



ItaliaMeteo: Towards a national met-ocean service to support coastal resilience and environmental sustainability

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 12 December 2023

 Palazzo Malvezzi - University of Bologna



Outline

- The state of the art of «managing» resilience, taking into account the Climate Change impacts, concerning coastal areas: monitoring and forecasting systems available today, structural and non-structural way to manage natural risks: the Early Warning System in Italy
- The whole governance of the system: the «+» and the «-»
- The need for a stronger coordination: the role of ItaliaMeteo
- The opportunities offered by the PNRR to improve the resilience
- The adaptation action: improving EWS and some... conclusions

Impacts of climate change on marine and coastal ecosystems

- The impacts of climate change cause important alterations that affect the benefits of ecosystems provide human life, such as food (fishing, aquaculture, etc.), benefits for the health, but also mitigation of climate change itself, absorbing CO₂ from the ocean, etc.
- Climate change determines an increase in the risk of coastal flooding, both due to the increase in sea level and the possible increase in storm surges.
- The warming of the sea and the reduction of ice contribute to the migration of animal species towards higher latitudes and altitudes, in conditions which, due to environmental limits and barriers, can increase the probability of extinction.
- Climate change reduces the oxygen content, increasing the risk of episodes of hypoxia and anoxia (oxygen deficiencies in the body) and decreasing the availability of nutrients. The consequence is a drop in primary production

Flooding infrastructures and urban centers



What is the Resilience and how it can be increased in relation to coastal risk

Coastal resilience is the capacity of coastal natural and socio-economic systems to persist, adapt or transform when faced with disturbances induced by factors such as sea-level rise, extreme events and human impacts, whilst maintaining their essential functions.

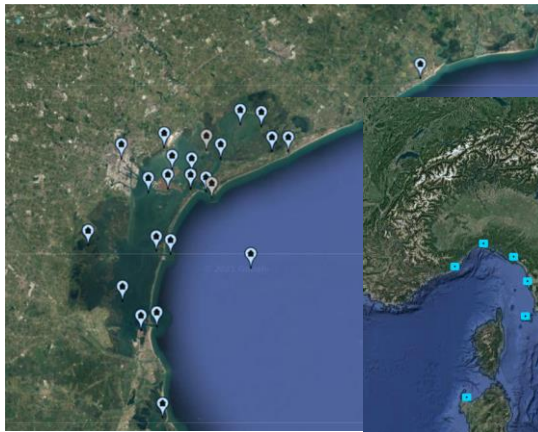
(European Marine Board “Building Coastal Resilience in Europe”)

What do we need to improve resilience?

The need of "weather, marine and climate" data and products

(emerging by a survey performed in the framework of the MISTRAL project, chaired by CINECA)

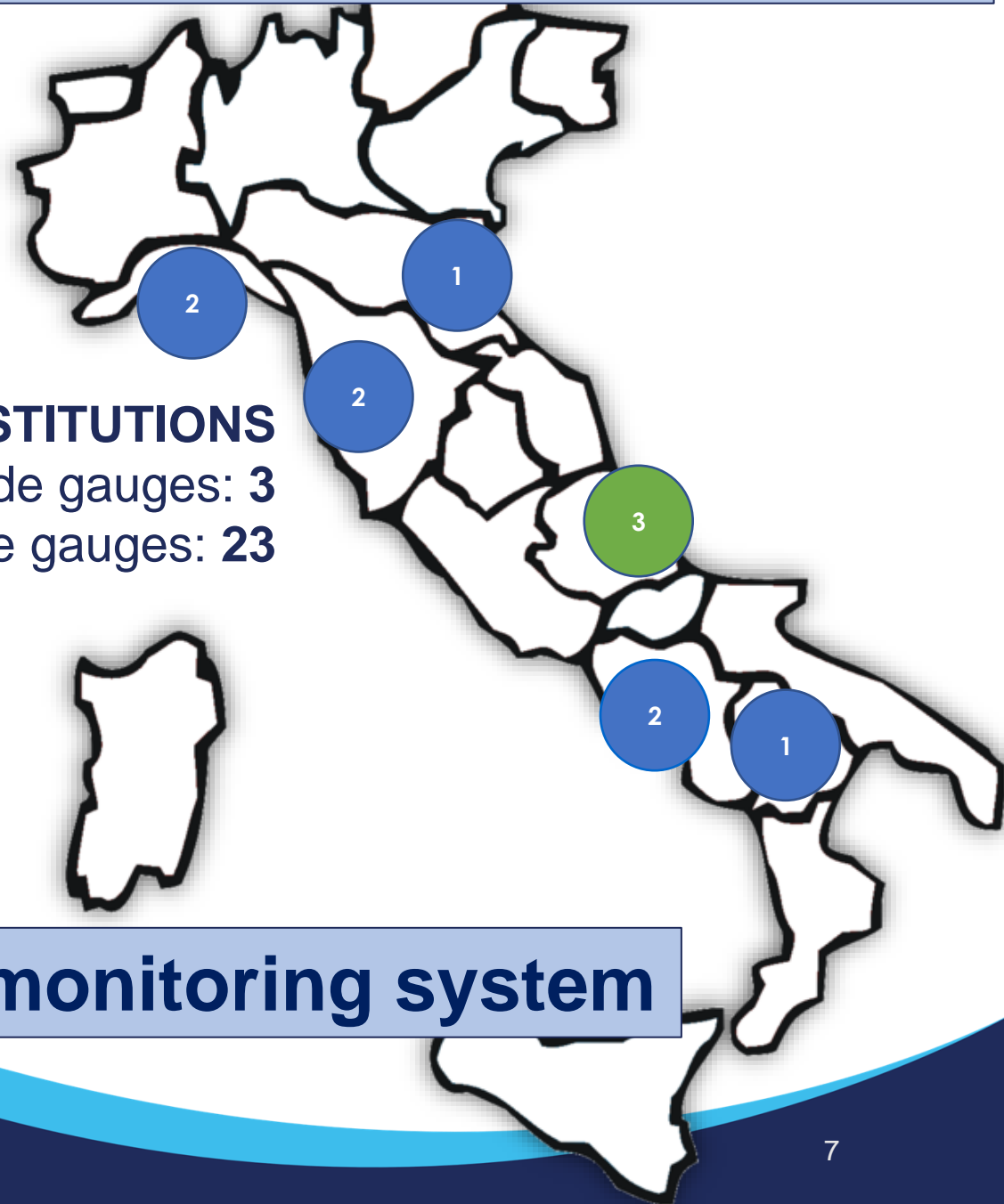
DATA	Available, certified, homogeneous, validated. Need for time series, easily communicable, geo-referenced and of different types (conventional, radar and satellite). Need for a national OPEN portal... Problem: Lack of a strong national weather reference
FORECAST	Need of more numerical and map forecasts easily available; back office services; need of a probabilistic forecasts with uncertainty assessment; "ex-ante" estimate of reliability; resolution increase.
OPEN PROBLEMS AND WHAT TO IMPROVE	Too much inhomogeneity; develop new business services. Non-immediate availability of event data; difficulty in accessing historical series; lack of scientific culture and training on problematic climatic events; clearer languages in communication; greater public / private collaboration !
CUSTOMIZED PRODUCTS	Personalized press releases; profiled portal for different users; need to put in communication the platforms already existing; availability of information through three-dimensional dynamic maps. Bring out the authority of the Source. Assistance: building spaces for dialogue between "meteo" producers and users



Tide gauges: 59
Wave gauges: 15

PUBLIC INSTITUTIONS

- Tide gauges: 3
- Wave gauges: 23



The «marine» national monitoring system

OVERALL SEA MODELLING SYSTEM MONITORING STATIONS

Extract from the survey carried out by the Steering Committee for Meteorology and Climatology (Law n.205 / 2017)

Wave motion models:

- A. WAM Model (WAve Model) operational at AM and ISPRA,
- B. WaveWatch3 (WW3) operational at ARPAL, LAMMA Toscana, CMCC)
- C. SWAN model operational at ARPA-ER.5. and CETEMPS

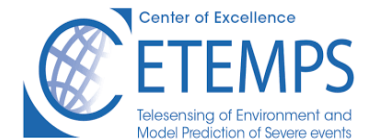
Ocean models: ROMS, CMCC models

- A. Fine-scale ROMS model operational at LaMMA Toscana (North West Med) and ARPA-ER (Adriatic).
- B. CMCC model for Mediterranean forecasts (1/24 degree), based on NEMO at daily operational basin scale.
- C. CMCC model for Black Sea forecasts (1/16 degree), based on NEMO at daily operational basin scale.
- D. CMCC model for global ocean forecasts (1/16 degree), based on NEMO.
- E. ROMS model coupled with fine-scale WRF and SWAN on the Adriatic operating at UNIVPM (UNIVPM-CETEMPS)

Storm surge and tide forecast models

- A. SHYFEM 2D model (with data assimilation) developed by CNR-ISMAR, operational at ISPRA in 2 versions (ECMWF and BOLAM ISPRA weather forecast fields) on the Italian coasts, the Upper Adriatic and the Venice lagoon
- B. ISPRASTAT_2008 model developed by ISPRA in 2 versions (ECMWF and BOLAM ISPRA weather forecast fields) for forecasting storm surges and tide levels in 7 locations in the Northern Adriatic.

Italian "actors" working in marine and coastal monitoring and forecasting





- ANIMAZIONI
 - Mediterraneo
 - Tirreno Settentrionale
 - Aree regionali
 - Sardegna Settentrionale
 - Sardegna Meridionale
 - Tirreno Centrale
 - Tirreno Meridionale
 - Mar Ionio
 - Mar Ionio - Golfo di Taranto
 - Mar Adriatico meridionale
 - Mar Adriatico settentrionale
 - Aree Costiere Tirreno settentrionale
 - Aree Costiere Tirreno meridionale
 - Aree Costiere Adriatico Settentrionale
- Previsioni

Home / Sistema di previsione costiero / Mar Mediterraneo

Previsioni dello stato del mare nel Mediterraneo

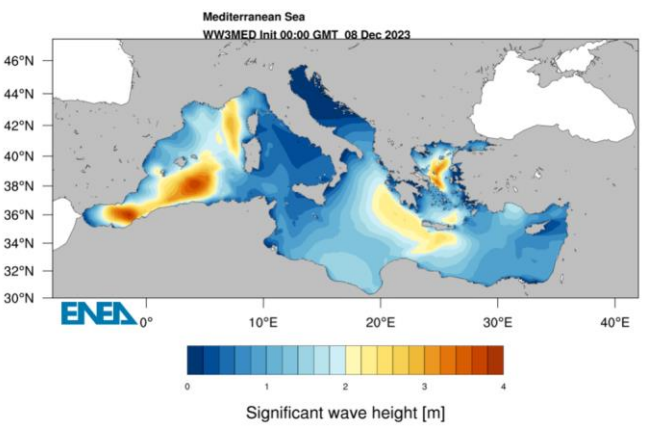
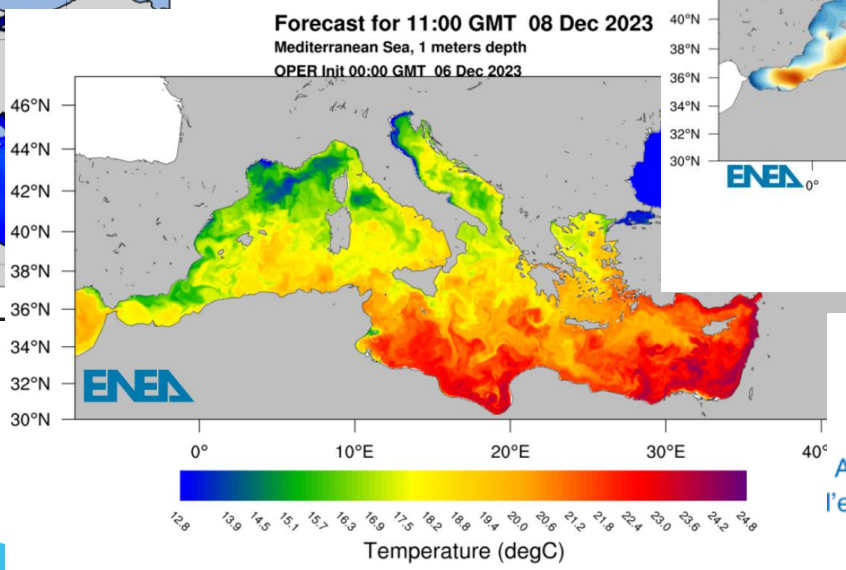
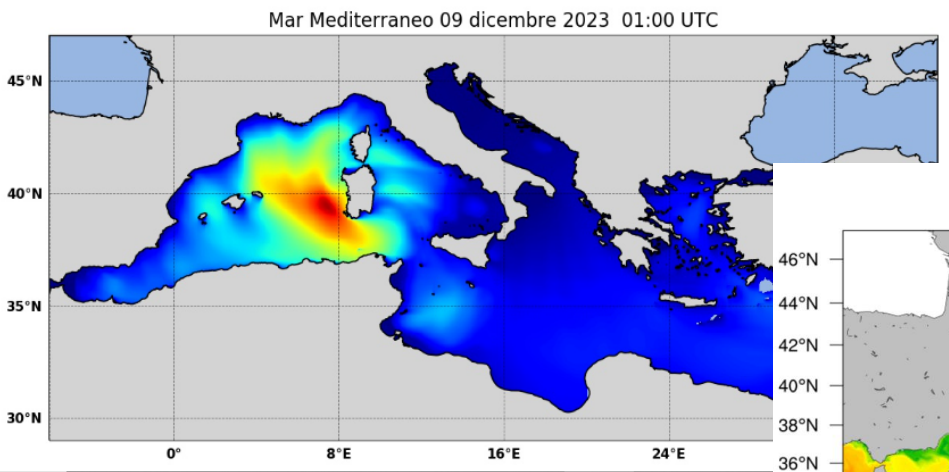
Altezza d'onda significativa in metri

Controlli dell'animazione

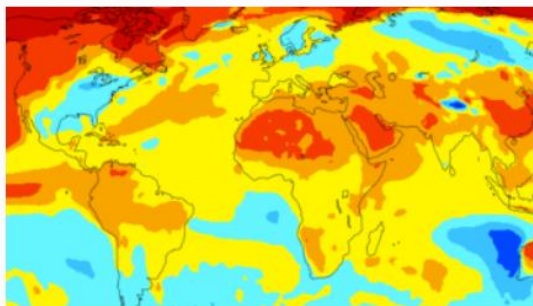
Imm. n°

 Velocità
 Modalità

La previsione mostrata in ogni immagine è relativa a ora e data secondo il formato:
ora (hhZ), giorno (dd), mese (mmm), anno (aaaa).



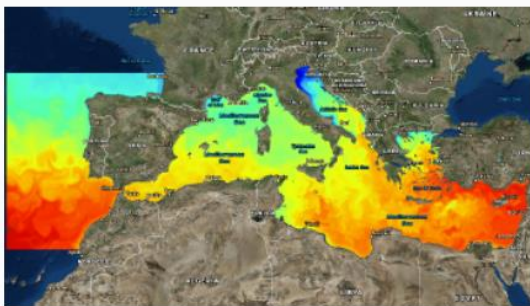
Agenzia nazionale per le nuove tecnologie,
l'energia e lo sviluppo economico sostenibile



CMCC Seasonal Prediction System

The Euro-Mediterranean Center on Climate Change operates routinely a Global Seasonal Ensemble Prediction System (CMCC-SPS3.5) based on a Coupled Atmosphere-Ocean-Land-Cryosphere Global Model.

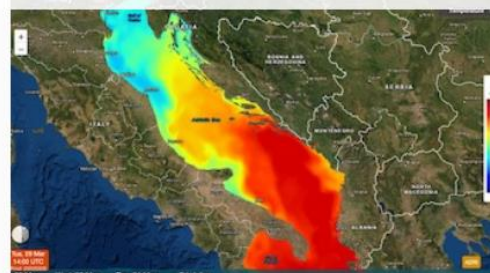
CMCC Seasonal Prediction System is realized by CSP Division



Mediterranean Forecasting System

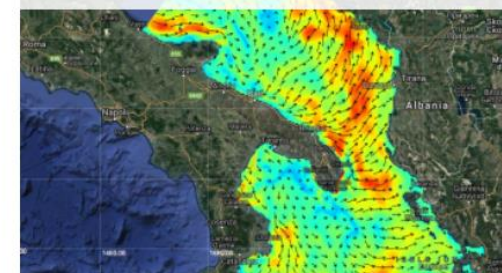
The Mediterranean Forecasting System (MFS) is a numerical ocean prediction system that produces analyses, reanalyses and short term forecasts for the entire Mediterranean Sea and its Atlantic ocean adjacent areas.

MFS is realized by OPA Division and ODA Division



The Adriatic coastal Forecasting System (AdriFS)

AdriFS is a numerical ocean prediction system that produces simulations and short-term hydrodynamic and wave forecasts for entire Adriatic Sea, with specific higher resolution in the overall coastal areas. The operational chain is based on a downscaling approach starting from CMEMS – MFS. AdriFS is realized by OPA Division.

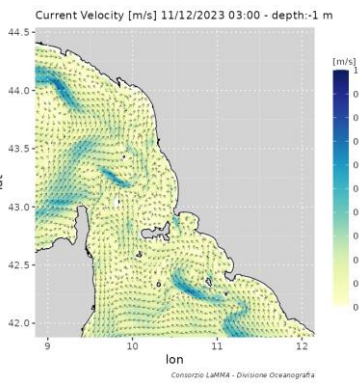
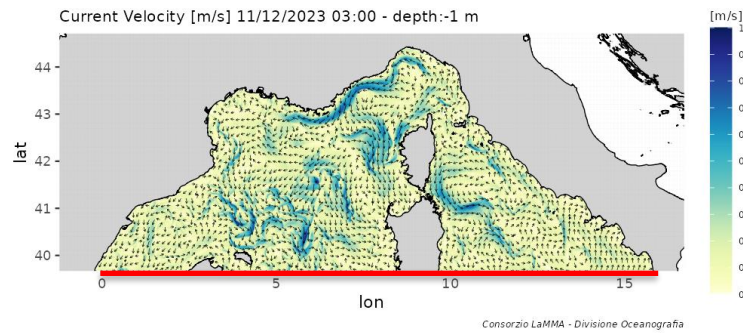


Southern Adriatic Northern Ionian coastal Forecasting System (SANIFS)

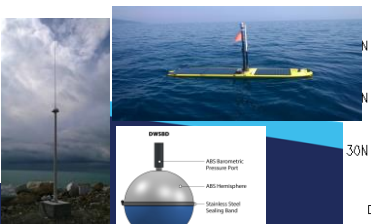
SANIFS is a numerical ocean prediction system that produces simulations and short-term hydrodynamic forecasts for Southern Adriatic Northern Ionian Seas, with specific higher resolution in coastal areas and harbors of Apulia region. The operational chain is based on a downscaling approach starting from CMEMS – MFS. SANIFS is realized by

LAMMA meteomarine/coastal operational chains

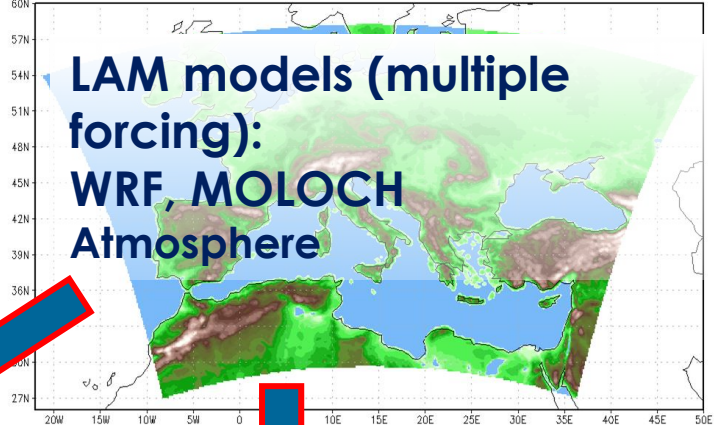
ROMS - NWMED Circulation (waves)



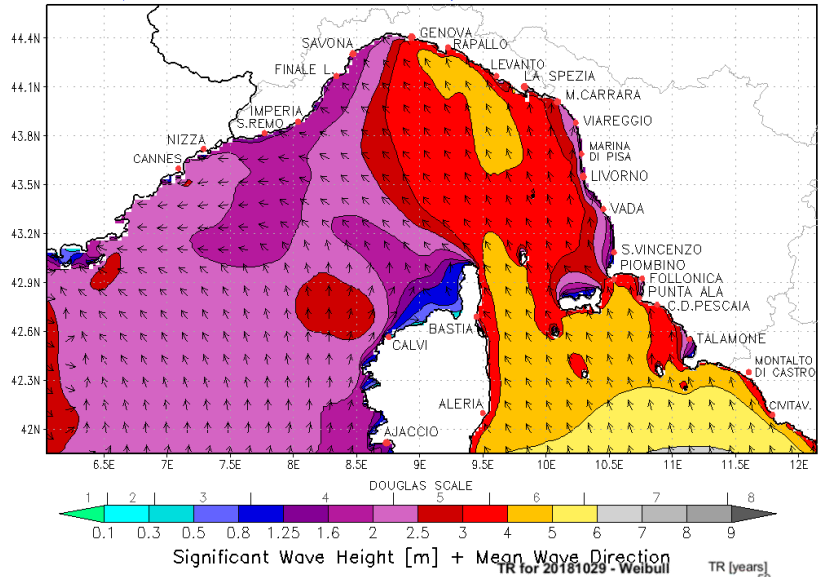
Data integration & validation with regional measurement networks (buoys, HF-radars)



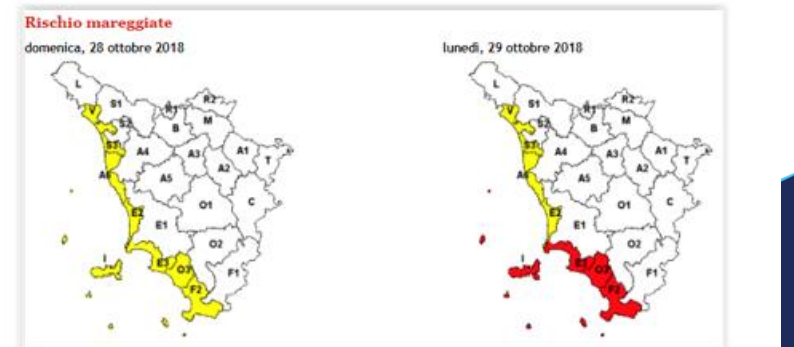
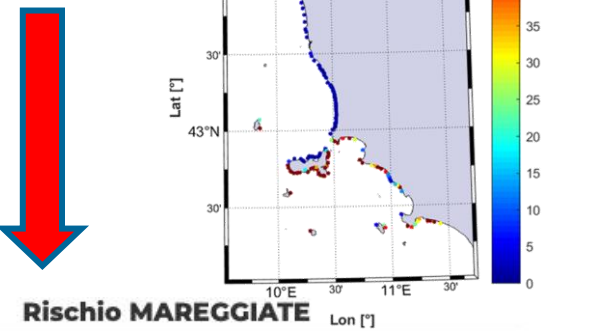
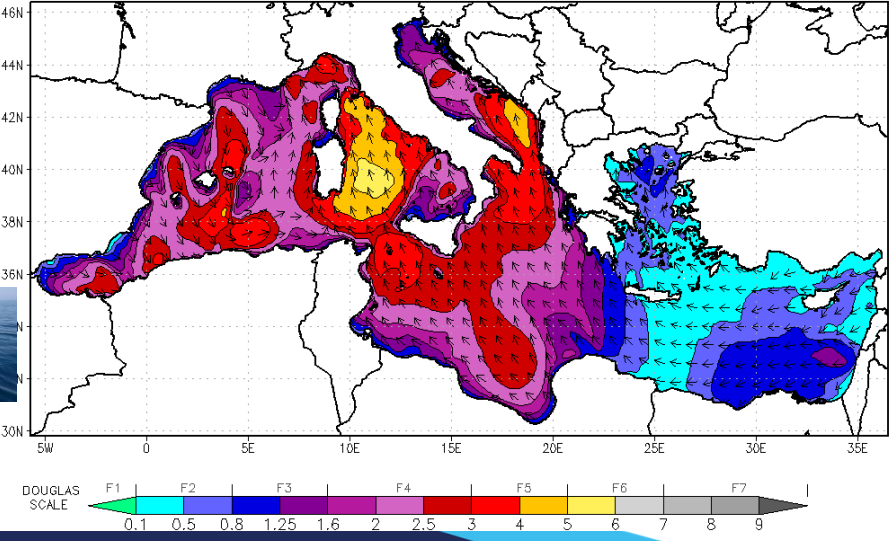
LAM models (multiple forcing):
WRF, MOLOCH
Atmosphere



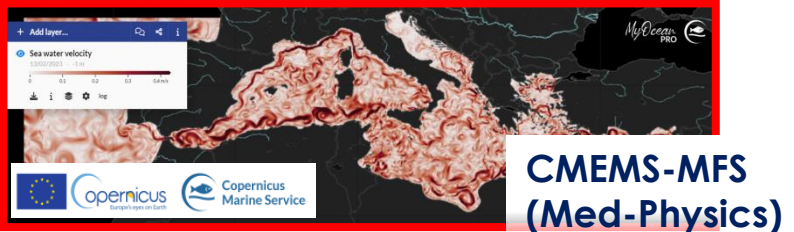
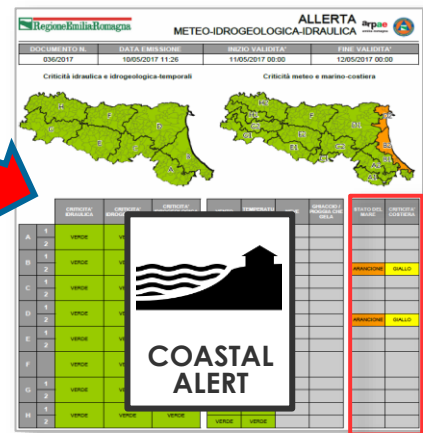
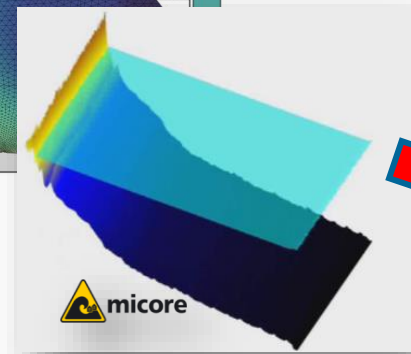
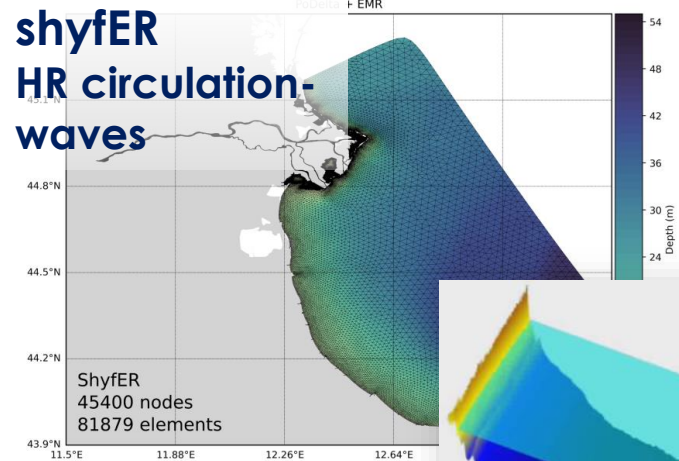
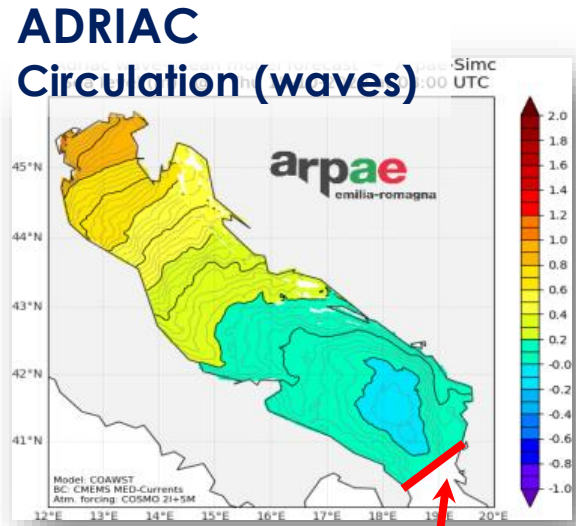
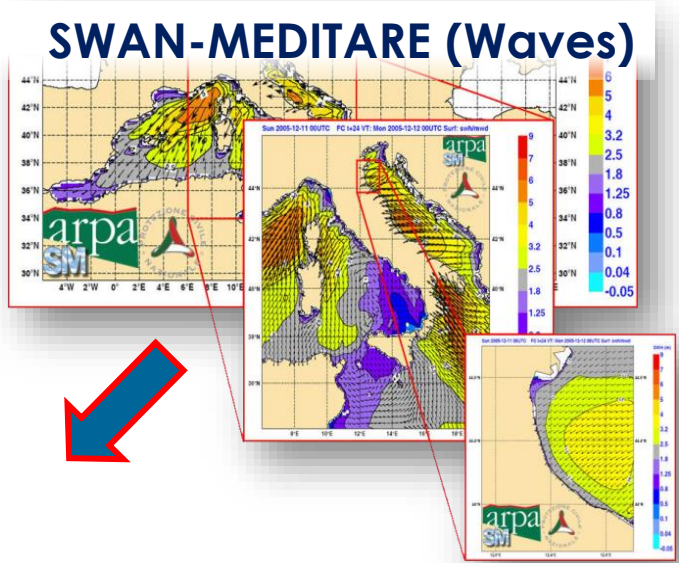
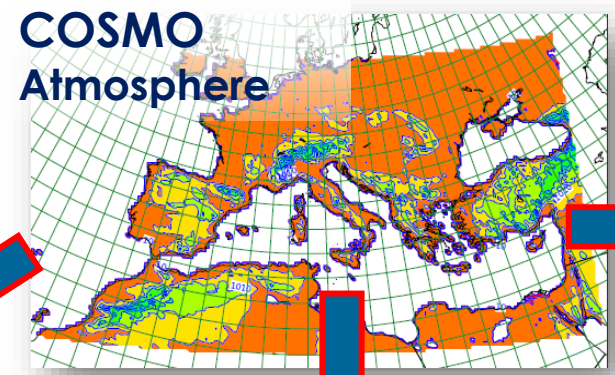
Consorzio LaMMA WW3 3km - WRF ECMWF 3km
Init.: Mon, 29 OCT 2018 00 UTC Valid: Mon, 29 OCT 2018 11 UTC T=+11h



Consorzio LaMMA WW3 10km - WRF GFS 14km
Init.: Mon, 29 OCT 2018 00 Valid: Mon, 29 OCT 2018 06 T=+6h



Arpae meteo-marine-coastal operational chains



22 November 2022

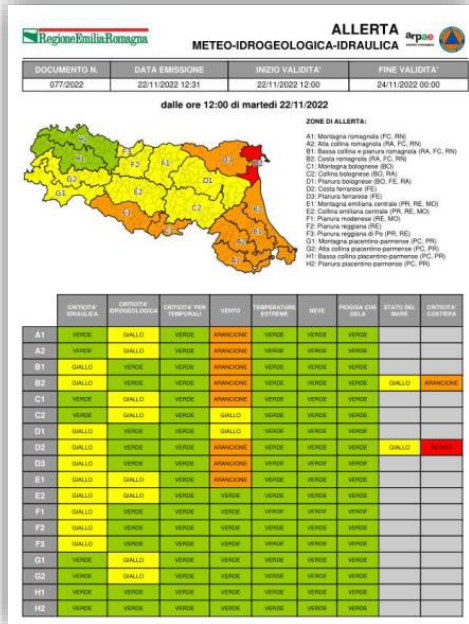
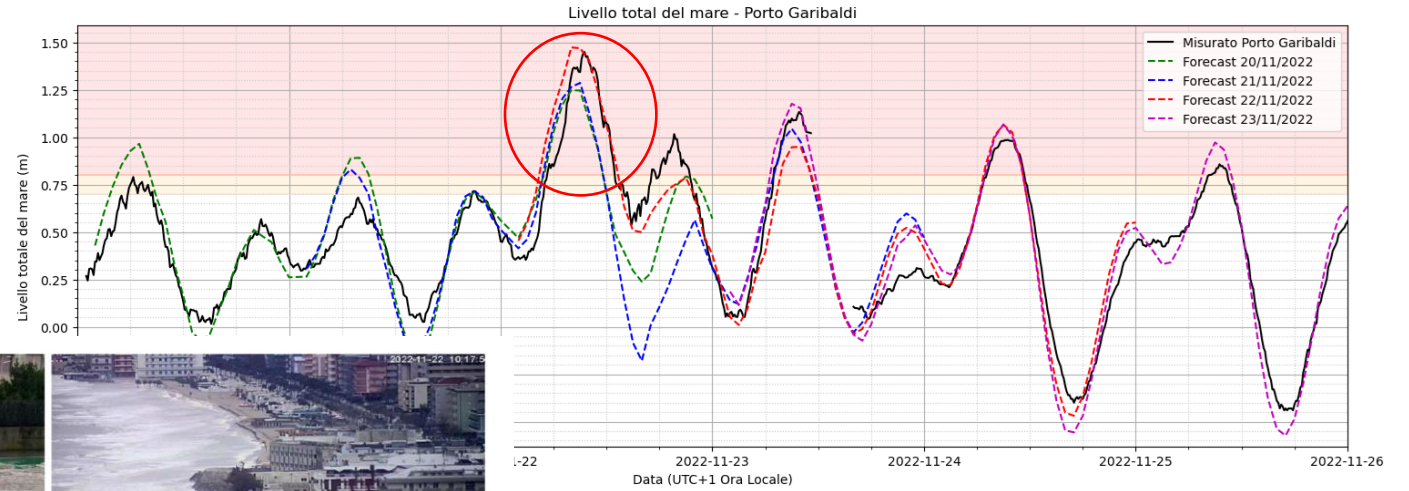


Figura 27 : Allagamento delle strade a Valverde, Cesenatico a sinistra e a Cesenatico a destra il 22 novembre 2022 (foto da <https://www.cesenatoday.it>).



Figura 28: Allagamenti a Marina di Ravenna (foto da <https://www.ravennatoday.it/>) a sinistra e a Marina di Comacchio (foto da <https://bologna.repubblica.it>) a destra il 22 novembre 2022.



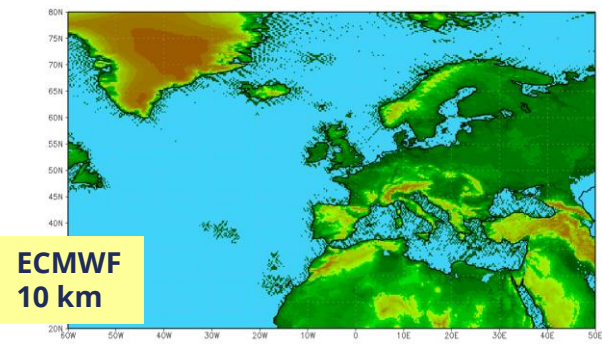
Porto Garibaldi
145 cm h 09:30 del 22/11

Adriac per il 22/11

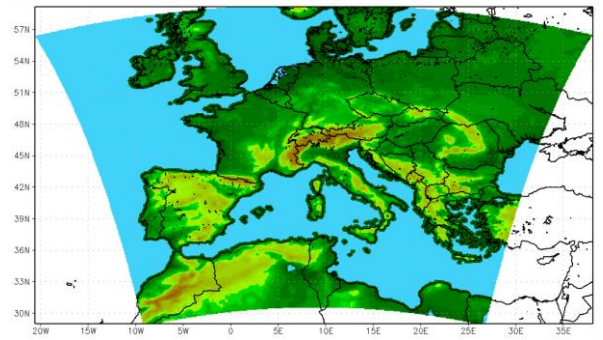
- corsa 21/11 ☐ **129 cm h 08:00**
- corsa 22/11 ☐ **148 cm h 08:00**

ARPAL marine-coastal operational chains: wave

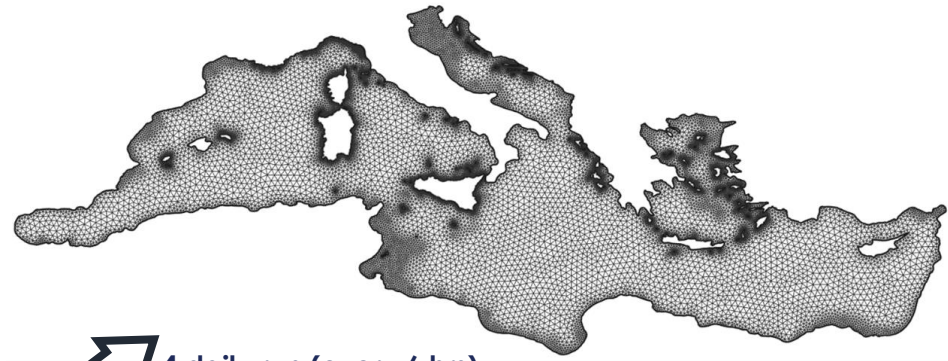
Atmosphere



BOLAM 8 km

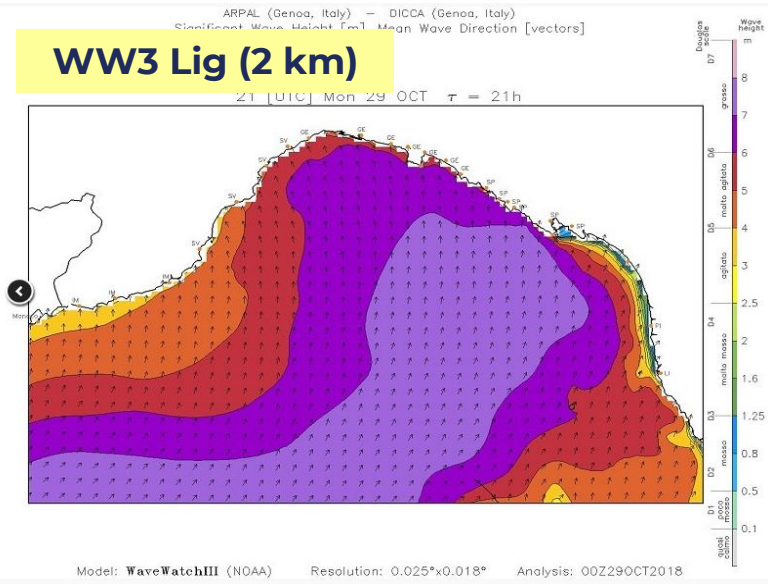
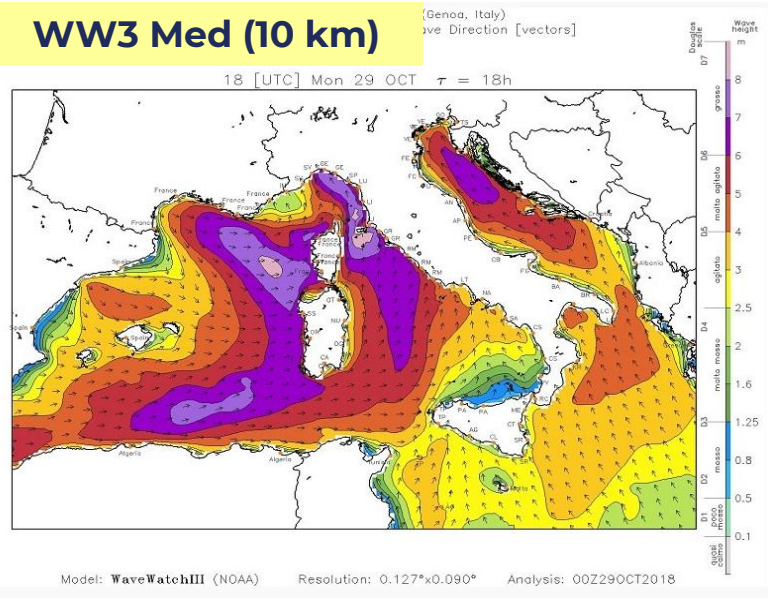
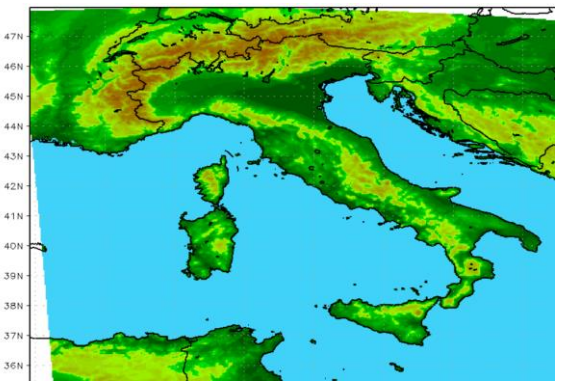


Wave: WAVEWATCH III



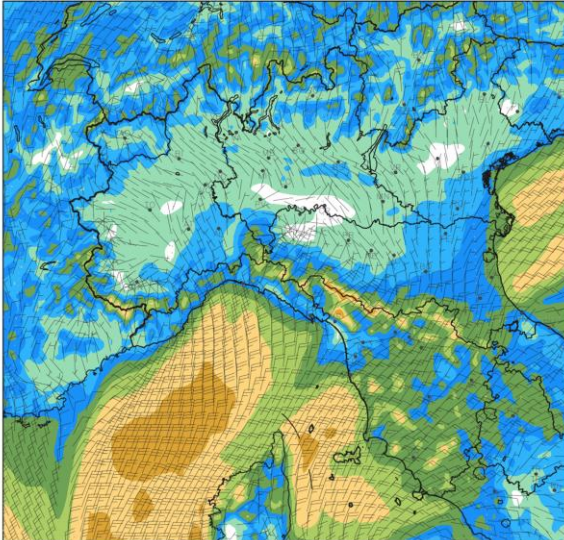
4 daily run (every 6 hrs)

MOLOCH 1.5 km

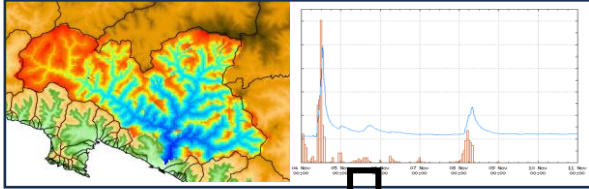


ARPAL marine-coastal operational chains: hydrodynamic

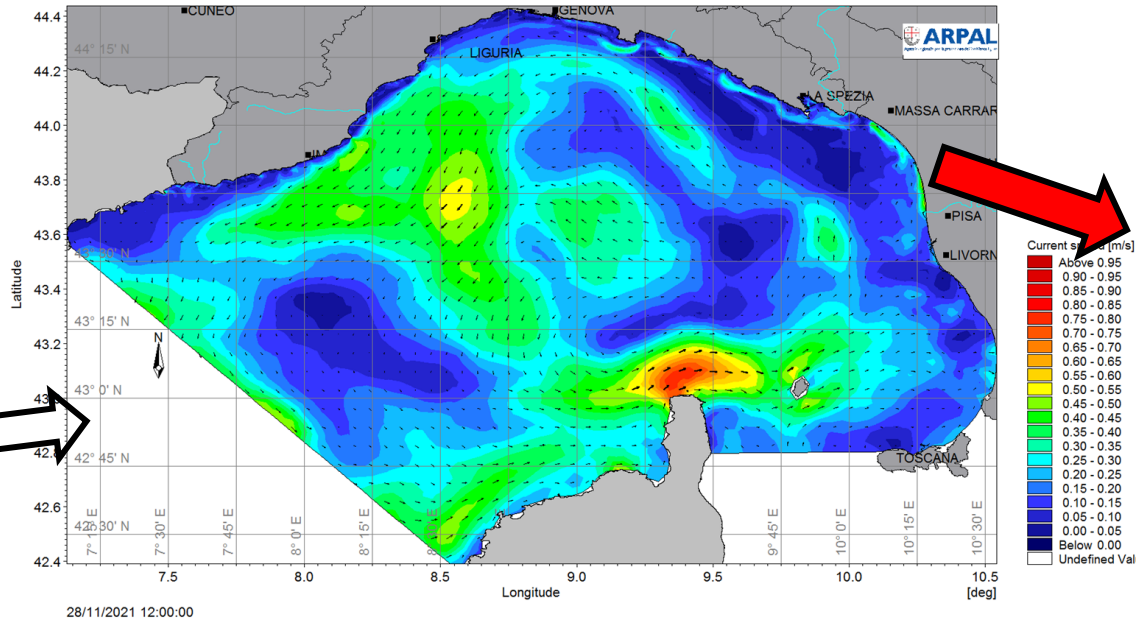
meteorological model: MOLOCH 1.5 km



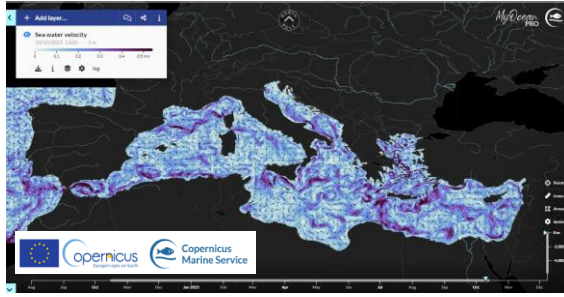
Hydrological model: DRift



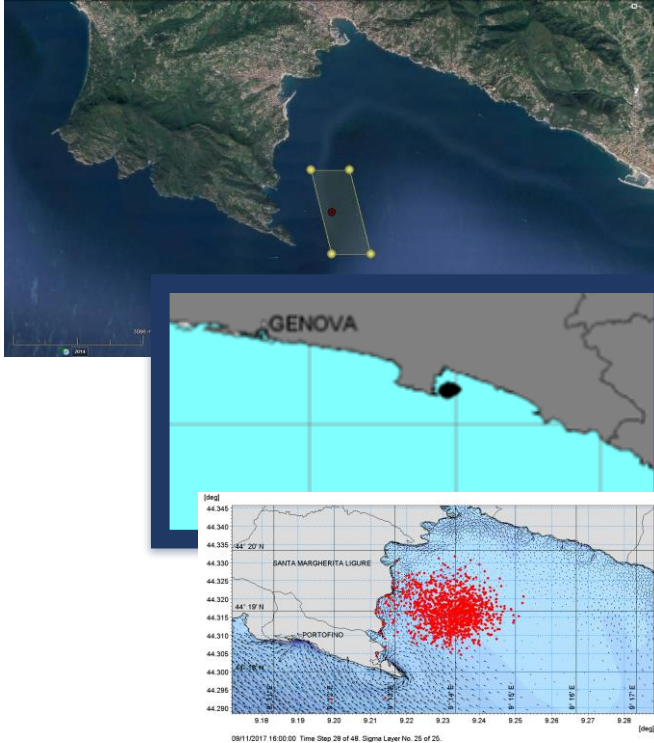
MIKE 3 HD Hydrodynamic Model: 70 m coastal resolution



CMEMS-MFS (Med-Physics)



Application: Oil Spill



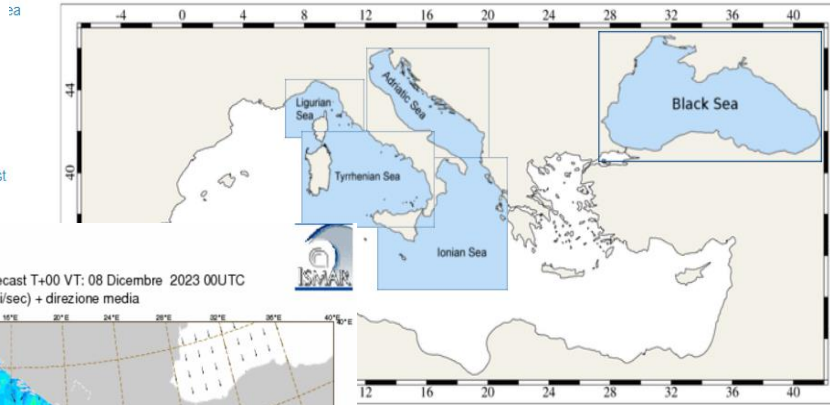


CNR ISMAR
ISTITUTO
DI SCIENZE
MARINE

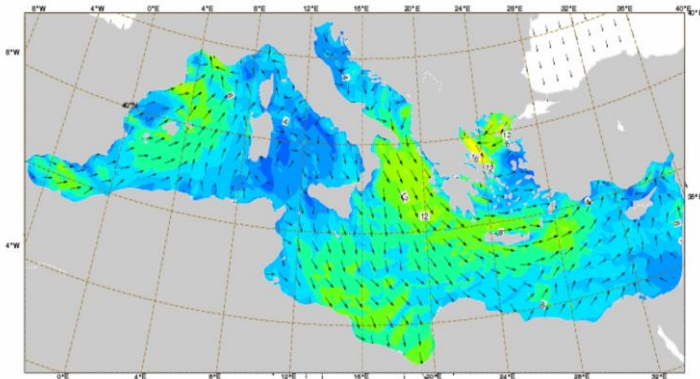
Kassandra is a storm surge operational forecast system for the Mediterranean and Black seas. It consists in a 3D finite element hydrodynamic model (SHYFEM), including a tidal model, in a third generation finite element spectral wave model (WWMII), fully coupled to the hydrodynamic model and using as input surface data obtained from a suite of meteorological models provided by ISAC-CNR.

Choose the area of interest from the list below or by clicking on the image.

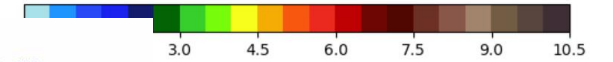
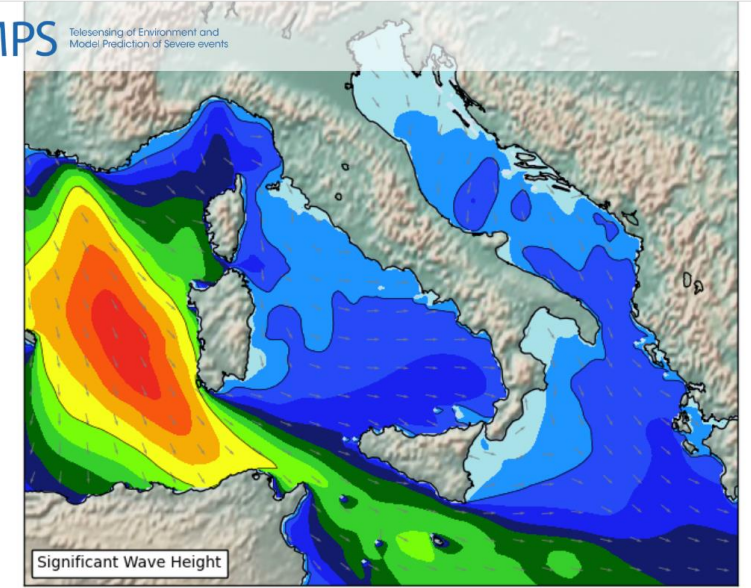
- Adriatic Sea
- Ionian Sea
- Tyrrhenian Sea
- Ligurian Sea
- Black Sea
- Romanian Coast



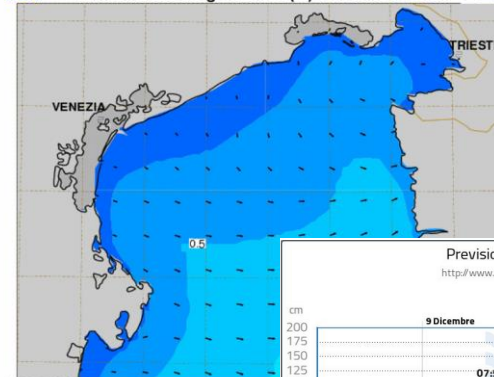
CNMCA 08 Dicembre 2023 00UTC Forecast T+00 VT: 08 Dicembre 2023 00UTC
Vento a 10 metri (metri/sec) + direzione media



Center of Excellence
CE TEMPS
Telesensing of Environment and
Model Prediction of Severe events



Previsione per il : 10 Dicembre 2023 ore 05 UTC
Altezza d'onda significativa (m) + direzione media



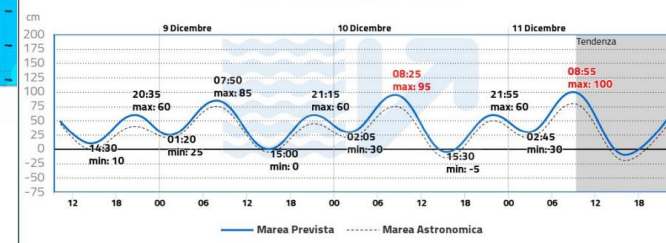
FORECAST del: 2023 12 08 ore 00



Centro Previsioni e
Segnalazioni Mare

Previsione di marea delle ore 10:30 del 08-12-2023

<http://www.comunevenezia.it/maree> - Centro Previsioni e Segnalazioni Mare
Valori riferiti allo zero mareografico di Punta Salute



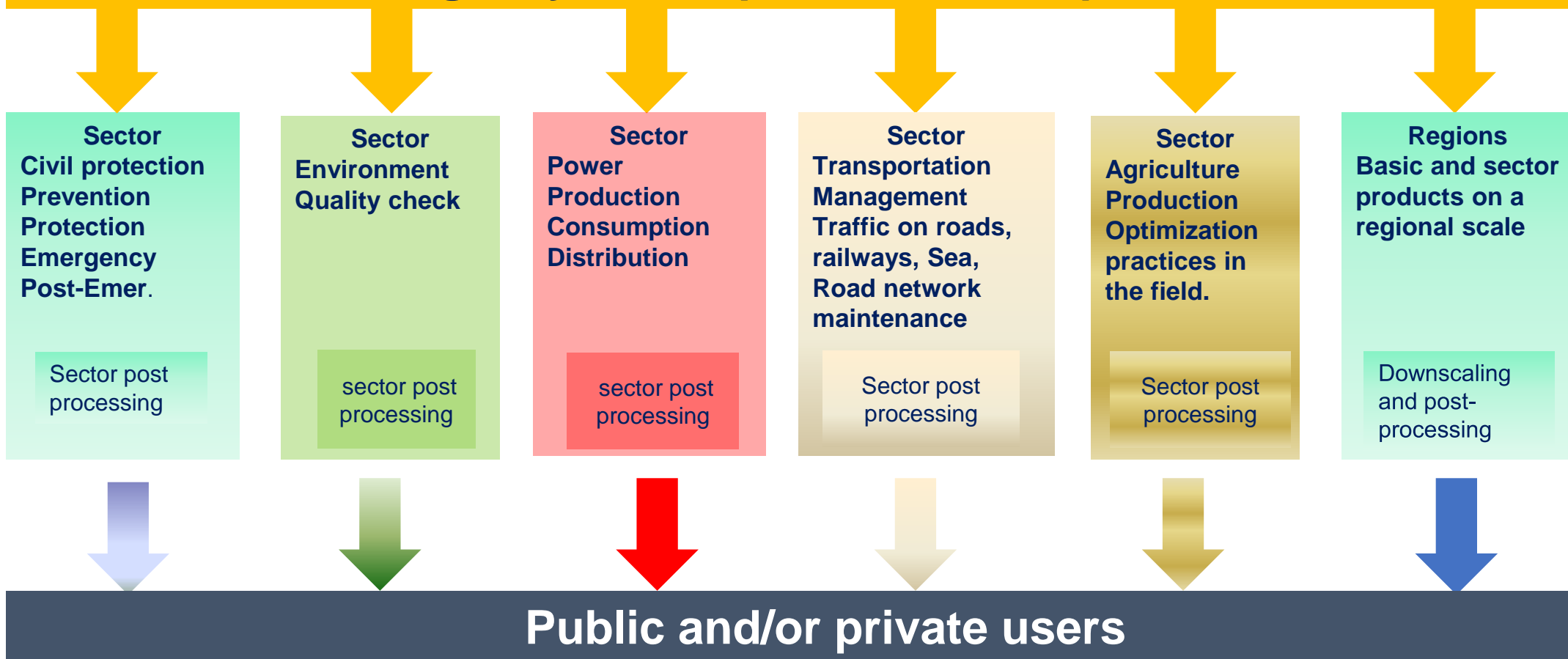
What do we need to improve resilience?

- Need for data, Models, EWS, adaptation plans and strategies, training, but **above all there is a strong need for national-regional-local governance**
- In Italy today, there is a **great deal of fragmentation** in the "weather", "climate" and also "**coastal and marine**" sectors. This fragmentation is reflected, for example, in a **large number of independent and sometimes overlapping modelling systems**, which do not allow for an adequate valorisation of the efforts made.
- ItaliaMeteo Agency is the "National Civil Weather Service" which was missing in Italy and has the **task of building a unified governance**

ItaliaMeteo Agency, IMA:

- ...is the new National Meteorological and Climatological Agency for Italy, established with the Law n. 205/2017, fulfilling the functions of National Meteorological Service, cooperating with the Italian “ENTI METEO” through specific agreements
- ...provides optimal uniform standards for observational networks, establishing the technological criteria of quality, frequency, temporal acquisition and spatial resolution;
- ...collects and stores the observational data, forecasts and simulations acquired by the ENTI METEO, as well as those it receives directly from the ECMWF, EUMETSAT, ESA, Copernicus;
- ...redistributes to the ENTI METEO data, products, elaborations, analyses and meteorological, climatological and marine forecasts and evaluations;
- ...coordinates the activities in the field of meteorology, climatology and marine meteorology, also to support the state and regional authorities in charge of civil protection, health and environmental protection, agricultural policy functions, in the areas of their respective competence.

ITALIAMETEO Agency has to provide BASIC products / services



The opportunities offered by the PNRR to improve the resilience

3 Strategic Pillars

- Digitalisation and innovation
- Ecological transition
- Social inclusion

M1. Digitalisation, Innovation, Competitiveness, Culture

M2. Green Revolution and Ecological Transition

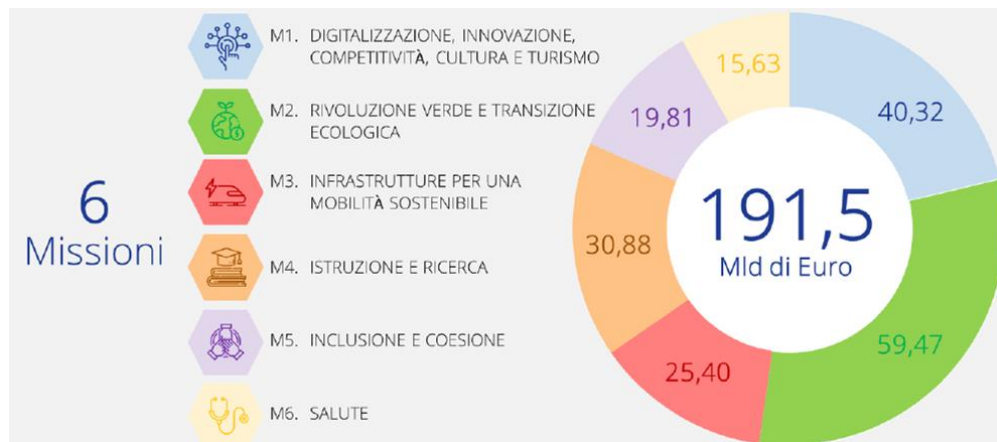
M3. Infrastructures for Sustainable Mobility

M4. Education and Research

M5. Inclusion and Cohesion

M6. Health

6 Missions



General Objective M2C4 – Land and water resource protection

Measure M2C4.3 Safeguarding air quality and land biodiversity through the protection of green areas, soil and marine areas

INVESTMENT 3.5 - Restoration and protection of the seabed and marine habitats
(*Marine Ecosystem Restoration*)

PNRR-MER Objective: M2C4-26

- Operational Arrangements between EC and Italy - 21.12.2021:
"Complete at least 22 large-scale interventions for the restoration and protection of seabed and marine habitats and coastal observation systems".
- Timeline: by 30 June 2025
- Verification by external audit
- Compliance with the DNSH (Do Not Significant Harm) principle

PNRR-MER Interventions

- LINE A: seabed restoration interventions, with related mapping activities of relevant seabeds
- **LINE B: interventions to strengthen monitoring capabilities for the knowledge of marine-coastal ecosystems;**

INTERVENTO	Tipologia
A1-A2-A3-A4-A5. Attività per il ripristino letti a ostriche	RIPRISTINO ATTIVO E PASSIVO
A6-A7-A8. Attività per il ripristino di habitat coralligeno e/o Posidonia e/o Cystoseira	
A9-A10-A11. Protezione di habitat sensibili (Campi ormeggio)	
A12. Individuazione ed eventuale rimozione degli attrezzi di pesca e di acquacoltura abbandonati o persi in mare	
A13-A14-A15. Esecuzione rilievi per la mappatura di habitat profondi	MAPPATURA
A16-A17-A18. Esecuzione rilievi per la mappatura di habitat costieri LIDAR	
B19. Sistemi di monitoraggio radar costiero	RETI OSSERVATIVE
B20. Sistemi AUV fino a 3000 m con SAR e Multibeam	
B21-B22. Rete ondamentrica e correntometrica d'altura	
B23-B24-B25. Rete ondamentrica e correntometrica costiera	
B26-B27-B28. Rete mareografica nazionale	
B29. Rete Mareografica della Laguna di Venezia e dell'Alto Adriatico	
B30. Rete di stazioni fisse per il rilevamento in continuo di parametri chimico-fisici e trofici nelle lagune	
B31 - Sistema modellistico oceanografico e stato del mare in modalità ensemble	SISTEMI DI OSSERVAZIONE INTEGRATI
B32 - Sistema modellistico bio-geo-chimico da accoppiare con modello oceanografico	
B33 - Sistema modellistico di previsione del livello del mare su scala nazionale oceanografico	
B34 - Sviluppo di un sistema modellistico ecologico degli ambienti lagunari	
B35 - Sviluppo del sistema per l'analisi dell'impatto degli scarichi in mare	
B36 - Sviluppo di un sistema per l'analisi idrodinamica ad alta risoluzione degli eventi di inquinamento "short term" ed impatti su turismo, acquacoltura e altre attività produttive	
B37. Nave oceanografica maggiore	UNITA' NAVALE

Intervention B31: a forecast wave and circulation modelling system

Principle:

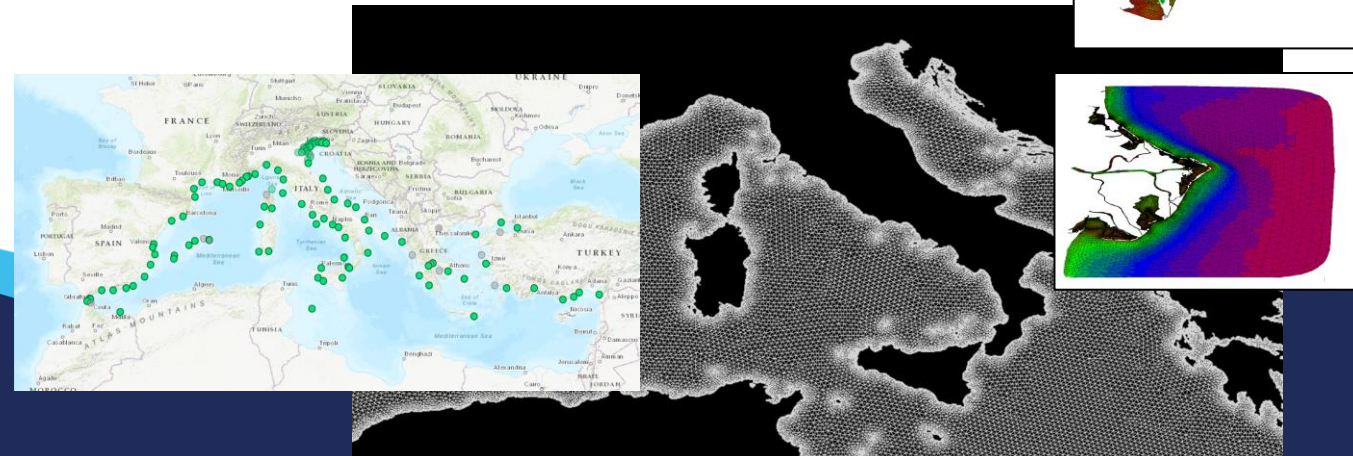
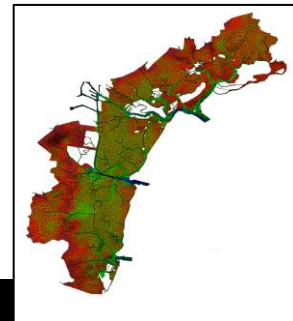
- To develop a National Forecasting System **that integrates existing** operational models provided by Public Institutional Weather Agencies/Services
- **Improve** the reliability of short-term forecasts **through Ensemble** techniques
- Improve wave and circulation coastal forecast through **local nesting**
- Frame the development of the products with **the institutional involvement of ItaliaMeteo**, in order to integrate them into the existing panorama of operational products provided by the meteorological agencies/services and to ensure their operation after 30 June 2026, the end of the MER project.

"National Scale Modeling System for Sea Level Prediction"

ISPRA, ItaliaMeteo, CNR-ISMAR, Venice Municipality, Arpae...

Development and operational testing of a **national-scale prediction system for sea level and sea state**, supporting coastal risk management, integrating developments carried out by various **public bodies** over the last decade to create a shared and state-of-the-art updated operational system.

- Operational coupling of the oceanographic model SHYFEM and the WaveWatch3 model (WW3) for a national sea level and sea state forecast model
- Tide gauges data assimilation based on the Ensemble Kalman Filter technique
- Set-up of an information technology platform for the management, visualization, and national-scale distribution of predictive modeling data
- The operational system relies on various forecasting systems using different meteorological forcing as inputs, specifically: ECMWF, BOLAM, MOLOCH, COSMO/ICON
- Very high-resolution local models



The adaptation action: improving EWS and some...conclusions

What do we need to improve EWS, other than the availability of more and better Data and Model?

Better communication !



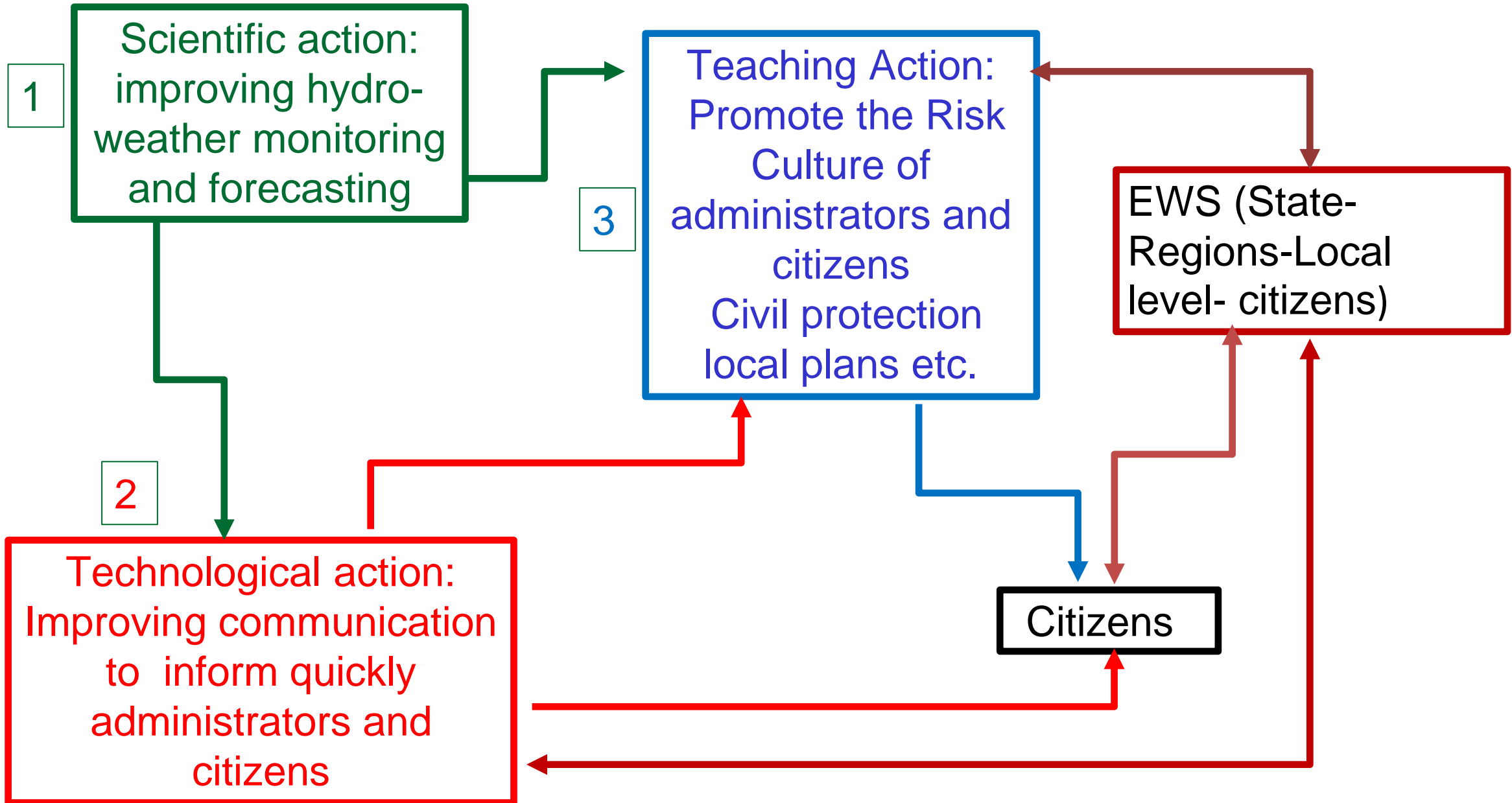
Clear and understandable languages that lead to correct action and behavior: not only new technologies!

Improved citizen participation !



Improve the resilience of local communities and citizens and their knowledge of risk of their territories

Conclusion: The three Lags of the Resilience Table !



Thank you!

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