Planbureau voor de Leefomgeving

Simulating Urban Land Use Change…

…to Explore Urban Planning Strategies

…in the context of Flood Risk

Bart Rijken
VU Amsterdam, PBL

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Simulating Urban Land Use Change…

…to Explore **Urban Planning Strategies**

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Simulating Urban Land Use Change…

…to Explore Urban Renewal Strategies

…in the context of **Flood Risk**

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Questions

Flood risk:
- How much could flood risk be **reduced**?

Strategies:
- Using what urban planning **strategies**?

Land use change:
- In what **scenarios** viz. land use change?

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Focus

Flood risk:
- **Impact**: potential damage
- To **residences**

Strategies:
- Urban **planning**: 1) zoning; 2) construction

Land use change:
- Urban: demolition and (re)construction of **residences**
- **Local!**

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Contents

- Land use change: drivers & mechanisms
- Simulating land use change
- Application
  - Strategies
  - Scenarios
  - Results

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Land Use Change: Drivers & Mechanisms

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Drivers and mechanisms

- Drivers:
  - **Demand** (quantity/quality):
    - Demography: people > households > houses > land
    - Economy: income, jobs etc.
  - **Supply**:
    - Depreciation building stock
    - Changes in urban planning: land as well as buildings
- Mechanisms:
  - Change if NPV **potential use** > NPV **current use**
  - This includes **transition** *costs*
  - If so: **opportunity costs** of not changing

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Simulating Land Use Change

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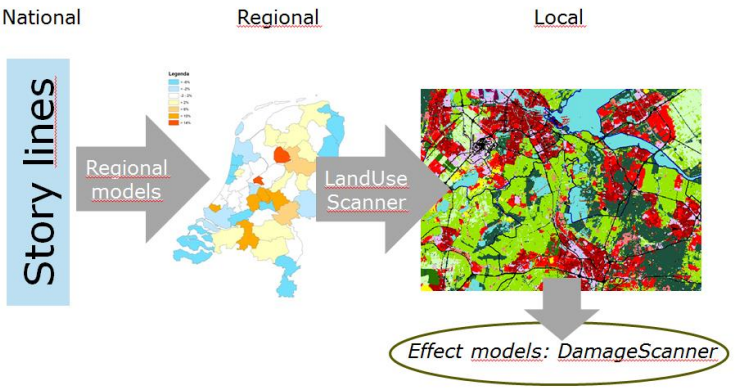
Three scale levels, three modules



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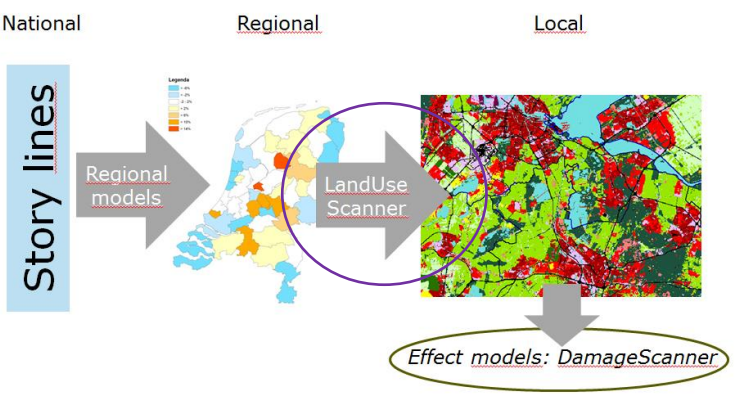

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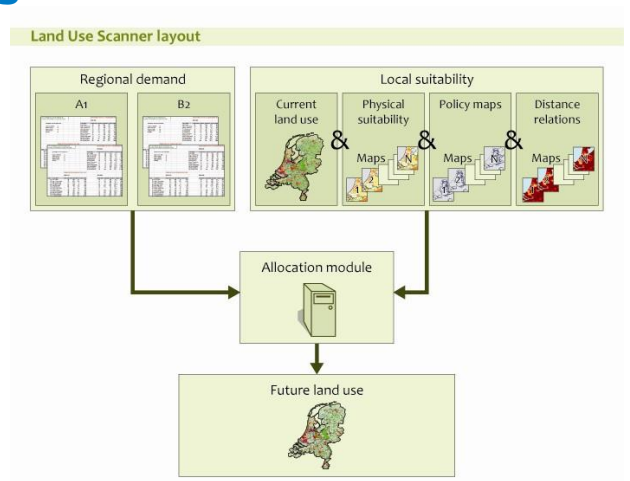
2: From regional to local level: LUS



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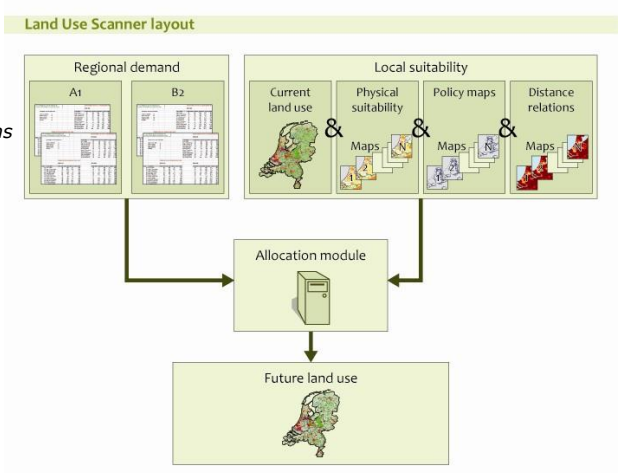
    - *Competing land use claims*
  - *Local* supply: NPV



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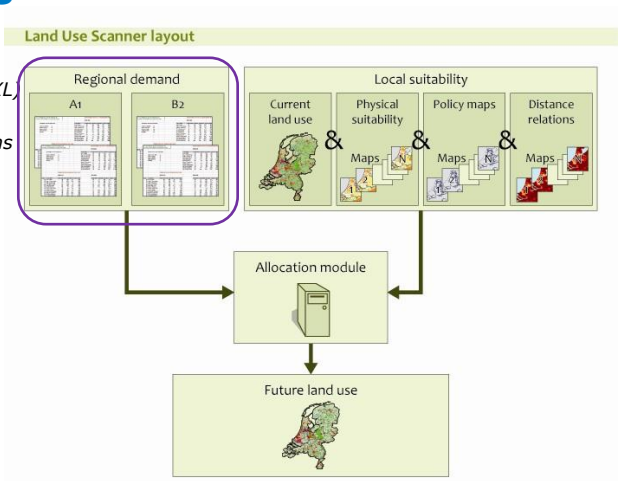

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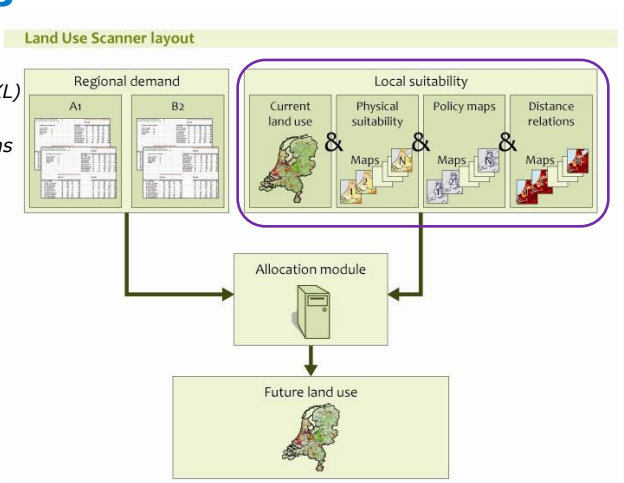

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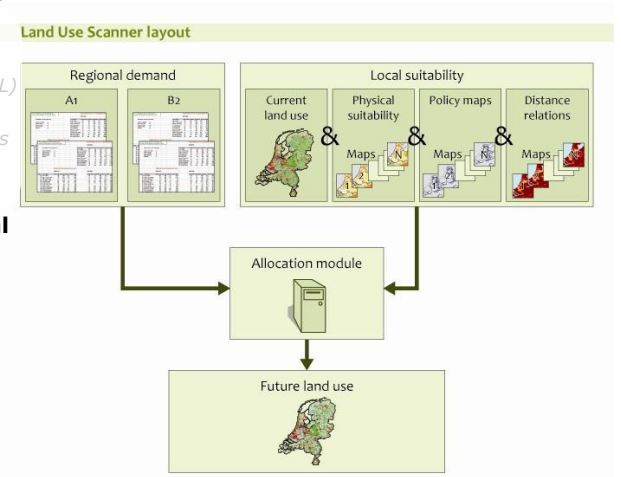

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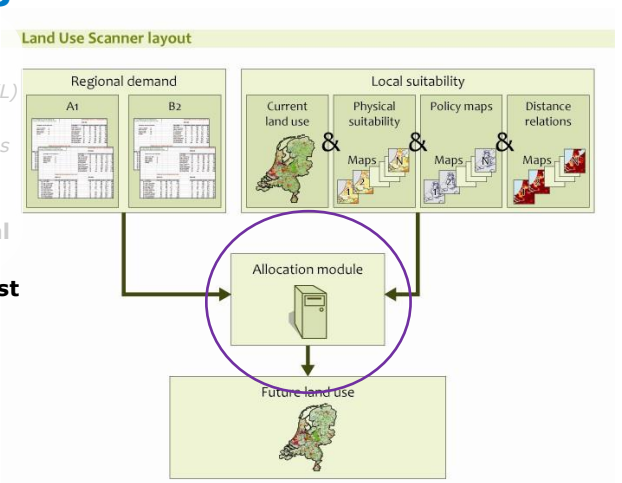

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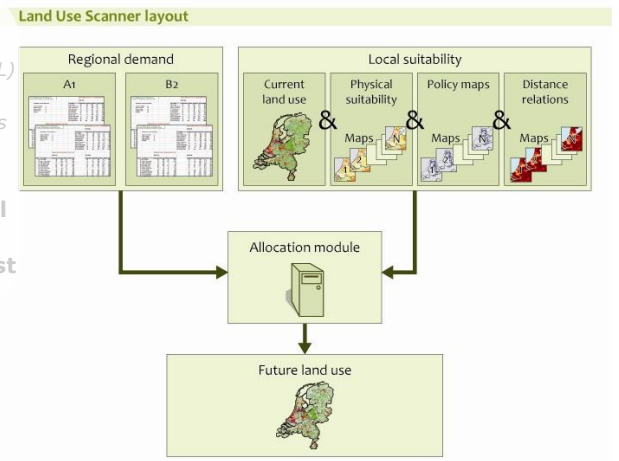

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- Simulates change on a **local scale (1 ha grid)**
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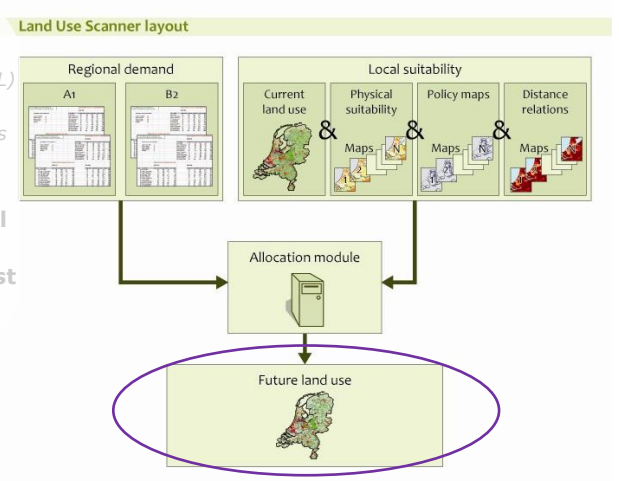
- **Time steps:** 10 years

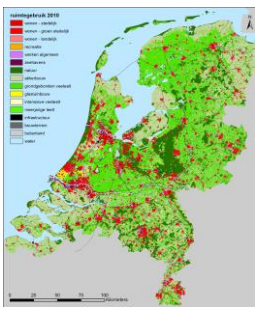
- **Output** (ha, 2050), i.a.:
  - Residences (density, type)
  - Other land use: nature, agriculture etc.

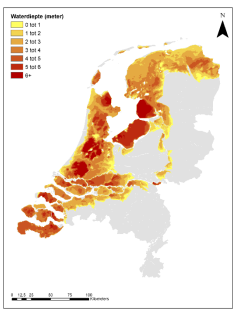


3: Calculating potential flood damage

= exposure

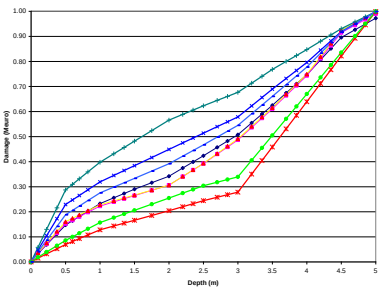
= [#residences/type * value * depth]





*** vulnerability**

* dam. function/type



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Application

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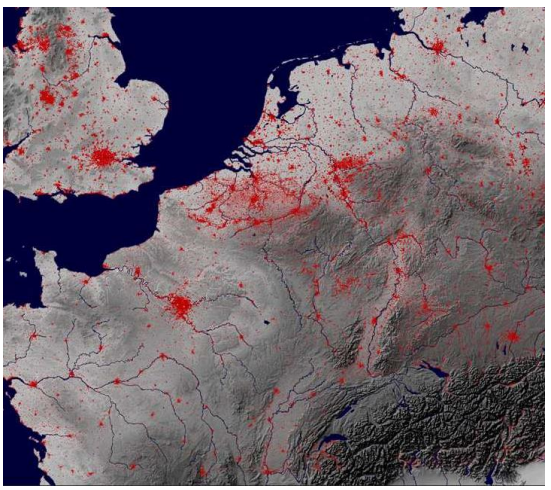
The Netherlands



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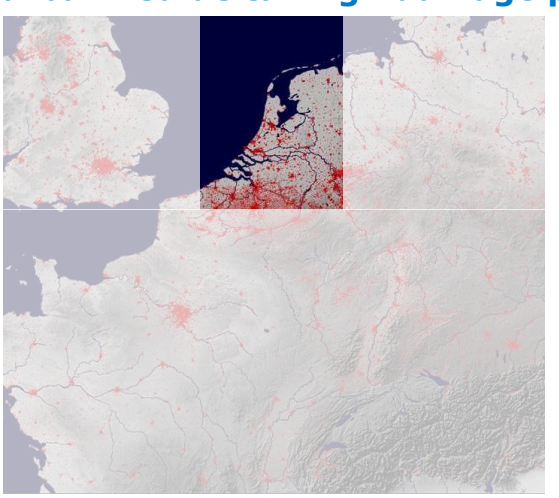
A highly urbanized delta: high damage potential



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A highly urbanized delta: high damage potential

- By how much could this be **reduced**?

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A highly urbanized delta: high damage potential

- Using what urban planning **strategies**?

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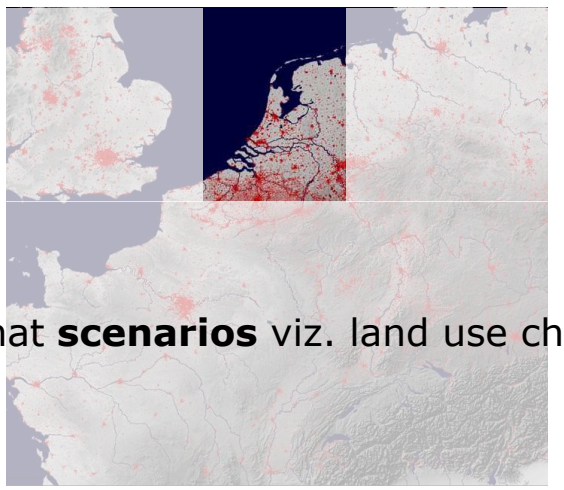
A highly urbanized delta: high damage potential



- In what **scenarios** viz. land use change?

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Strategies

- Typology based on two dimensions:
  - *Vertical*:
    - **Building** (vulnerability): flood-proof **construction**
    - **Land** (exposure): **zoning**: no construction in low areas
  - *Horizontal (domain)*:
    - **Intensive** margin: existing built-up areas
    - **Extensive** margin: green field areas

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Strategies

- Based on this typology: five **strategies**:

ID	Name	Zoning	Construction
I	Extensive zoning	Extensive	None
II	Extensive construction	None	Extensive
III	Intensive construction	None	Intensive
IV	Intensive combination	Intensive	Intensive
V	**Total**	**Both**	**Both**

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Strategies

- Based on this typology: five **strategies**:

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III	Intensive construction	None	Intensive
IV	Intensive combination	Intensive	Intensive
V	**Total**	**Both**	**Both**

- **Hypotheses**:
  - Highest reduction if dimensions are *combined*
  - Highest reduction through *construction* measures
    - ➢ 100% effective; not bounded by housing market regions
  - Highest reduction in *intensive* margin
    - ➢ *Absolute* reduction only if demolition and/or reconstruction

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Scenarios

- Netherlands, **2050**

- Key uncertainties: **demography & economy**
- Yielding two **scenarios**: **High** growth vs. **Low** growth

- Common (policy) assumptions:
  - **Intensification**:
    - Percentage: 30-50%
    - Only in residential areas base year
    - Only after full demolition
  - **Zoning** (nature, landscape, safety etc.): observed policies

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Scenarios

- National **demolition and construction** residences:*

Scenario	Intensive margin			Extensive margin	Total	
	Demolition	Construction	Net	Construction	Demolition	Construction
High	1.390	2.307	**916**	1.813	**1.390**	**4.120**
Low	1.303	784	**-519**	356	**1.303**	**1.140**

*2008 – 2050, * 1.000 residences, including reconstruction

Scenarios

- National **demolition and construction** residences:

Scenario	Intensive margin			Extensive margin	Total	
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High	1.390	2.307	**916**	1.813	**1.390**	**4.120**
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- Main **hypothesis**:
  - In *High*, both highest increase and highest reduction
    - Highest increase in *High-BAU*
    - Highest decrease in *High-Total*
  - ➢ High growth: both opportunity and threat

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Results

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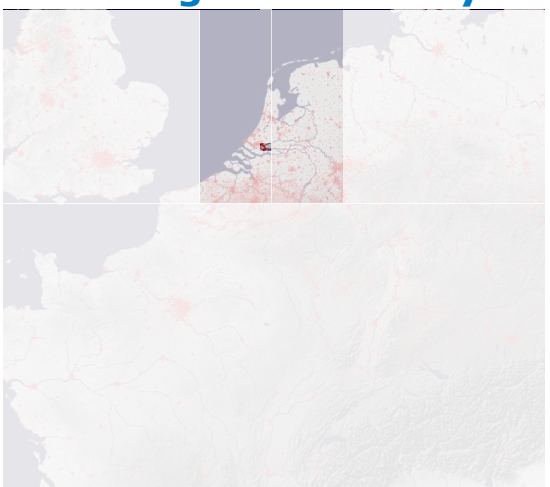
First zooming in to the city level…



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…the Drechtsteden…

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…the Drechtsteden…

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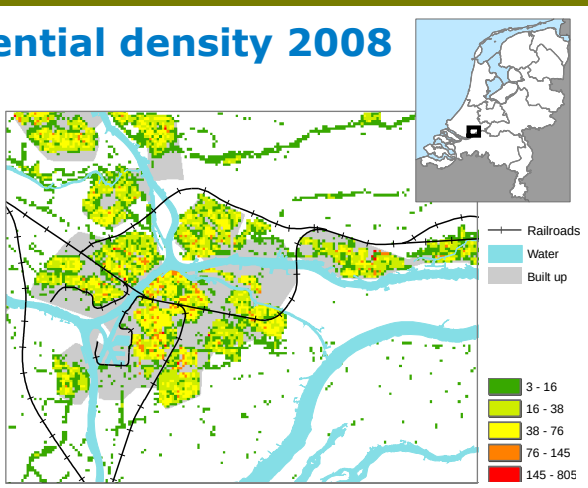
Residential density 2008

- Agglomeration of 150.000 people
- Clustered around a network of rivers
- Residential densities of 35/ha on average
- Little high-rise: high vulnerability



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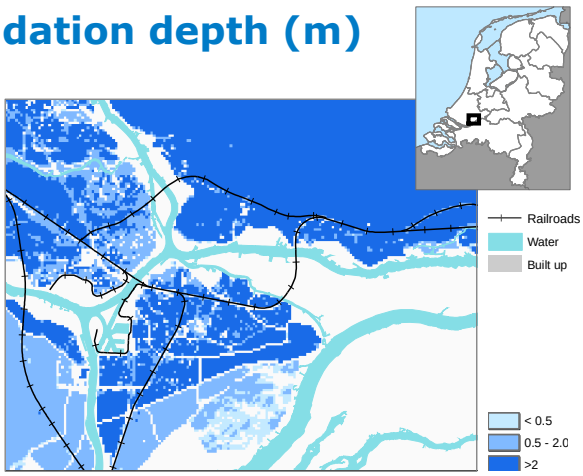
Inundation depth (m)

- Depths: 0.5 – 2.5m
- >10% - 40% depreciation
- Greatest depths in and around current built-up



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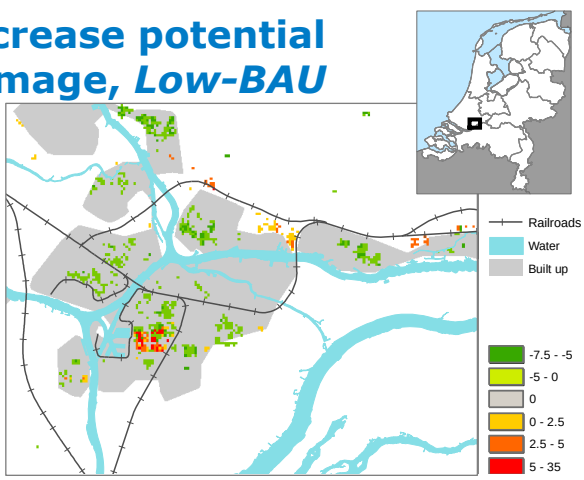
Increase potential damage, *Low-BAU*

- Increase and decrease coexist
- Increase mainly in early growth phase:
  - Intensification
  - Green field development
- Decrease because of vacancy and demolition later on
- Reason coexistence: short (10 year) planning horizons



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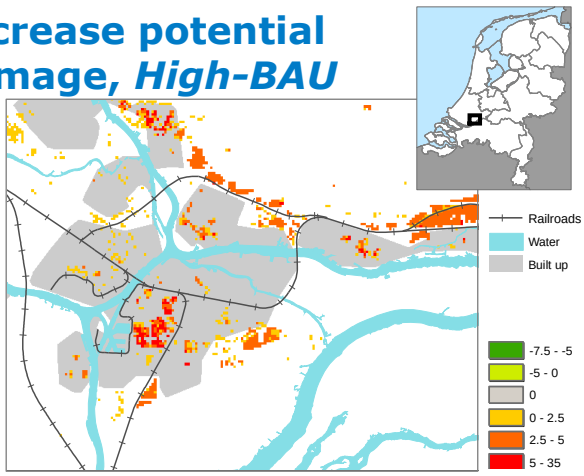
Increase potential damage, *High-BAU*

- Only increase
- Through both:
  - Intensification
  - Green field development
- Latter concentrated in high-exposure areas in and around built-up 2008.



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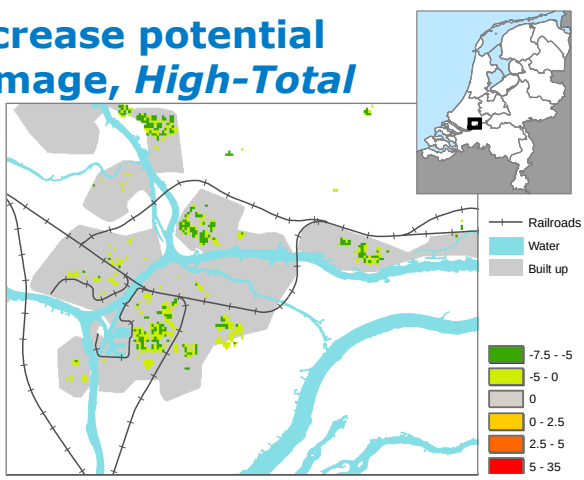
Increase potential damage, *High-Total*

- No increase
- Absolute decrease through redevelopment (instead of vacancy and demolition)



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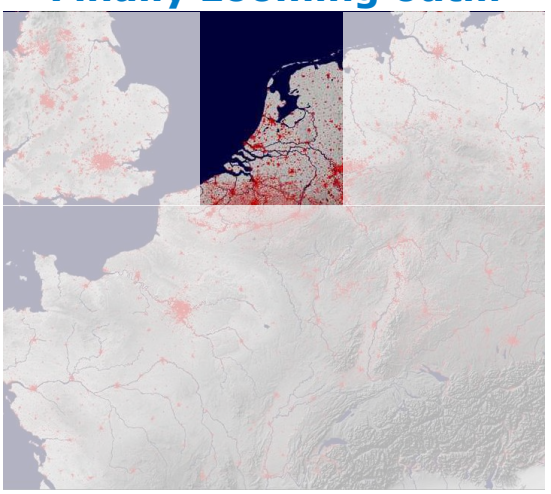
Finally zooming out…



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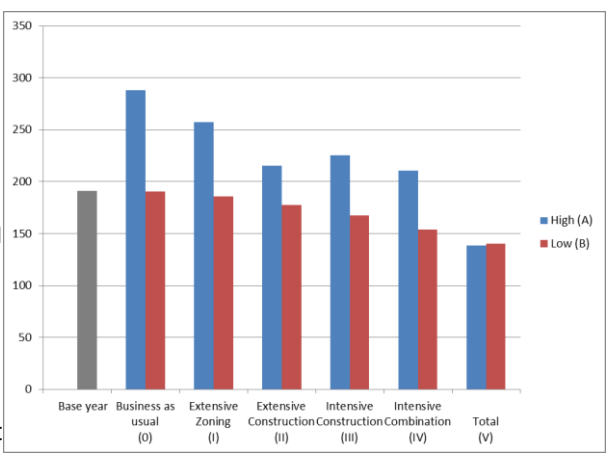
Potential damage to residences, NL (x bln EUR)

- Significant damage reduction feasible:
  - To less than 150 bln in 2050
  - In both *High* and *Low*
  - Viz. Both *BAU* and 2008
- As expected:
  - both highest damage and highest reduction in *High*
  - lowest reduction in *BAU*, and highest in *Total*
  - highest reduction through construction measures
- Interestingly: low impact intensive combination



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Conclusion & Discussion

- Useful toolset for evaluation **effectiveness** urban planning strategies in different scenario's
- **Integrated** modelling framework: **consistency** > **plausibility**
- Many **exogenous** parameters:
  - reconstruction flows
  - intensification: percentage, location, conditions
- No specification local **cost** of the strategies
- **Consequences**:
  - Fast exploration of "**what if**" scenarios
  - No automated **reality checks** or **optimization** of strategies
- **Work in progress**

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Thank you for your attention

Questions?

Comments?