Integrated river forecasting system with the ocean one on case studies

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Work Package Title	Pilot projects
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Activity Title	Marche Pilot Project
Partner in Charge	LP
Partners involved	PP9 in collaboration with CIMA Foundation and CETEMPS (PA Agreement), CNR ISMAR
Status	Final
Distribution	Public

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1. Introduction

A collaboration between research partner was carried on to evaluate a future integration between the regional river forecasting system and the ocean, on case studies.
Marche Region provided historical estimated and modelled time series of flow data to STREAM research partners and investigated to include in one of the operational hydrological chain an oceanographic module.

2. Evaluation of integration of hydrological model with oceanographic model

Agreement with two research public bodies, Competence Centre of the Civil Protection System (CIMA Foundation and CETEMPS) in charge of hydrological and hydraulic modeling on Marche pilot were signed in order to investigate the future integration of the regional operative hydrological model with oceanographic model. Marche Region collaborated with CNR and CMCC research partners providing both flow measured and modelled data. In particular CIMA Foundation run the hydrological model on the historical period 2011-2020 at the month of each main river and provided data to sea modelists.

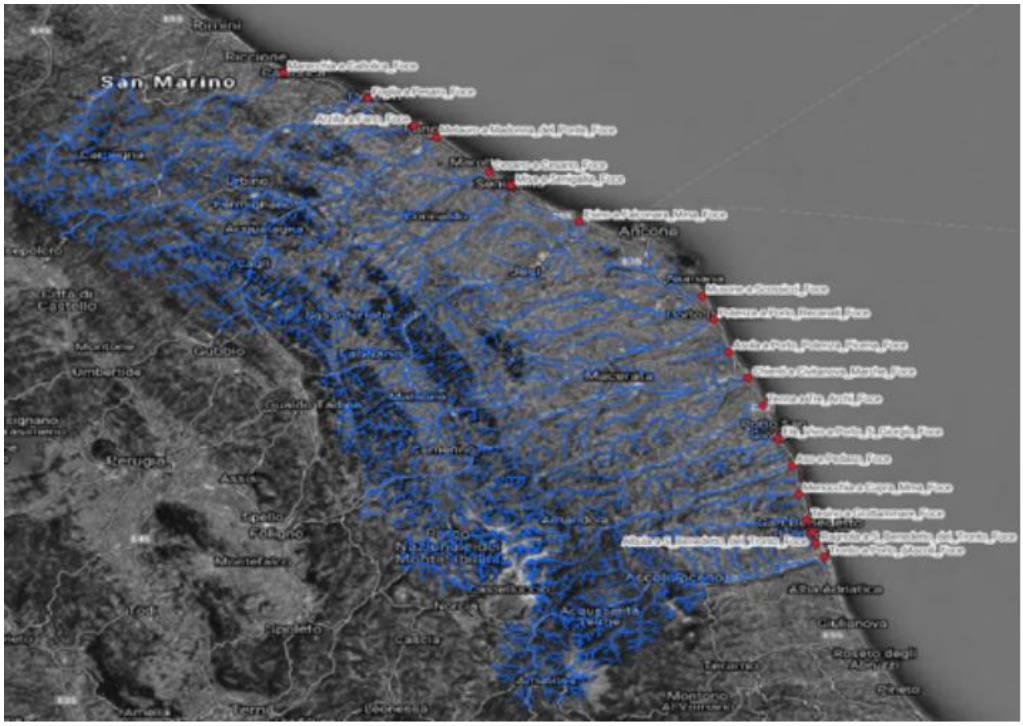

Figure 2. River section at the mouth of each main river for Continuum model

In collaboration with CNR-ISMAR partner and CETEMPS Competence Centre a dedicated research on case studies was realized in order to investigate the interaction of the sea level in the ChYm hydrological model, one of the operative forecast model used by the Functional Centre of Marche Region to evaluate soil effect in case of severe meteo event.

CHyM (Cetemps HYdrological Model) is a distributed parameter hydrological model based on a regular spatial grid. It includes explicit computation of the various physical processes that contribute to the hydrological cycle. The model has been implemented by the hydrological modeling group of CETEMPS since 2002 (Tomassetti, B. et al.2005; Coppola, E. et al.,2007; Verdecchia, M. et al. 2008, Verdecchia, M. et al. 2009, Coppola et al., 2014).

Coastal flooding is the dynamic interaction of a variety of oceanographic processes (e.g. waves, tides and surge levels) and local topographic characteristics. In order to estimate the risk related to the sea obstruction to the stream flow is necessary to couple an oceanographic model with an hydrological or hydraulic models. CHyM is able to assimilate the forecasted sea level by an oceanographic models.
In order to simulate the sea obstruction to the stream flow, a new module was already added into the CHyM model in the framework of the AdriaMORE project.

The sea-level module assimilates hourly sea-level data, used to modify the Manning's coefficient, in order to increment the friction at the river outlet, when the sea level reaches critical values.

The following case studies were chosen for STREAM activity:

- River mouth: Foglia and Musone ;
- Events: 3 February 2019; 12-13 november 2019.

In this study, a hydrological stress index (BDD) was used to estimate the stress state instead of the river discharge value simulated by the model, with the aim of predicting the correct alert level, rather than the correct discharge values. In the simulation of this case study, CHyM model has been forced with rain gauge and temperature observed data, with a spin-up time of 4 days (96 hours).

CETEMPS detailed tecnical reports are provided as annexes (see d.5.1.2 Annexes 1 and 2).

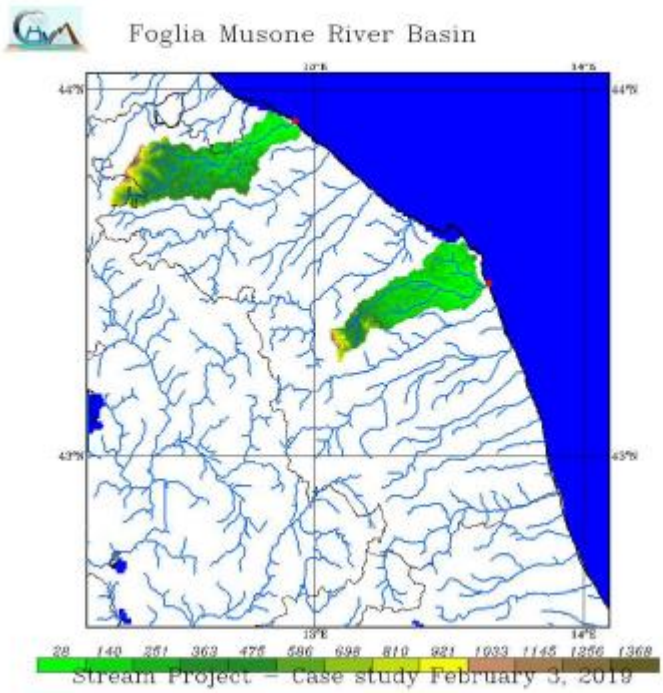

Figure 1. Musone and Foglia basin rebuilt by CHyM Model. In red the points of outlets used for the analisys (Musone 43°28'26.53"N; 13°38'33.23"E - Foglia 43°55'27.45"N; 12°54'3.85"E).

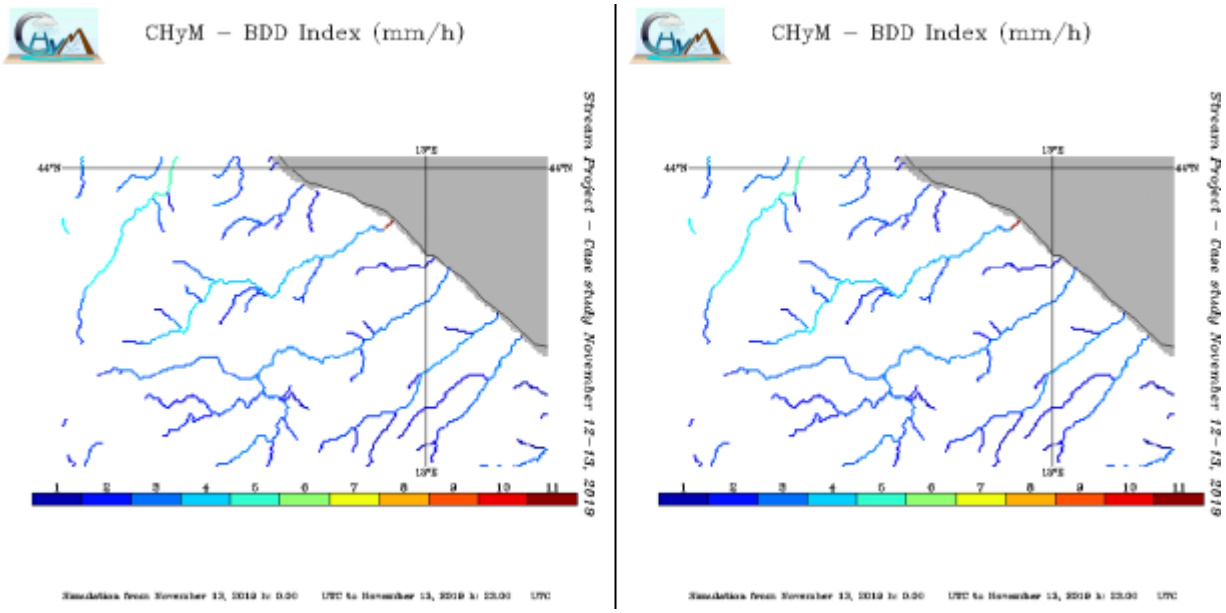

Figure 2. Estimated BDD Index Map for the different simulations on Foglia outlet

3. Conclusion

Coastal flooding is the dynamic interaction of a variety of oceanographic processes (e.g. waves, tides and surge levels) and local topographic characteristics. To estimate the risk related to the sea obstruction to the stream flow is necessary to couple an oceanographic model with a hydrological or hydraulic models.
Preliminary studies took place in order to investigate future operative chain fusing hydrological and sea modelling, in order to better forecast marine flooding.
The integration of CHyM with the wave height data simulated by the hydrodynamic model SHYFEM, a two-dimensional shallow water finite element model developed at the ISMAR-CNR, was investigated on case studies.
CHyM hydrological model with waveheight module has been tested on the identified case study to verify its capability to identify critical stress situation over the Musone and Foglia river estuary.
This preliminary study highlighted how to use the BDD stress index, developed at CETEMPS and related to pluvial floods, to estimate the stress caused by storm surges on areas near the mouths of rivers.
The results, very encouraging, have shown that it will be possible to find a general, non-site specific, approach for the estimation of the stress index relating to all the mouths of rivers falling into the region.
This condition will be possible by coupling off-line the oceanographic model with the hydrological model and, through the operational chain created ad hoc, monitor the performance of the forecasting tool daily.
In addition, new case studies must be considered to confirm the results of this study.

4. Bibliography

Colaiuda V., Lombardi A., Verdecchia M., Mazzarella V., Antonio R., et al. Flood Prediction: Operational Hydrological Forecast with the Cetemps Hydrological Model (CHyM). Int J Environ Sci Nat Res. 2020; 24(3): 556137. DOI: 10.19080/IJESNR.2020.24.556137.

5. Annexes

Technical reports:

- d.5.1.2_Annex1.pdf
- d.5.1.2_Annex2.pdf