavecchia Case Study



DIGITAL VEGETATION POSITIONS





Percentage wave height reduction

Seagrass as NBS for wave energy reduction

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0.016





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Higher attenuations obtained with the broken strips along with the cluster arrangement

Umesh, P.A.P., Pinardi, N., Alessandri, J., Federico, I., Causio, S., Unguendoli, S., Valentini, A., Staneva, J., 2022. A digital twin modelling framework for the assessment of seagrass nature based solutions against storm surges. Sci. Total Environ. 847, 157603. https://doi.



0.6

LS1 LS2

Results obtained: the Cyber Italy Platform

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	TALY						(†)	UR RI
♠ > Places > Rimini	> Projects > Progetto 1 > Scenari	os > List						
Scenario List								Compare
Name	Description	Owner	Туре	Status	Start Execution	End Execution	Actions	Compare
Scenario 1, Rimini with barriers	Scenario 1: This is a base scenario on Rimini with barriers	pre-calcolato	Barrier	Succeeded	20/02/2025 01:00:00	20/02/2025 01:00:00	×	
Scenario 2, Rimini without barriers	Scenario 2: This is a what-if scenario based on Rimini with barriers scenario	pre-calcolato	Barrier	Succeeded	20/02/2025 01:00:00	20/02/2025 01:10:35	×	
Scenario 3, Rimini without dunes	Scenario 3: This is a base scenario on Rimini without dunes	pre-calcolato	Dune	Succeeded	20/02/2025 01:00:00	20/02/2025 01:00:00	×	
Scenario 4, Rimini with dunes	Scenario 4: This is a what-if scenario based on Rimini without dunes scenario	pre-calcolato	Dune	Succeeded	20/02/2025 01:00:00	20/02/2025 01:10:36	×	
Scenario 7, Rimini without restoration	Scenario 7: This is a base scenario on Rimini without restoration	pre-calcolato	Area Restored	Succeeded	20/02/2025 01:00:00	20/02/2025 01:00:00	:	
Scenario 8, Rimini with restoration	Scenario 8: This is a what-if scenario on Rimini with restoration	pre-calcolato	Area Restored	Succeeded	20/02/2025 01:00:00	20/02/2025 01:00:00	:	
Scenario 13, Rimini with restoration	Scenario 13: This is a what-if scenario on Rimini with restoration	pre-calcolato	Area Restored	😶 Draft	20/02/2025 01:00:00	20/02/2025 01:00:00	:	×
Scenario 14, Rimini with restoration	Scenario 14: This is a what-if scenario on Rimini with restoration	pre-calcolato	Area Restored	Succeeded	20/02/2025 01:00:00	20/02/2025 01:00:00	:	

Results obtained: Rimini with/without barriers



CYBERITALY A > Places > Rimini > Projects > Progetto 1 > Scenarios > Compare ← Comparison + + -0 1 111 111 18111 1 1 Wave-Period Wave-Period X5.09 5.09 4.68 4.68 4.27 4.27 3.86 3.86 3.44 3.44 3.03 3.03 No. Scenario 1, Rimini with barriers Scenario 2, Rimini without barriers

This event is generated by a wave defined by height of 2.7m off-shore, a wave period of 7 seconds, and a wave direction of 45 degree North.

Title	Description	Value
Maximum wave height	Maximum value of significant wave height (in meters) during the event shown.	2.51 m
Average wave height	Average value of significant wave height (in meters) during the event shown.	1.86 m
Average wave direction	Average value of wave direction (in degree North) during the event shown.	45.44 degree N
Mean wave period	Mean wave period (in seconds) during the event shown.	5.81 s
Maximum currents intensity	Maximum value of water currents intensity (in meters/seconds) during the event shown.	0.65 m/s

This event is generated by a wave defined by height of 2.7m off-shore, a wave period of 7 seconds, and a wave direction of 45 degree North.

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Title	Description	Value
Maximum wave height	Maximum value of significant wave height (in meters) during the event shown.	2.51 m
Average wave height	Average value of significant wave height (in meters) during the event shown.	1.86 m
Average wave direction	Average value of wave direction (in degree North) during the event shown.	45.05 degree N
Mean wave period	Mean wave period (in seconds) during the event shown.	5.81 s
Average wave variation	Average wave height variation in the nearshore area for the event shown, when the barriers are removed. The value is expressed as a percentage.	6.3 %

Results obtained: Rimini with/without dunes

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- Run simulations of custom barriers what-if scenarios defined by Users
- Run simulations of custom dunes what-if scenarios defined by Users
- > Stabilization / Improvements / Other requirements from Users



Thank you for your attention!