Adaptation of the Meuse to the Impacts of Climate Evolutions

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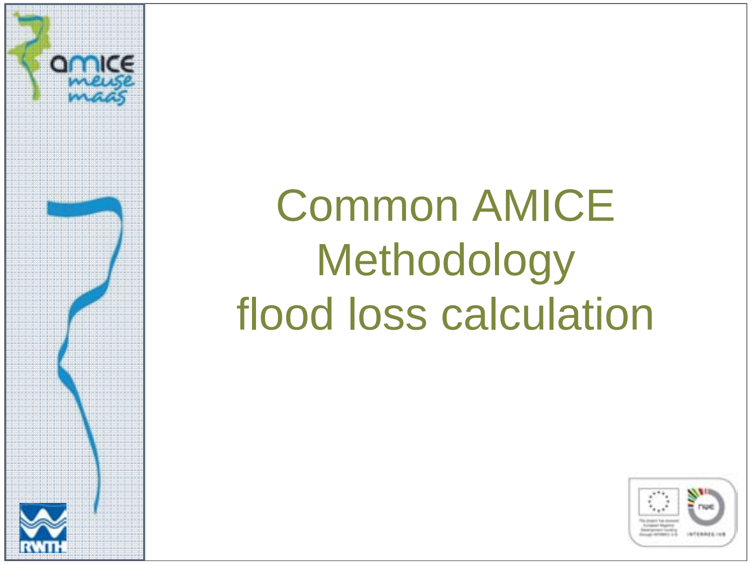
AP7

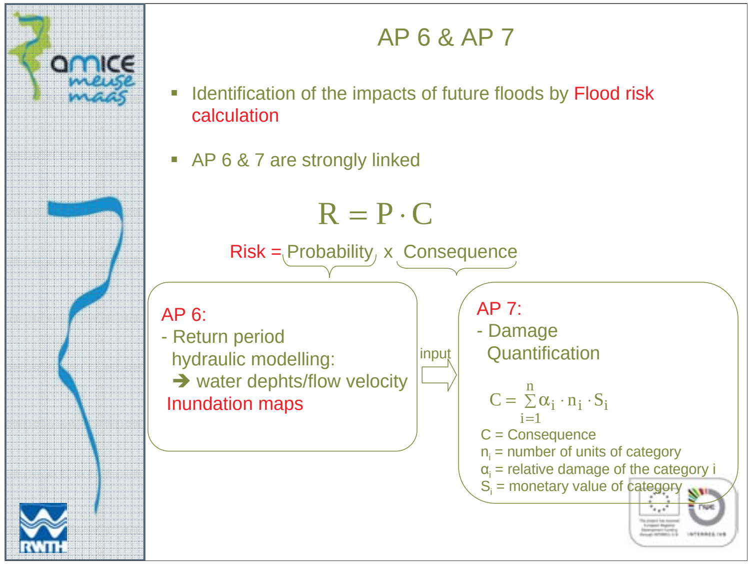
Quantification of the impacts of future floods and low-flows on the economy in the transnational Meuse basin

My name is Benjamin Sinaba, I am from the University of Aachen and I would like to show what we are doing in the framework of Action 7.



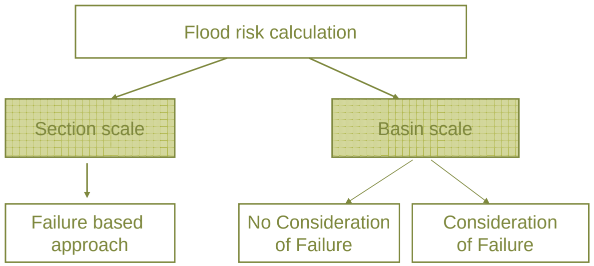
We created a methodology with the help of the other AMICE Partners ofr flood loss calculation.

The identification of impacts will be done by flood risk assessment



After receiving inputs from Action 6, we need to define the damage categories that will be used in our study.

Flood risk calculation approaches



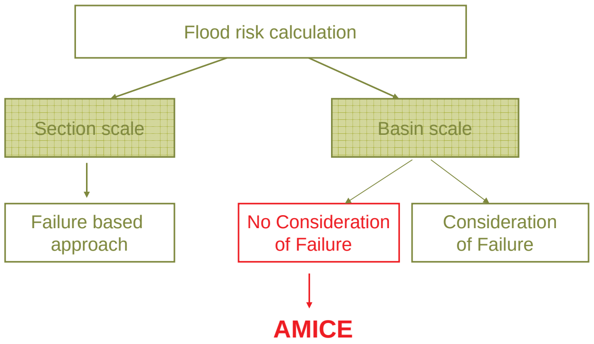
Working at the section scale level is more relevant for studying impacts of the failure of a protective line. The probability of a dike breach is taken into account.

Flood risk calculation approaches

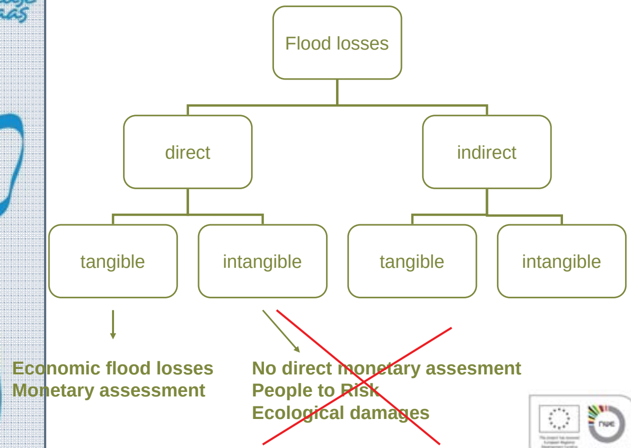
- Failure based approach on section scale:
  Focus on the probability of failure of the floodprotection section (e.g. dike)
  Decoupling of probability analysis and hydodynamic analysis
- No Failure approach basin scale:
  integrated risk consideration basin wide without considering the failure of the flood protection line
- Failure based approach basin scale:
  integrated risk consideration basin wide
  Complex: Monte Carlo based determination of probabilities
- Focus on AMICE is the impact of climate change on the whole meuse basin

➔ No failure approach basin scale sufficient for AMICE purposes

Flood risk calculation approaches



Classification Flood losses



Inventory of national Methodologies

Each country has its own rules and methods for risk assessment

1. How to produce comparable outputs?

➔ **1. Questionnaire on existing Methodologies and used data**

- Monetary- / Qualitative Assessment
- Assessment of direct / indirect flood losses
- Mobile / Immobile flood losses
- National / partially common approach / common approach
- Land use data
- Damage categories considered
- Flood damage functions / hydraulic input variables (t/h/v…)
- Assessment of direct/indirect losses

Inventory of national Methodologies

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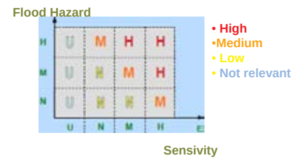


➔ **Monetary Risk Assessment within Amice**

(At least in internal processing)

We will try to calculate the flood damage in a monetary way at first. If some impacts prove to difficult to quantify, we can use a qualitative assessment grid.

Inventory of national Methodologies

1. How to produce comparable outputs?

➔ **1. Questionnaire on existing Methodologies and used data**

- Assessment of direct/indirect losses ?????

Direct flood losses:
by inundation direct induced damages.
direct flood losses postulate direct contact with water, e.g. buildings, inventory, traffic areas and agricultural areas

Types of economic damages

- **Indirect flood losses:**
  indirect damages are not generated by direct contact with water. indirect damages are caused by interruption of economic activities. e.g.
  1. Immediate asset value losses; a short term consequence of inundation of business e.g. loss of production, disruption of economic activities
  2. Induced asset value losses; affected companies are suppliers of not affected companies (chain reaction)
  3. Prosperity damages, a long term consequence in a flood affected area due to lost of confidence in safety, absence of tourism, reduction of investments in the affected area

➔ Indirect flood losses are out of scope within AMICE
Risk calculation by direct flood losses

Inventory of national Methodologies

1. How to produce comparable outputs?

➔ **1. Questionnaire on existing Methodologies and used data**

- Direct flood losses **mobile / immobile**
- Immobile flood losses:

  Asset values which can't be removed during flood (fixtures, houses….)
- Mobile flood losses:

  Removable asset values before or during flood (furniture, cars…)

➔ **Both immobile / mobile flood losses considered**

Calculation Procedure

1. How to produce comparable outputs?

➔ **1. Questionnaire on existing Methodologies and used data**

- National / partially common approach / common approach

  All calculating procedures are comparable
  Differences in used data (Land use, considered damage categories,damage functions......)

1. **national / partially common/ common approach ??**

➔ **Partners decide for a partially common approach on direct economic flood losses**

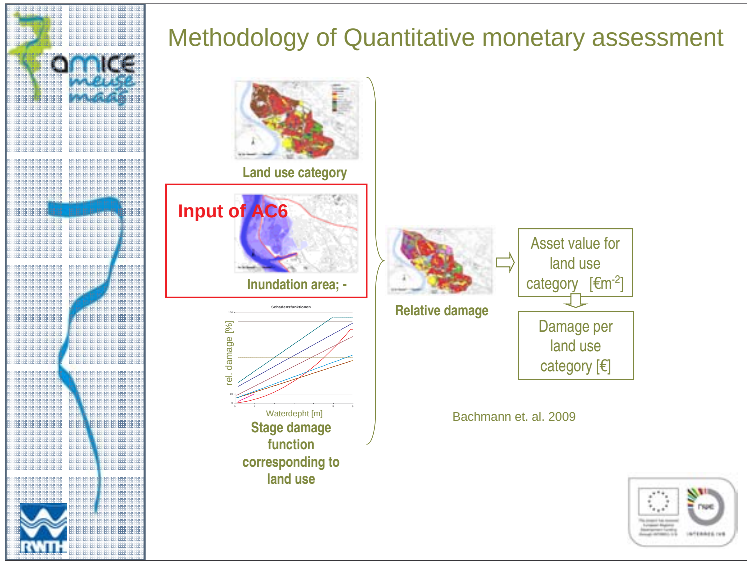
➔ Partners will use the same scenarios and have to decide on used input data

➔ Monetary Assessment

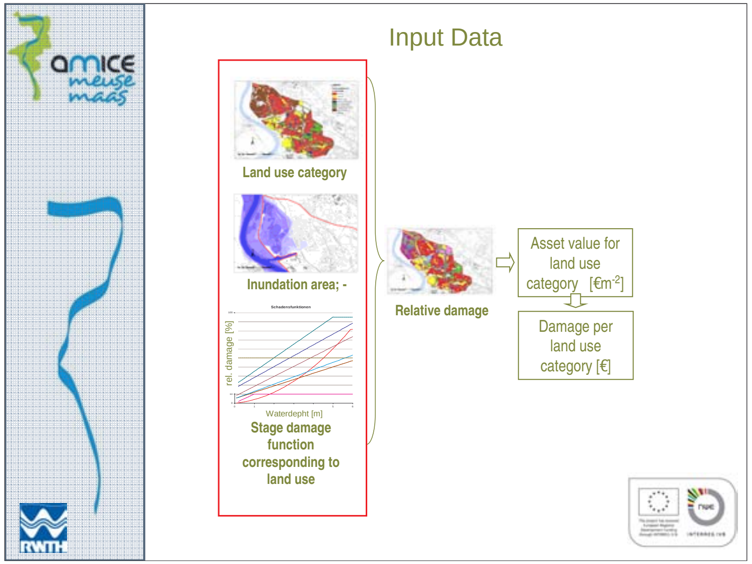
The risk calculation is done in the same way in all countries. But the basic data used for that calculation is different.

In the national approach, each country uses its own methodology and datasets.
In the common approach, all countries use exactly the same data.

Finally, we decided on a partially common approach : with the same scenarios but different damage functions.



amice meuse maas
Methodology of Quantitative monetary assessment
Land use category
Input of AC6
Inundation area; -
rel. damage [%]
Waterdepht [m]
Stage damage function corresponding to land use
Relative damage
Asset value for land use category [€m-2]
Damage per land use category [€]
Bachmann et. al. 2009
RWTH



amice meuse maas
Input Data
Land use category
Inundation area; -
rel. damage [%]
Waterdepht [m]
Stage damage function corresponding to land use
Relative damage
Asset value for land use category [€m-2]
Damage per land use category [€]
RWTH

Damage Categories

- First step in damage calculation procedure:
  Aggregation of considered damage categories by available land use data and available damage functions
- On the basis of the first Questionnaire Amice partners agreed on Corine Land Cover data
- The Corine Land Cover Project is intended to provide consistent localized geographical information on the land cover of 12 Member States of the European Community
- 44 Corine Land use categories
- Spatial resolution
  - scale: 1:100.000
- Free available as 100m x 100m Raster
  250m X 250m Raster
  http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster

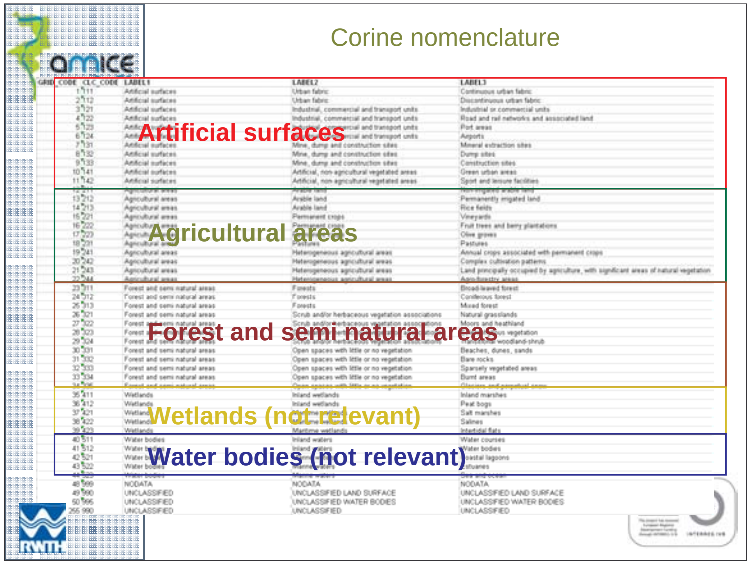
Damage Categories

- Aggregation of the Corine categories to damage categories regarding available damage functions on the basis of the Second Questionnaire
- Linking of the available damage functions with corresponding monetary values with the Corine categories

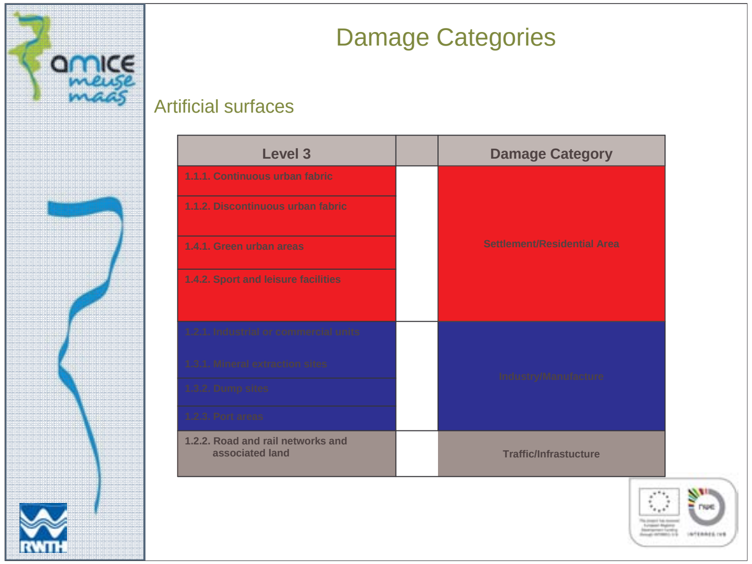
=> 6 damage categories for analysis within AMICE

1. Settlement/Residential Area/Urban fabric
2. Industry/Manufacture
3. Traffic/Infrastructure
4. Agriculture
5. Forestry
6. Miscellaneous

The 44 Corine categories have been aggregated into 6 only so it is easier to link it to the dmaage functions.



Wetlands and Water bodies are not relevant for a flood risk calculation so are not taken into account.



Artificial surfaces have been further split in 3 distinct categories.

Damage Categories

Agricultural Areas

2.1.1. Non-irrigated arable land		Agriculture
2.1.2. Permanently irrigated land		
2.1.3. Rice fields		
2.2.1. Vineyards		
2.2.2. Fruit trees and berry plantations		
2.2.3. Olive groves		
2.3.1. Pastures		
2.4.1. Annual crops associated with permanent crops		
2.4.2. Complex cultivation		
2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation		
2.4.4. Agro-forestry areas		
3.2.1. Natural grassland		

Damage Categories

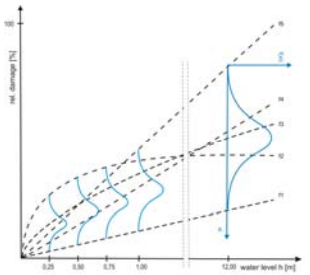
Forest

3.1.1. Broad-leaved forest		Forest
3.1.2. Coniferous forest		
3.1.3. Mixed forest		
3.2.4. Transitional woodland/shrub		
3.2.2. Moors and heathland		No value
3.2.3. Sclerophyllous vegetation		
3.3.1. Beaches, dunes, and sand plains		
3.3.2. Bare rock		
3.3.3. Sparsely vegetated areas		
3.3.4. Burnt areas		
3.3.5. Glaciers and perpetual snow		

Damage functions

- **For the common AMICE approach all categories are linked with the national damage functions**
- If there are several damage functions available for one damage category

=> Generation of a new damage function by arithmetic average values/probability density curves.



1. Large number of damage functions for one category
2. Representation of this variety by stochastic interpretation

=> Probability Density Function for each water level

=> Population Mean

=> One damage function for economic damage assessment

Comparative analysis

- Comparative analysis by using an "IKSM" approach as a second alternative / sensitivity analysis related to the IKSR approach (Rhine Atlas, 2001)
- Same damage categories as in the "AMICE Approach"

=> Comparative analysis: transnational damage function vs. national specific damage functions

=> Consistency by using one common approach (for basin wide decision making)

=> Risk results are not biased by the use of national damage functions and the transnational discrepancies between them

The damage functions used on the Rhine basin will be adapted to the Meuse basin.

Prognosis

- The AMICE Project is intented on two scenarios for forecasting calculation
- (Basic) 0 -Scenario
  The basic AMICE forecasting calculations will be performed under the assumption of constant socio economical conditions for 2020 – 2050 and 2070 – 2100
- (Land use change) 1 - scenario
  Land use changes on the 4 IPCC scenarios by the University of Amsterdam.
  - Complementary modeling and sensitivity analysis
  - Access of results?

=> Results are available as far as 2030

Results to be generated

- 2 sets of damage functions:
  - National
  - "IKSM", refined from IKSR
- At least 2 land use / socio-econ. runs:
  - Basic calculations (0-Scenario for 2009, 2020-2050 and 2070-2100)
  - land use change (CLUE-Model)

	Reference state	2020-2050	2070-2100
Partially common approach	0 -Scenario	0 - Scenario	0 -Scenario
		1 -Scenario	
IKSM Approach	0 - Scenario	0 - Scenario	0 -Scenario
		1 -Scenario	

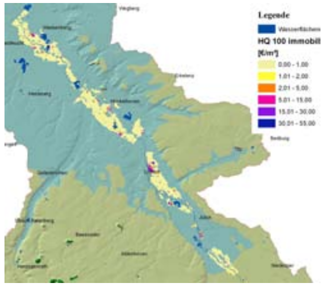
➔ 8 soci-econ. runs for each Return period HQ_{10}, HQ_{50}, HQ_{100}, HQ_E

➔ **32 runs**

The return periods of floods that are planned to be used are 10 years, 50 years, 100 years and an Extreme case.

Risk Communication

- The flood risk is calculated monetary within AMICE
- Partners agreed: Risk calculation will be done with as much detail as possible but final presentations will be simplified



Example: risk map of the rur catchment due to HQ_{100}

For the final presentations of results on maps, it is difficult to illustrate climate change at a high resolution. We could get troubles with inhabitants seeing their house flooded, when it is not at present.

Risk Communication

- Risk communication will be done in a qualitative way Impacts of climate change should be presented as % of change
- With the Assessment of the consequences of future floods on the entire Meuse basin an analysis of potential damage and costs is provided, taking into account relevant aspects of the basin's economy

Low Flow Losses

Low Flow

- Assessment of impacts of Low Flow on the in in the Meuse basin
- When the water demand exceeds the water availability, several economic sectors could be affected
- When the water level in the river falls below a certain threshold and the water extraction for cooling circuits has to be stopped. This forces the power plant to operate with reduced energy production
- The Action is limited to the sectors

  - Energy
  - Navigation
  - Drinking Water
  - Agriculture

AMICE has limited budget and time so only 4 sectors are considered.

Low Flow

- Coping with Low Flow risk:
  Methodologies different to flood risk calculation
- No direct relation to hydraulic impact factors (water level) in form
  No existing damage functions
  Different indicators for low flow losses
- Methodologies based on hydrological data
- Water demand / availability balances to highlight water shortages….

Monitory values are harder to produce for low-flows.

Low Flow Losses indicators

- Navigation:

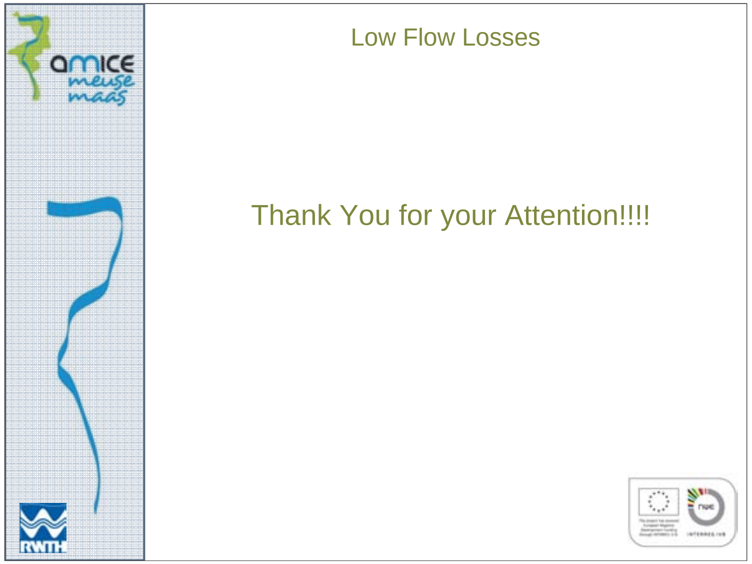
  - Pumping costs at sluices
  - Waiting times at sluices
- Energy:

  - Discharge thresholds for cooling water
- Agriculture:

  - Losses on yield
- Drinking Water

  - Additional costs when drinking water extraction has to be stopped due to low flow and has to be delivered from other reservoirs

The first results shall be available next spring.



Questions from the audience

S.Folkertsma: Why are you not taking into account damage on the wetlands ?

B.Sinaba: We do not consider any ecological damages, only damage to built infrastructures, agriculture, etc

S.Folkertsma: But floods can bring a lot of garbage, and you need to remove them after a flood.

B.Sinaba: Of course there is a damage, but it is indirect … and so out of the scope of AMICE.

M.Fournier: That would be the same for industries for example, if there is a leak of pollutants cause by flood, there is a damage but that is indirect and very hard to quantify.

J.DeBijl: These maps, are they also used by the High Water Directive ?

M.Fournier: We want to follow what is being negotiated for the Flood Directive and use it in AMICE but for some countries the risk maps are not defined yet precisely.

B.Dewals: Why do you construct probability distribution functions for given water depth if you have for instance 4 or 5 damage functions ? If you have different damage functions, you combine them.

B.Sinaba: If one damage function is very accurate for one category, there is no need to add others. But sometimes, there are several relevant damage categories, for example resulting from the aggregation of sub-categories. Then we can combine them and get a probability distribution.

N.P.Huber: That however won't be used in AMICE where we will define 1 damage category for each land-use. That would be however useful for further analysis. It is already the case in Germany. When we scanned the literature, we found 10 or 15 different damage functions for a same category. And we wanted to take into account this full variability.

B.Sinaba: The variability in the flood damage functions can result from data used in each study, for example if they used only a 1 meter water depth, or in other 3 to 5 m depth to evaluate the damage.