Flood damage data gathering: procedures and use

Daniela Molinari[1], Giuseppe Aronica[2], Francesco Ballio[1], Nicola Berni[3], Claudia Pandolfo[3]

[1] Politecnico di Milano

[2] Università di Messina

[3] CFD – Regione Umbria

The European "Floods" Directive 2007/60/CE

22 Dec 2015
Flood risk
management plans

22 Dec 2013
Flood hazard maps
and flood risk maps

22 Dec 2011
Preliminary flood risk
assessment
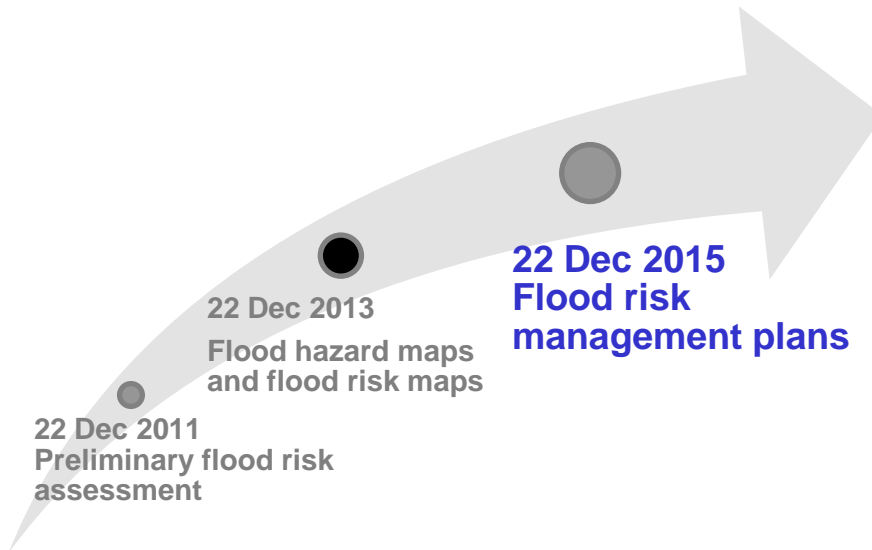
FLOOD RISK MANAGEMENT PLANS:

✓ **SHALL ADDRESS ALL ASPECTS OF FLOOD RISK MANAGEMENT**
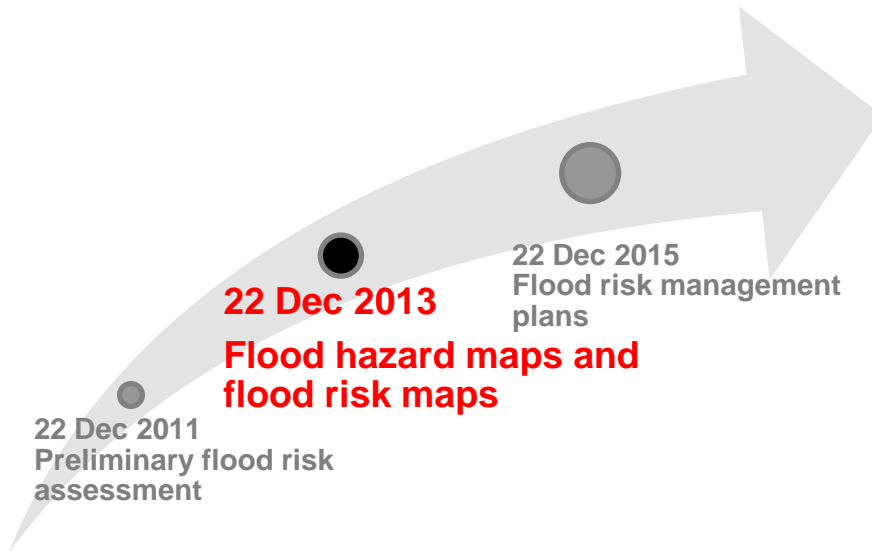
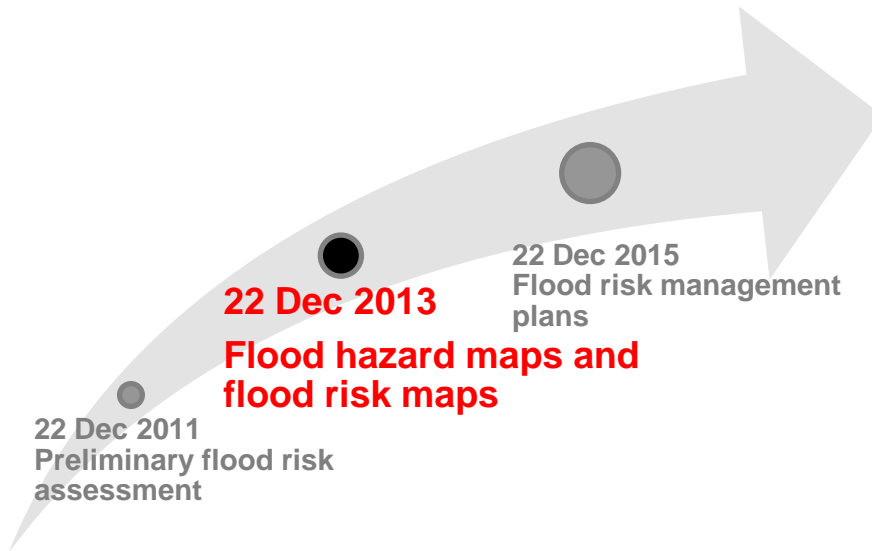✓ **MUST BE BASED ON FLOOD HAZARD MAPS AND FLOOD RISK MAPS**

The European "Floods" Directive 2007/60/CE

22 Dec 2015
Flood risk management plans

22 Dec 2013

Flood hazard maps and flood risk maps

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Preliminary flood risk assessment

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FLOOD RISK MAPS:

SHALL SHOW ALL THE POTENTIAL ADVERSE CONSEQUENCES ASSOCIATED WITH FLOOD SCENARIOS

Depth-damage curves are the standard tool to estimate direct damage to buildings

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→

existing curves are site specific, strictly valid for the area where they have been derived

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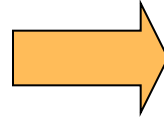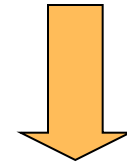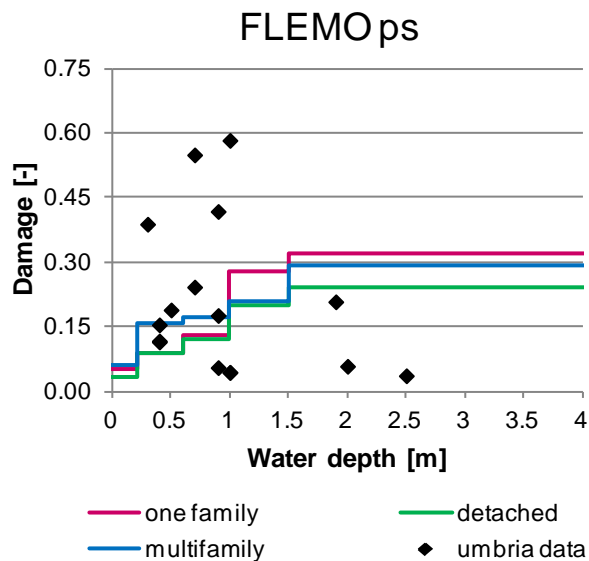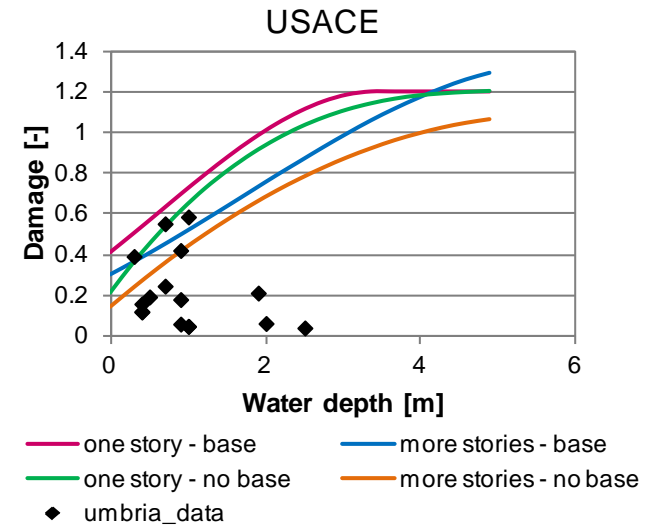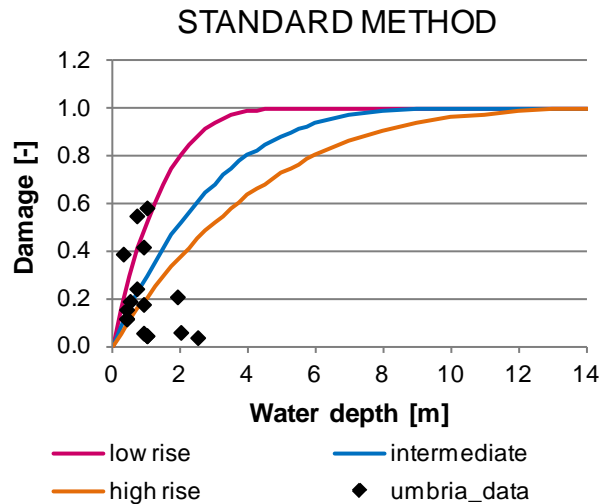**existing curves are site specific, strictly valid for the area where they have been derived**

Comparison between existing curves and Italian data

STANDARD METHOD

Damage [-] vs Water depth [m]

Legend:
- low rise
- high rise
- intermediate
- ◆ umbria_data

USACE

Damage [-] vs Water depth [m]

Legend:
- one story - base
- one story - no base
- more stories - base
- more stories - no base
- ◆ umbria_data

FLEMO ps

Damage [-] vs Water depth [m]

Legend:
- one family
- multifamily
- detached
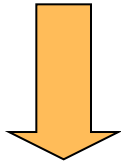- ◆ umbria data

Existing curves hardly reproduce observed data

Depth-damage curves are the standard tool to estimate direct damage to buildings

existing curves are site specific, strictly valid for the area where they have been derived
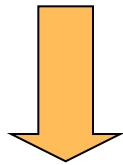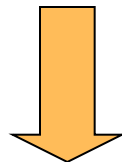
NO CURVES ARE AVAILABLE FOR ITALY

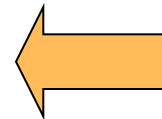**Depth-damage curves are the standard tool to estimate direct damage to buildings**

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NO CURVES ARE AVAILABLE FOR ITALY

SPECIFIC CURVES MUST BE IDENTIFIED

What we are going to talk about?

AIM: to describe flood damage data collection and validation in order to define depth-damage curves for the Italian context

FOCUS: → local scale

→ residential sector

OUTLINE:

- ✓ *Data collection*
- ✓ *Ex-post evaluation of H,V,E,D*
- ✓ *Comparison between existing curves and collected data*
- ✓ *Critical discussion and suggestions*

POLITECNICO DI MILANO

Barcellona Pozzo di Gotto (Sicily)

Flash flood on 22nd, November, 2011

Tiber alluvial fan (Umbria)
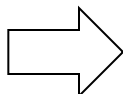

Riverine flood on 25-28, November, 2005

✓ **two different types of event (flash floods vs. riverine floods)**
✓ **two different times for data collection**
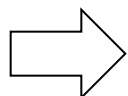
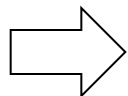|	Barcellona	Umbria
TIME OF COLLECTION ⟹	Few days after the flood	Several months after the flood
INFORMATION ON DAMAGE ⟹	Report by affected citizens (i.e. papery forms) **577 items**	Technicians' estimates **35 items**
INFORMATION ON HAZARD ⟹	Technicians' surveys + Monitored data	Flood event reports (Monitored data + surveys)

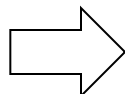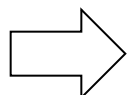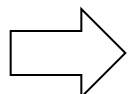|	**Barcellona**	**Umbria**
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INFORMATION ON HAZARD ⇨	**Technicians' surveys + Monitored data**	**Flood event reports (Monitored data + surveys)**

→ **Availability of damage data decreases with time**
→ **Reliability of damage data increases with time**

Hazard data

Required data (for every affected item)	Available data	
	Barcellona	**Umbria**
• Water depth at building location	• Water depth at building location (<u>52 of 577 affected items</u>) • Extent of flooded area	• Water depth at building location (<u>22 of 35 affected items</u>) • Extent of flooded area

→ Hazard data must be collected asap with ad hoc surveys

Case study: Barcellona

Water depth at building location [m]

🔴	0.2 to 0.5
🔵	0.5 to 1
🟡	1 to 1.5
🟢	1.5 to 2
🩷	2 to 2.5

Hazard data

MLFP-2D (Multi Level Flood Propagation 2-D) :
A hyperbolic model based on DSV equations (Aronica et al., 1998) was used. The conservative mass and momentum equations for two-dimensional shallow-water flow, when convective inertial terms are neglected, were be written as follows:

$$\frac{\partial H}{\partial t} + \frac{\partial (uh)}{\partial x} + \frac{\partial (vh)}{\partial y} = 0$$

$$\frac{\partial (uh)}{\partial t} + gh\frac{\partial H}{\partial x} + ghJ_x = 0$$

$$\frac{\partial (vh)}{\partial t} + gh\frac{\partial H}{\partial y} + ghJ_y = 0$$

where:
H is the free surface elevation
u and v are the *x* and *y* components of flow velocity
h is the water depth

These equations were solved by using a finite element technique with triangular elements. The free surface elevation is assumed to be continuous and piece-wise linear inside each element, where the unit discharges in the x and y directions are assumed to be piece-wise constant.

Hazard data

time on 22/11/2011
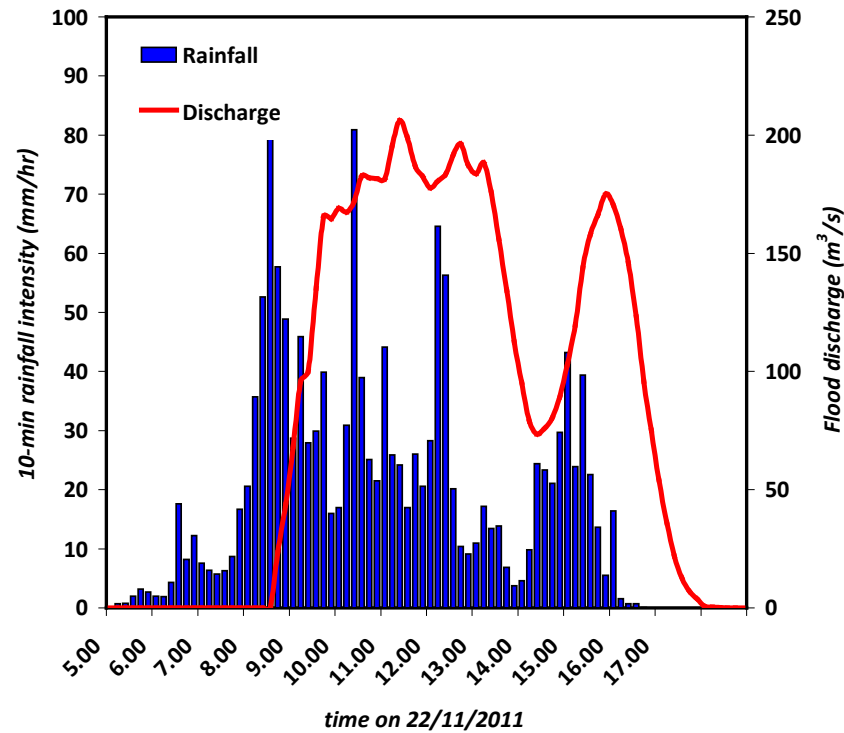
> *LIDAR DEM 10 m resolution*

> *LIDAR DEM 20 m resolution*

both derived from a LIDAR DEM 2 m resolution

DEM Elevation (m)
- 0 - 3
- 3 - 6
- 6 - 10
- 10 - 14
- 14 - 18
- 18 - 21
- 21 - 25
- 25 - 30
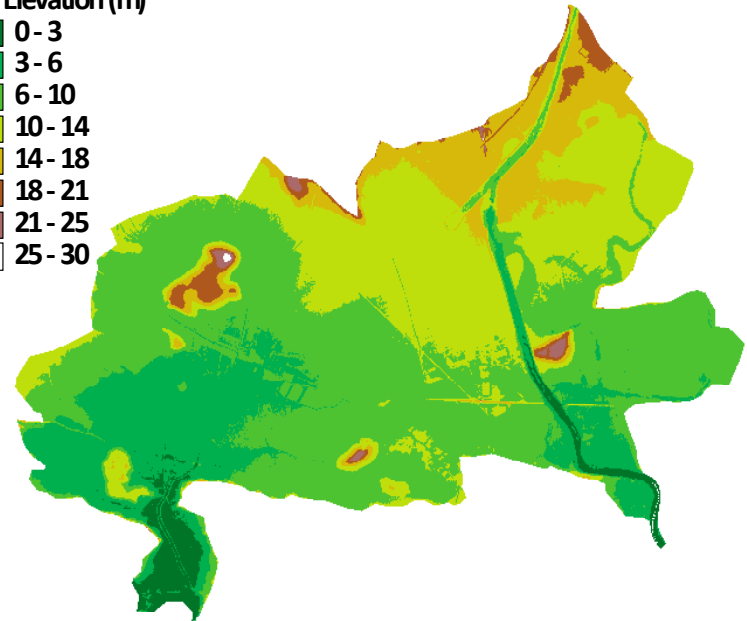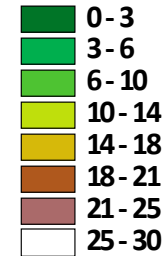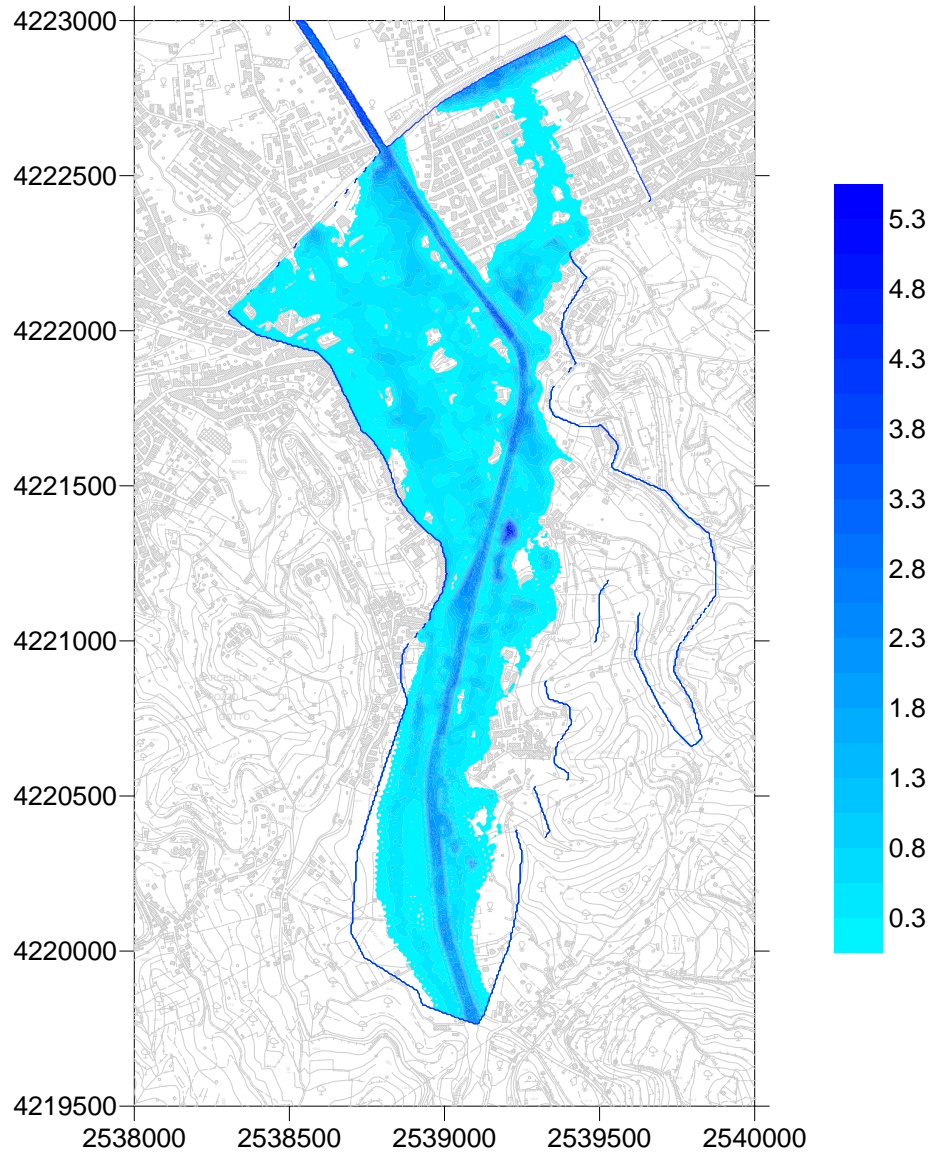
→ *Hazard data estimation requires accurate inundation dynamics modeling, for each flooded area*

Exposure, Vulnerability and Damage

	Required data (for every affected item)	Available data	
		Barcellona	**Umbria**
Exposure	• Buildings surface • Buildings economic value		• Buildings surface (16 of 35 affected items)
Vulnerability	• Explicative vulnerability parameters (context specific)	• Typology of building (all 577 affected buildings)	• Presence of basement • Number of stories • Use of basement • Level of maintenance (all 35 affected buildings)
Damage	• Economic value • Location	• Location (i.e. address) •Types of damage	•Economic value • Location (i.e. address) •Types of damage

Estimation: - **COMPARISON WITH CADASTRIAL DATA and MAPS**

- **ESTIMATION by REAL ESTATE AND PROPERTY PRICE DATABASE**

 (for economic value)

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→*Inconsistencies among different sources*

→*Lack of univocal classification among different sources*

→*Partial coverage of data*

→*Inadequate vulnerability data*

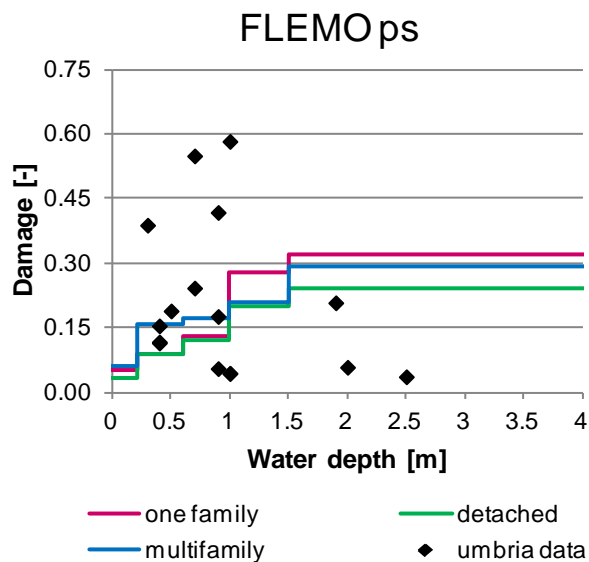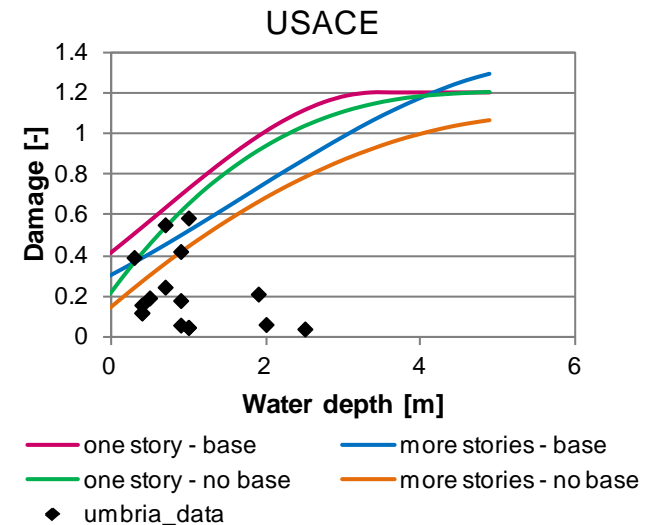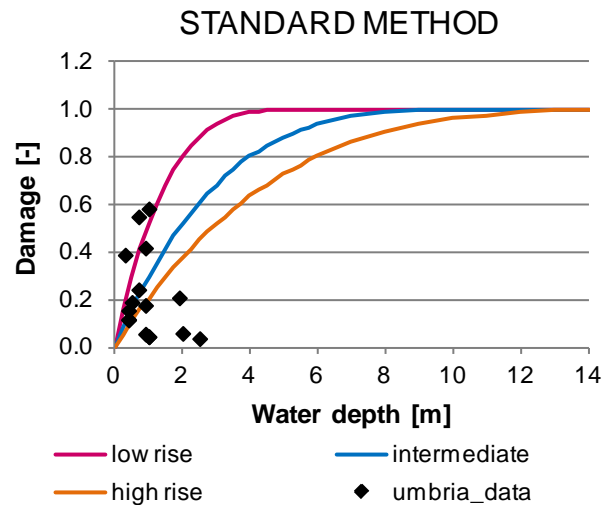→*Lack of knowledge about damage economic value in the aftermath of events*

Results

Available data are inadequate to identify/validate depth-damage curves

STANDARD METHOD

Legend: low rise — intermediate — high rise ◆ umbria_data

USACE

Legend: one story - base — more stories - base — one story - no base — more stories - no base ◆ umbria_data

FLEMO ps

Legend: one family — detached — multifamily ◆ umbria data

- *Complete data are too scattered to identify a trend*

- *Complete data (16 in total) are few for the validation of existing curves or the definition of new ones*

Results

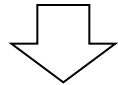*Available data are inadequate to identify/validate depth-damage curves*

→*PROPOSAL FOR THE NEXT IMPLEMENTATION OF THE FLOODS DIRECTIVE*

→ *PROPOSAL FOR FUTURE DATA COLLECTION (IN ORDER TO SUPPORT the definition of DEPTH-DAMAGE CURVES)*

Neglect hazard analysis of past events and analyse new data only to identify exposure and vulnerability explicative variables for damage

⬇

Identify which of existing curves are the most suitable for the Italian context to be used in risk maps

FEASIBLE TIME CONSUMING

Neglect hazard analysis of past events and analyse new data only to **identify exposure and vulnerability explicative variables for damage**

⬇

Identify which of existing curves are the most suitable for the Italian context <u>to be used in risk maps</u>
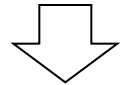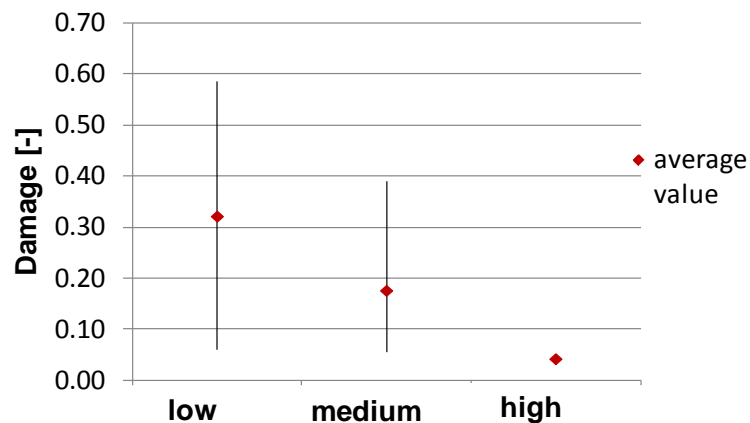
FEASIBLE TIME CONSUMING

Relative damage vs. maintainance (max, min and avreage data per class)

◆ average value

Source	Hazard factors	Vulnerability factors
Standard method	-Water depth	-Building typology
USACE	-Water depth	-Number of stories
		-Presence of basement
FLEMOps	-Water depth	-Building typology
		-Level of maintenance (i.e. building quality)

Develop **a new procedure to collect and storage data** in the aftermath of an event which should overcome present limits.

Develop specific depth-damage curves <u>to be used for risk maps update</u>

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Develop specific depth-damage curves <u>to be used for risk maps update</u>
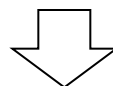
Damage form with compulsory and univocal fields:

- Building location (WGS84)

- Hazard data (water depth)

- Buildings vulnerability and exposure (univocal classification)

- Damage (economic value)

N.B. Damage forms include notes for compilation and must be filled in by **technicians**

SEZIONE 1 – DATI RELATIVI ALLA SCHEDA		Note alla compilazione
Codice ISTAT Provincia ⌊⌊⌊⌋	Scheda n° ⌊⌊⌊⌊⌊⌋	
Codice ISTAT Comune ⌊⌊⌊⌋	Data ⌊⌊⌊⌊⌊⌋	
Comune ⌊⌊⌊⌊⌊⌊⌊⌊⌊⌊⌋	Squadra ⌊⌊⌋	

SEZIONE 2 – LOCALIZZAZIONE EDIFICIO

Coordinate geografiche (Datum WGS84)	⌊⌊⌊⌊⌊⌊⌋ N ⌊⌊⌊⌊⌊⌊⌋ E	
Riferimenti catastali	Foglio ⌊⌊⌊⌋ Mappale ⌊⌊⌊⌊⌋	
Indirizzo	0 via, viale 1 corso 2 vicolo 3 piazza, largo 4 località ⌊⌋ Nome _____ N° civico _____ N° accessi ____	

SEZIONE 3 – CARATTERISTICHE EDIFICIO

| Superficie coperta	⌊⌊⌊⌋ mq	
N° di piani fuori terra	⌊⌊⌋	
Altezza dell'edificio dal piano della strada	⌊⌊⌋ m	
Presenza di seminterrato	SI NO	
Destinazione d'uso del piano vulnerabile	☐ garage ☐ fondo ☐ taverna/cucina ☐ zona giorno ☐ presenza di impianti Specificare:_____	Il piano vulnerabile è costituito dal seminterrato, se presente, oppure dal piano terra.

Develop **a new procedure to collect and storage data** in the aftermath of an event which should overcome present limits.
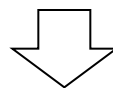
Develop specific depth-damage curves <u>to be used for risk maps update</u>

Creation of a geo-referenced database to storage collected data
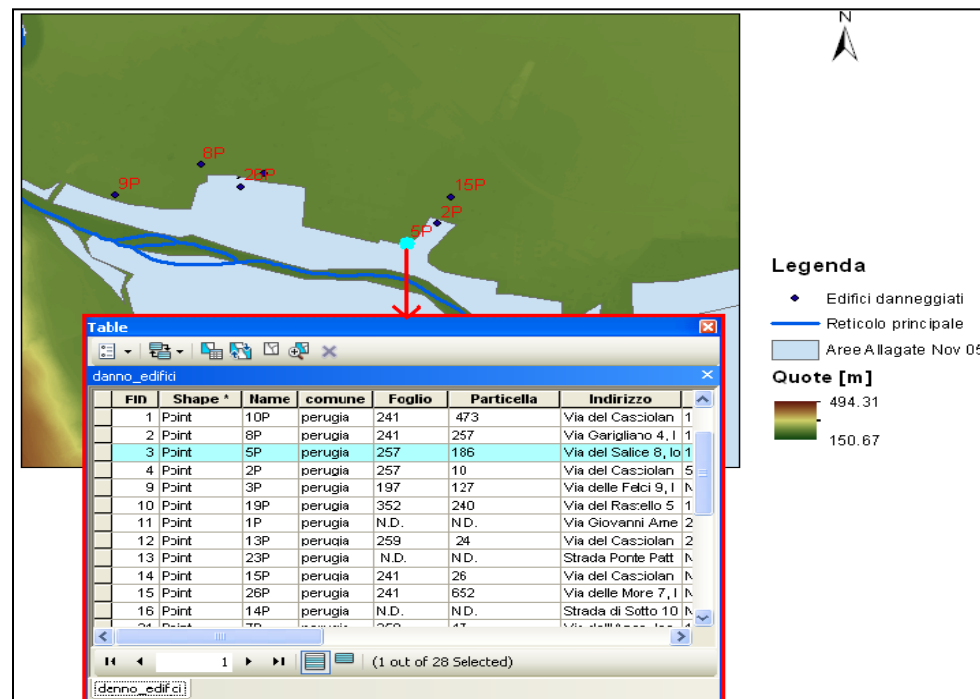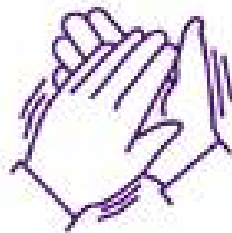
Thanks for your attention!

Daniela Molinari, PhD
Politecnico di Milano – Dept. of Environmental, Hydraulic, Infrastructures and
Surveying Engineering
Piazza Leonardo Da Vinci 32
20133, Milano
Tel +39 02 2399 6263
Fax +39 02 2399 6298
daniela.molinari@polimi.it