Rischio costiero, sistemi di prevenzione

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La cooperazione al cuore del Mediterraneo

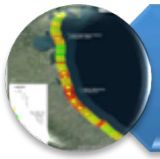
Agenda


Il rischio costiero da mareggiata a scala Europea


Strumenti operazionali per la previsione


Strumenti a scala europea e regionale


Il ciclo di gestione dei disastri


Prevenzione: valutazioni di vulnerabilità e rischio


Impatto sugli elementi esposti

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Il rischio costiero da mareggiata a scala Europea

ANYWHERE

ROBUST FORECASTING TOOLS

- Le **inondazioni costiere** sono uno dei principali pericoli naturali che determinano impatti sociali, economici e ambientali (Hinkel et al., 2014).
- Il fenomeno della **storm surge-acqua alta,** è la causa principale delle alluvioni costiere (Resio, 2012).

COASTAL FLOODING

French Coast Xynthia storm Feb-2010

COASTAL EROSION

UK east coast Xaver storm Dec-2013

- Con l'aumentare dello sviluppo della fascia costiera il rischio aumenterà, aumentando gli elementi esposti, aldilà che aumentino le forzanti (mareggiate) come frequenza o intensità

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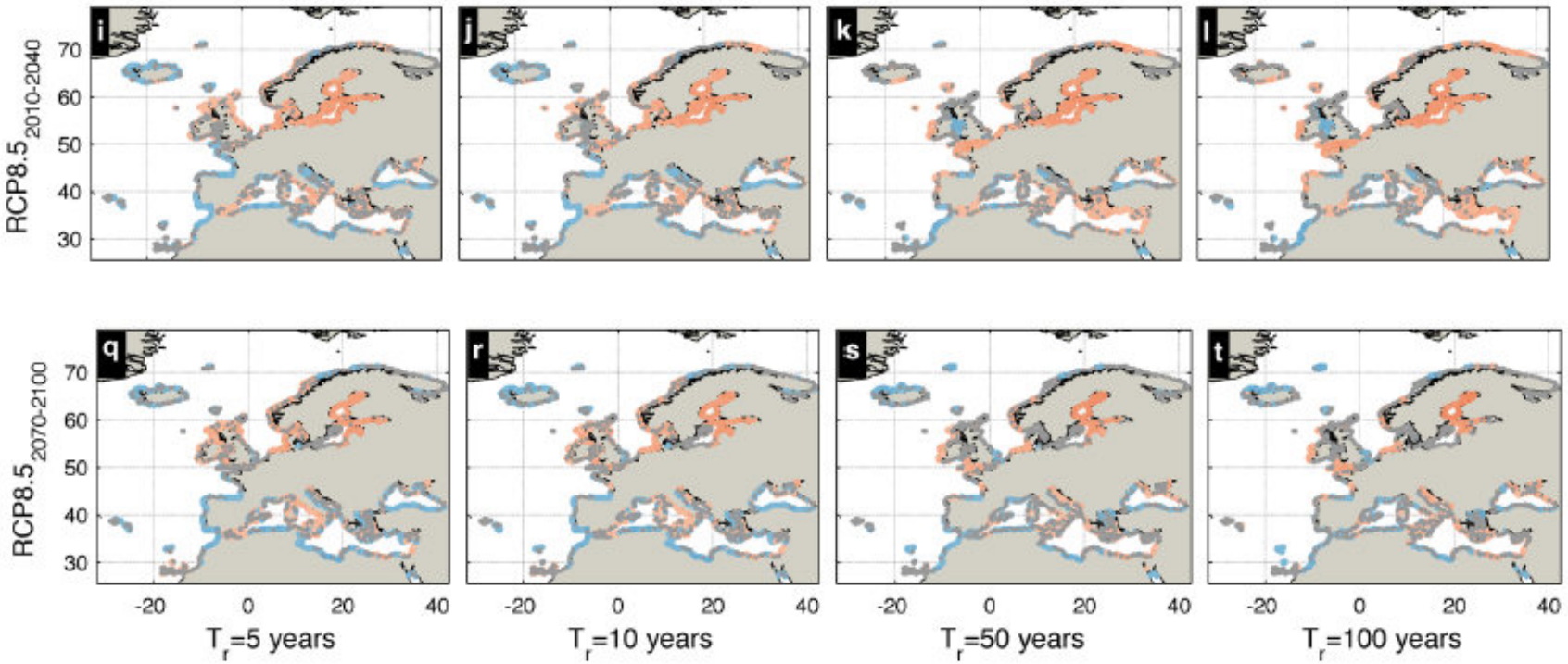
Cosa ci aspetta fino al fine del secolo ?



Trend di aumento delle acque alte (% variazione nell'apparizione di eventi estremi)

Vousdouskas et al. (2016)

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Il ciclo di gestione dei disastri

Source: Van Dongeren, A., Ciavola, P., Martinez, G., Viavattene, C., Bogaard, T., Ferreira, Ó., Higgins, R. and McCall, R.: Introduction to RISC-KIT: Resilience-increasing strategies for coasts, Coast. Eng., 134, 2-9, doi:10.1016/j.coastaleng.2017.10.007, 2018.

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Il rischio operazionale: la svolta

www.micore.eu

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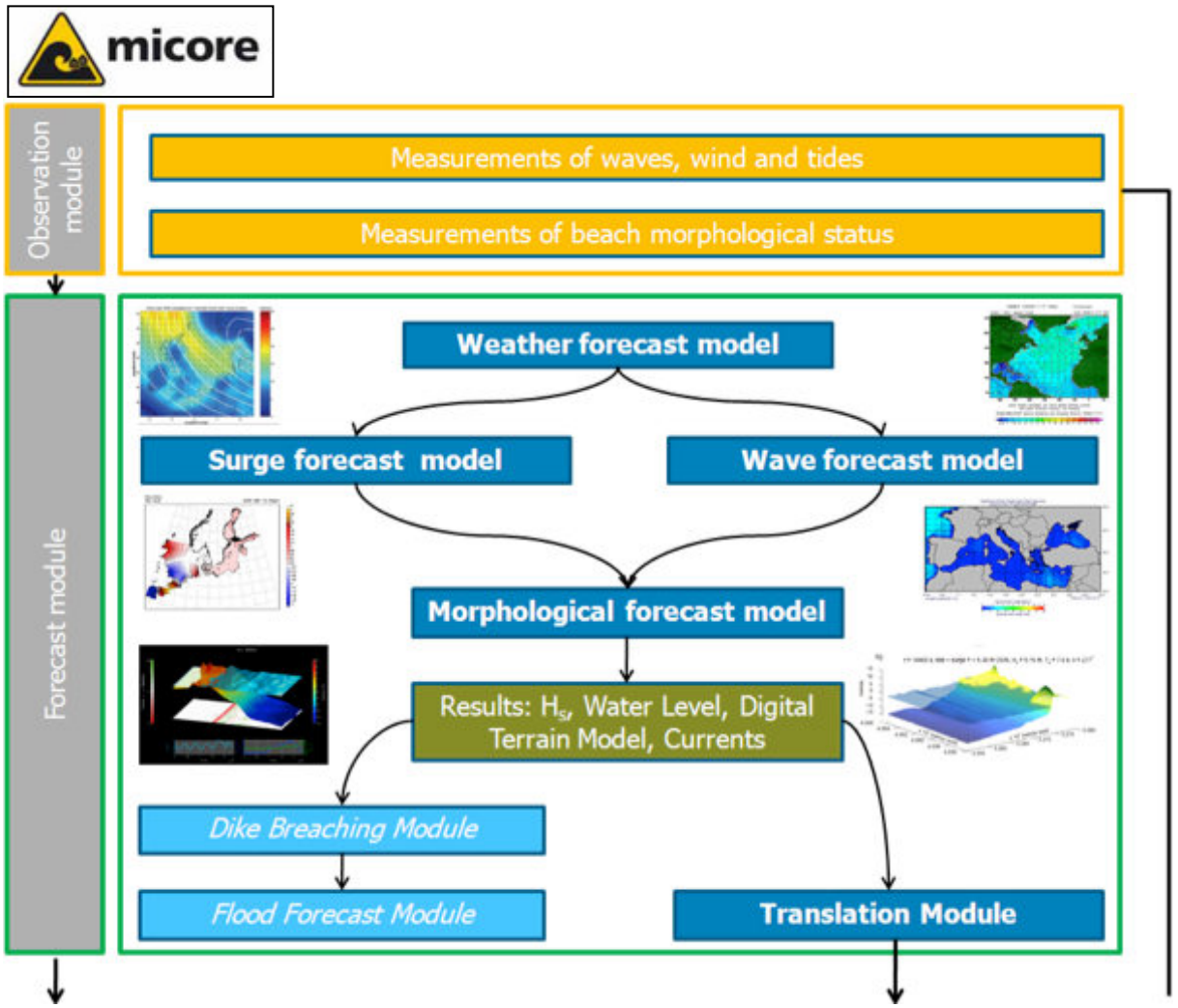
Schema di catena operativa

Ciavola et al. (2011)

Storm impacts along European coastlines. Part 2: lessons learned from the MICORE project. Environmental Science & Policy doi:10.1016/j.envsci.2011.05.009



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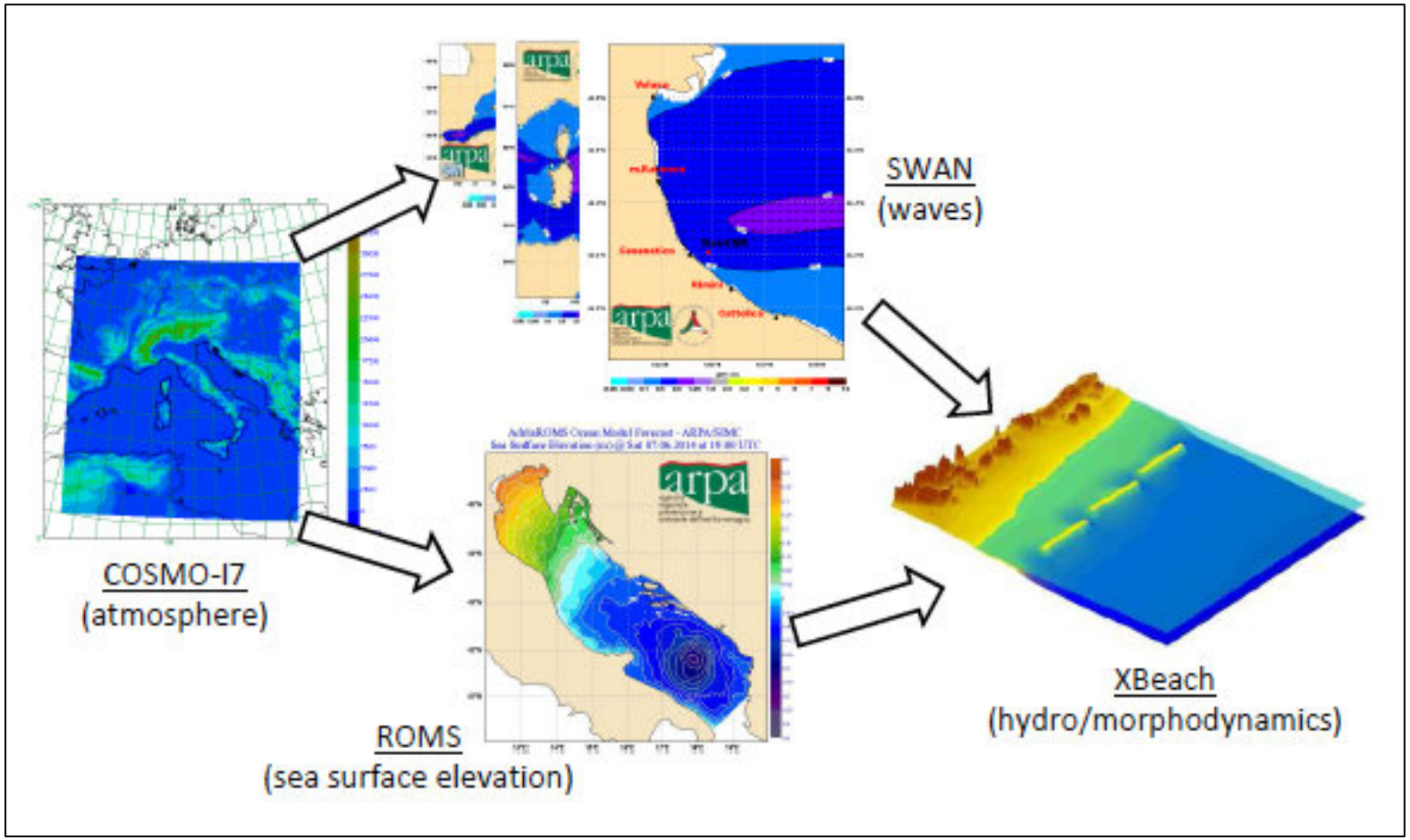
La catena operativa in Emilia-Romagna



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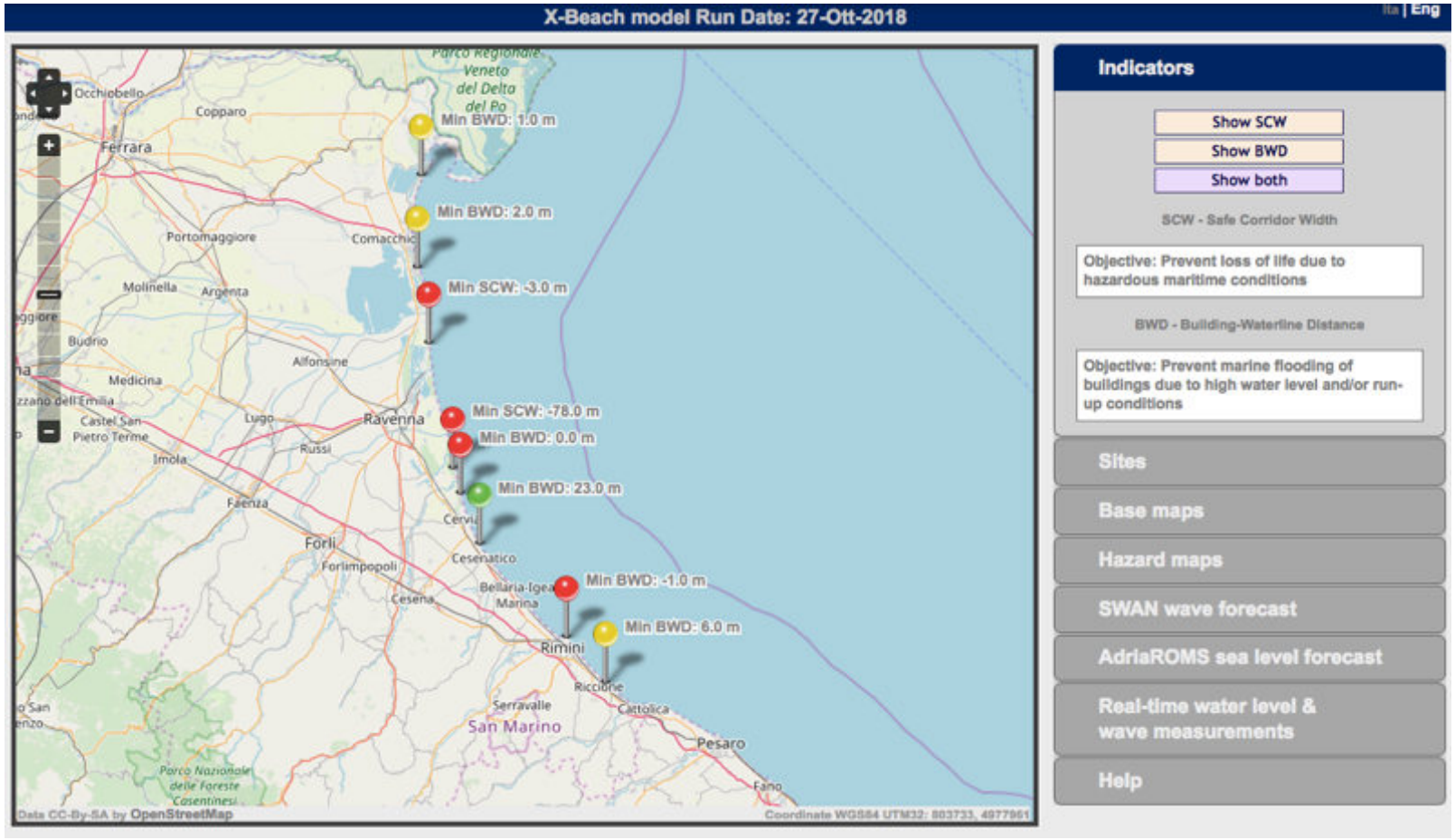
La catena operativa in Emilia-Romagna



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La sfida per chi è in prima linea

Emilia-Romagna Sea-Flood 5 February 2015

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ANYWHERE

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(EnhANcing emergencY management and response to extreme WeatHER and climate Events)

Hazards to Impacts models

ANYWHERE

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Main Products and algorithms Contact

Multi Hazard Early Warning System
MH-EWS products
www.anywhere-h2020.eu/catalogue

HAZARDS

Meteorological forecast and nowcast

Floods, flash-floods, debris flow and landslides

Storm surges

Heatwaves and weather-induced health impacts

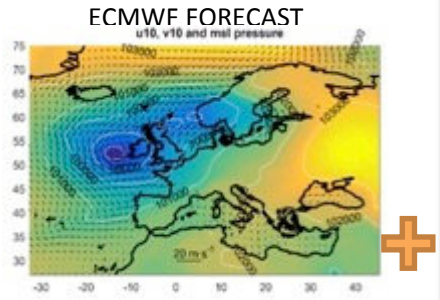
Weather-induced forest fires

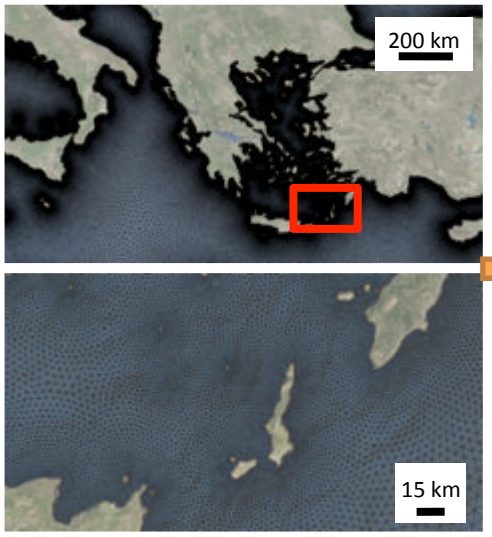
Droughts

Convective storms, severe winds

Snowfall

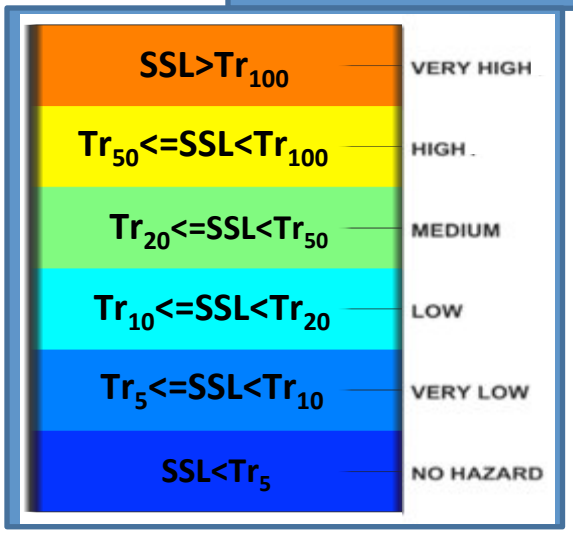
Il sistema a scala Europea





STORM SURGE LEVEL (SSL)

HISTORICAL HINDCAST



Comparison with the storm surge level for different return period (Tr=[5,10,20,50,100])

HAZARD LEVEL

Fernández-Montblanc, T., Vousdoukas, M. I., Ciavola, P., Voukouvalas, E., Mentaschi, L., Breyiannis, G., ... & Salamon, P. (2019). Towards robust pan-European storm surge forecasting. Ocean Modelling, 133, 129-144. doi: https://doi.org/10.1016/j.ocemod.2018.12.001

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Il sistema a scala Europea

ANYWHERE

CIRCULATION MODEL SCHISM (Zhang and Baptista, 2008)

- 2D Barotropic model
- Semi-Implicit ΔT=400 S
- Unstructured mesh
- Number of nodes: 339138
- Tide: Open boundary (Tidal constituent from FES2012) and tidal forces.
- Atmospheric forcing: ECMWF (u10, v10 and MSL pressure)
- Resolution: ~70 Km(Greenland) – 10 Km (eurpean coastline)
- Wave forces from WWMIII
- Surface stress wave dependent

COUPLED

SPECTRAL WAVE MODEL WWMIII (Roland et al., 2012)

- It solves wave action equations
- Source terms growth / dissipation ST4 (Arduin et al 2010).
- Bottom Friction JONSWAP Shallow wave breaking (0.78)
- Number of directional bins 24
- Number of frequency bins 24
- Nonlinear 4-wave interactions DIA (Hasselman et al, 1985)
- Elevation and current from SCHISM

Fernández-Montblanc, T., Vousdoukas, M. I., Ciavola, P., Voukouvalas, E., Mentaschi, L., Breyiannis, G., ... & Salamon, P. (2019). Towards robust pan-European storm surge forecasting. Ocean Modelling, 133, 129-144. doi: https://doi.org/10.1016/j.ocemod.2018.12.001

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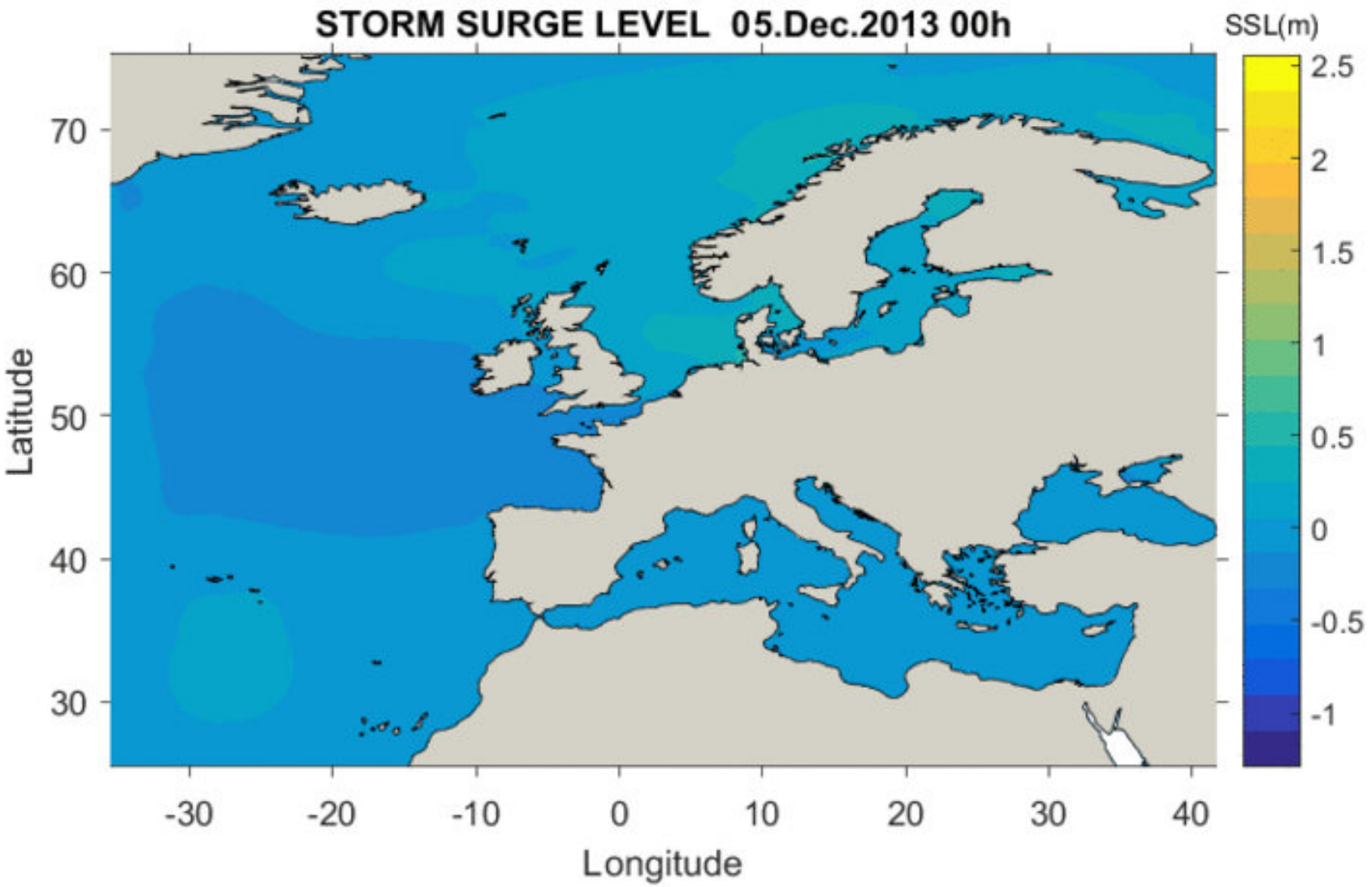

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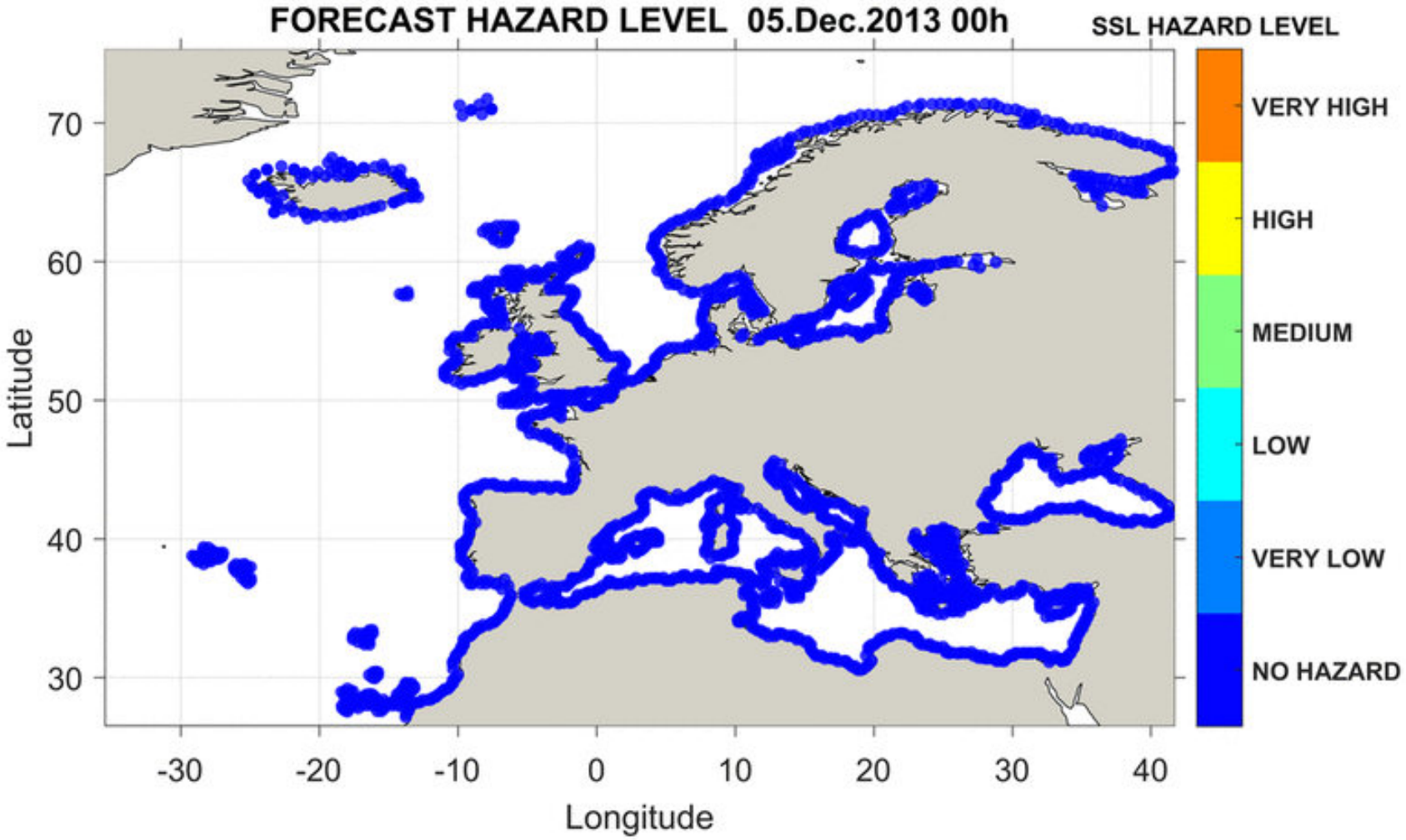

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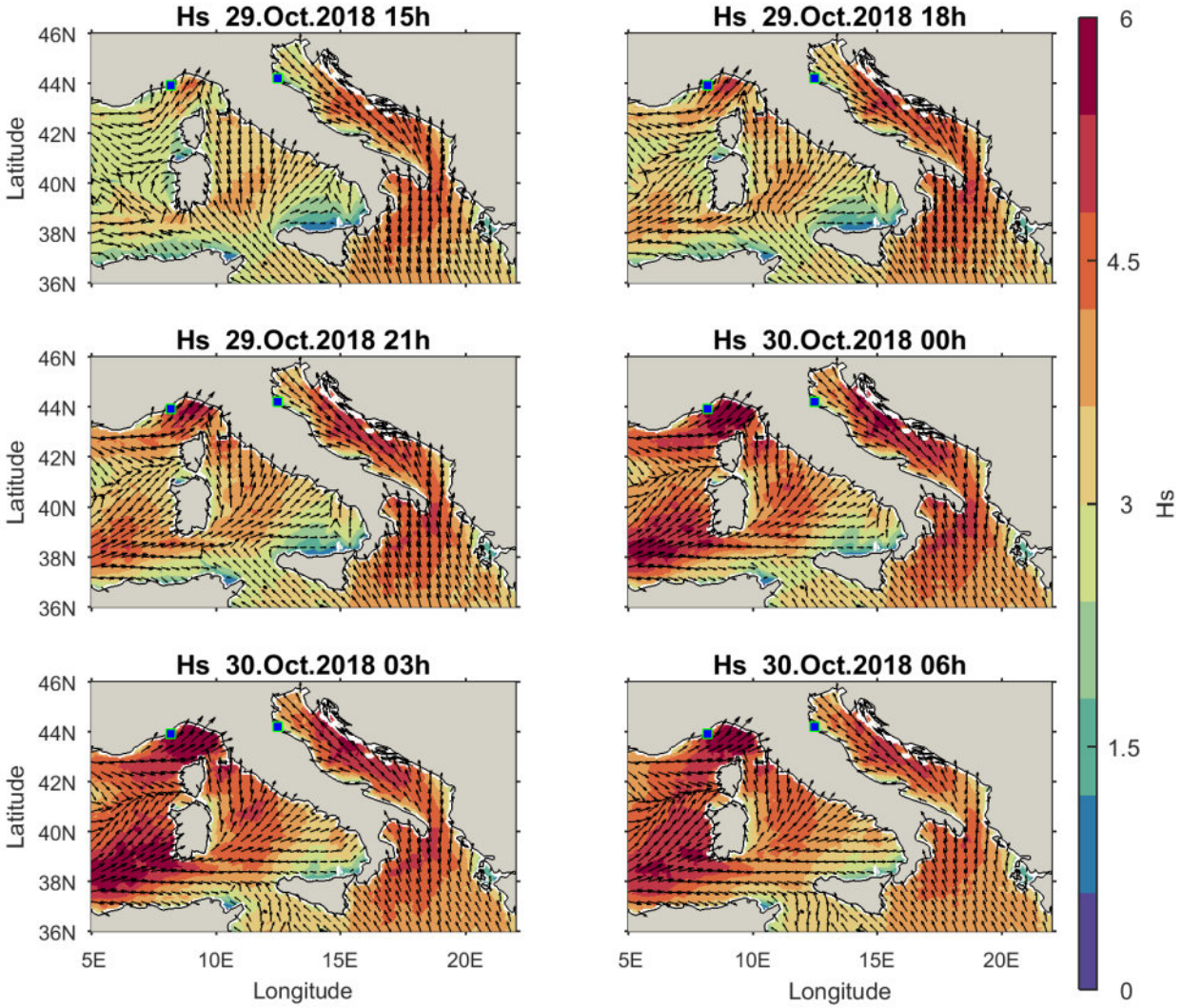
Test mareggiata 28 ottobre 2018-altezza d'onda



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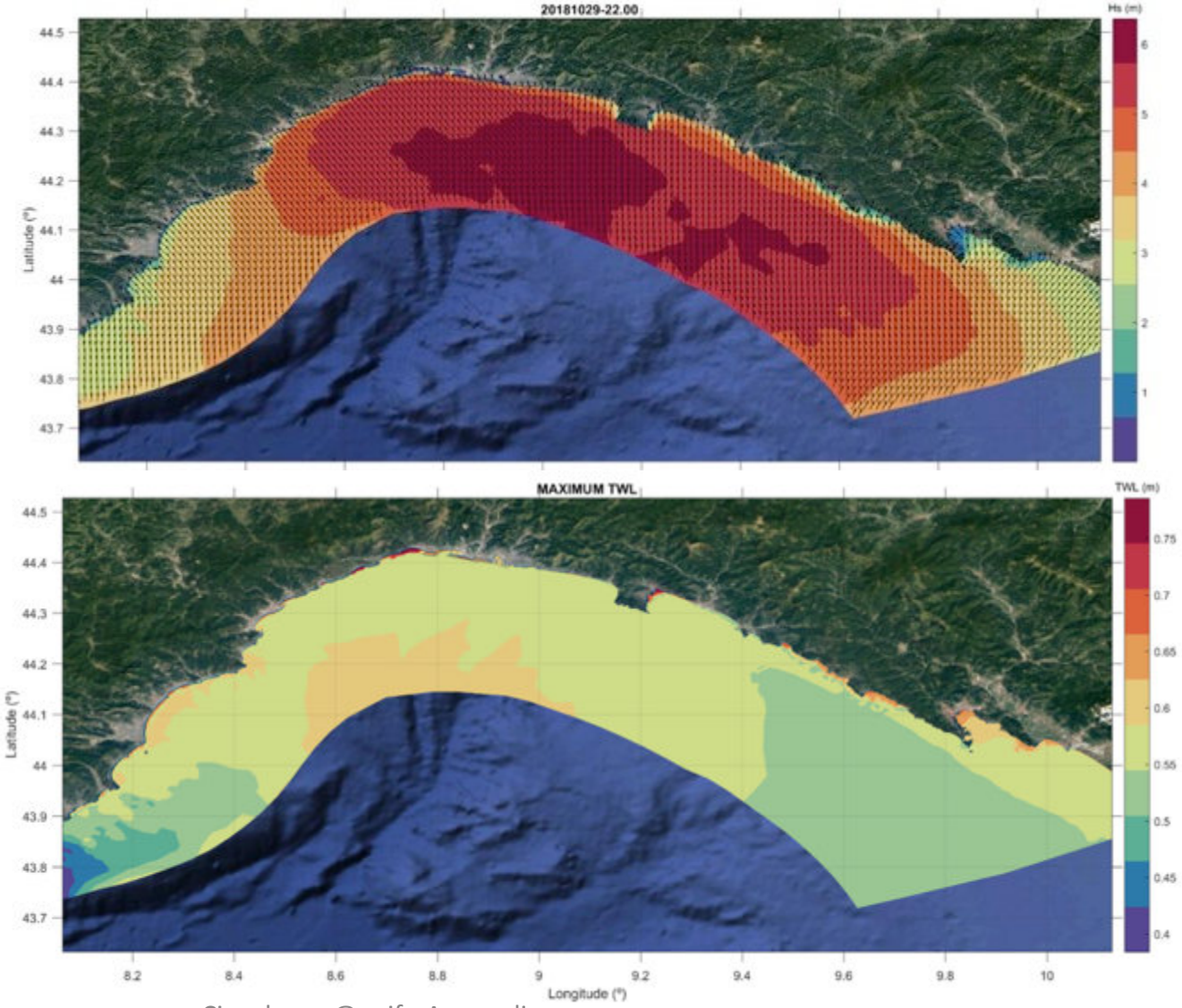
Test mareggiata 28 ottobre 2018-altezza d'onda e livello

Altezza d'onda

Livello del mare



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Il ciclo di gestione dei disastri

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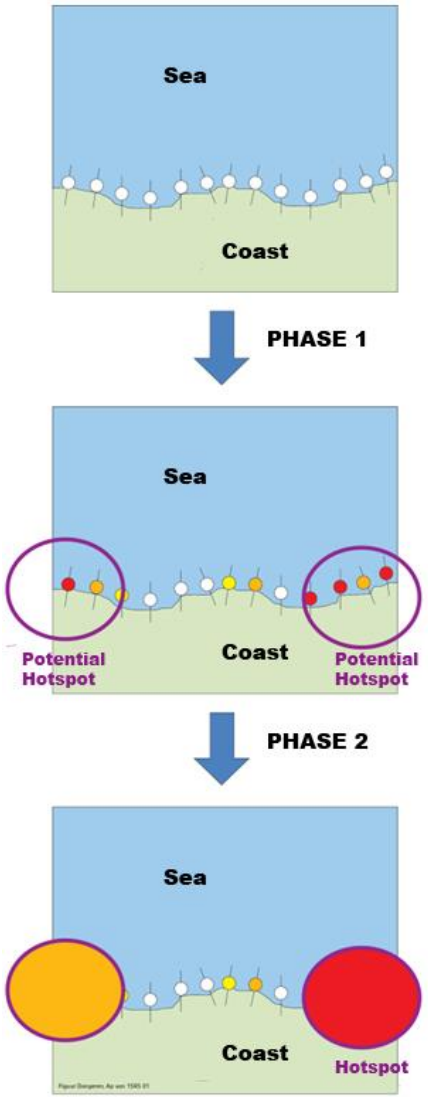
Prevenzione: valutazioni di vulnerabilità e rischio



COASTAL RISK ASSESSMENT FRAMEWORK - CRAF	
CRAF 1	Identificazione di aree sensibili (Hotspots) a scala regionale
CRAF 2	Classificazione degli hotspot in base all'impatto di eventi estremi (dove intervenire prima)

RISC-KIT

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CRAF 1 - metodologia

- **Interazione** con gli utilizzatori finali (ER SGSS)
- La costa è stata suddivisa in **settori** di ~1km di lunghezza
- E' stato scelto un **profilo rappresentativo** per ogni settore
- Modelli semplificati per **erosione** e **inondazione** **(in_CoastFlood, T10 e T100, Perini et al., 2016** e **2017)**
- Identificazione degli **elementi esposti** nelle zone inondate
- Approccio basato su un indice costiero (**Coastal Index**)

$$CI = \left[\left(i_h * i_{exp}\right)\right]^{\frac{1}{2}}$$

C. Viavattene, J.A. Jiménez, O. Ferreira, S. Priest, D. Owen, R. McCall, 2018. Selecting coastal hotspots to storm impacts at the regional scale: a Coastal Risk Assessment Framework, Coastal Engineering, 134, 33-47. https://doi.org/10.1016/j.coastaleng.2017.09.002

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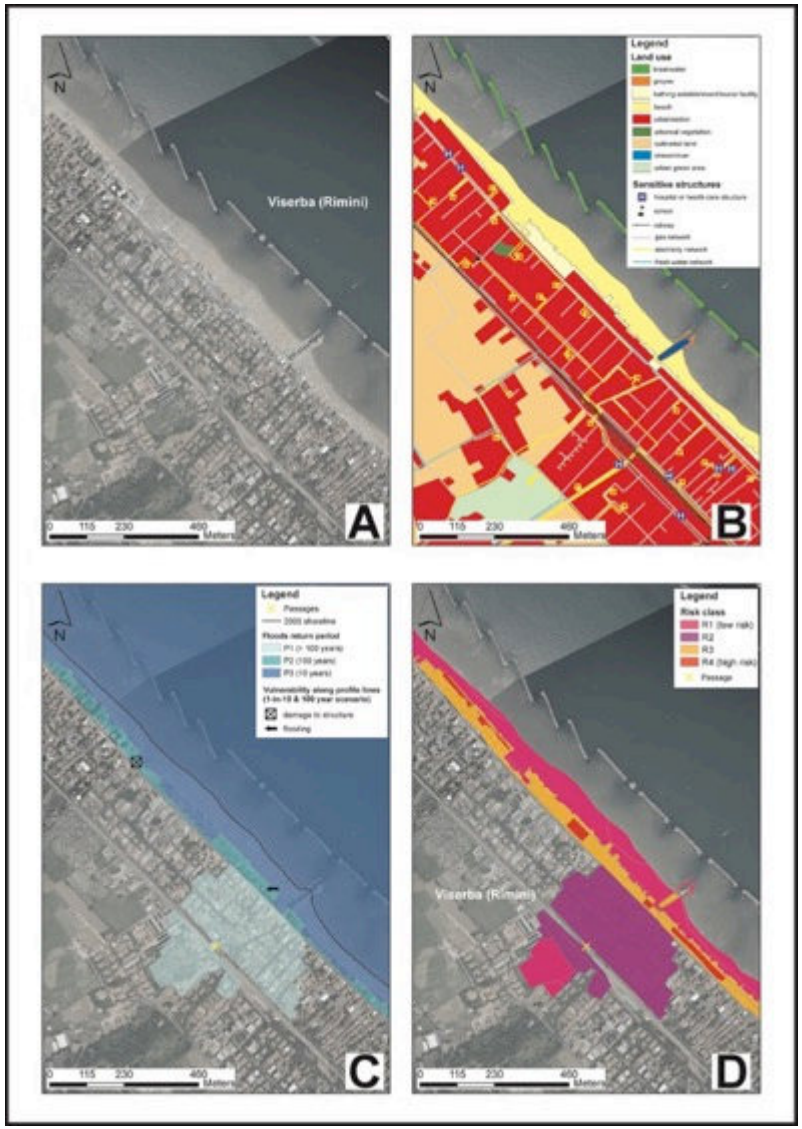
Indicatore di pericolosità - hazard

$$CI = \left[\left(i_h * i_{exp}\right)\right]^{\frac{1}{2}}$$

Indicatore di pericolosità (erosione e inondazione)



Perini, L., Calabrese, L., Salerno, G., Ciavola, P., Armaroli, C. (2016). Evaluation of coastal vulnerability to flooding: comparison of two different methodologies adopted by the Emilia-Romagna region (Italy). NATURAL HAZARDS AND EARTH SYSTEM SCIENCES, Volume 16, Issue 1, p. 181-194.

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Indicatori di esposizione - exposure

$$CI = \left[\left(i_h * i_{exp}\right)\right]^{\frac{1}{2}}$$

$$i_{exp} = \left[\left(i_{exp-LU} * i_{exp-POP} * i_{exp-TS} * i_{exp-UT} * i_{exp-BS}\right)\right]^{1/5}$$

- i_{exp-LU}: Uso del suolo
- $i_{exp-POP}$: Popolazione
- i_{exp-TS}: Sistema dei trasporti
- i_{exp-UT}: Sistemi di reti (gas, acqua, luce)
- i_{exp-BS}: Attività economiche

C. Viavattene, J.A. Jiménez, O. Ferreira, S. Priest, D. Owen, R. McCall, 2018. Selecting coastal hotspots to storm impacts at the regional scale: a Coastal Risk Assessment Framework, Coastal Engineering, 134, 33-47. https://doi.org/10.1016/j.coastaleng.2017.09.002

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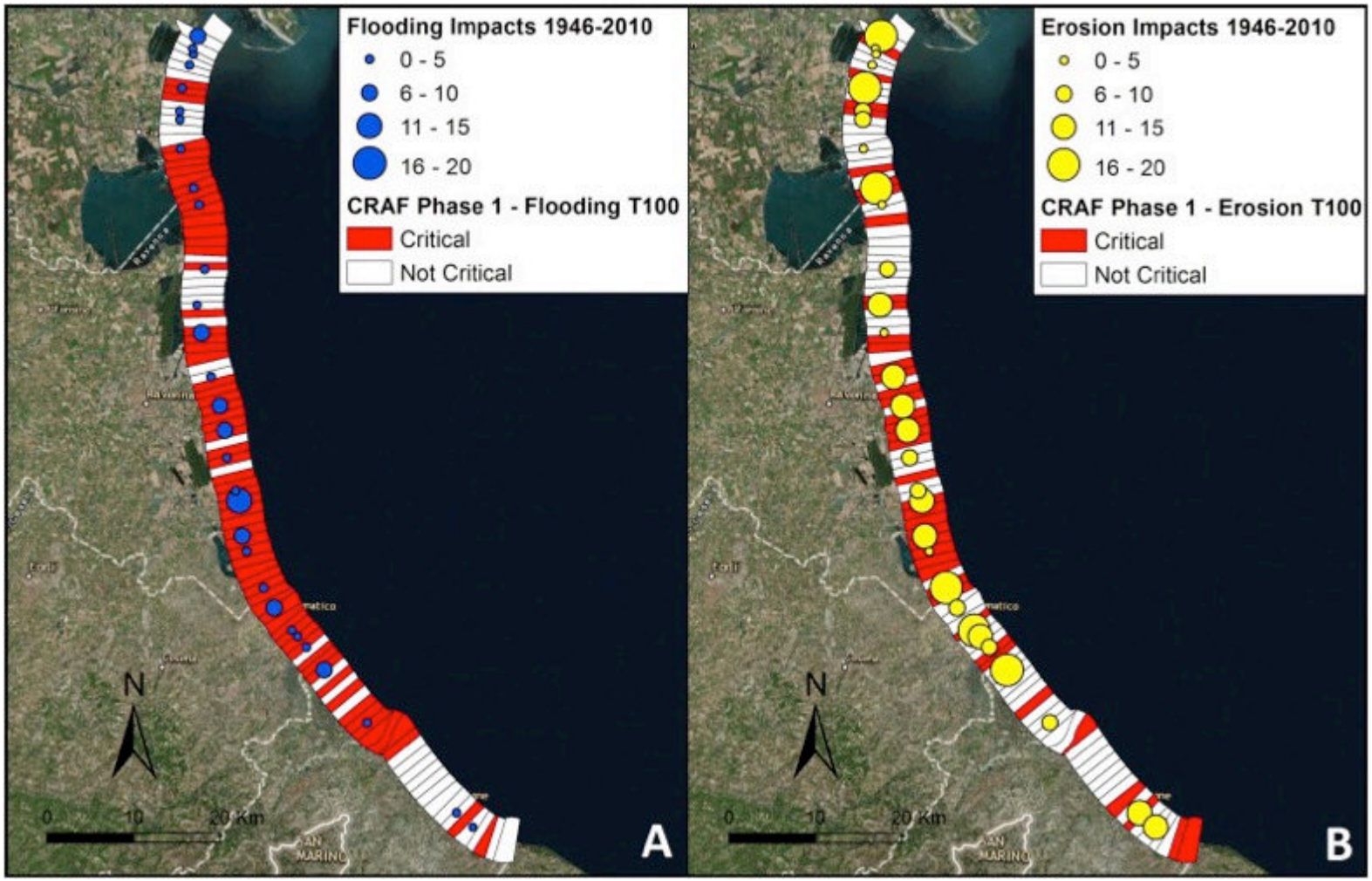
Identificazione degli hotspots e selezione per la fase 2



C. Armaroli, E. Duo, 2018. Validation of the Coastal Storm Risk Assessment Framework along the Emilia-Romagna coast, Coastal Engineering, 134, 159-167. https://doi.org/10.1016/j.coastaleng.2017.08.014

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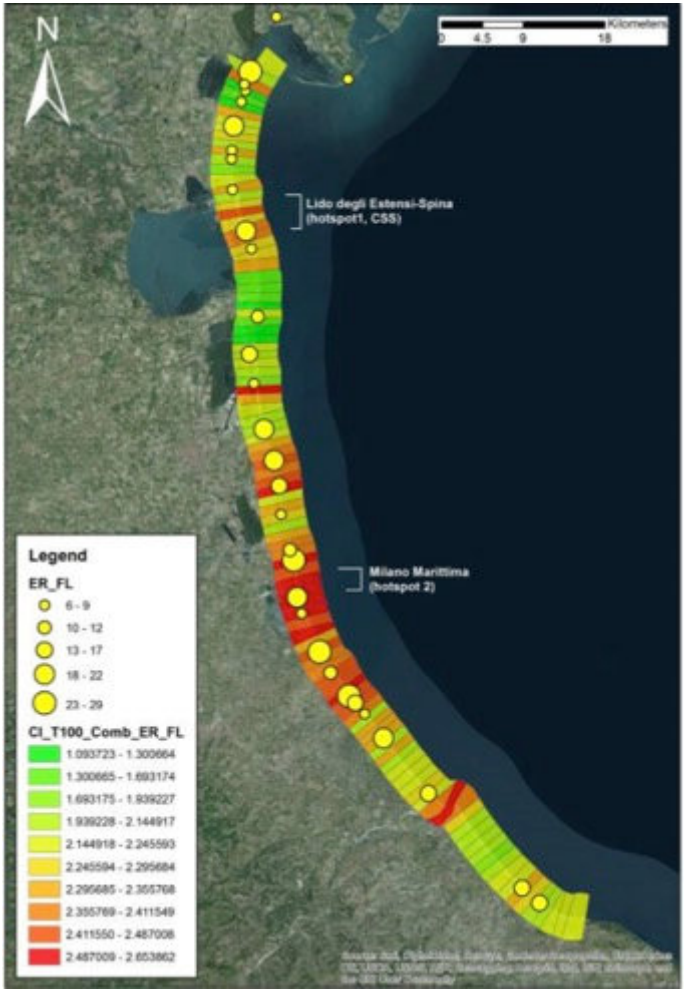
Identificazione degli hotspots e selezione per la fase 2



2 mareggiate sintetiche triangolari

Periodi di ritorno di 10 e 100 anni

Topografia dell'area di studio

Modello digitale del terreno (DEM)

Profili di spiaggia

Griglie composte di centinaia di profili ciascuna

C. Armaroli, E. Duo, C. Viavattene, 2019. From hazard to consequences: evaluation of direct and indirect impacts of flooding along the Emilia-Romagna coastline, Italy. FRONTIERS IN EARTH SCIENCE, GEOHAZARDS AND GEORISKS, https://doi.org/10.3389/feart.2019.00203

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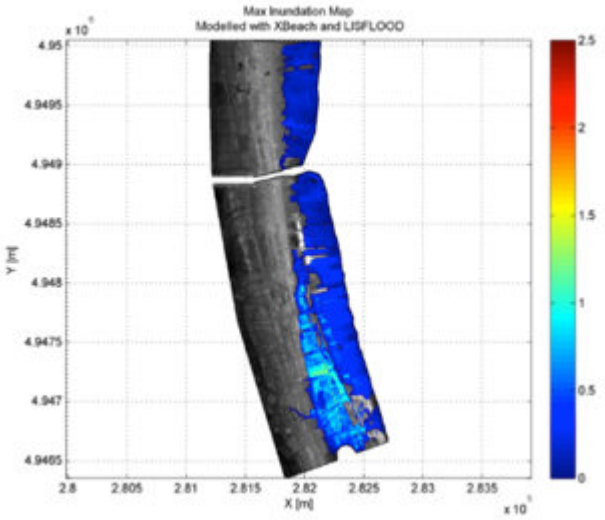
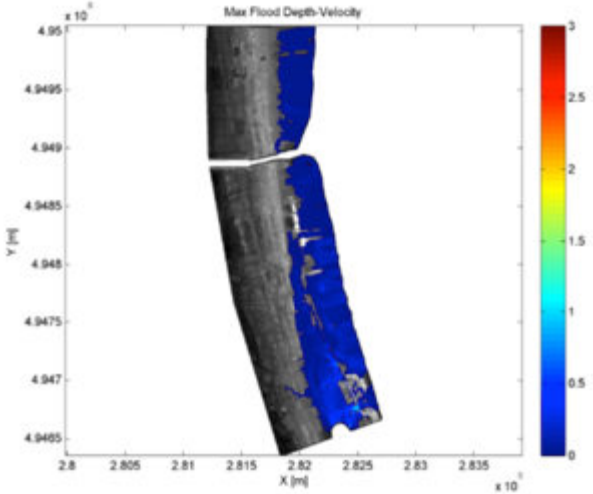
RISC-KIT

Modellazione di inondazione e erosione con i modelli XBeach e LISFLOOD-FP

5-1: Parameters of the selected extreme events (adapted from Perini et al., 2016).

ID	Scenario	RP	Storm Surge	High Tide	Wave Setup	TWL	Hs	Tp	Dur
		[years]	[m]	[m]	[m]	[m]	[m]	[sec]	[days]
T10	Freq.	10	0.79	0.4	0.3	1.75	4.7	8.9	1.75
T100	Low Freq.	100	1.02	0.4	0.39	1.81	5.9	9.9	2.3





Es: Lido degli Estensi-Spina

C. Armaroli, E. Duo, C. Viavattene, 2019. From hazard to consequences: evaluation of direct and indirect impacts of flooding along the Emilia-Romagna coastline, Italy. FRONTIERS IN EARTH SCIENCE, GEOHAZARDS AND GEORISKS, https://doi.org/10.3389/feart.2019.00203

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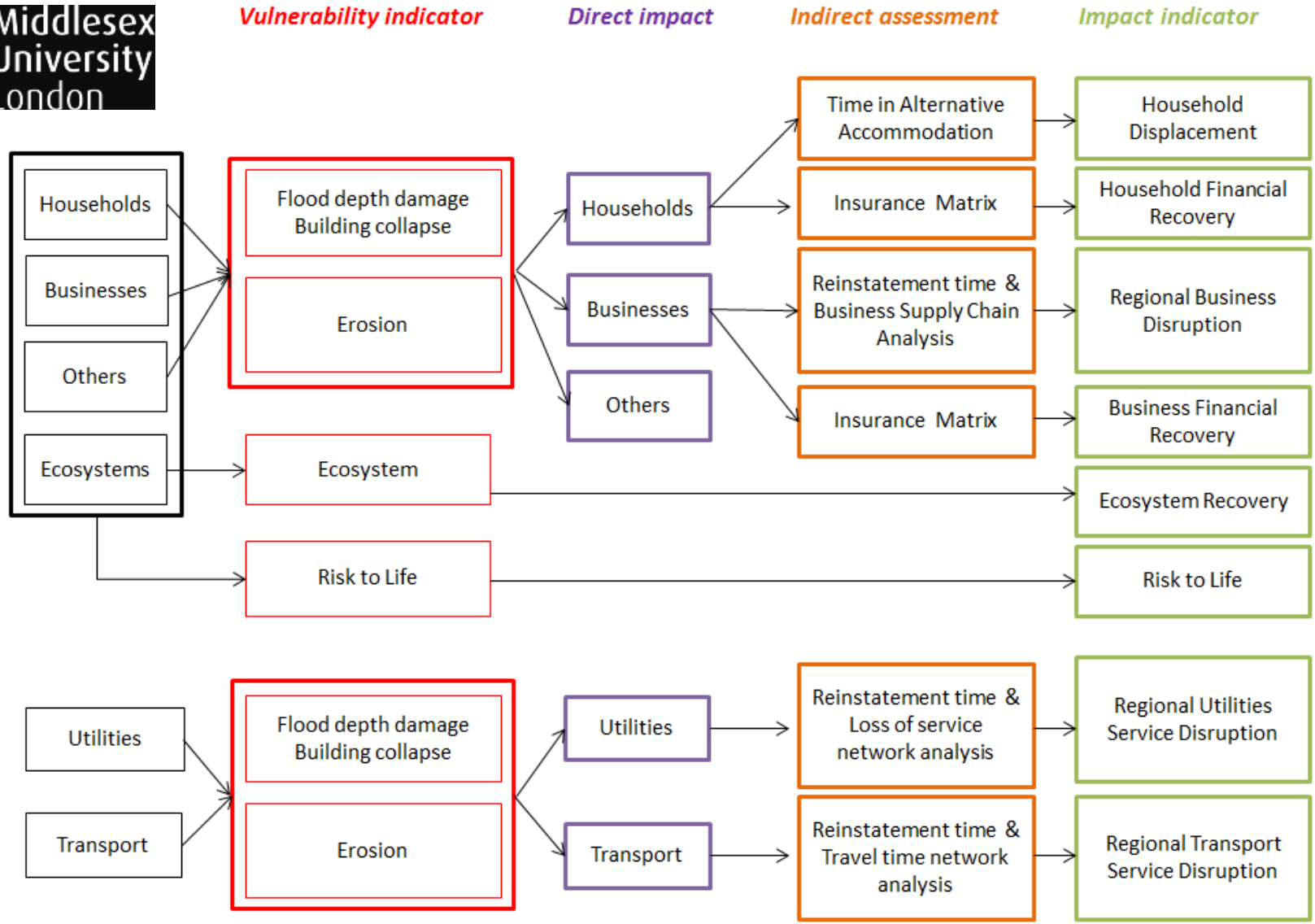
RISC-KIT

INTEGRATED DISRUPTION ASSESSMENT MODEL (INDRA)

Middlesex University London



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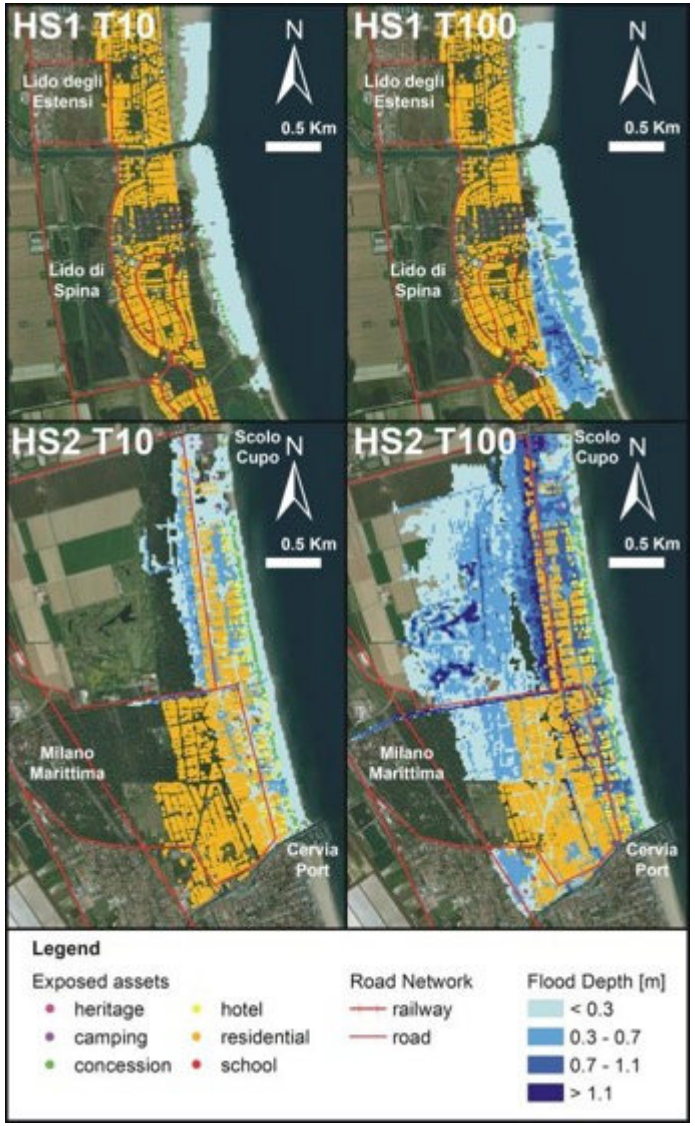

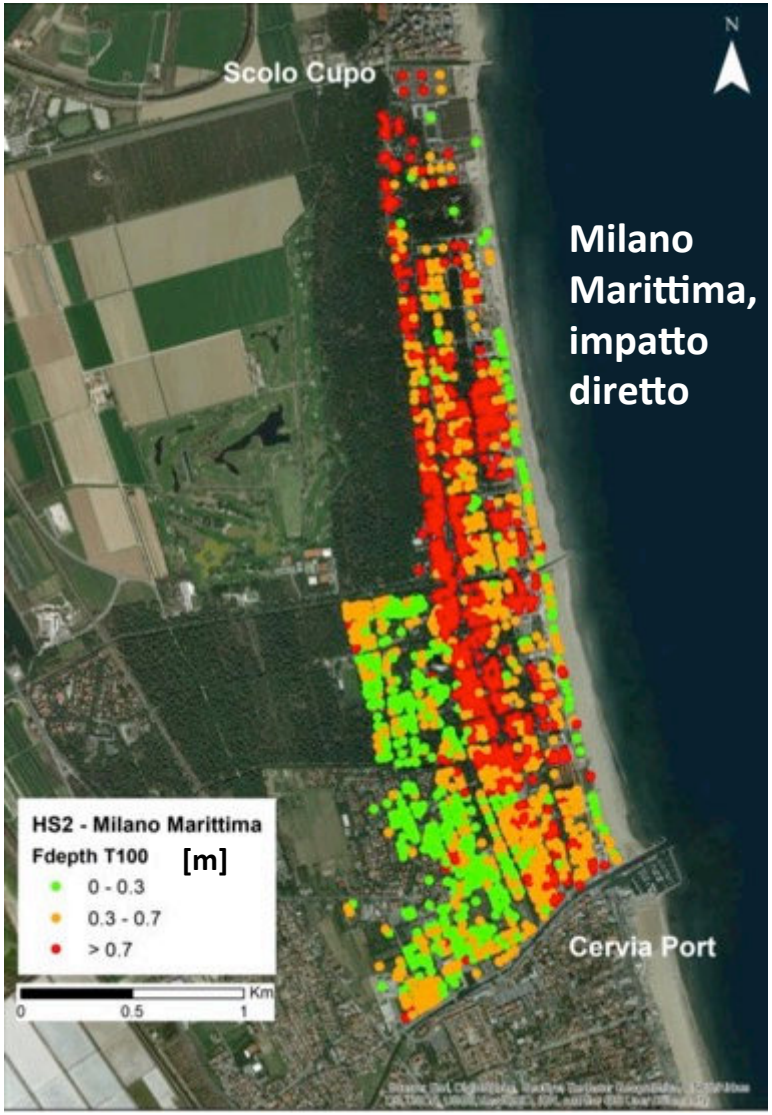

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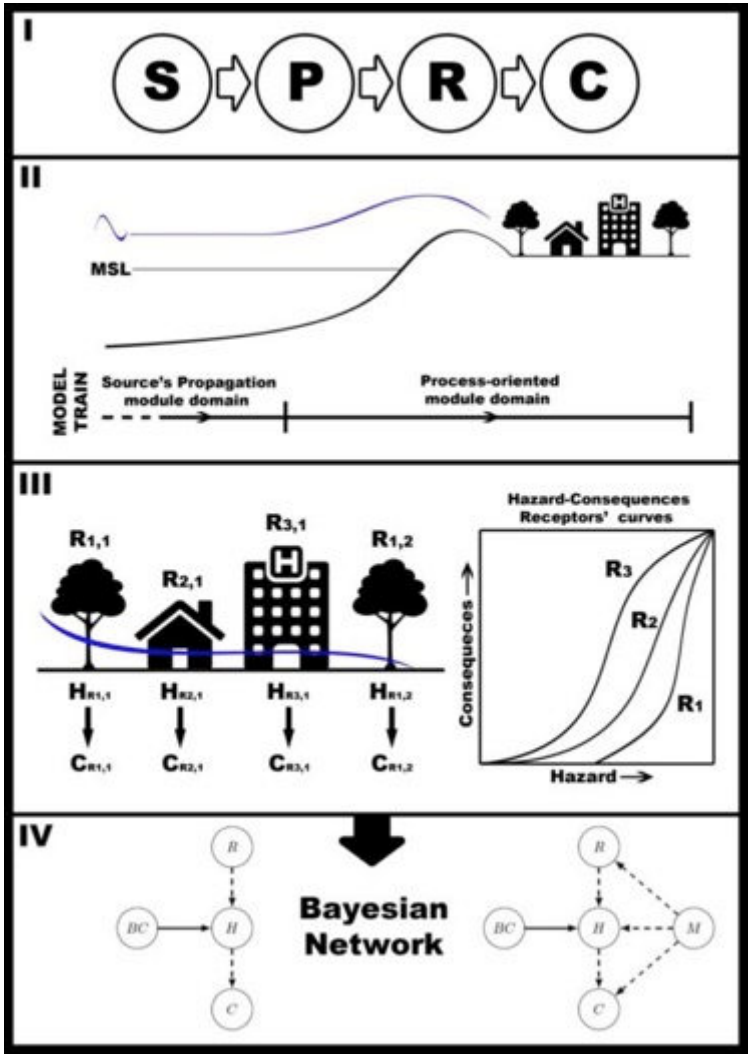
Approccio SPRC

RISC-KIT

RISCHIO = PERICOLOSITA' X CONSEGUENZE



Source
- Scala locale/regionale

Pathways
- Scala locale (caso studio)

Receptors
- Scala del recettore

Consequences
- Scala del recettore

Sanuy, M., Duo, E., Jäger, W. S., **Ciavola, P.,** and Jiménez, J. A.(2018). Linking source with consequences of coastal storm impacts for climate change and risk reduction scenarios for Mediterranean sandy beaches, Nat. Hazards Earth Syst. Sci., 18, 1825-1847, https://doi.org/10.5194/nhess-18-1825-2018.

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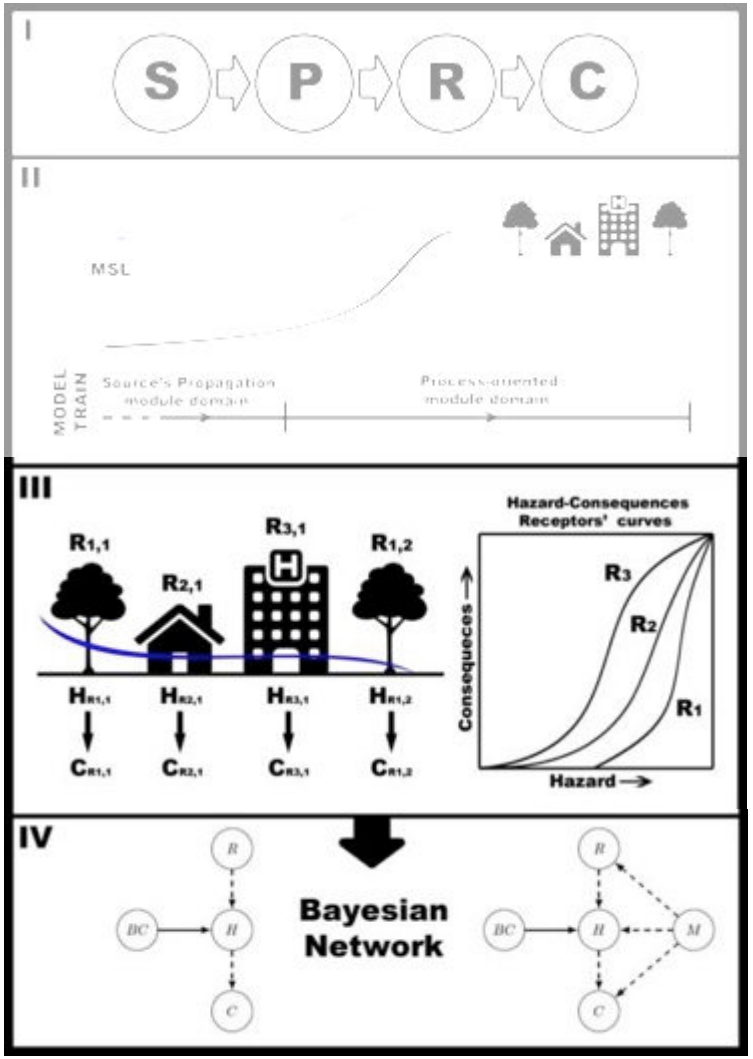
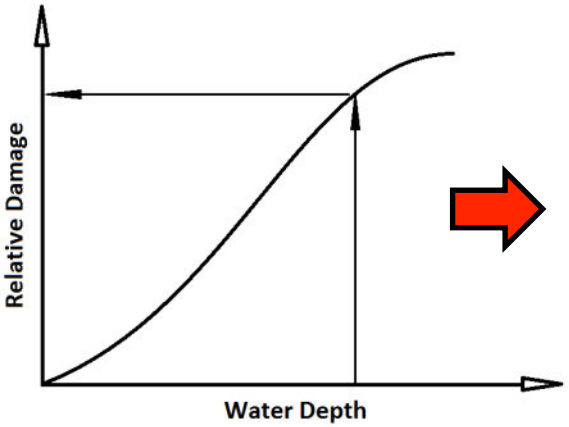
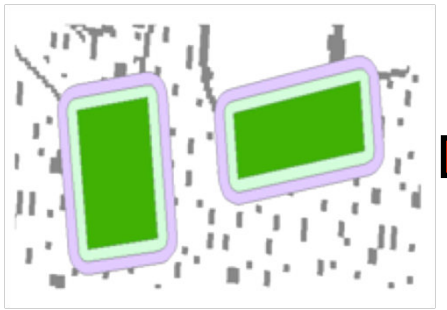
Approccio SPRC





Ad es. inondazione: classificazione del relative damage per definire il livello di rischio da inondazione



Ad es. erosione: Livello di rischio dipende dall'entità dell'erosione in riferimento ad un buffer predefinito attorno ai recettori

Sanuy, M., Duo, E., Jäger, W. S., **Ciavola, P.,** and Jiménez, J. A.(2018). Linking source with consequences of coastal storm impacts for climate change and risk reduction scenarios for Mediterranean sandy beaches, Nat. Hazards Earth Syst. Sci., 18, 1825-1847, https://doi.org/10.5194/nhess-18-1825-2018.

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