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 POLITECNICO DI MILANO



## THE ROLE OF VULNERABILITY FOR FLOOD EARLY WARNING SYSTEMS (FEWSs) EFFECTIVENES

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# What are we going to talk about?

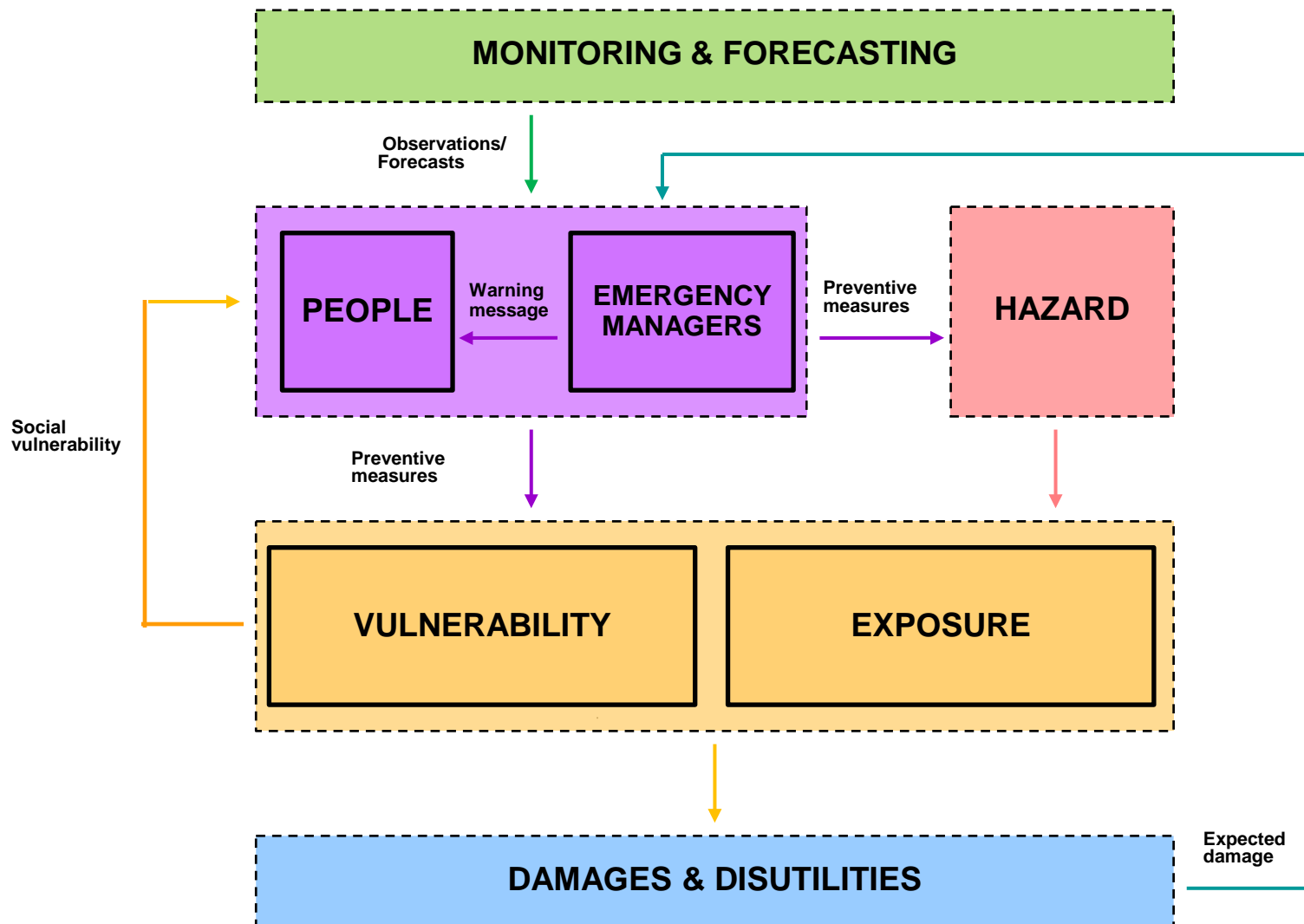
**AIM:** to investigate how vulnerability affects FEWSs' performance and how it can be modelled

## OUTLINE:

- ✓ To define FEWSs' performance
- ✓ To identify /discuss vulnerability role for FEWSs' performance
- ✓ To supply a case study to describe how vulnerability can be modelled in FEWSs' performance assessment
- ✓ To discuss present state of the art and needs for future research

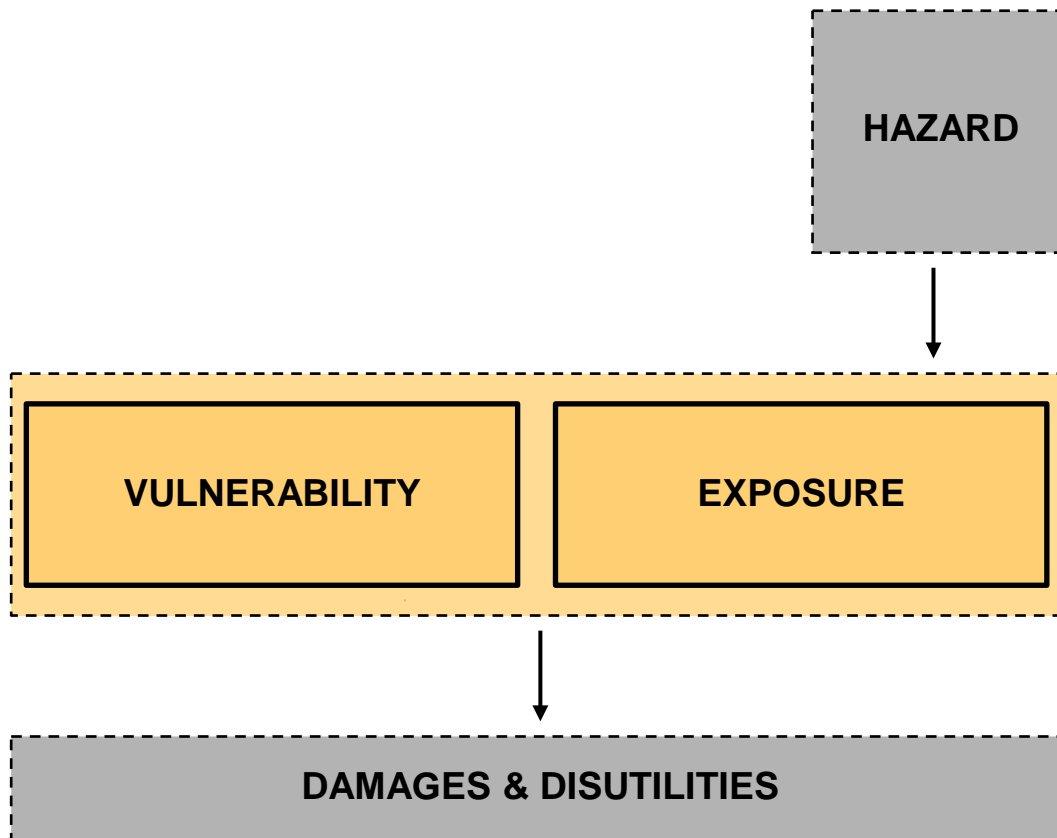


# FEWSs performance as potential damage reduction



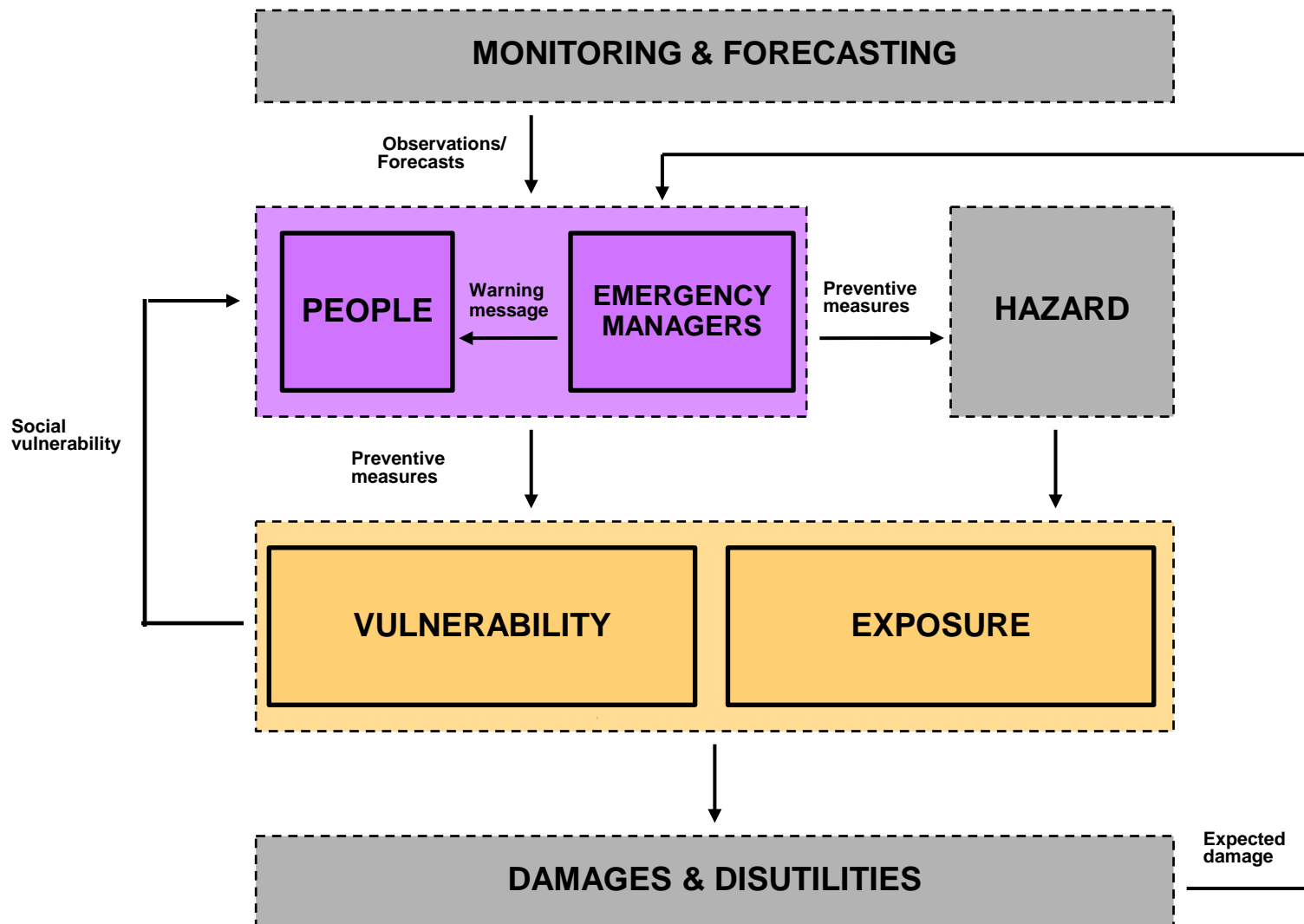


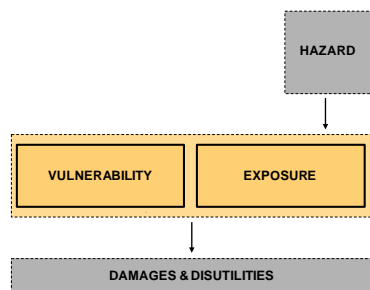
# Vulnerability's role to define potential damage



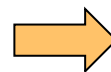


# Vulnerability's role to define actual damage





## PHYSICAL



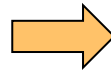
- ✓ Fragility of built environment (buildings, infrastructures, structural measures, etc.)
- ✓ Fragility of environment
- ✓ .....

## SYSTEMIC



- ✓ Lifelines interconnections
- ✓ Economic links
- ✓ .....

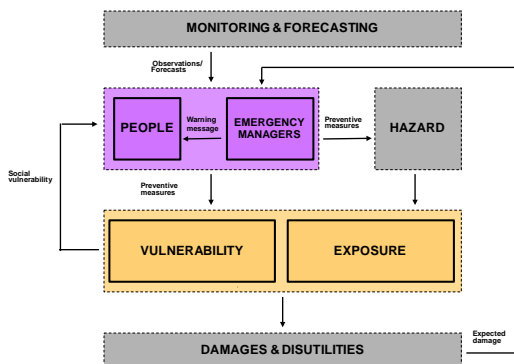
## SOCIAL



- ✓ Fragility of people
- ✓ .....



# Actual damage: vulnerability factors



## PHYSICAL



- ✓ Reliability of instruments (e.g. monitoring)
- ✓ .....

## ORGANISATIONAL



- ✓ Forecasting performance
- ✓ Warning effectiveness
- ✓ Civil protection level of preparedness (capacity to react)
- ✓ ...

## SOCIAL



- ✓ People level of preparedness (capacity to react)
- ✓ .....



**AFFECTING CAPACITY to REACT → POTENTIAL DAMAGE REDUCTION**



**AIM:** to evaluate FEWS' s capacity to reduce potential damage

## STEPS

1. Evaluation of potential damage
2. Evaluation of actual damage

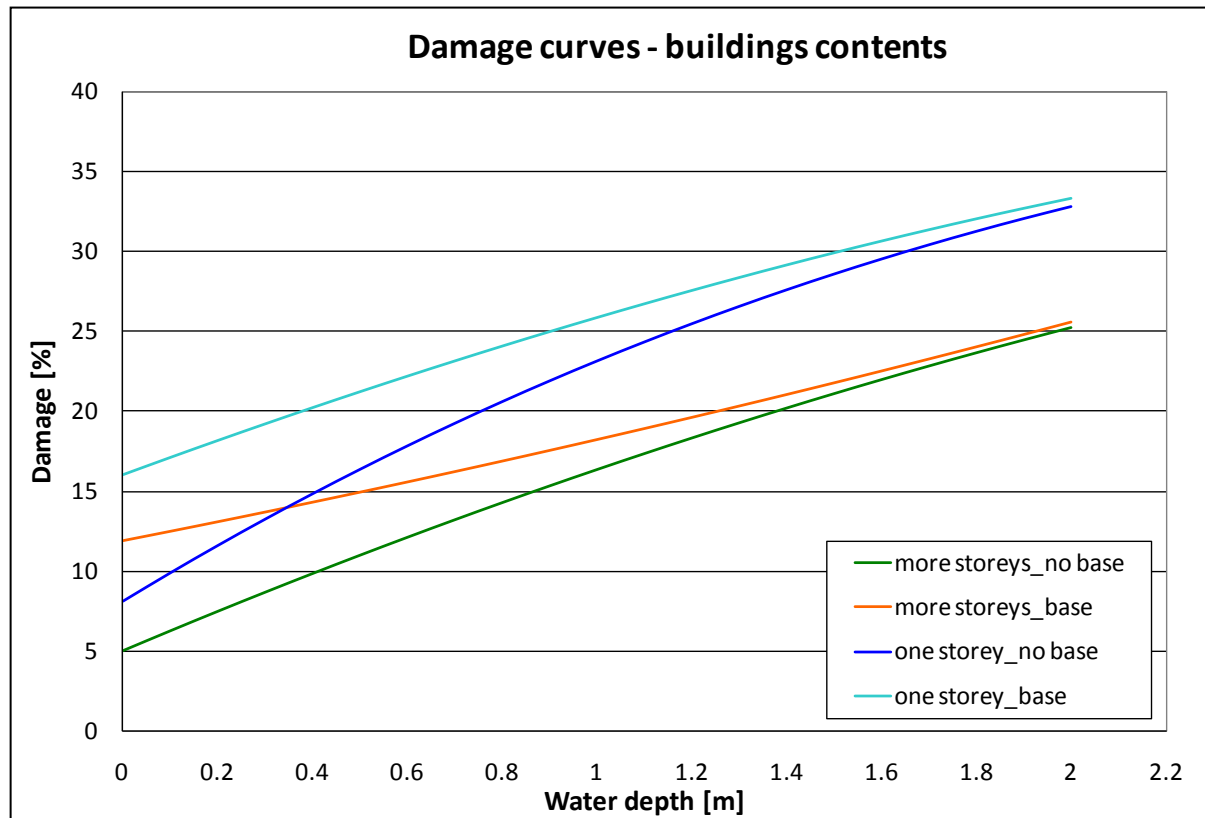
### Assumptions

- ✓ Economic approach → intangibles are not evaluated
- ✓ Damage assessment limited to → Buildings
  - Lifelines (i.e. roads & railways)
  - Emergency costs
- ✓ Damage assessment limited to → Direct damages
- ✓ Back analysis → Damage evaluation regards 36 past events





## Vulnerability of built environment → DEPTH-DAMAGE CURVES



Source: USACE (USA)

## VULNERABILITY FACTORS

### Vulnerability of buildings

- Number of storeys
- Presence of basement
- Type of use

### Vulnerability of lifelines

- Service supplied



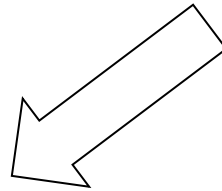
# Actual damage assessment: the role of forecasting performance

WARNING OUTCOMES		Observed	
		Flood	No flood
Forecasted	Flood	Forecasted Event	False Warning
	No flood	Missed Event	Calm



# Actual damage assessment: the role of forecasting performance

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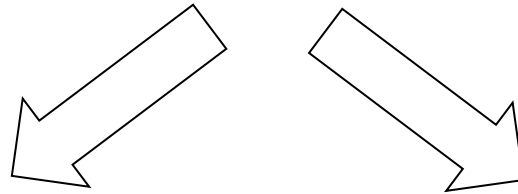


DAMAGE		Observed	
		Flood	No flood
Forecasted	Flood	+	0
	No flood	++	0



# Actual damage assessment: the role of forecasting performance

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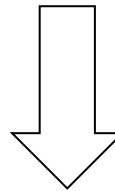
DAMAGE		Observed	
		Flood	No flood
Forecasted	Flood	+	0
	No flood	++	0

WARNING & EMERGENCY COSTS		Observed	
		Flood	No flood
Forecasted	Flood	E+W	W
	No flood	E	0



# Actual damage assessment: the role of forecasting performance

WARNING OUTCOMES		Observed	
		Flood	No flood
Forecasted	Flood	Forecasted Event	False Warning
	No flood	Missed Event	Calm



WARNING OUTCOMES		Observed	
		Flood	No flood
Forecasted	Flood	0.22	0.08
	No flood	0.25	0.44



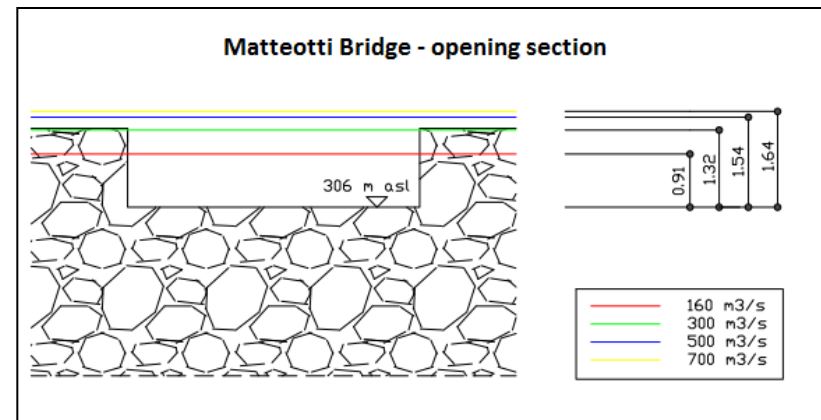
# Actual damage assessment: vulnerability modelling

## Level of preparedness – mitigation measures

### Mitigation Action (Contingency plan)

- Levees temporary rising/reinforcement
- Bridges gates
- Individual actions (e.g. lift contents, turn off gas, etc)

### HYDRAULIC ANALYSIS (i.e. weir outflow)



### FIXED PERCENTAGE OF POTENTIAL DAMAGES

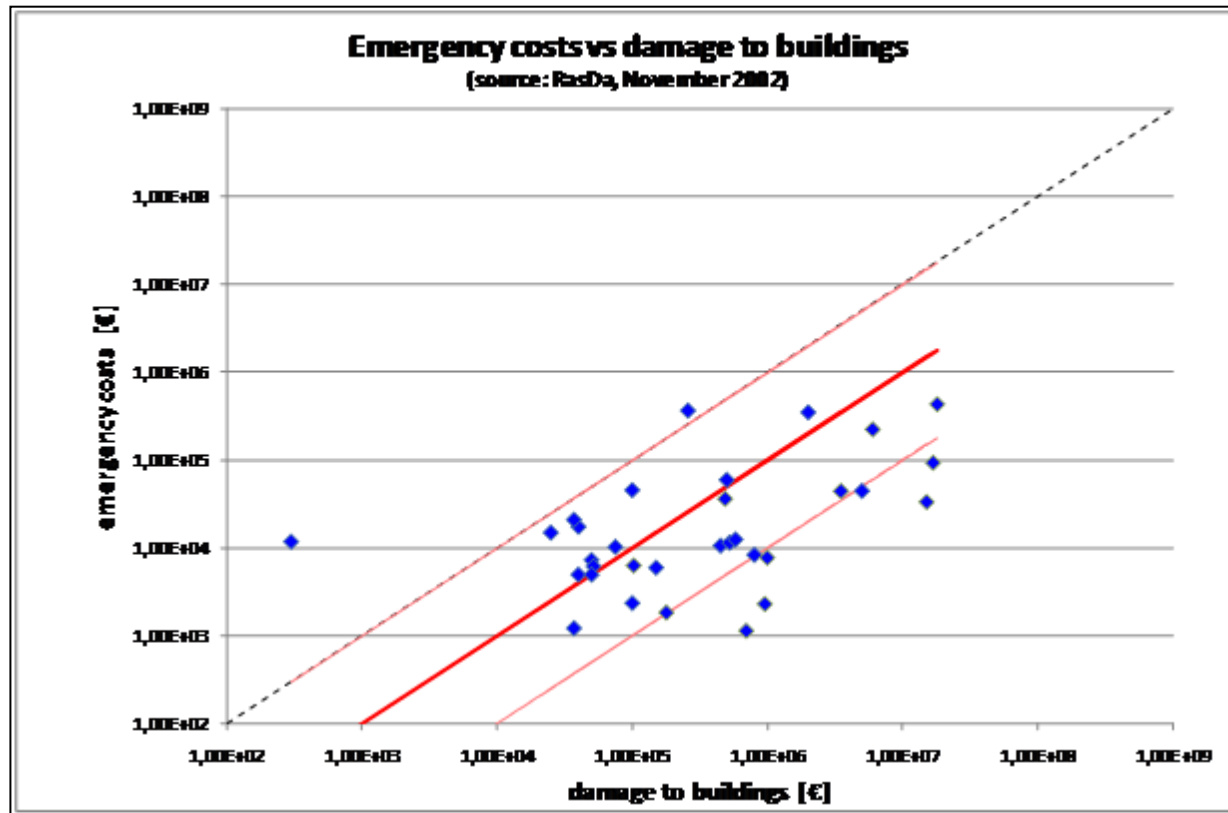
#### Vulnerability factors:

- Lead time
- People experience



# Actual damage assessment: vulnerability modelling

## Level of preparedness –warning costs



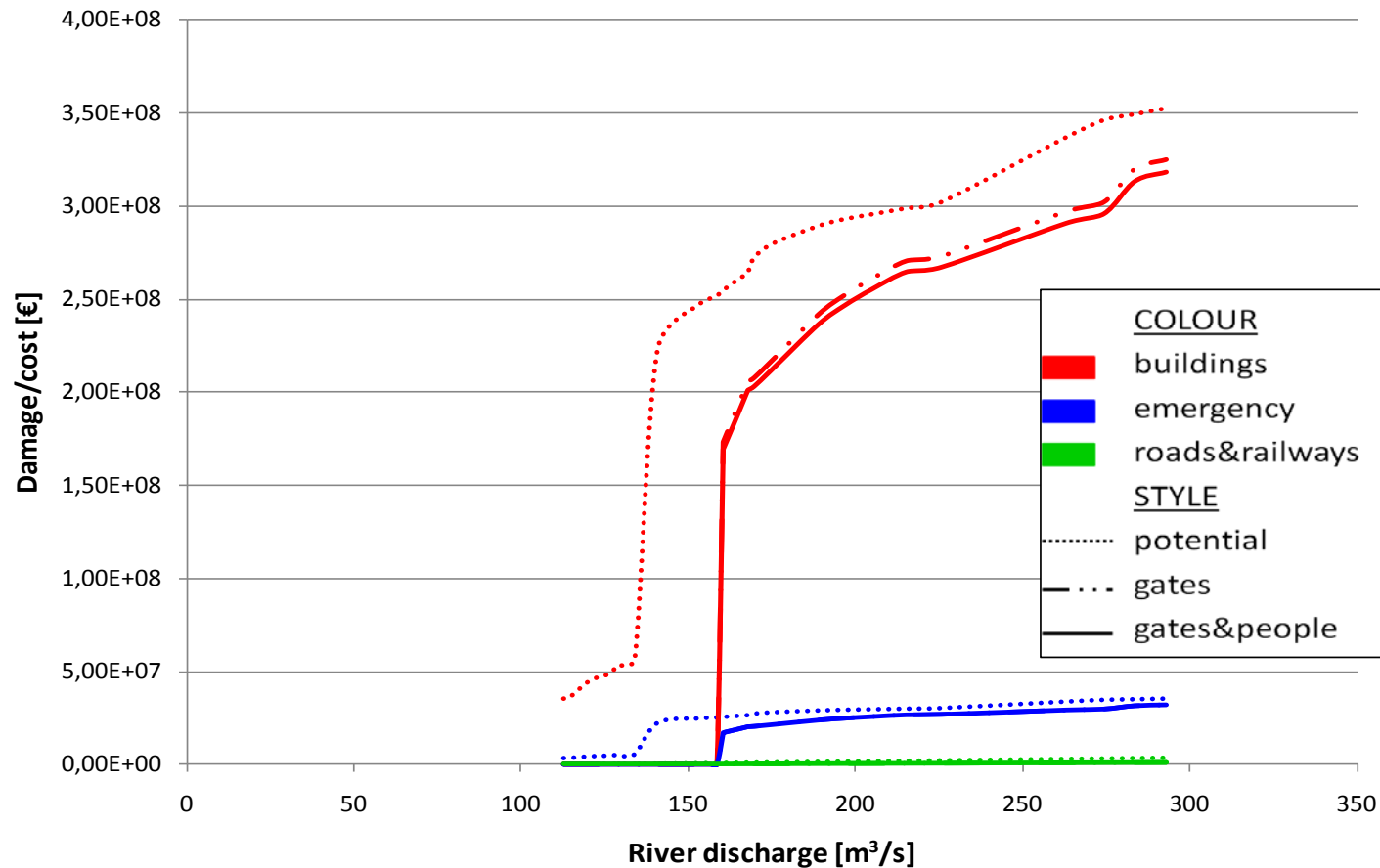
## ANALYSIS OF LOCAL DATA

Vulnerability factors:

- socio/political context



## Potential vs. actual damages

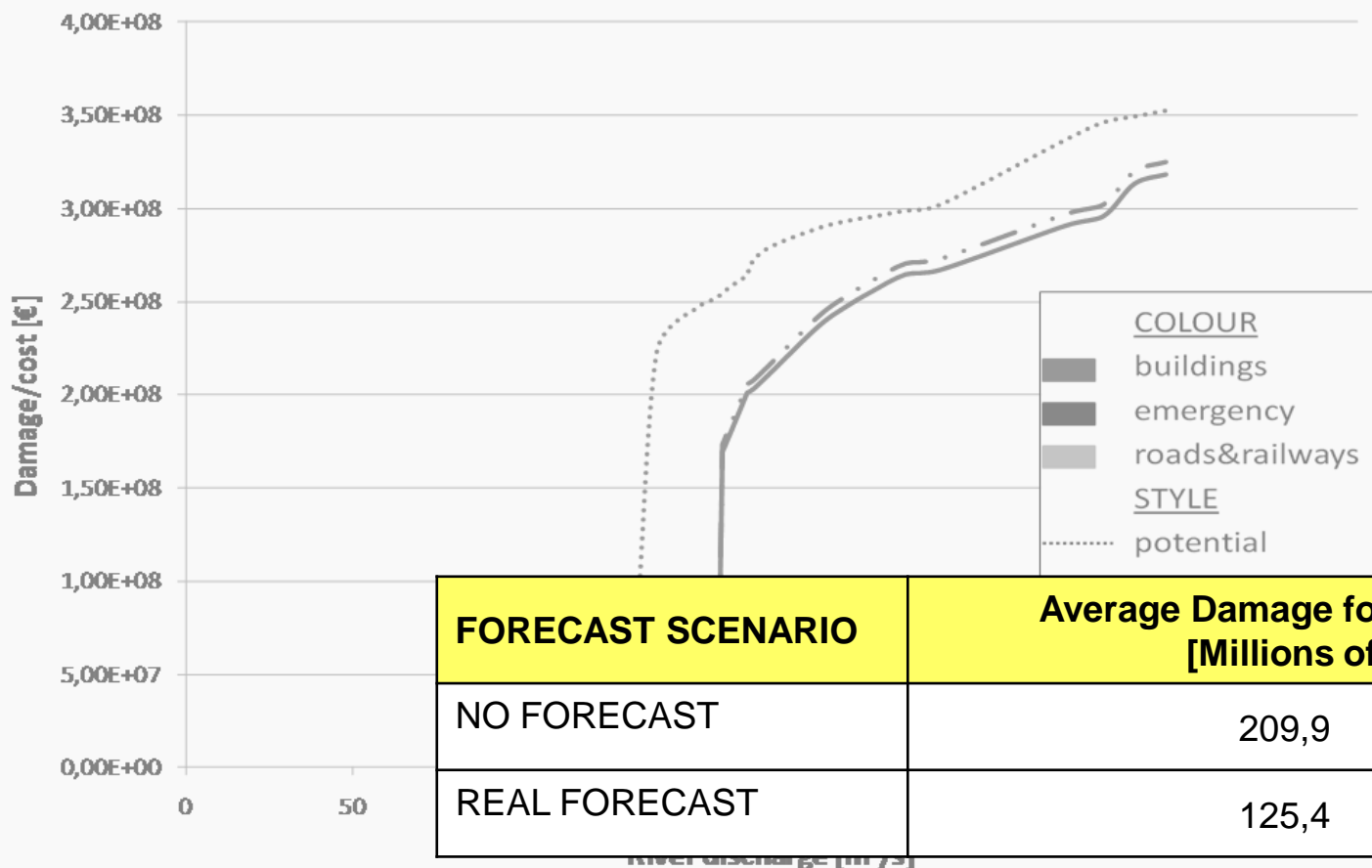






# FEWSs performance assessment: results

Potential vs. actual damages





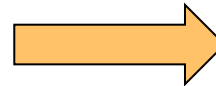
## Main findings

**Vulnerability plays a crucial role affecting both POTENTIAL and ACTUAL DAMAGES**



**Vulnerability should be included in FEWSs assessments**

**There is a need to improve current VULNEARBILITY MODELS**



**All relevant vulnerability factors must be taken into account**



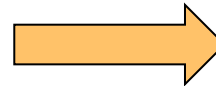
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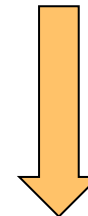


Vulnerability must be included in FEWSs assessments

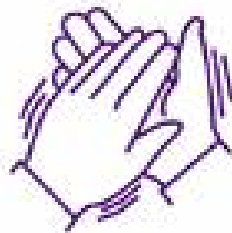
There is a need to improve current **VULNEARBILITY MODELS**



All relevant vulnerability factors must be taken into account



**Molinari D., Handmer J., A behavioral model for quantifying flood warning effectiveness, *Journal of flood risk management* (on line first)**



**Thanks for your attention!**

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