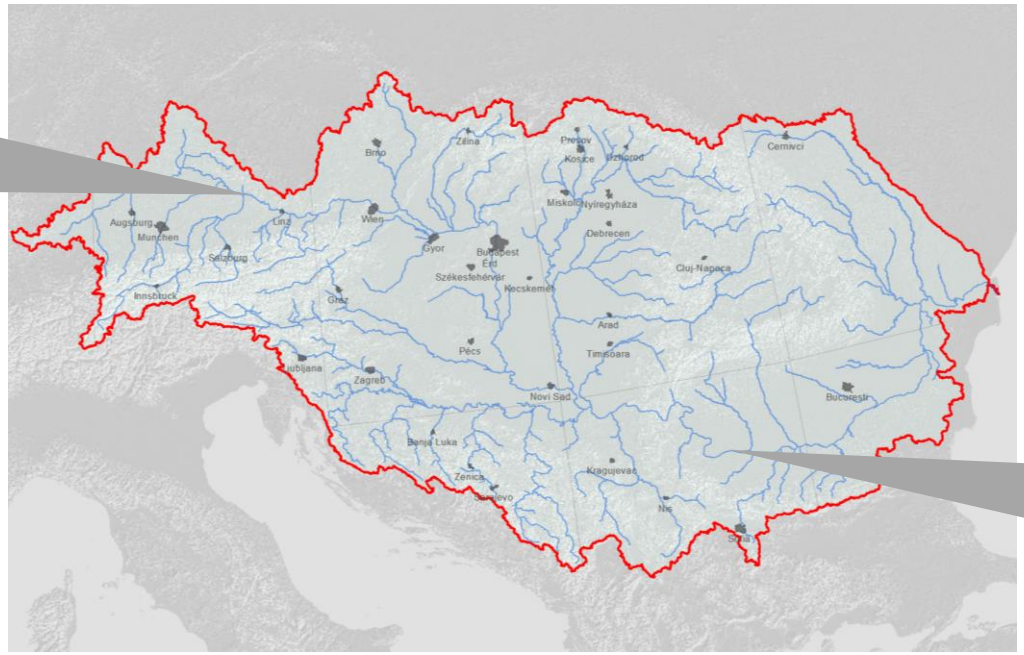

KULTURisk Danube case study

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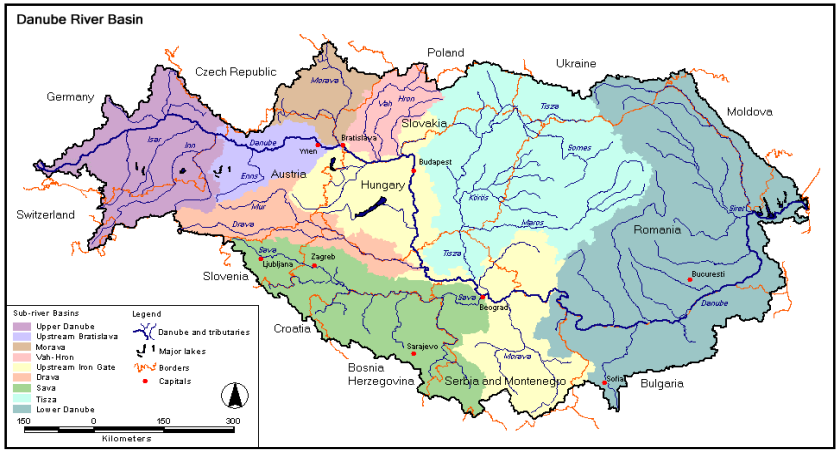
Danube case study

- Flood vulnerability in the Danube
  - June 2013 in Czech Republic ,German, Austria, Slovakia, Hungary and Serbia (12 billion EUR)
  - Spring 2006 in Serbia, Bulgaria and Romania (250 million EUR)
  - August 2002 in Czech Republic, Austria, Germany, Slovakia, Hungary, Romania and Croatia (15 billion EUR)
- Aim of the case study
  - Applicability of the KULTURisk method to large scale trans-national River Basin
  - Assessment of the feasibility to assess benefits of early warning systems



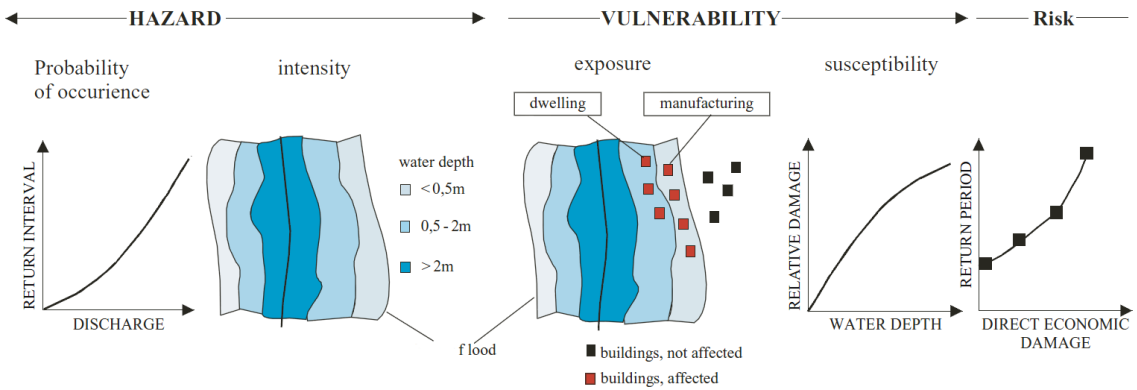
KULTURisk Methodology

Physical (RRA)

- Flood hazard for flood metrics
- Exposure to identify elements at risk
- Susceptibility for degree of exposure
- Risk to define risk index or cost

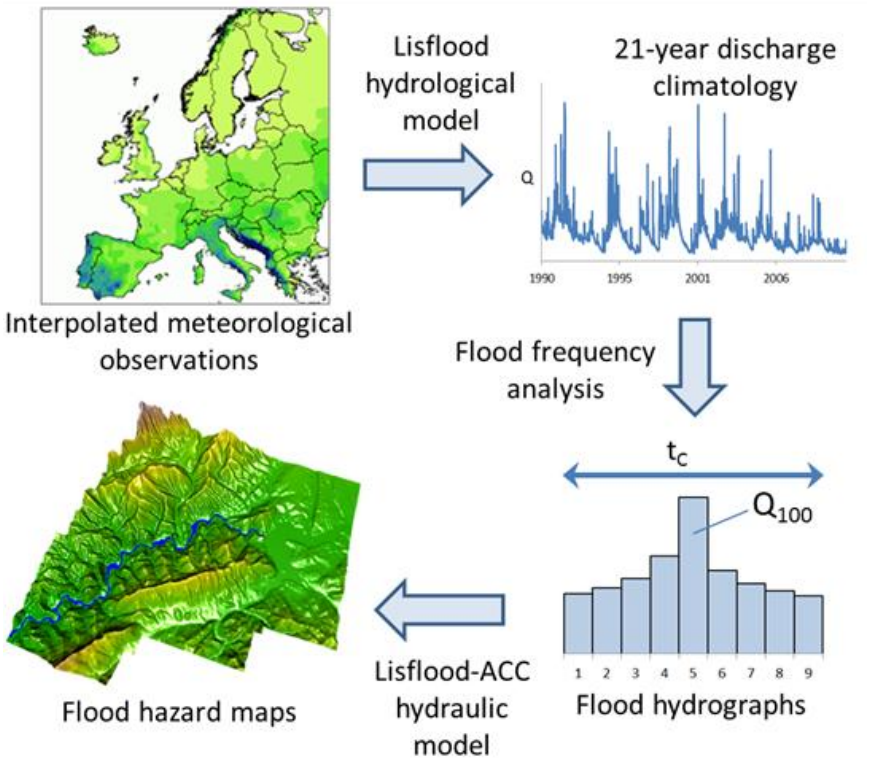
Social Economic (SERRA)

- Social aspects
  - Adaptive and coping capacity
    - Flood Early Warning System
- Economic aspects



Flood Hazard

- 21 year climatology
- LISFLOOD distributed rainfall-runoff model (5kmx5km)
- Flood frequency analysis to derive 100 year flood
- LISFLOOD-ACC hydraulic model (100mx100m) for flood extent, velocity, depth
- Flood extent maps evaluated against national and regional maps



Alfieri et al (2013). Flood hazard mapping

Regional Risk Assessment (RRA)

Component	Indicator	Receptor
Flood hazard	Water depth (m)	P,B
	Flow velocity (m/s)	P,B,I,A
	Flood extension (Km^2)	P,B,I,A
Exposure	Presence of people in residential areas	P
	Presence of buildings	B
	Presence of infrastructures	I
	Presence of agricultural typologies	A
Susceptibility	People over 75 years	P
	People infirm/ disable/ long term sick	P
	Vegetation cover	P,B,I,A
	Slope	P,B,I,A
	Soil type	P,B,I,A

People (P)
CORINE,Eurostat

Infrastructure (I)
OpenStreetMap

Buildings (B)
CORINE

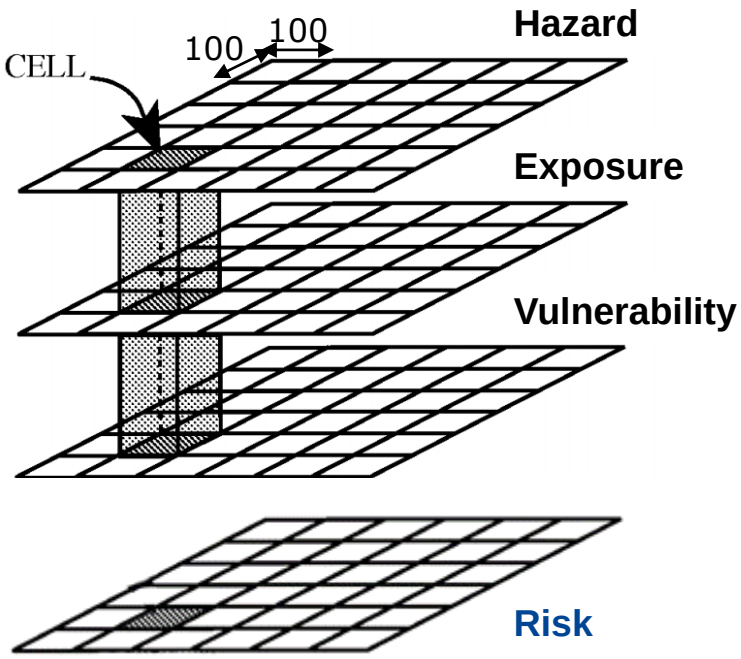
Agriculture (A)
CORINE

Other

- **Natural and semi natural systems**
- **Cultural heritage**

Assessment approach

- Maps are raster based
  - 100m x 100m
- Intersection maps
  - Risk = *f*(Hazard,Exposure,Vulnerability)
- Risk scores normalized to range 0 - 1
- Total risk index combines all receptors

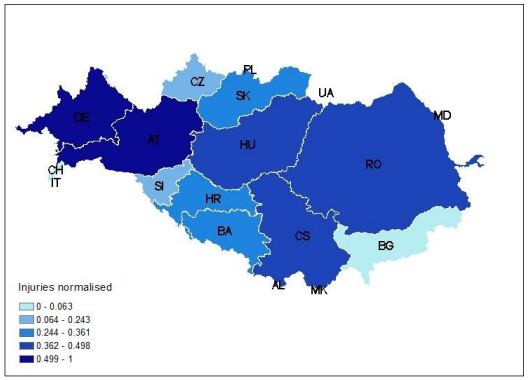


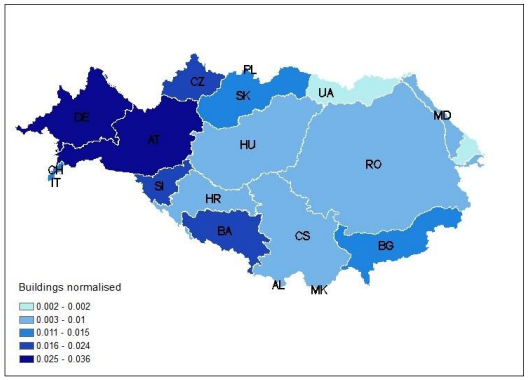
Total Risk

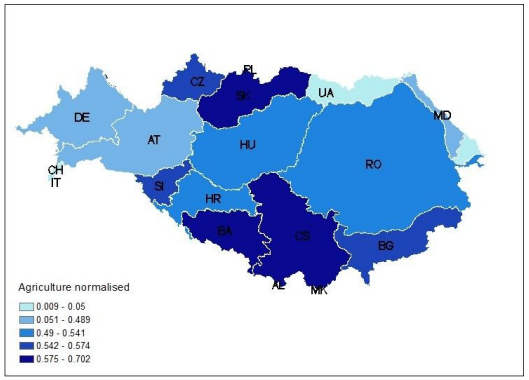
$$weight_P * risk_P + weight_B * risk_{B+}\ weight_I * risk_I + weight_A * risk_A$$

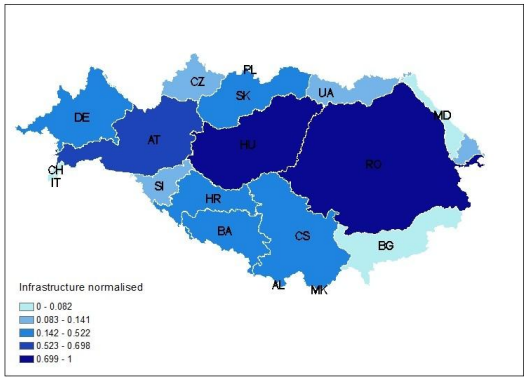
Risk scores Regional Risk Assessment (RRA)

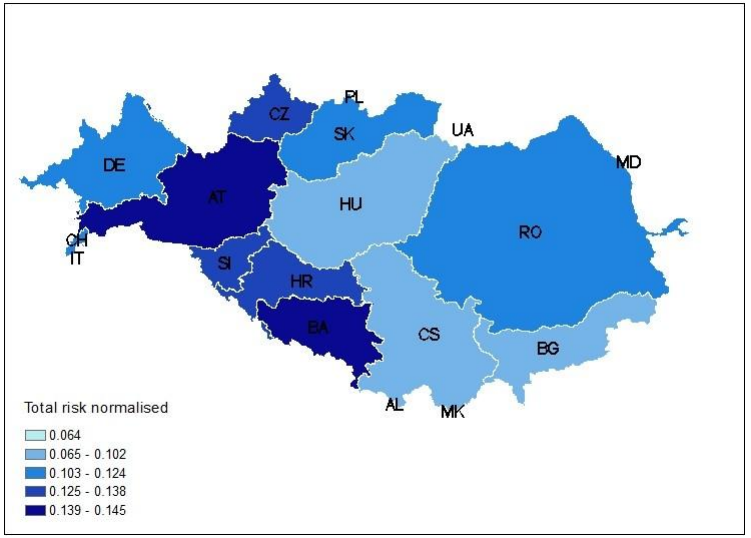
- Without social economic indicators
- Scores aggregated to country level



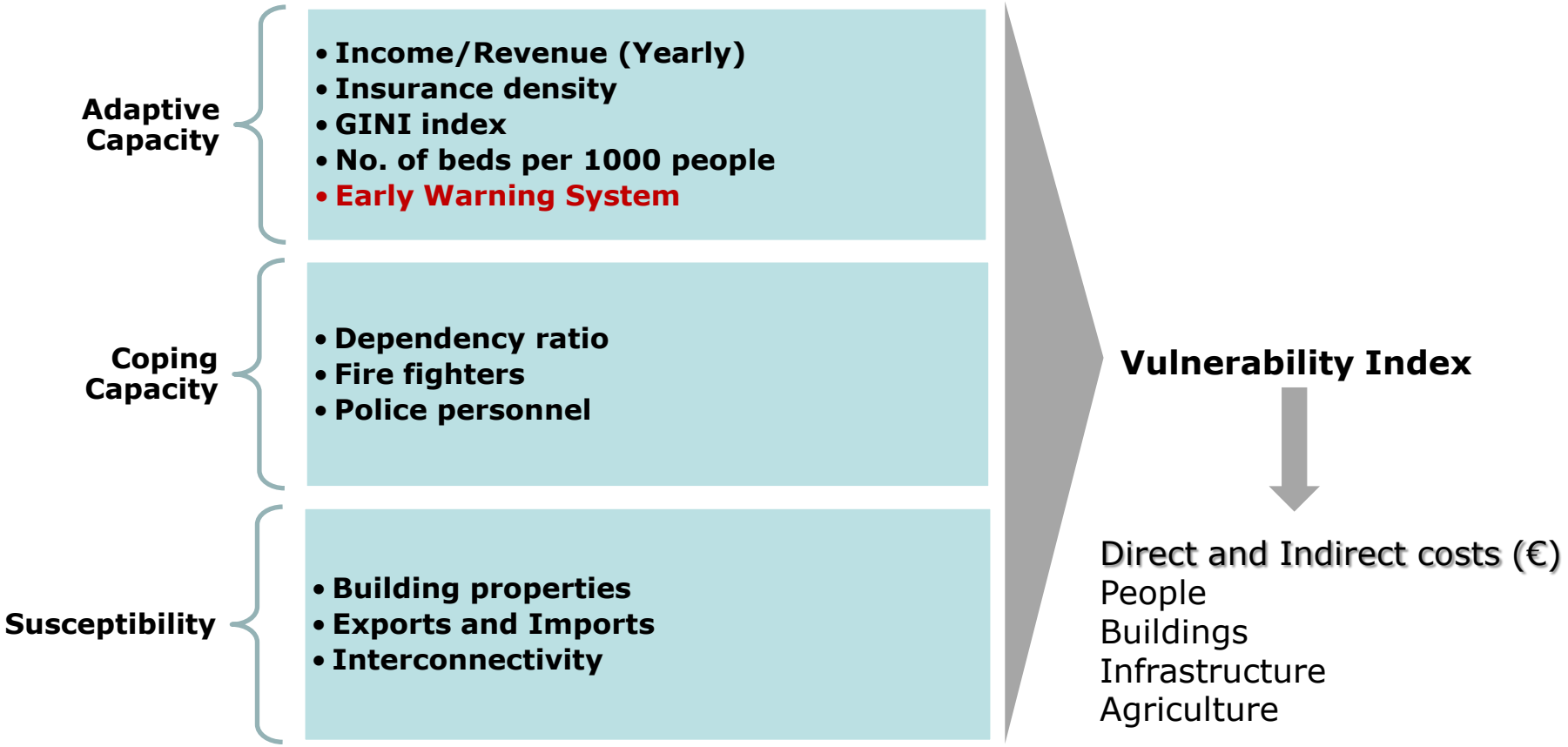








Social Economic Regional Risk Assessment (SERRA)



Early Warning System

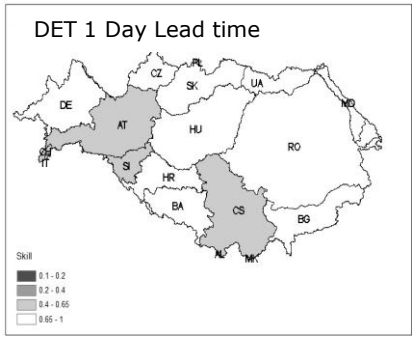
European Flood Awareness System (Operational since 2012)

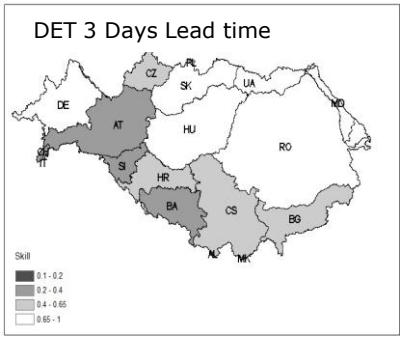
Scenario1 No existing flood early warning system (Baseline)

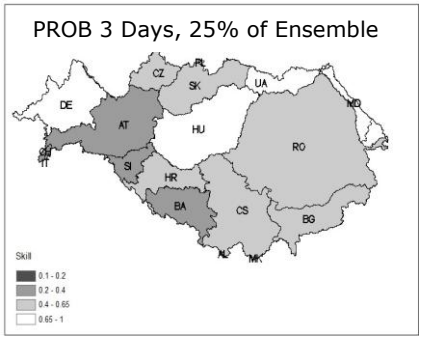
Scenario2 Perfect forecasts (Skill=100%)

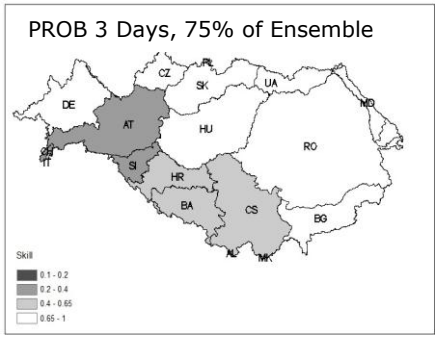
Scenario3 ECMWF Deterministic forecasts (One model , skill ≠100%)

Scenario4 ECMWF Probabilistic forecasts (51-member ensemble ,skill ≠100%)







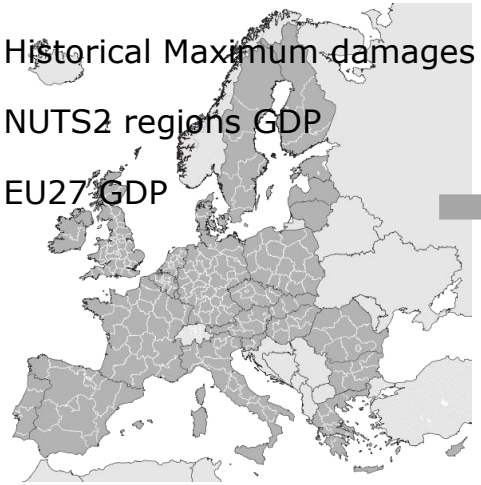


Higher skill for short lead times

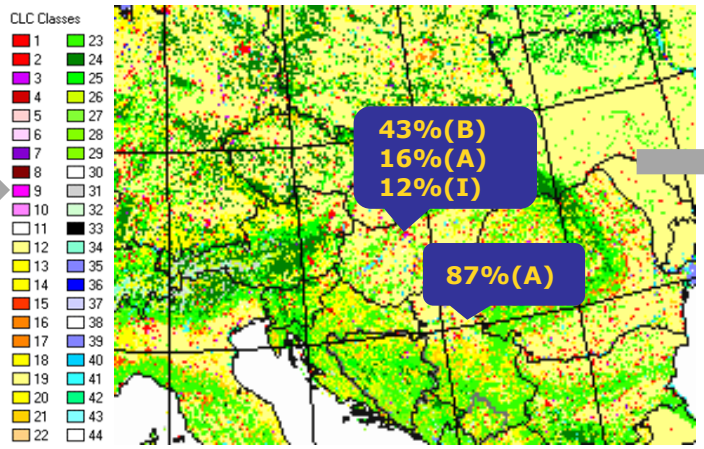
Higher skill for larger threshold

Economic estimates

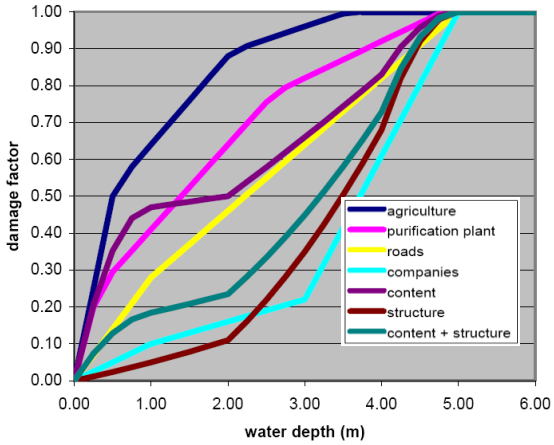
- People KULTURisk (Direct intangible, Indirect tangible, Indirect intangible costs)
- Buildings Huizinga (2007), Direct tangible
- Infrastructure Huizinga (2007), Direct tangible
- Agriculture Huizinga (2007), Direct tangible



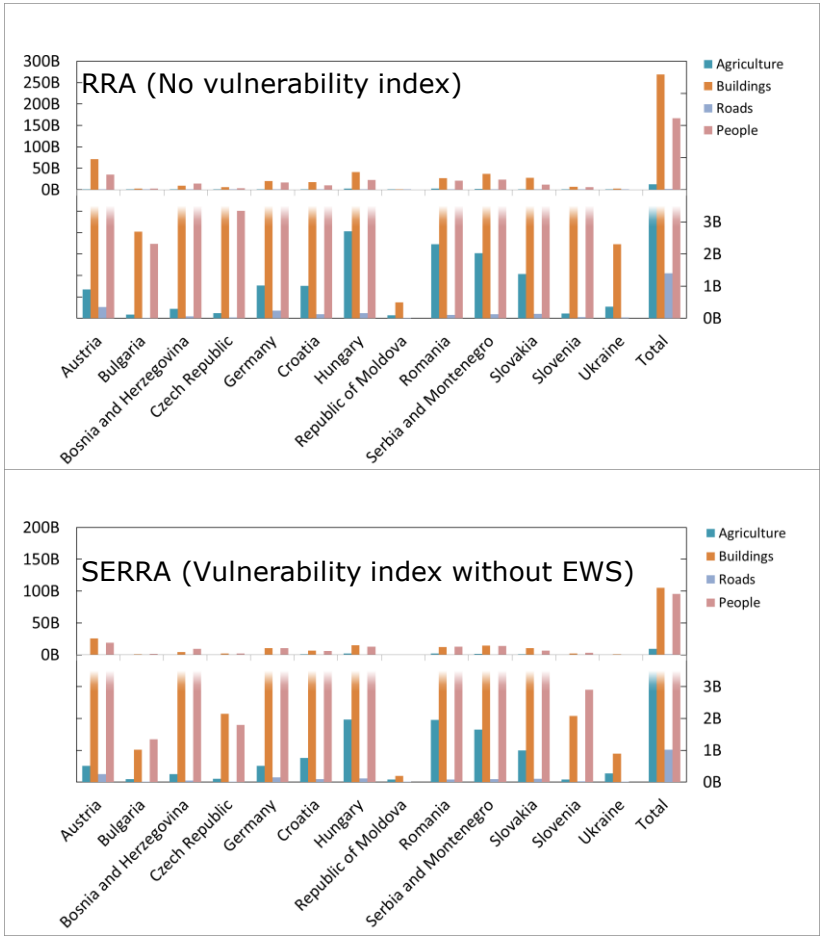
Huizinga (2007)



CORINE Land Cover



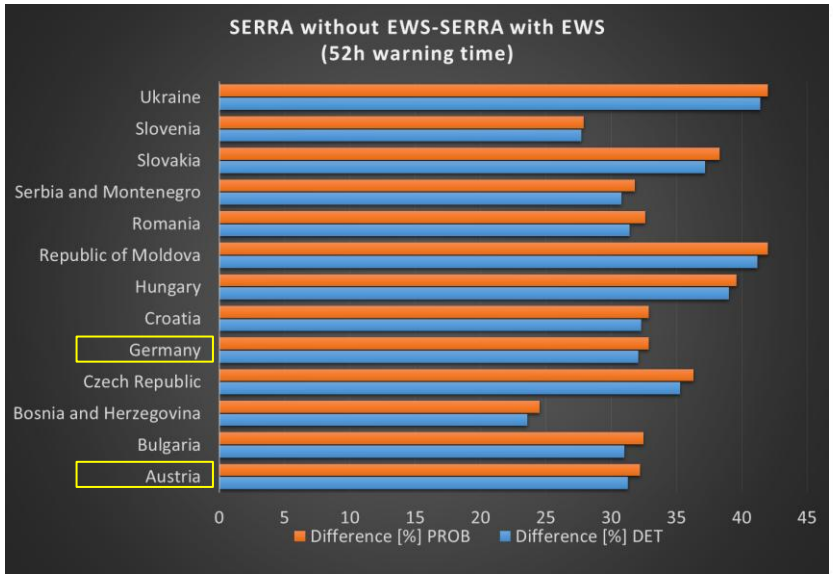
Economic costs

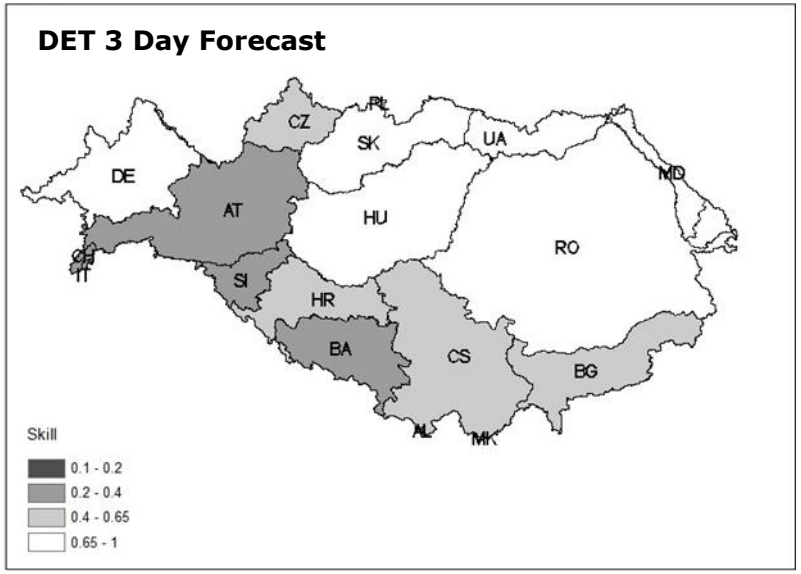


- Regional differences with some countries showing high risk across various receptors e.g. Austria, Hungary
- Number of people injuries appeared unusual hence high costs-DEFRA approach
- Importance of social economic indicators
  - Buildings costs ↓50%
  - People costs ↓35%
  - Roads costs ↓20%
  - Agriculture costs ↓15%

Economic costs with Early Warning System

- SERRA with EFAS
- Longer lead times do not produce significant additional reductions
- Differences between deterministic and probabilistic forecasting scenario costs were low
- Adaptive and coping capacities can compensate a worse EWS performance





Summary

- KULTURisk methodology can be applied but is data intensive
- Weighting introduces uncertainties
- Number of people injuries appeared unusual
- Importance of accounting for adaptive and coping capacities
- Early warning system benefits partially diminished by other factors
- Differences in loss reduction between the deterministic and probabilistic forecasting scenario were low – costs for false alarms and misses are not explicit
- Uncertainties not explicitly accounted for