New trends in flood hazard mapping in dense urban area

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Politecnico di Milano

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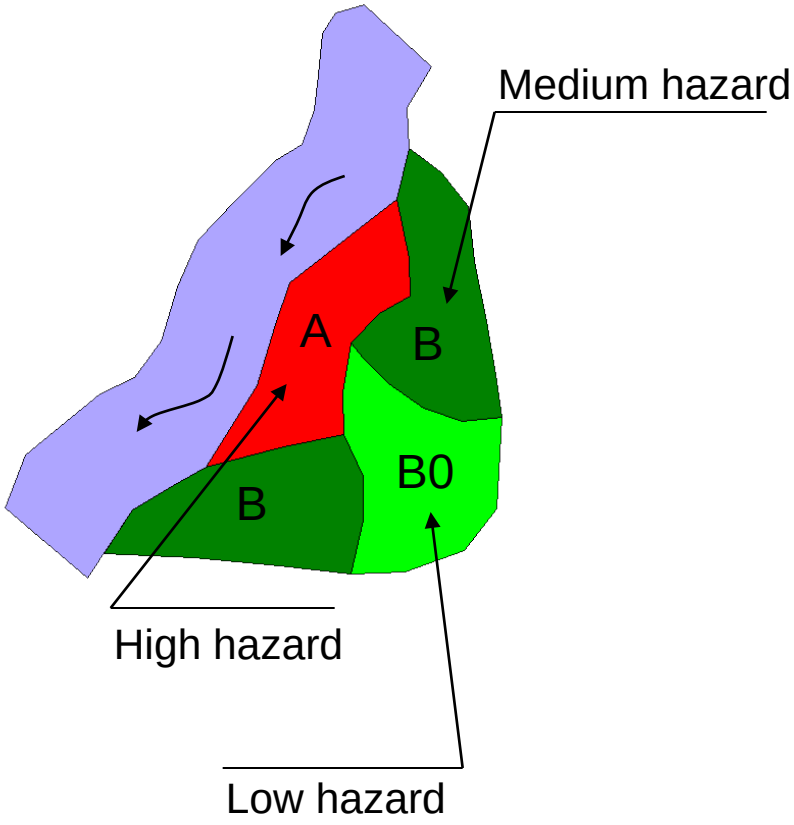
HS5.6/NH2.3: Floodplain mapping and flood prevention techniques in the 21st century

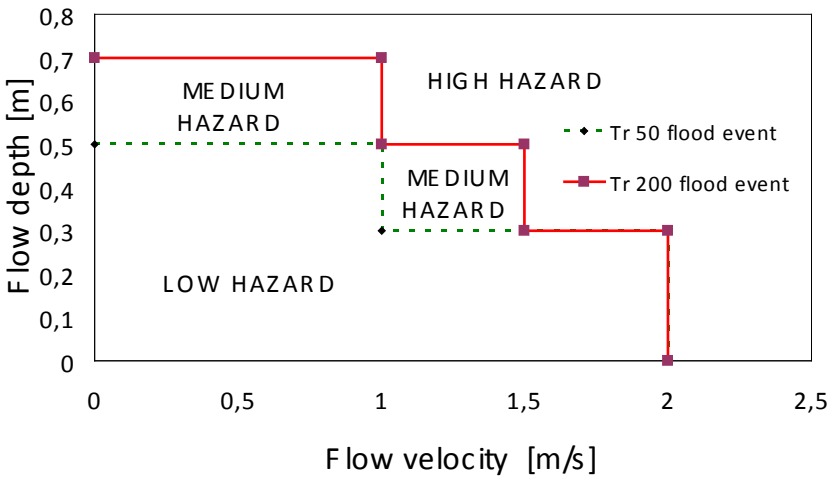
Vienna, 19 – 24 April 2009

New flood hazard criteria

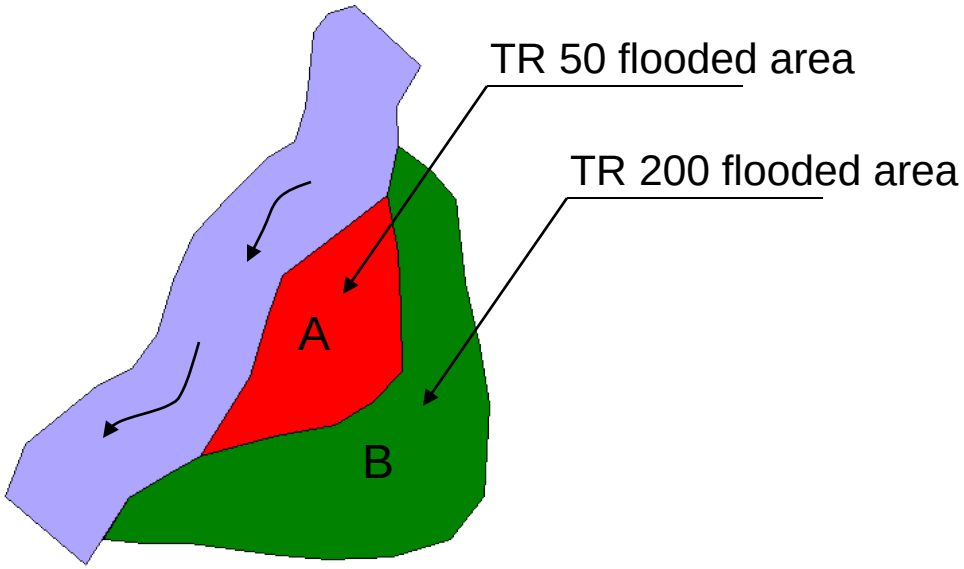
New directive



D.G.R. 250/2005*



Previous directive



** R. Rosso, 2005*

Issues

Unsteady models

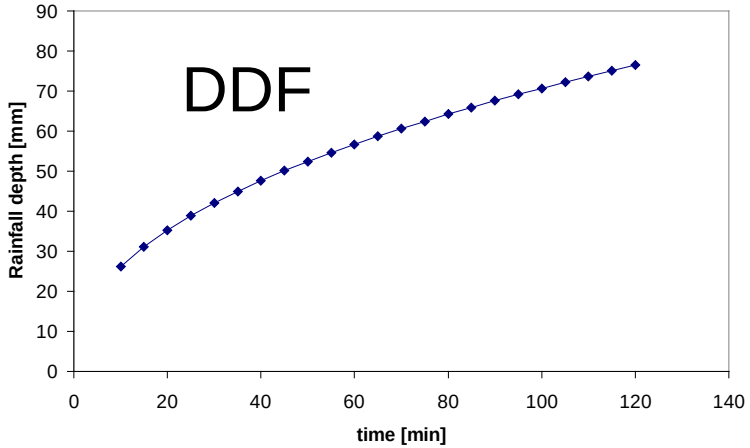
* Definition of flood hydrograph as boundary condition for numerical model

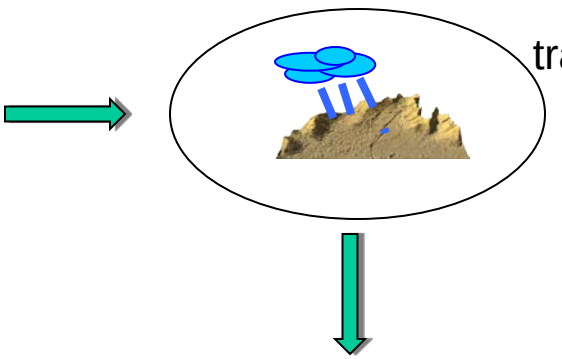
* Choice of the numerical model: 1D or 2D

Case Study

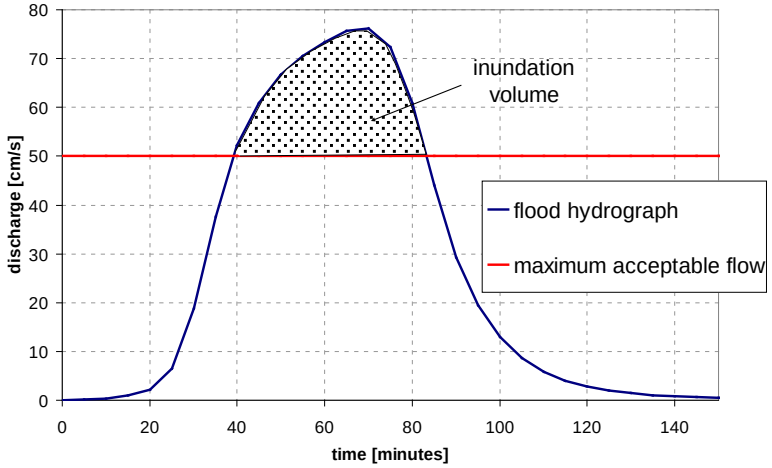

RODINE
MADONNA
EVIGNO
PINETA
VARCAVELLO
GORLERI
1.8 km²
DIANO
MARINA

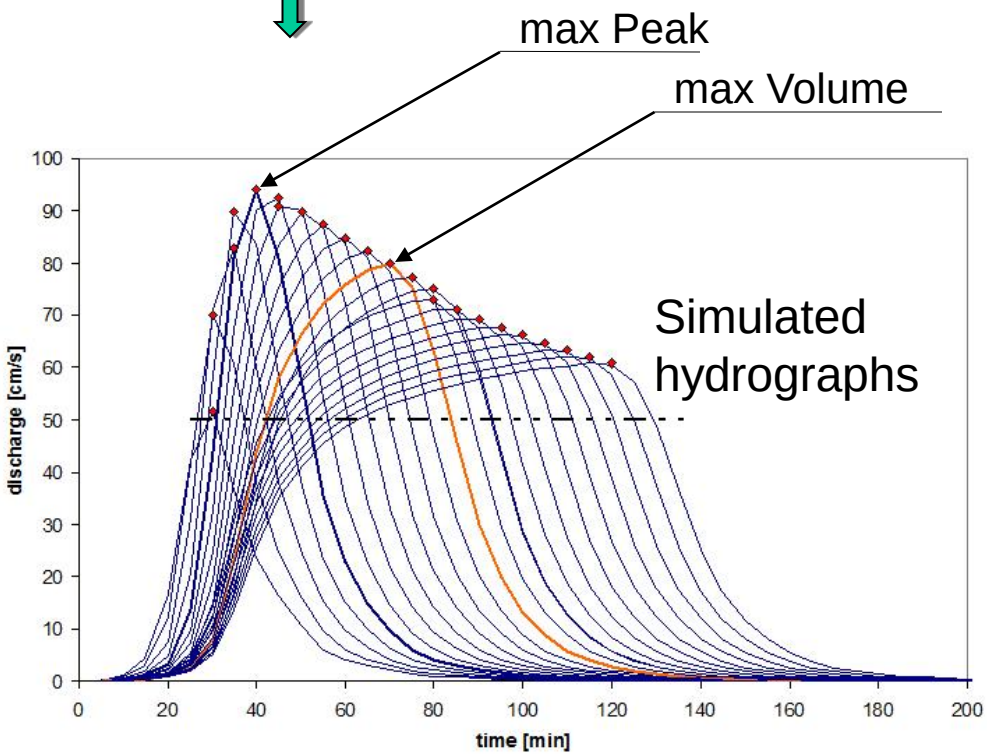
Design Hydrographs





Rainfall runoff transformation : FEST98

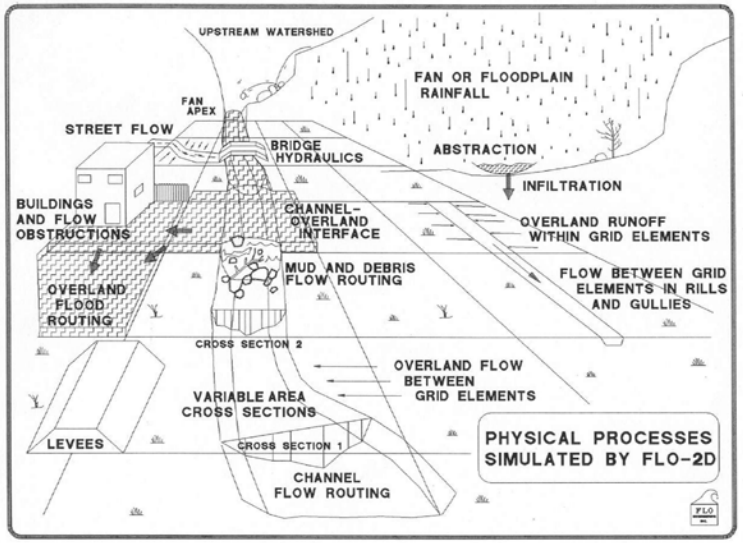




2D model

FLO-2D

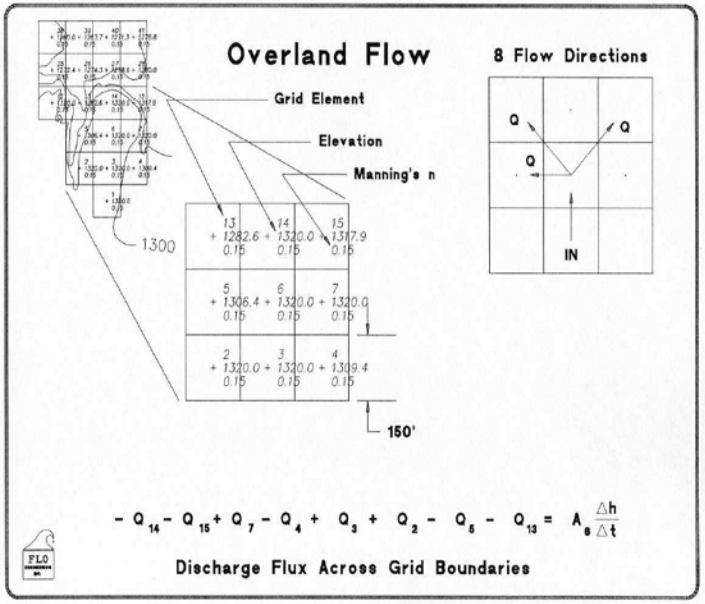
- Grid cell approximation of the domain
- Channel : 1D
- Floodplain: 2D



- Solve De Saint Venant equations in the 8 directions surrounding a cell:

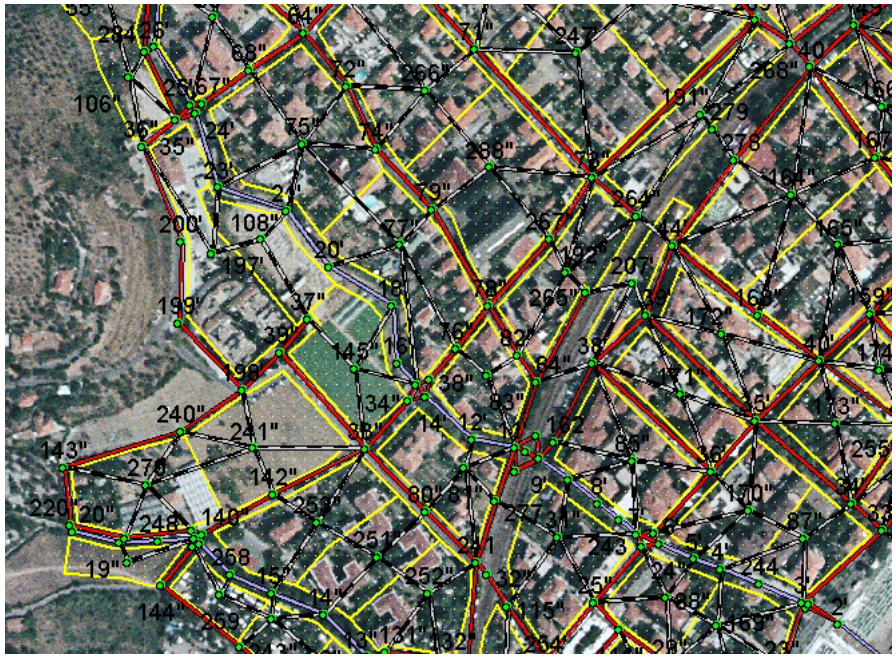
$$\begin{cases} \dfrac{\partial h}{\partial t} + \dfrac{\partial (hV_x)}{\partial x} = i \\ \dfrac{1}{g}\dfrac{\partial V_x}{\partial t} + \dfrac{V_x}{g}\dfrac{\partial V_x}{\partial x} + \left(\dfrac{\partial h}{\partial x} - S_{0x} + S_{fx} \right) = 0 \end{cases}$$

Explicit finite difference scheme



1D model

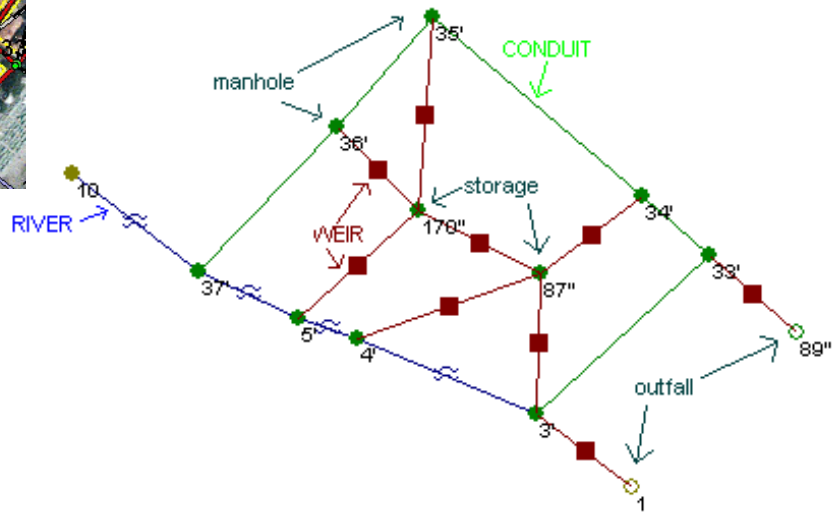
InfoWorks™ CS



Rivers and main streets are represented by conduits.

The street junctions and the connection between watercourse and street are represented by means of manholes.

Conduits are linked to storages through weirs



Preissman implicit finite difference scheme

2D model

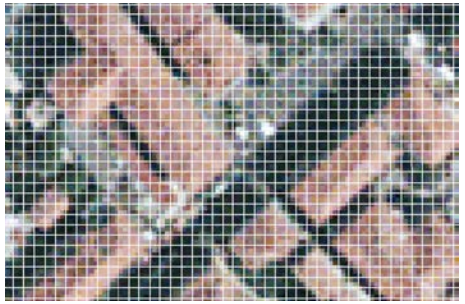
HAZARD MAPS, RIVER GORLERI :

DTM 1

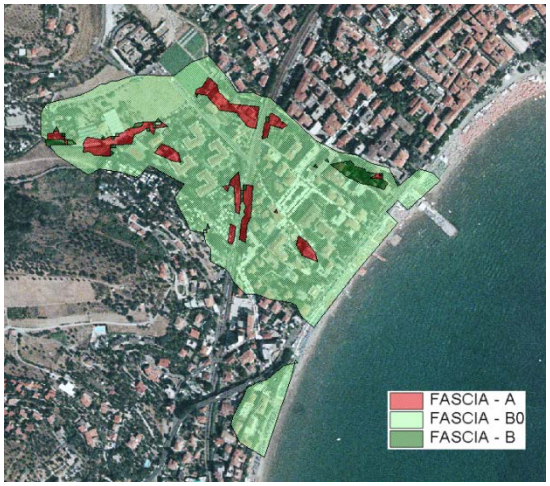
Spatial resolution: 2.5 m

Simulation time: 24 hours

Volume conservation error: 10% on the entire domain



DTM 2



Spatial resolution: 10 m

Simulation time: 15 minutes

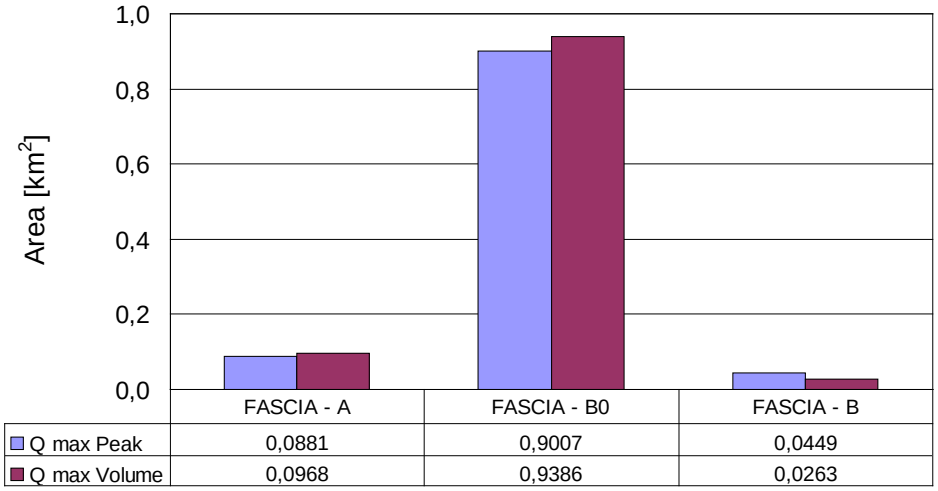
Volume conservation error: $8 \cdot 10^{-4}$% on the entire domain

Hazard map: effect of hydrograph

Max Peak Hydrographs

Max Volume Hydrographs

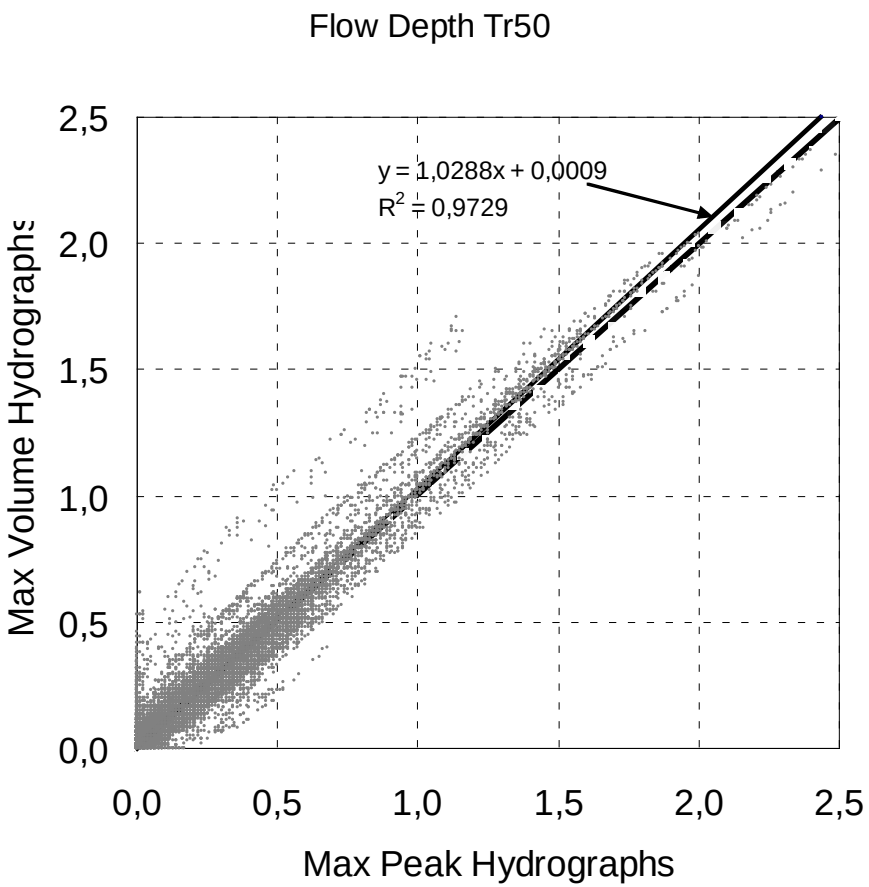
Hazard Extent

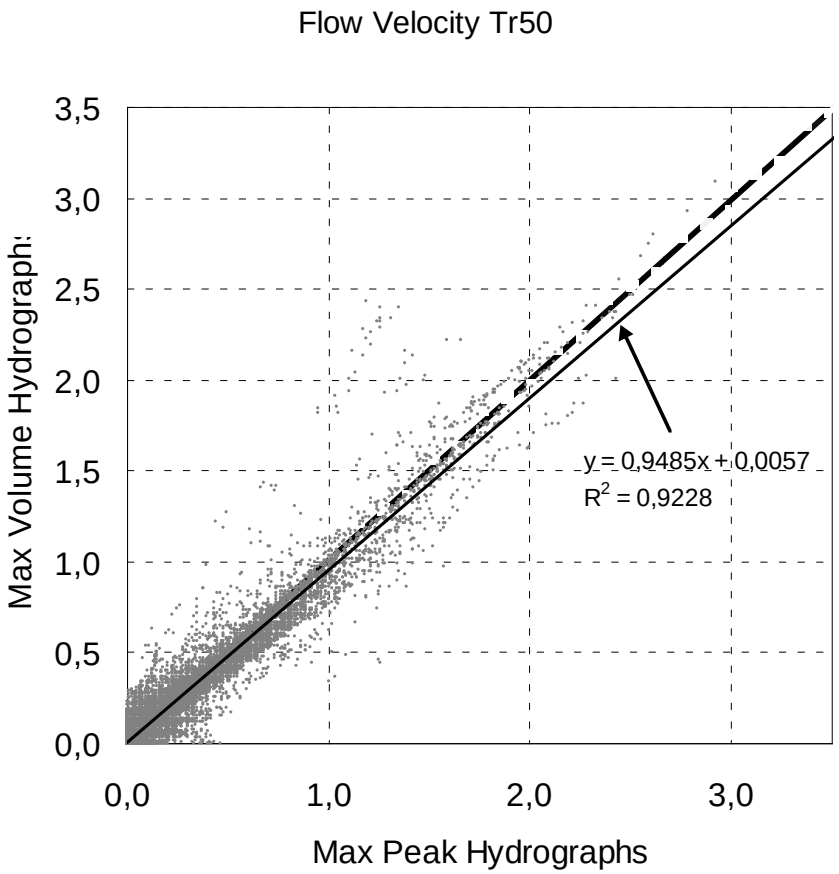


	FASCIA - A	FASCIA - B0	FASCIA - B
Q max Peak	0,0881	0,9007	0,0449
Q max Volume	0,0968	0,9386	0,0263

2D model simulation

Hazard map: effect of hydrograph





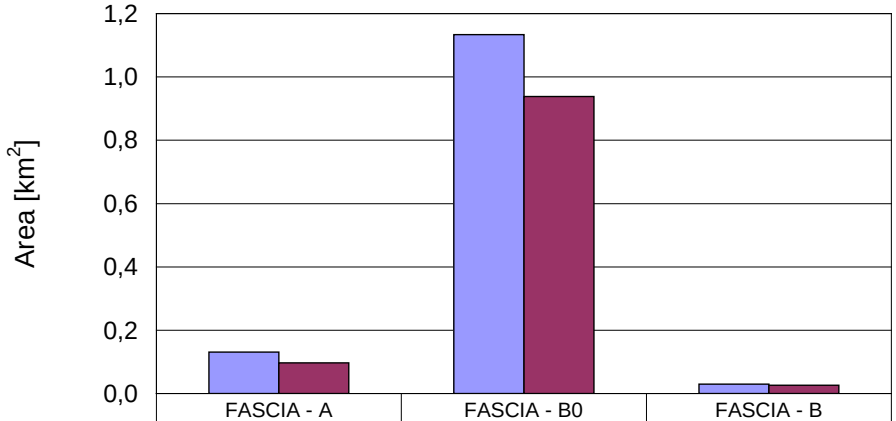
Hazard map: effect of the model

INFOWORKS-CS

FLO-2D

Hazard Extent

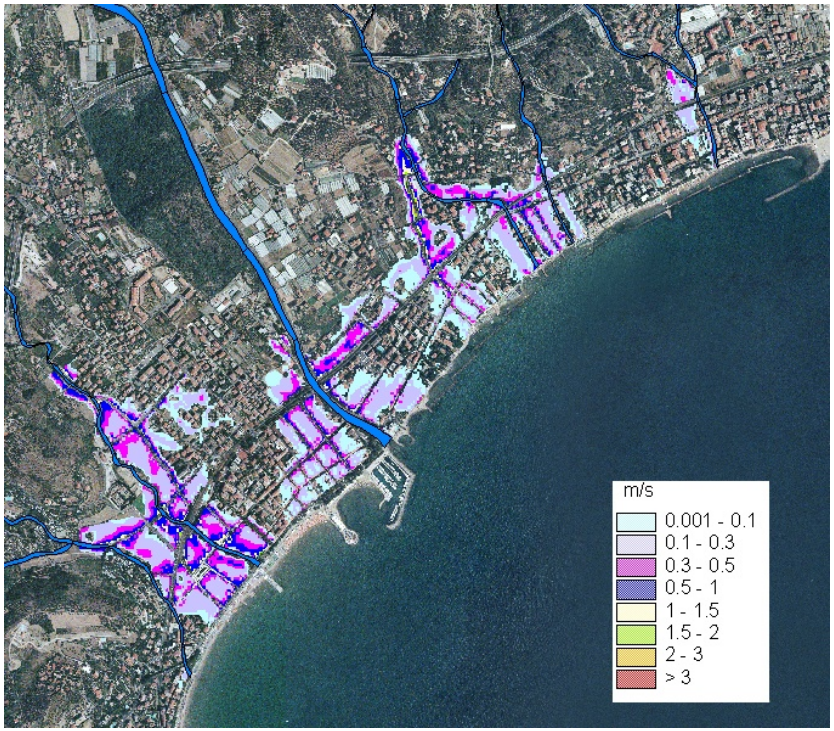
Max Volume Hydrographs



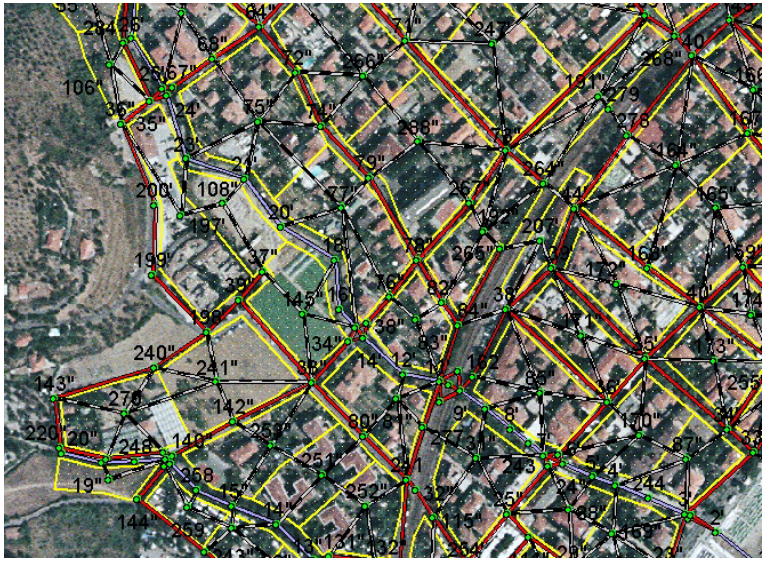
	FASCIA - A	FASCIA - B0	FASCIA - B
INFOWORKS-CS	0,1312	1,1338	0,0297
FLO-2D	0,0968	0,9386	0,0263

Flow velocity inside storage

Flow velocity from FLO-2D surrounding buildings



Building blocks are simulated as storages in INFOWORKS

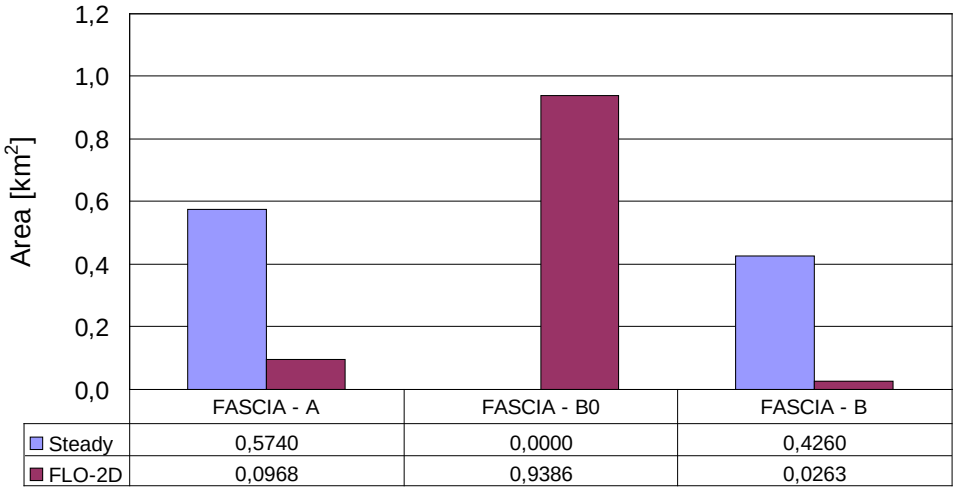


What change

Previous approach (1D, steady, only *h*)

New approach (2D, unsteady, *h* and *v*)

Hazard Extent



	FASCIA - A	FASCIA - B0	FASCIA - B
Steady	0,5740	0,0000	0,4260
FLO-2D	0,0968	0,9386	0,0263

Conclusions

• The use of different hydrographs (Q max Peak, Q max Volume) seems not to affect significantly the results in terms of flood hazard map.

•The comparison between results coming from 2D model (FLO-2D) and Quasi-2D model (INFOWORKS) shows that pattern of inundation is very similar. Differences are due to different approach to simulate hydraulic structures (still to be investigated).

•Further validation of the assumptions of Quasi-2D model comes from the analysis of flow velocity field simulated by FLO-2D in the area surrounding buildings: flow velocity is very low, aggregation of buildings can be simulated as storages.

THANK YOU FOR YOUR ATTENTION !

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