Regional-scale flood risk modelling: an integrated hydrological and hydraulic approach applied over the Po river

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Abstract

We describe an integrated hydrological and hydraulic modeling approach for the risk assessment of flood-prone areas and we present the first results obtained over the Po river (Northern Italy) at 90 m resolution.

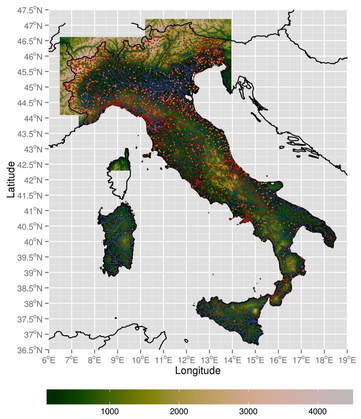
✓ collect the observational data needed for the **CHyM** hydrological model input and calibration;
✓ prepare a case study for the sub-basin of the Po river;
✓ develop the scientific technique for discharge mapping of the sub-basin;
✓ produce the flood map of the sub-basin with different return period.

Input to the CHyM hydrological model

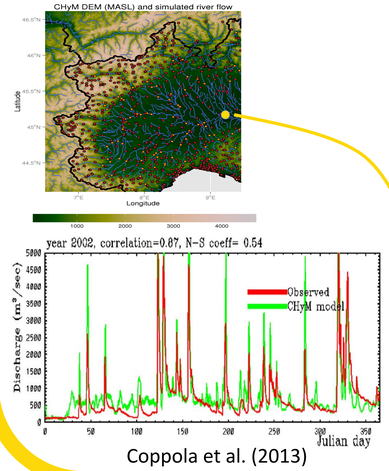
Currently available precipitation (red) and discharge (orange) stations over Italy. The river network is as reproduced by the CHyM hydrological model.

The precipitation dataset can be used as input to the CHyM hydrological model, while the discharge dataset is used for calibration and validation.

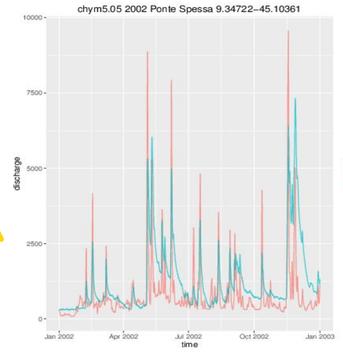
Station data currently present some inconsistencies and are in need of further homogeneisation and verification. For this reason in the future we will integrate the observational data with outputs from the RegCM regional climate model.



Case study – Po river

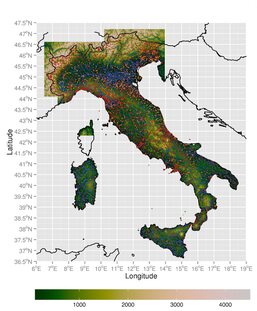


Coppola et al. (2013)



Example of comparison between discharge observed data and modeled data confirming previous results.

The method



CHyM hydrological model or stations data

N-year discharge climatology

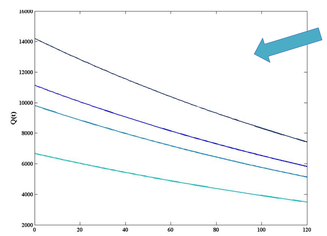
frequency analysis

t_C

1995 1996 1997 1998 1999 2000....

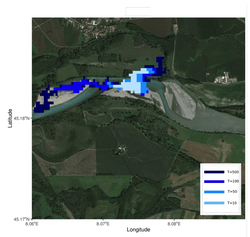
(Maione et al. 2003)

Statistical Flood Frequency analysis

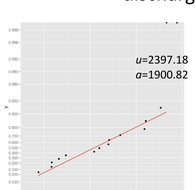


Return periods (T)

Lisflood-FP hydraulic model



The Gumbel distribution is hypothesized as statistical distribution of the annual maxima of discharge and the analysis is performed for each duration D, ranging from 0 to $D_f = f(A)$.



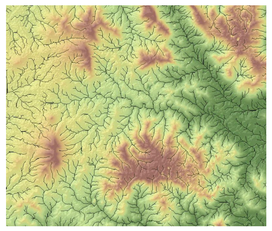
D=0 hours

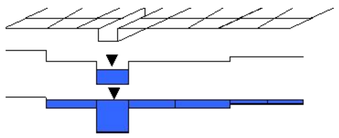
$$Q_T(D) = u - a \ln[-\ln(1-1/T)]$$

Flow-Duration-Frequency (FDF) curves.

$Q_T(D)$ = the maximum average discharge in a given duration D for each value of the return period T

The Lisflood-FP hydraulic model and the flood maps





Flood inundation model **LISFLOOD-FP** (Bates et al., 2010).

-Simulate the dynamic propagation of flood waves over fluvial, coastal and estuarine floodplains;
-Simplest physically plausible representation capable of simulating dynamic flooding at fine spatial resolution (10-100 m cell sizes).

Inputs:
- Aster Digital Elevation Model (90 m);
- Synthetic Design Hydrographs (SDH), calculated for each return period T.

Return period map showing areas predicted to be inundated during a flood event with an estimated probability of occurrence of 1% (return period T = 100 years) and 0.2% (return period T=500 years).