

Unit 15:

Flood Risk Management in the Short and Long Term and at Different Spatial Scales

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Structure of the presentation

- Objectives and background
- European water policies
 - EU flood risk directive (2007)
- Flood risk methodology in a changing environment
- Case studies from Austria at different scales
 - National, provincial, community level
- Summary and conclusions

Objectives

- How to estimate flood risk in the future? (flood risk in a changing environment ?)
- How to avoid emerging flood risk ?

Introduction : flood damages in Europe

- Between 1998-2010 more than 130 major floods occurred in Europe
- More than 800 fatalities
- Insured economic losses 25 billion €
- Flood 2002 (central Europe) caused 43 victims and 15-16 billion € damages
- 2021: > 220 victims, 22×10^9 € (Germany+ Belgium)
- Several other countries were also hit

Introduction: major drivers

- Flood frequency is changing
- Spatial distribution of population is changing
- Land use and spatial distribution of properties is changing

EU Flood Risk Directive

- In 2007 the flood risk directive (Directive 2007/60/EC) passed the EU parliament and it became effective in Austria in 2011
- It states that human activities and climate change contribute to an increase in the likelihood and adverse impacts of flood events.
- Directive established a framework in the field of water policy at **the catchment scale** and emphasizes a **precautionary approach**
- What is missing in the directive ?
 - Integration of groundwater
 - Consideration of sediments

The objectives of the FRD

- Reduce existing risks and avoid emerging new risks
 - Dynamic aspect considering changes in land use and climate
 - Updating procedure
- reduction of the adverse consequences from floods
 - for human health
 - the environment
 - cultural heritage and
 - economic activity associated with floods.

Tasks

- To achieve the objectives a basin wide framework for the assessment and management of flood risks based on
 - flood hazard maps
 - risk maps and
 - flood risk management planshas to be developed
- ‘flood risk’ means the combination of the probability of a flood event and of the potential adverse consequences

The EU-FRD schedule

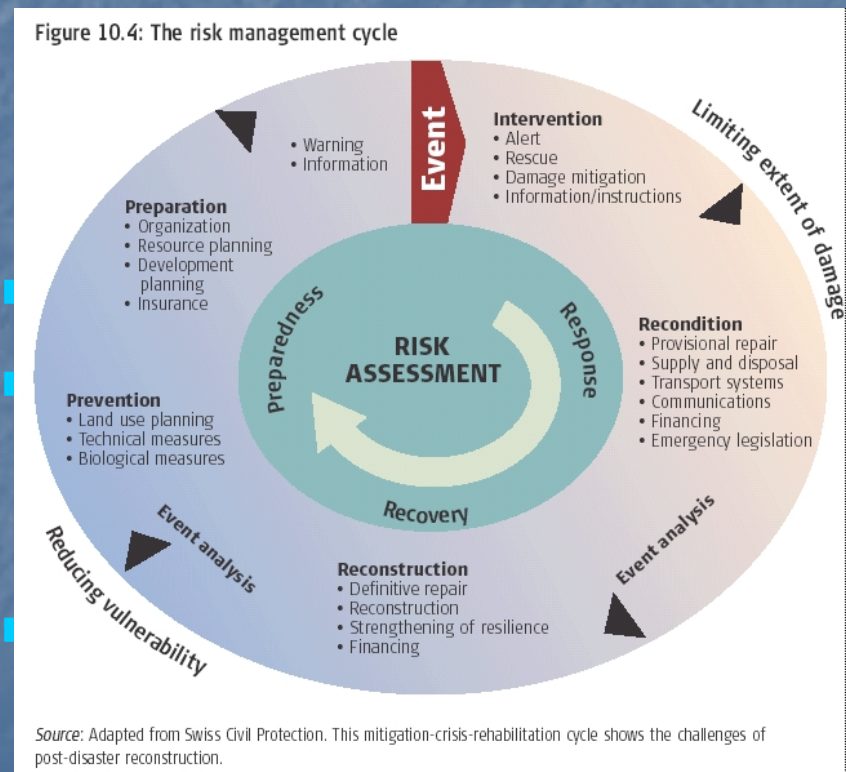


Flood risk management plans

- shall address all aspects of flood risk management focusing on
 - prevention, protection, preparedness,
 - including flood forecasts and early warning systems
- may also include the controlled flooding of certain areas
- Non-structural measures are emphasized
- plans established in one member state shall not include measures which significantly increase flood risks somewhere else
- plans were completed and published by December 2015
- Next updating round has started

Flood risk management plans

- shall address all aspects of flood risk management



preparedness,
and early warning systems
led flooding of certain areas
ember state shall not include
y increase flood risks

ublished by 22 December

Public participation

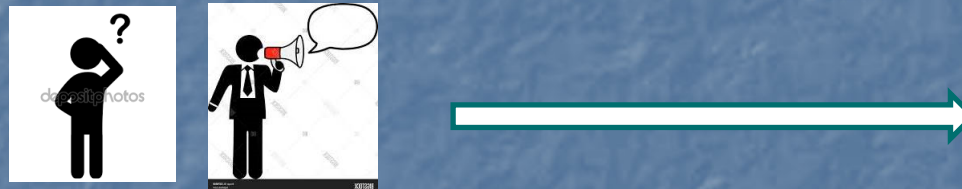
- make plans available to the public:
 - the preliminary flood risk assessment,
 - the flood hazard maps,
 - the flood risk maps and
 - the flood risk management plans.
- Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans
- All the plans/maps have to be updated each 6 years to consider dynamic development

Data base today

- Hazard maps show inundated areas for different flood probabilities (water depth, flow velocity)
- Flood risk maps show land use, number of endangered people, endangered objects and type of objects, sensible infra-structure
- Flood risk management plans (measures and benefits)
- Plans shall address all aspects of flood risk management focusing on
 - prevention, protection, preparedness,
 - including flood forecasts and early warning systems

A methodology to look ahead: How to identify and assess emerging risks ?

- Directive 2007/60/EC requires repeated preparation of flood risk maps recognising the dynamic aspects in flood risk
- But still, mostly we look back when taking decisions for the future

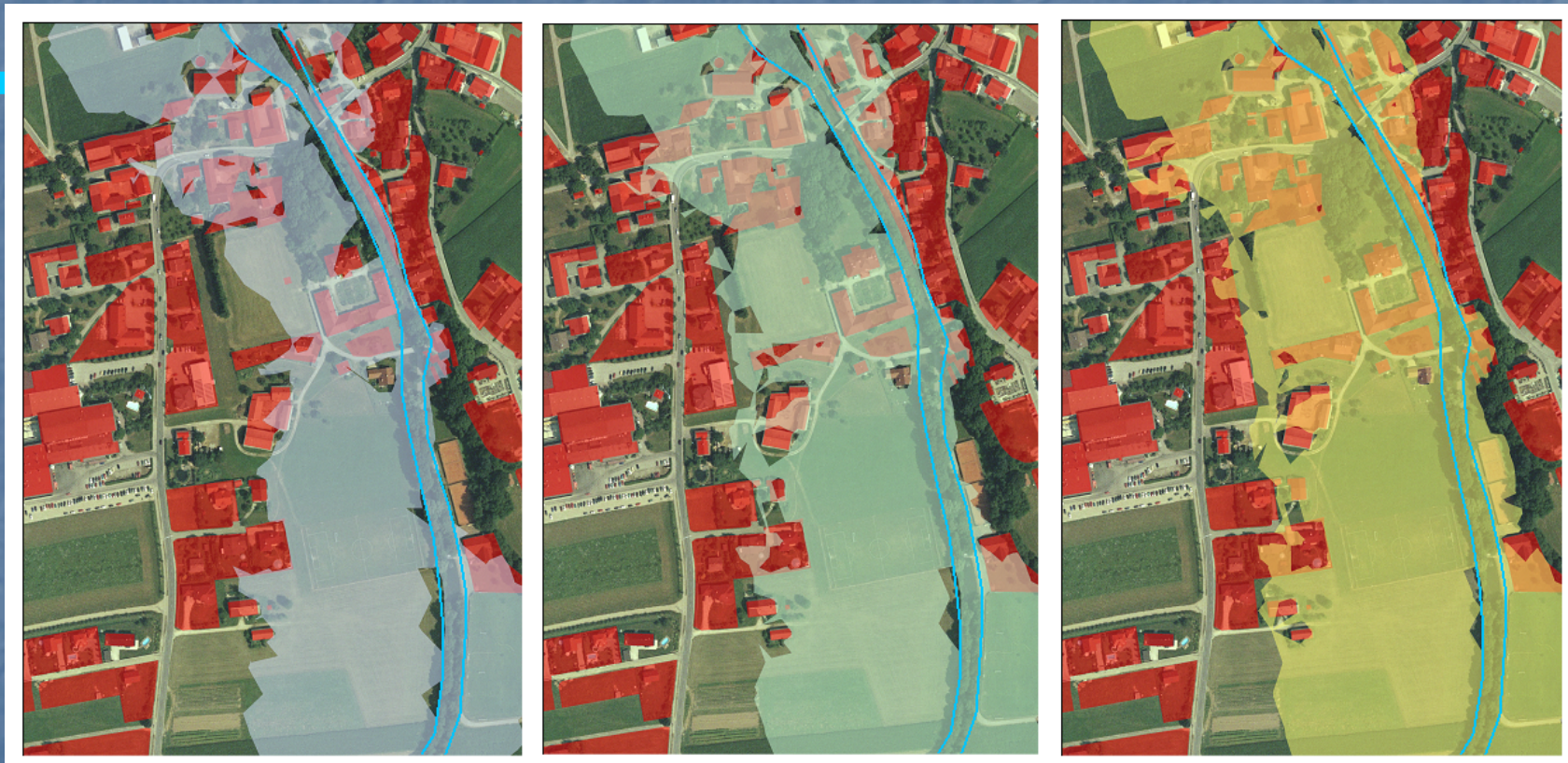


Whats about using scenarios ?

- Assess recent damage potential for different flood events
- Assess trends in population density
- Assess future damage potential according to regional development plans for the same flood events
- Assess the sensitivity of the damage potential with respect to magnitude of the flood

Inundation maps

Today:

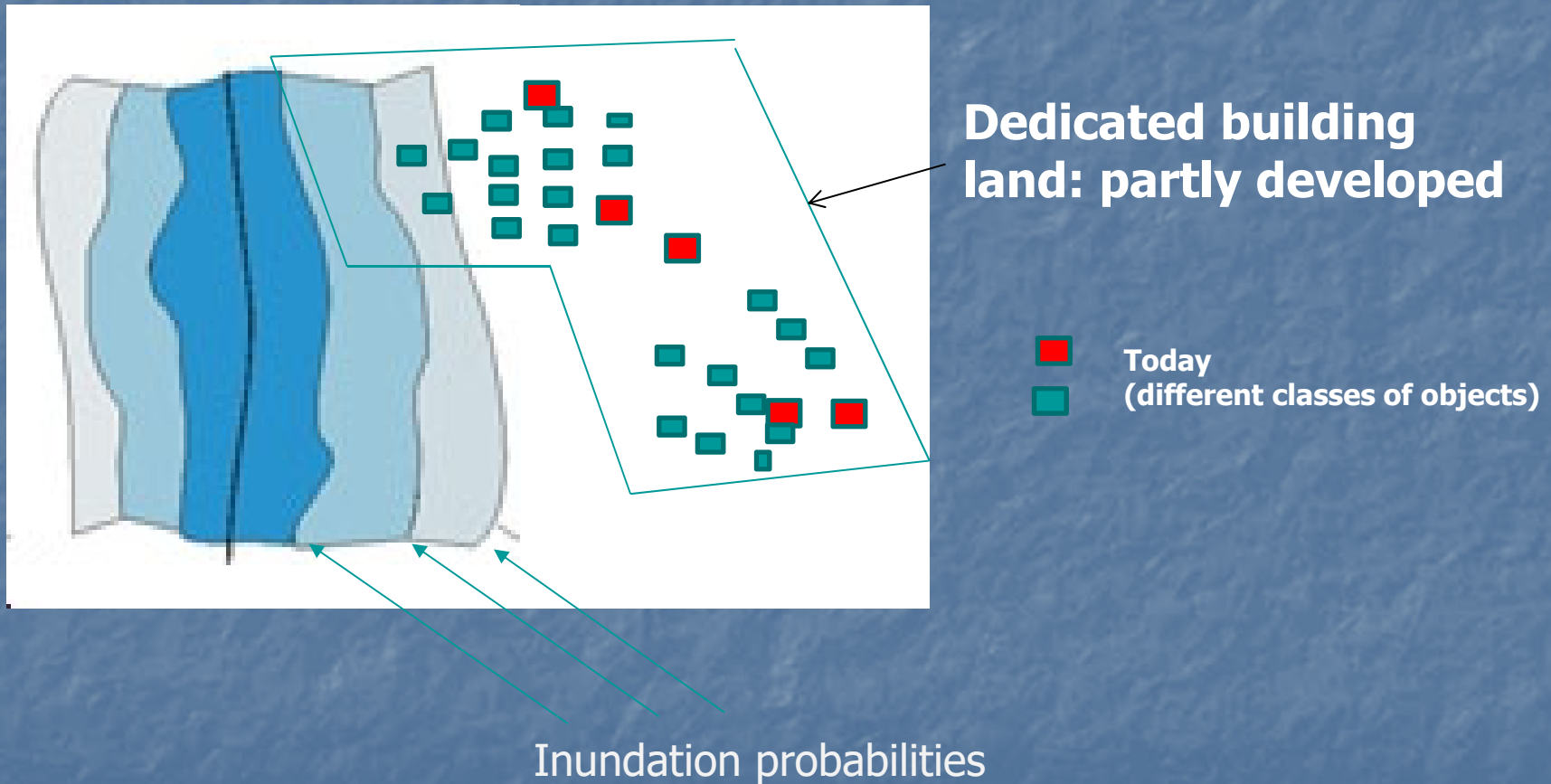


HQ30

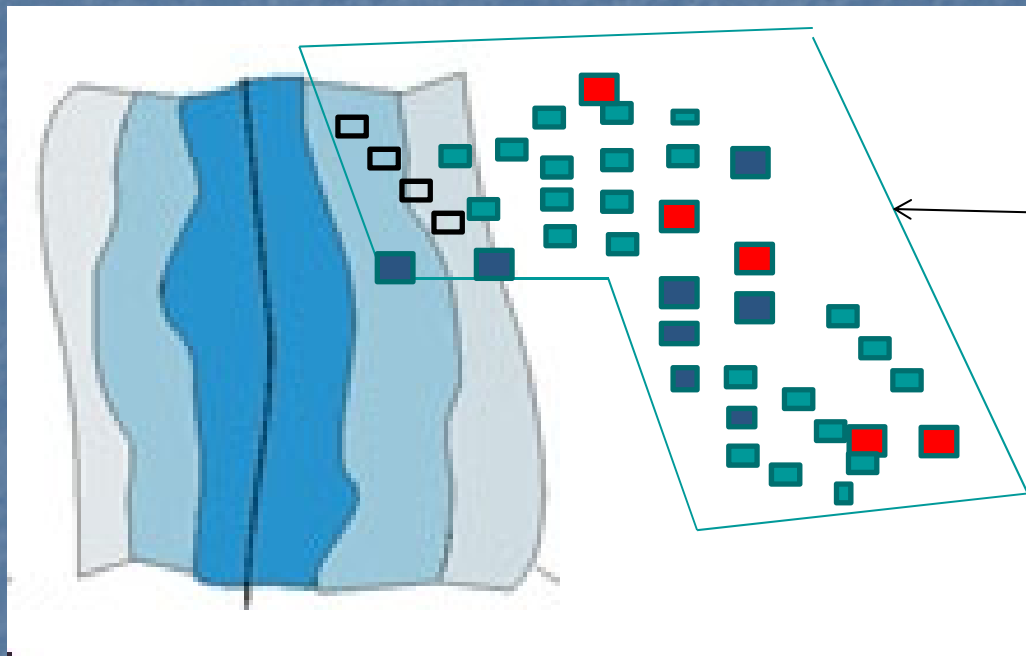
HQ 100

HQ 300

Emerging flood risk: recent situation



Emerging flood risk: future situation



**Dedicated building
land: partly developed**

- Today
- (different classes of objects)
- New
- (different classes of objects)

Situation 2030 due to increase of population

We don't know where new buildings will be developed but we assume that $x\%$ increase in population results in $x\%$ increase of damage

Emerging flood risk: future situation



ΔQ climate change (different return periods)
Situation 2030 and climate change

Development of a methodology to assess recent and potential future flood risk

- Recent flood risk assessment is based on the FRD guidelines and available maps
- Future flood risk is based on changes in flood frequency (climate change)
- Future damages are based on demographic changes
- Future exposure is based on local to regional land development plans

Risk assessment at different scales: case studies from Austria

- The land development plans are (mostly) available at the community level
- Climate change are dependent on the catchments (N or S of the Alps)
- Some examples
 - National
 - Regional
 - Local level

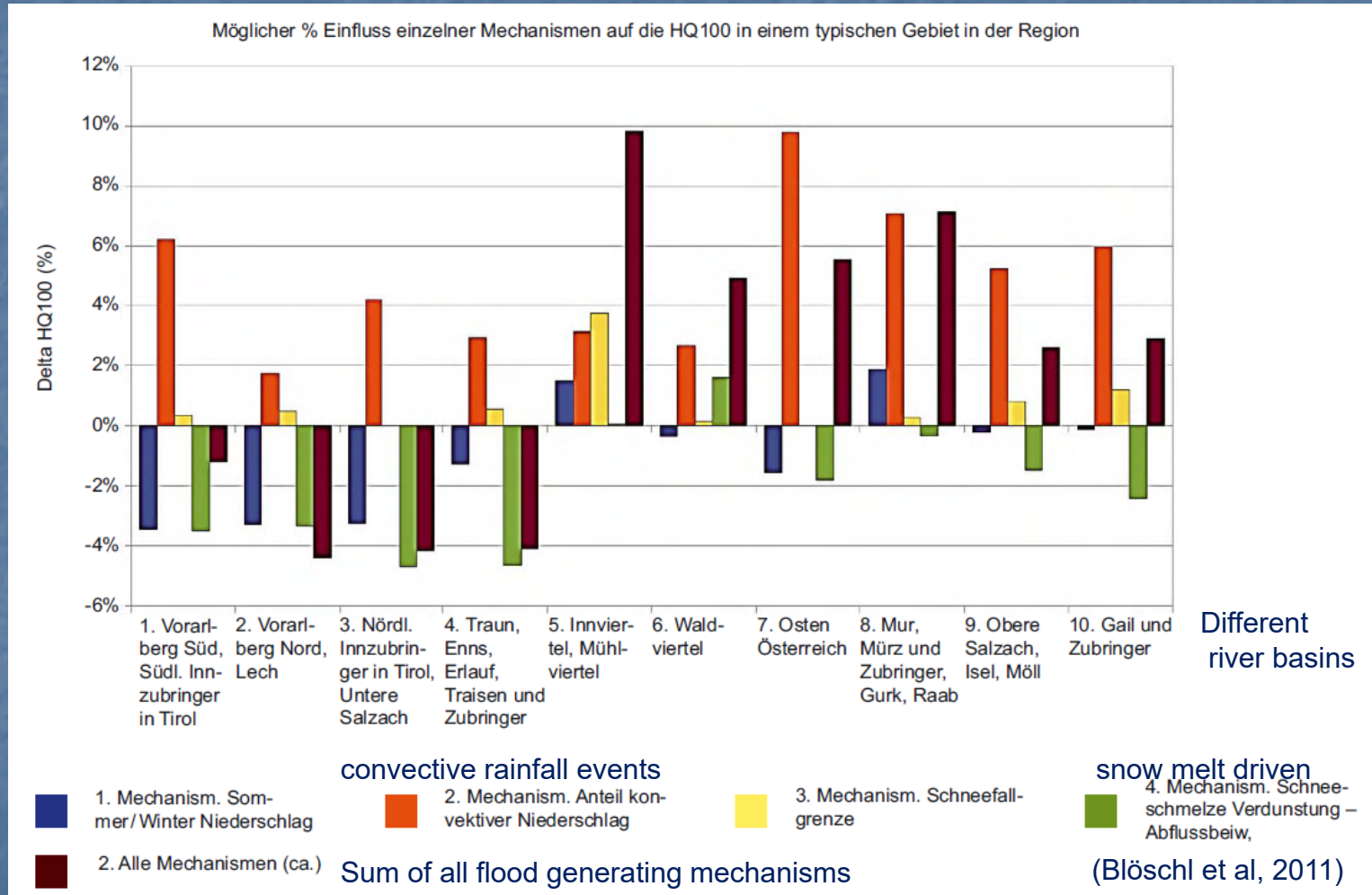
Expected changes in flood frequency

- Floods in alpine regions are triggered by different mechanisms
- Therefore, it depends on the catchments which process dominates
- Large uncertainty in quantitative assessment

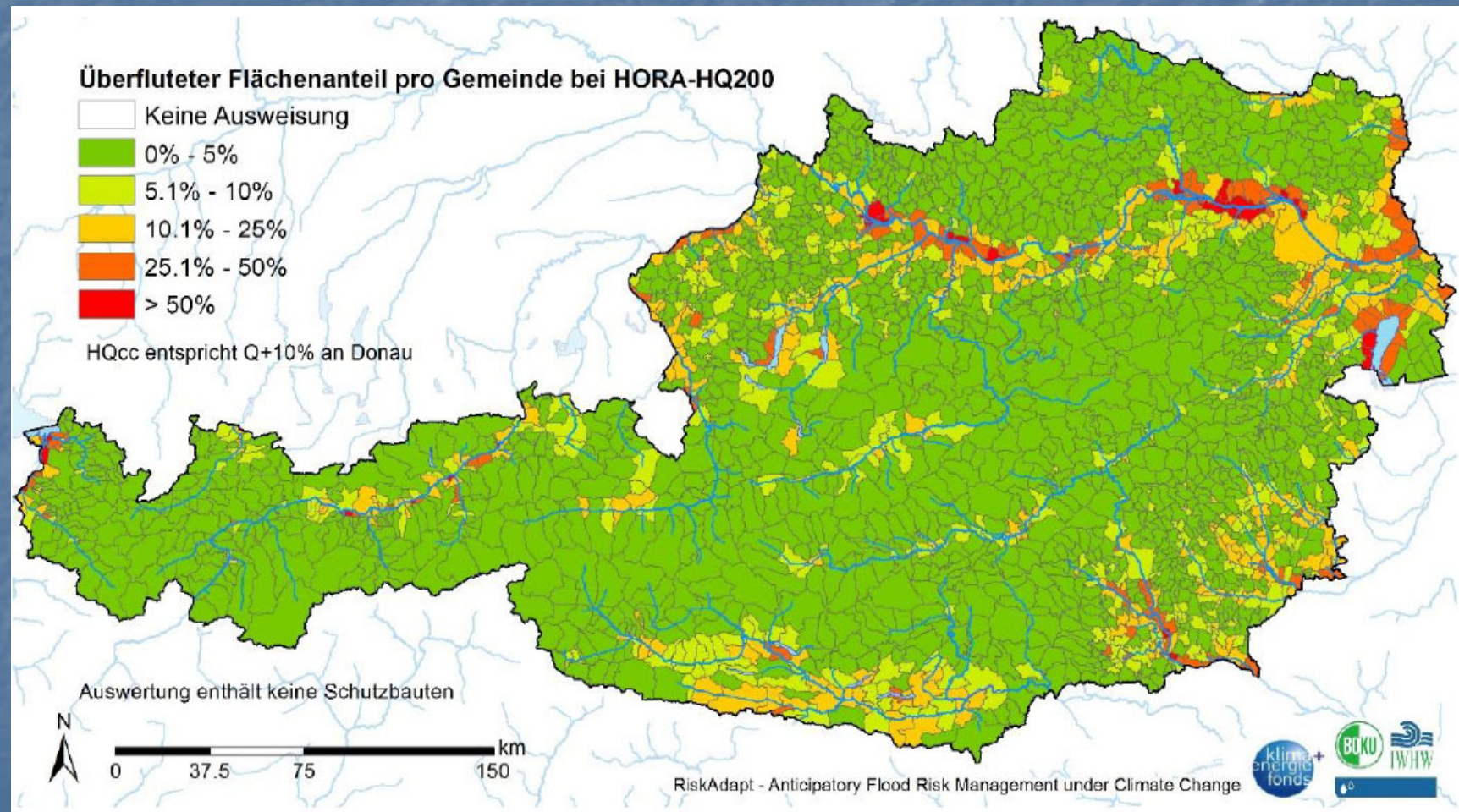


- A sensitivity analysis is applied (what happens if a flood event changes in xx % compared to recent data)

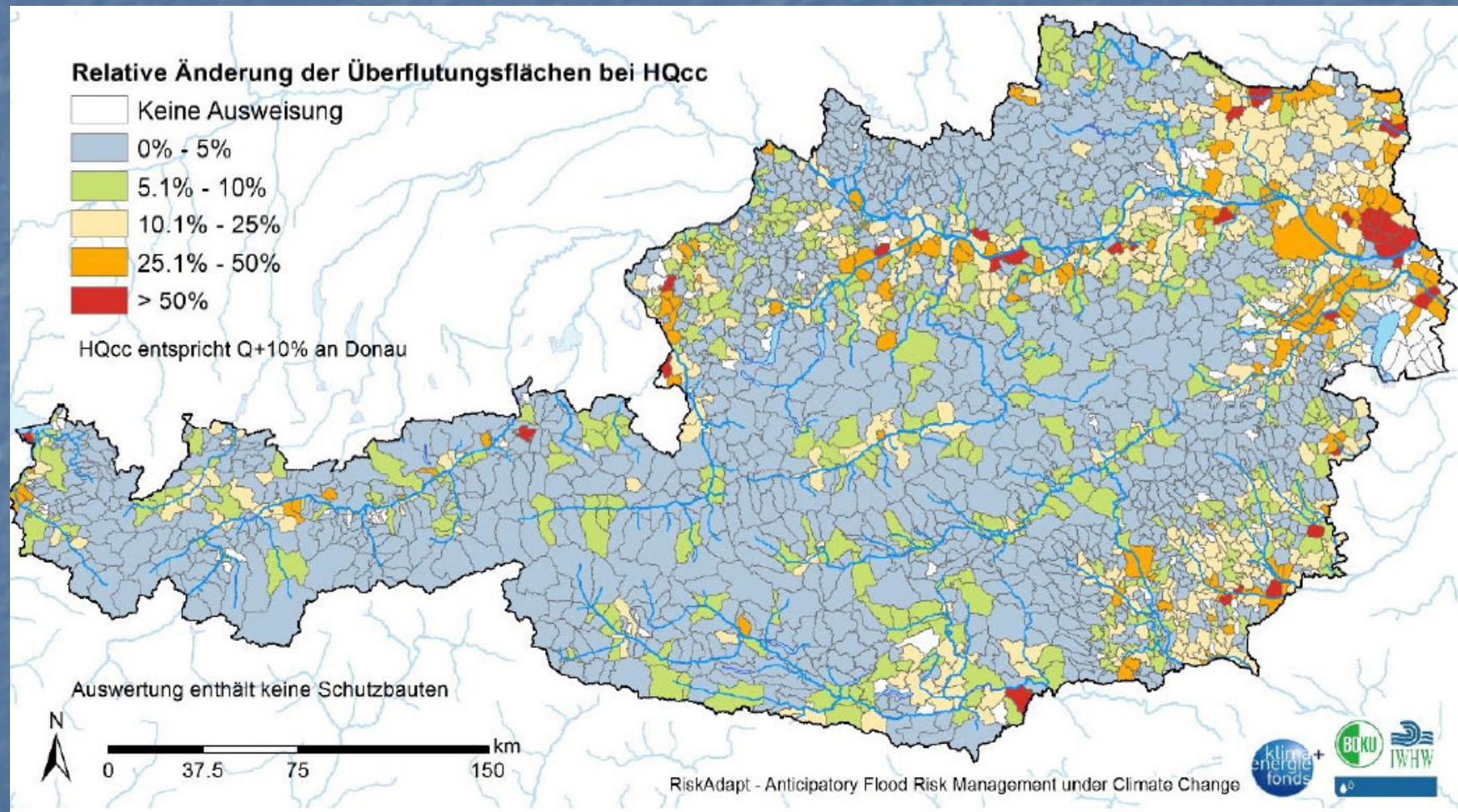
National level: Changes in a HQ100 flood events



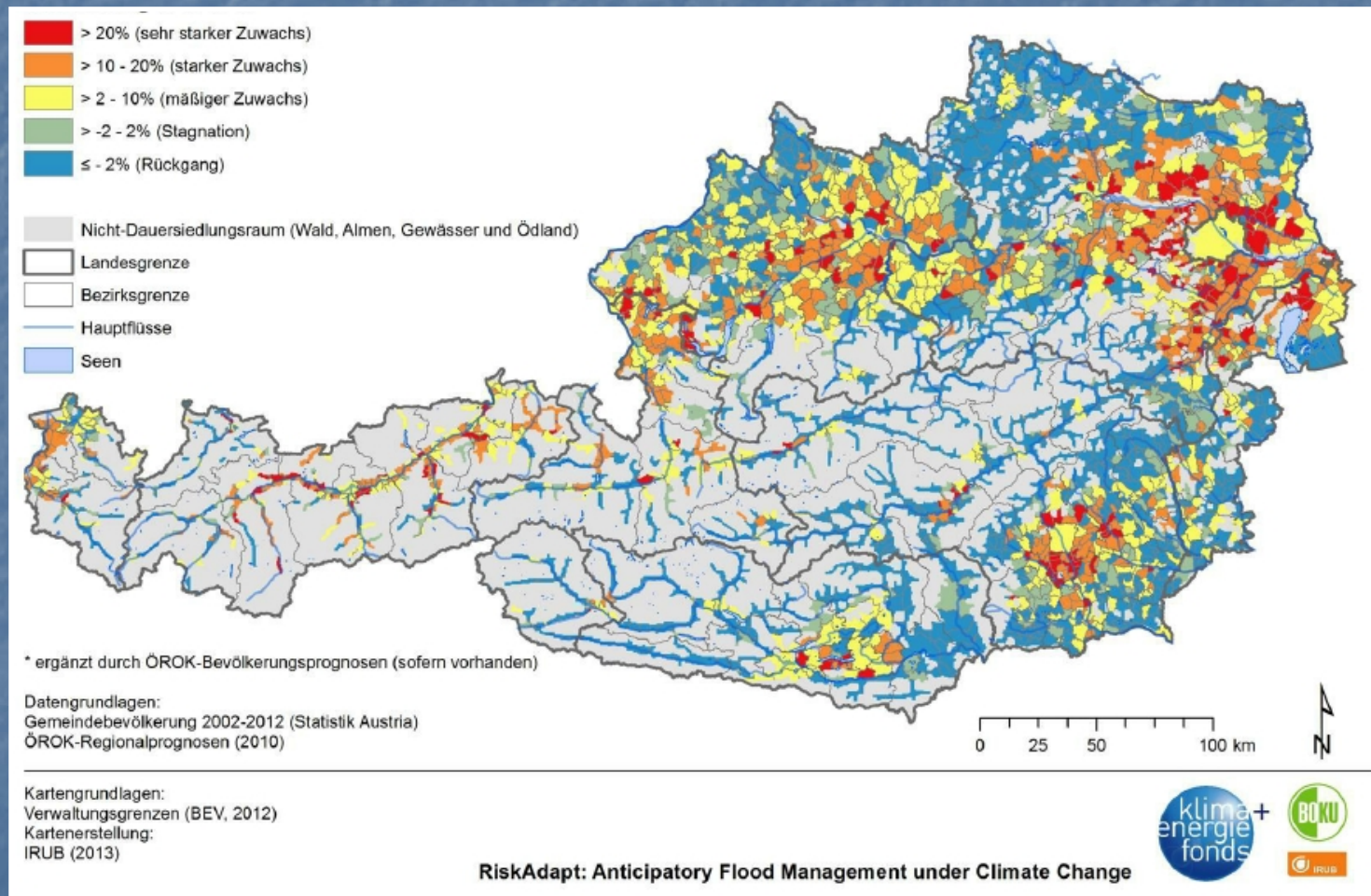
Inundated area at the lowest administrative level



Relative changes in the inundated area due to climate change



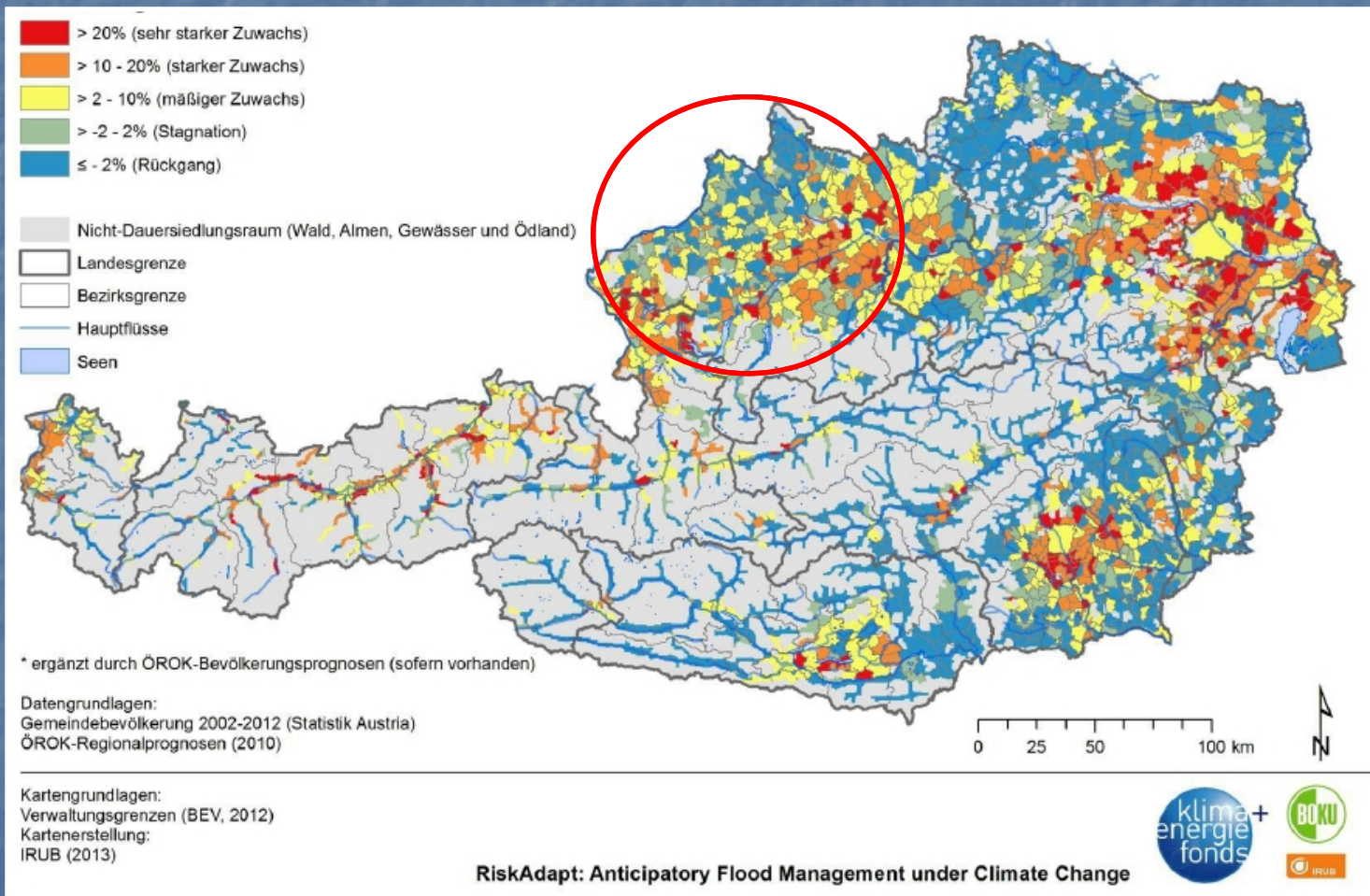
National level: Demographic changes until 2030



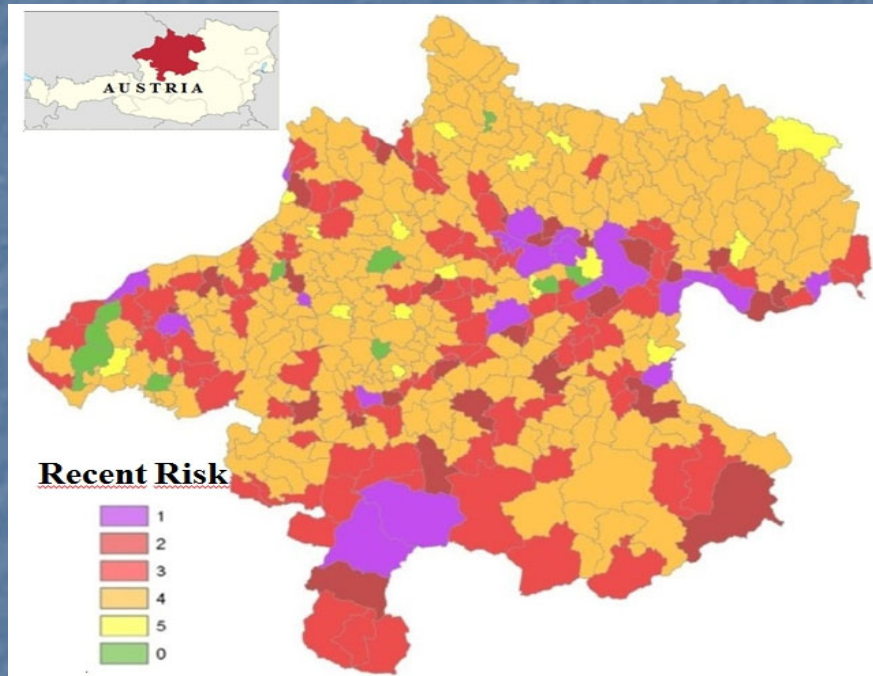
Demographic change (increase) causes

- Increase in residential area
- Increase in infra-structure (energy supply, water supply, production sector, communication, transport sector,...)
- At community level a land development plan is available
- These plans can be compared with inundation areas (without and with climate change)
- Result: recent situation, climate impacts, demographic changes, climate + demographic changes
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Regional analysis: Demographic changes until 2030



Regional level: Recent qualitative flood risk

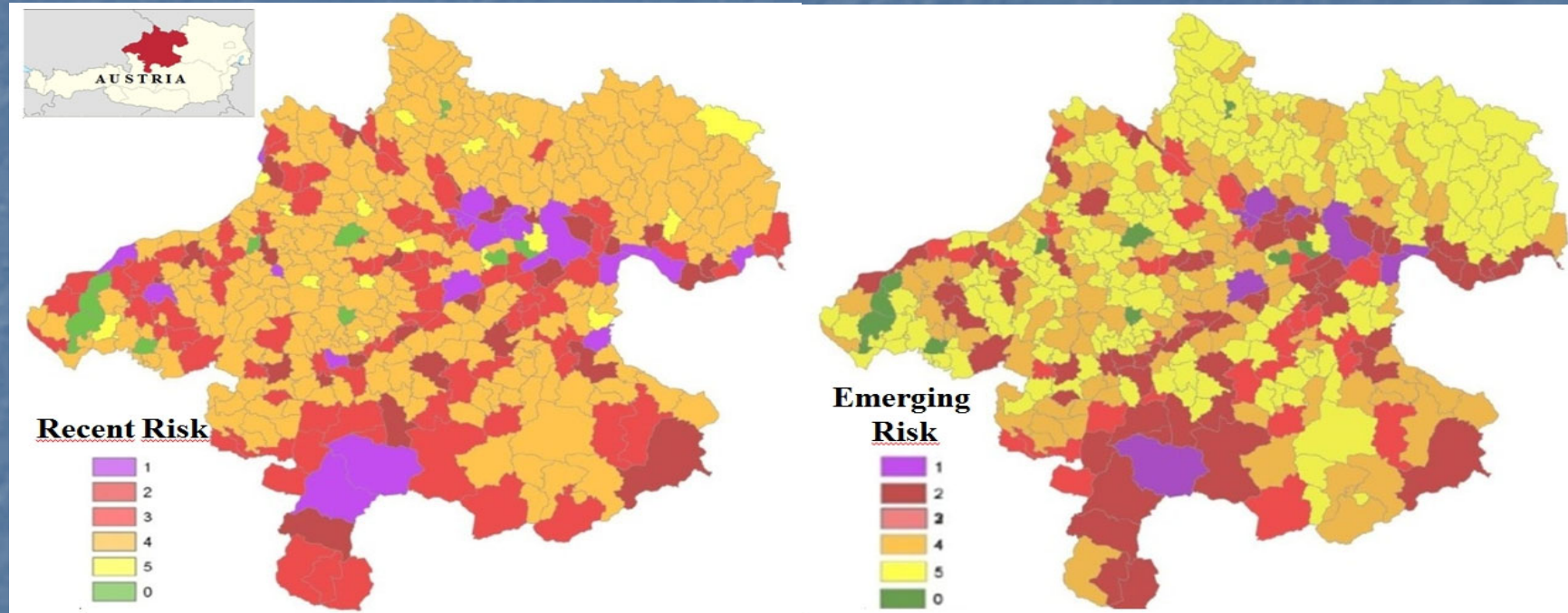


Very High ←————→ Very Low

Category1	Category 2	Category 3	Category 4	Category 5
>100 000 m ²	>50 000 m ²	>10 000m ²	>1000 m ²	nothing

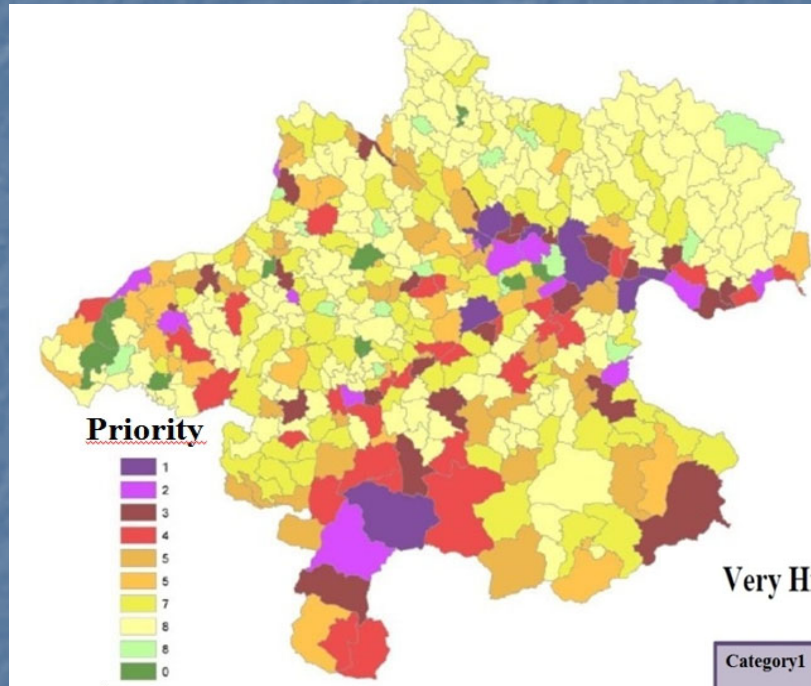
Recent Risk
(area of buildings in the flood plain)

Regional level: Changes in the damage potential (demography)



- Recent and emerging risks can be identified

Regional level: Combining recent risk with emerging risk



Hot spots:
already today high risk that
will additionally increase in the
future

Very High ← → Very Low

Category1 >100 000 m2	Category 2 >50 000 m2	Category 3 >10 000m2	Category 4 >1000 m2	Category 5 nothing
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Category 1 >500 000m2	Category 2 >100 000 m2	Category 3 >50 000 m2	Category 4 > 10 000 m2	Category 5 <1000 m2
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1	2	3	4	5	6	7	8	9
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Recent Risk
(area of buildings in the flood plain)

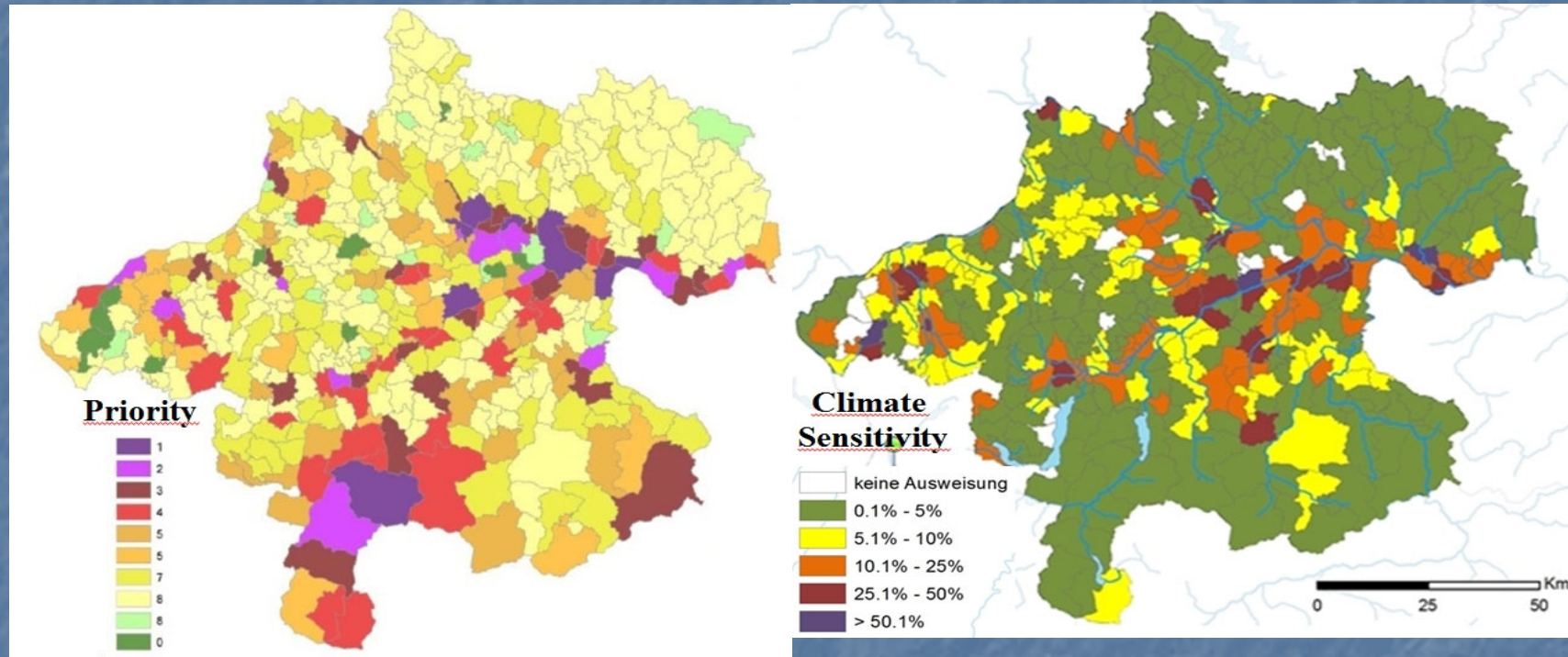


Emerging Risk
(undeveloped building area in the flood plain)

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Priority

Regional level: Climate change driven flood risk



- Identification of areas sensitive to climate change and regional development

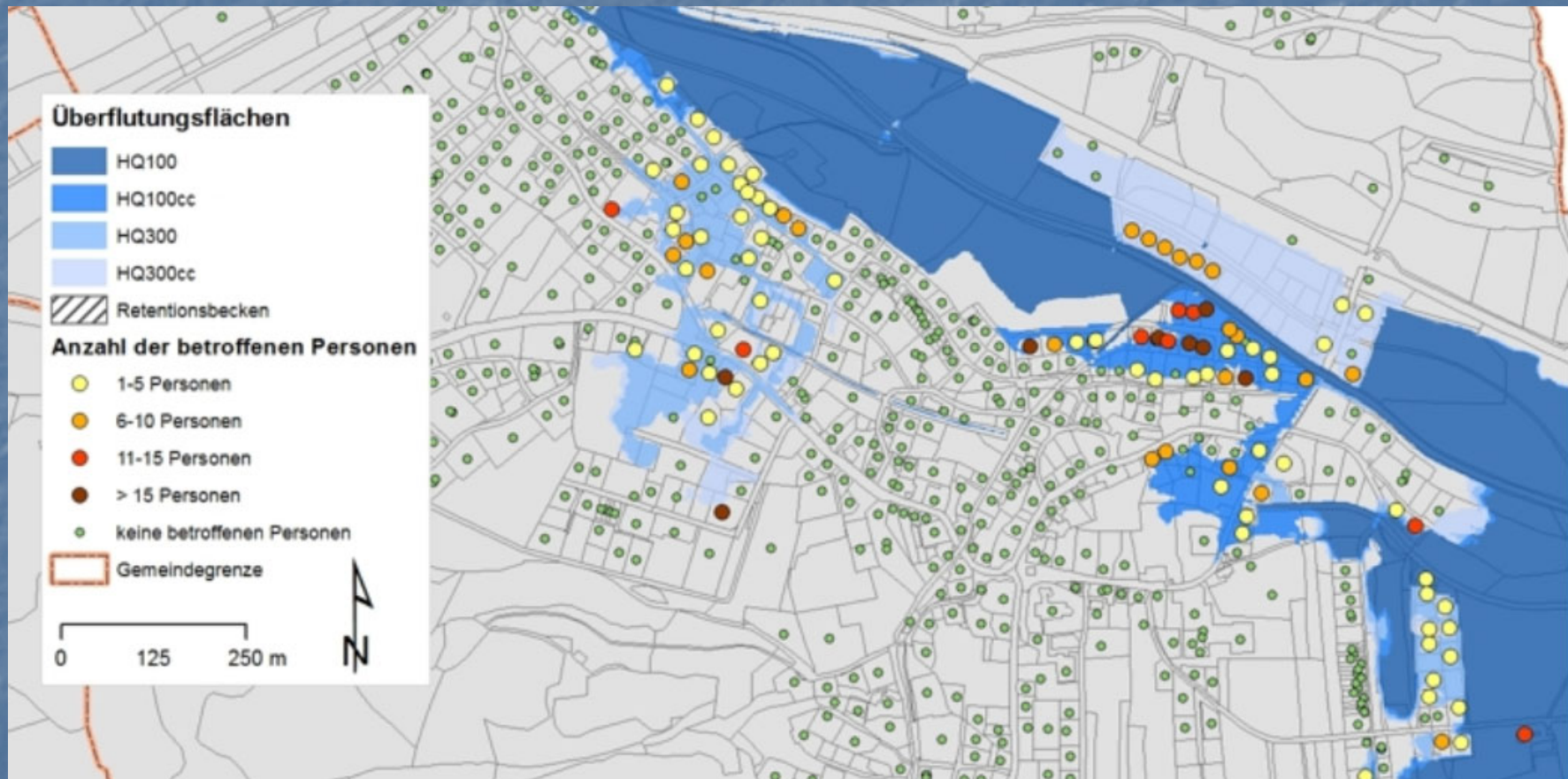
Regional level: summary and conclusions

- Considering land development plans, demographic changes and climate change scenarios it is possible to identify
 - Areas of existing risk
 - Hot spots
 - Areas of emerging risk

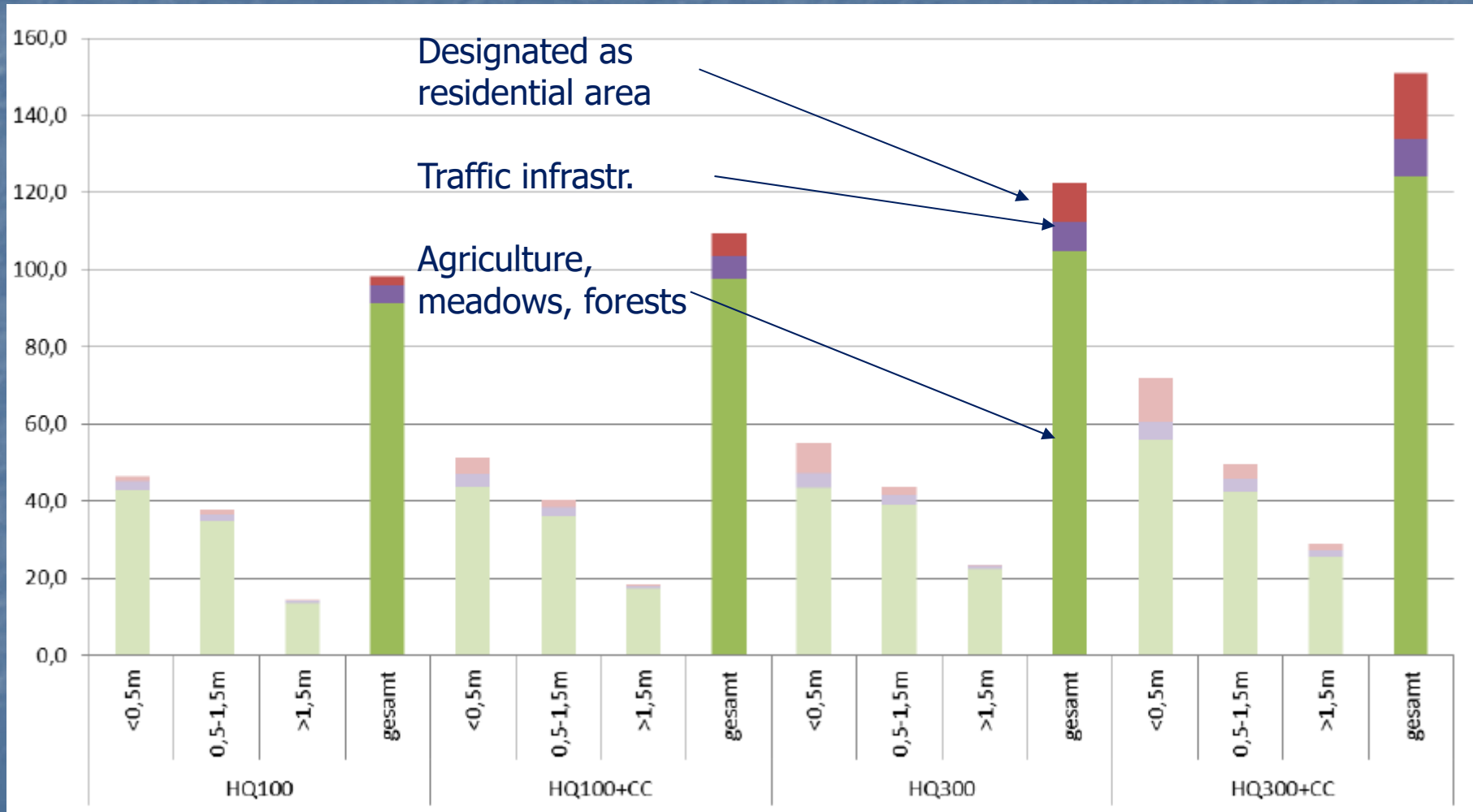
Local level:

- a community is protected against a HQ100
- Today 7% of residential area are exposed to a HQ100 event
- Under climate change a HQ300+cc would endanger about 18 %

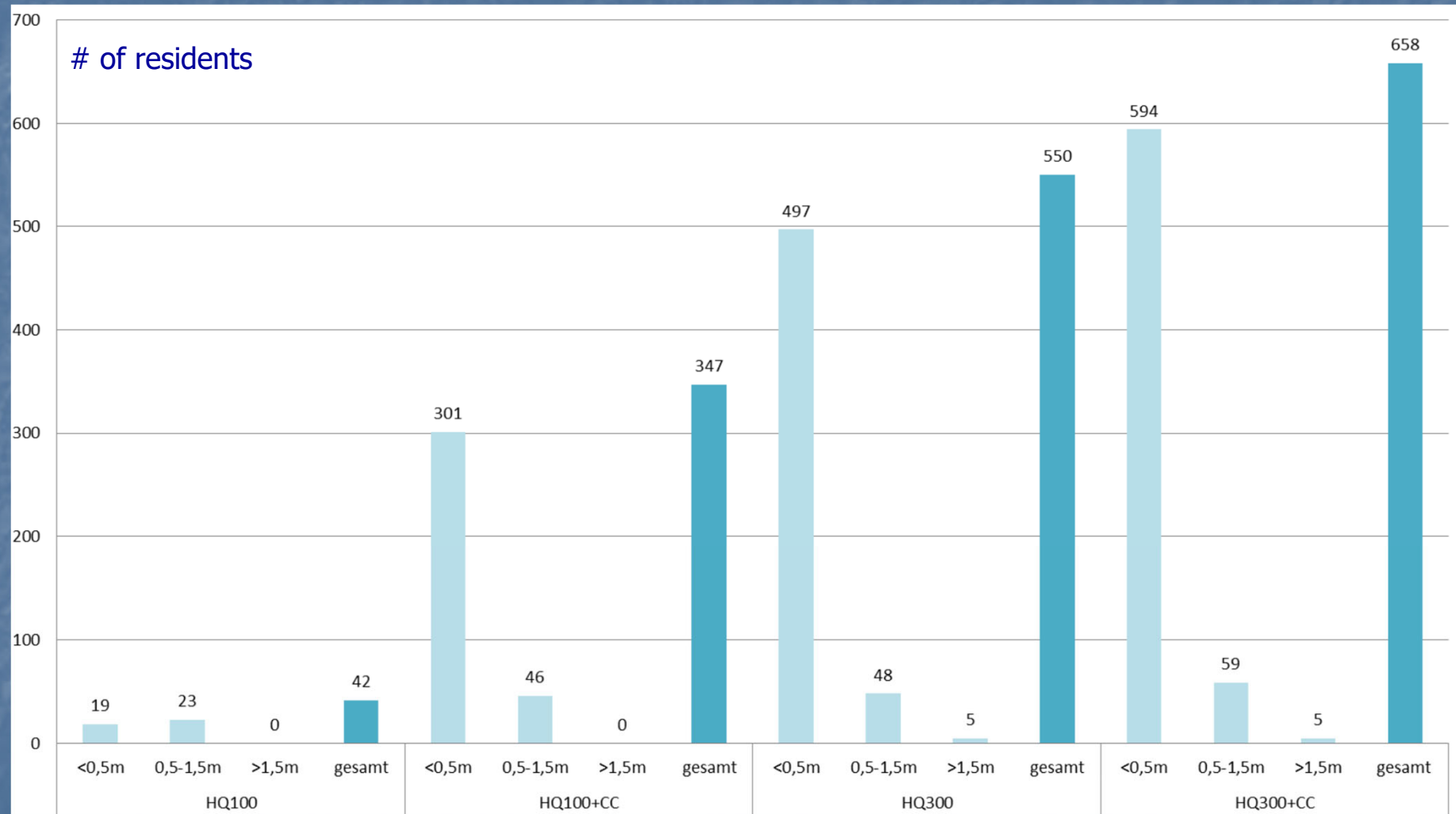
Local level: impacts on objects and # of residents



Local level: impacts of floods on different land uses



Local level: impacts of floods on population



Local level: summary and conclusions

- The already existing flood protection level for a HQ100 flood works well up to this level
- Any exceedance would lead to substantial risks
- An increase in population would result in utilisation of all designated residential areas and thus higher risks
- An increase in flood peaks would results would result in substantial increase of flood risks

Overall summary and conclusions

- The EU-FRD recognizes emphasizes to reduce existing flood risk and to avoid the emergency of new risks
- This concept provides the framework for risk assessment and management in a dynamic environment
- Essential points are
 - Involvement of the public at all levels
 - A basin wide approach
 - A clear ranking of the impacts

Overall summary and conclusions

- A methodology has been presented to assess flood risk at different spatial scales
- Sensitivity assessment of risk is essential
- Demographic data and forecasts are reliable
- Community development plans for land use and the designation of areas for specific uses are often in conflict with potential risks

Thank you very much for your attention

Most of the material has been taken from
The ARCP report on: Anticipatory Flood Risk Management under
Climate Change Scenarios: From Assessment to Adaptation
(RiskAdapt, Hogg K. et al.)

Questions !!!!!!!

Overview of flood risk management perspectives

Options for Risk Mitigation

- Possible decisions refer to

$$R(X^*) = \int_{X^*}^{\infty} f(Q) \cdot D(Q) dQ$$



Reducing damage potential

Actions A_i to control $D(Q)$:

- Revise building codes
- Harmonisation of risk maps with local/ regional development
- Early warning systems
- Raising awareness about risk exposure
- Avoid secondary damages
- Resettling people outside the flood plain (buying land..)
- Reduction of the uncertainty in $D(Q,t)$

Options for Risk Mitigation

- Possible decisions refer to

$$R(X^*) = \int_{X^*}^{\infty} f(Q) \cdot D(Q) dQ$$

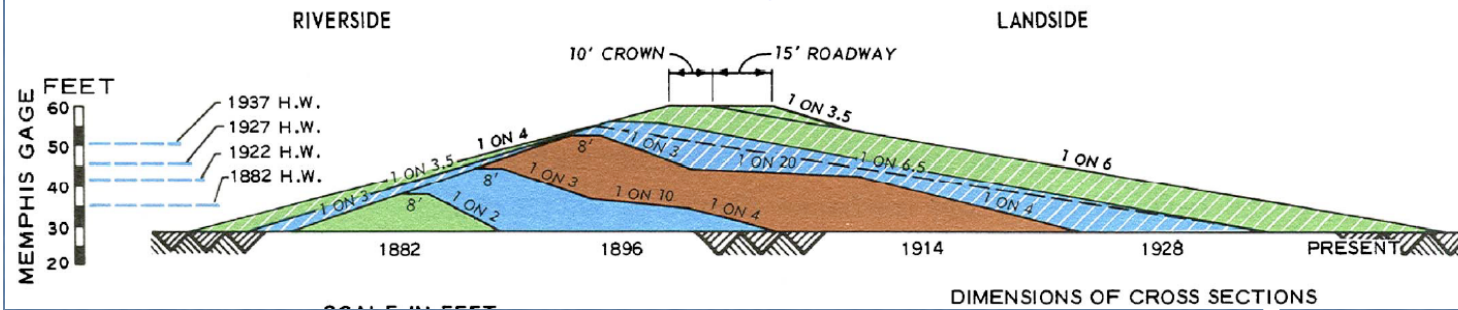


Changing pdf

Actions A_i to control $f(Q)$:

- Increase natural retention capacity
- Consider surface and groundwater systems
- Reduction of the uncertainty in $f(Q)$
- Consideration of human interventions
- Consideration of sediment transport and discharge

Options for Risk Mitigation

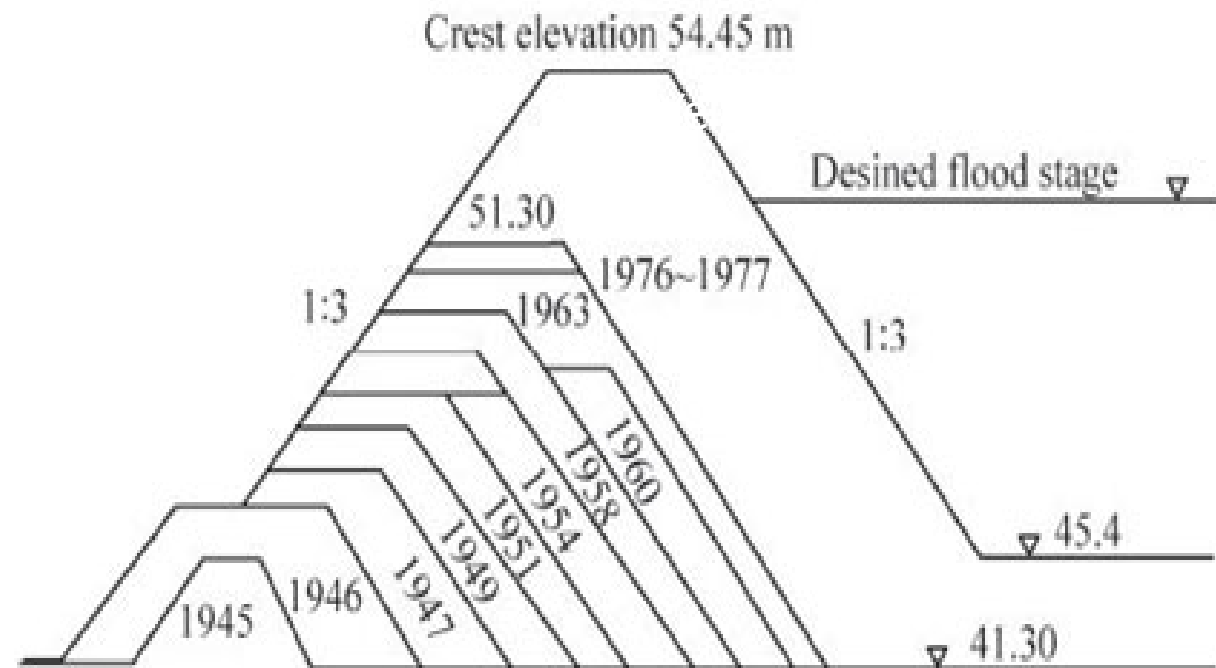


(D., 2008)

$Q)dQ$

Action

•Increase



(2015)

Options for Risk Mitigation

- Possible decisions refer to

$$R(X^*) = \int_{X^*}^{\infty} f(Q) \cdot D(Q) dQ$$



Changing protection level

Act

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Options for Risk Mitigation

- Possible decisions refer to

$$R(X^*) = \int_{X^*}^{\infty} f(Q) \cdot D(Q) dQ$$



Risk transfer

Actions A_i to control $R(X^*)$:

- Insurance system and/or catastrophic funds
- Clear separation of responsibilities among individual and public authorities
- Risk zonation and individual responsibilities

Redefinition of Risk

- Risk:

$$R(X^*, t) = \int_{X^*}^{\infty} f(Q, t) \cdot D(Q, t) \cdot dQ$$

$f(Q, t)$	flood frequency
$D(Q, t)$	damage (losses)
X^*	resistance

- But then we have to trade-off future risk with today's risk (we have to discount the future)