

A vertical strip on the left side of the slide shows a topographic map with contour lines, roads, and buildings. Labels like "Kniagelhus" and "Ørsemose" are visible.

ASTRA Final Conference

Land-use Scenarios and Sea Level Rise
– Danish Experiences

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10. – 11. December 2007
Helsinki, Finland

Overview

- Background
- Adaptation to Climate Change
- The Land-use model
- Examples
- Conclusion and further research

Background

- Most coastal cities are concerned about sea level rise, storm surges and flooding
- Several cities have already experienced intense and damaging storms attributed at least partly to climate change
- Predictions about an even worse future !!!

Flooding examples



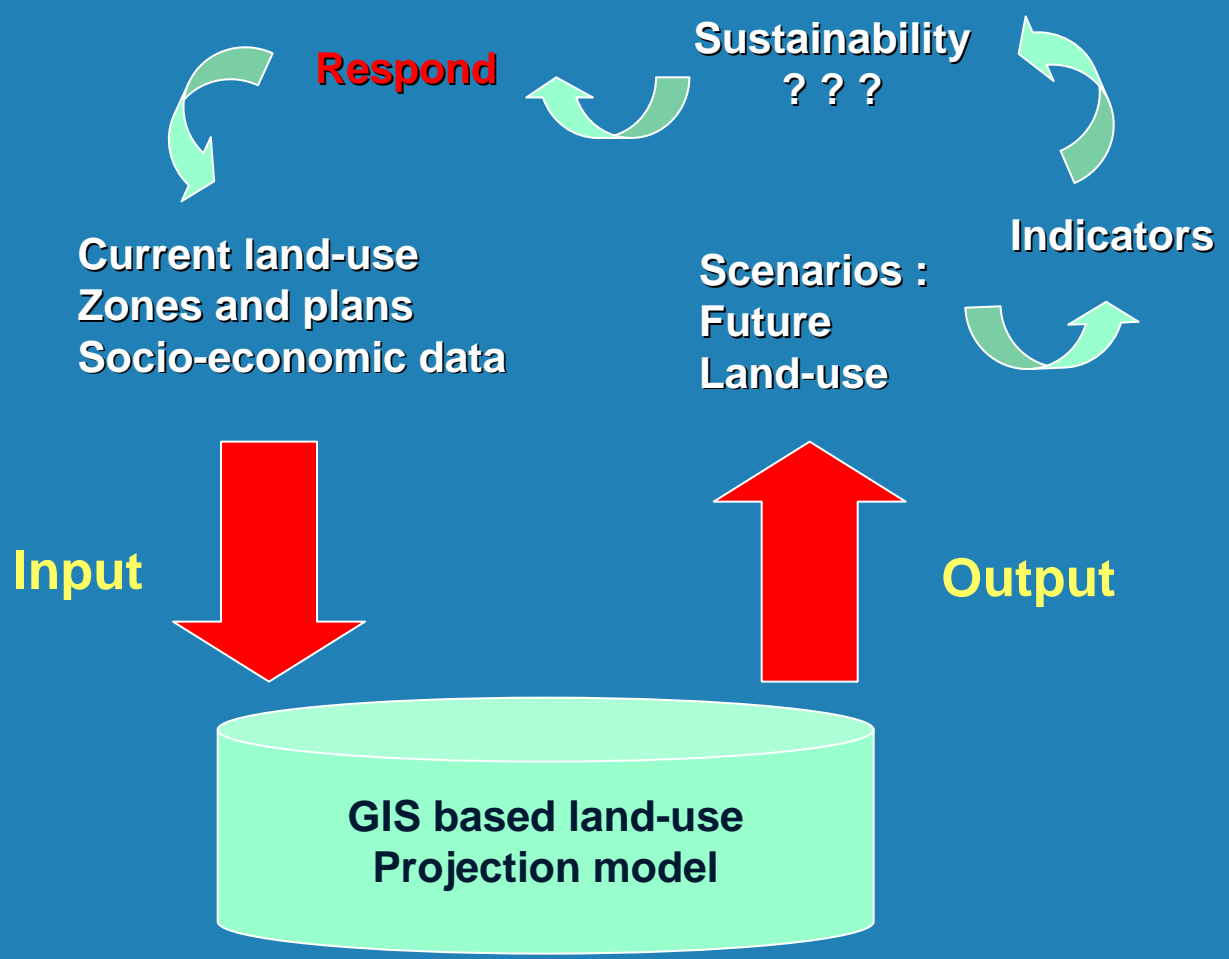
Flooding examples



The aim of the current project

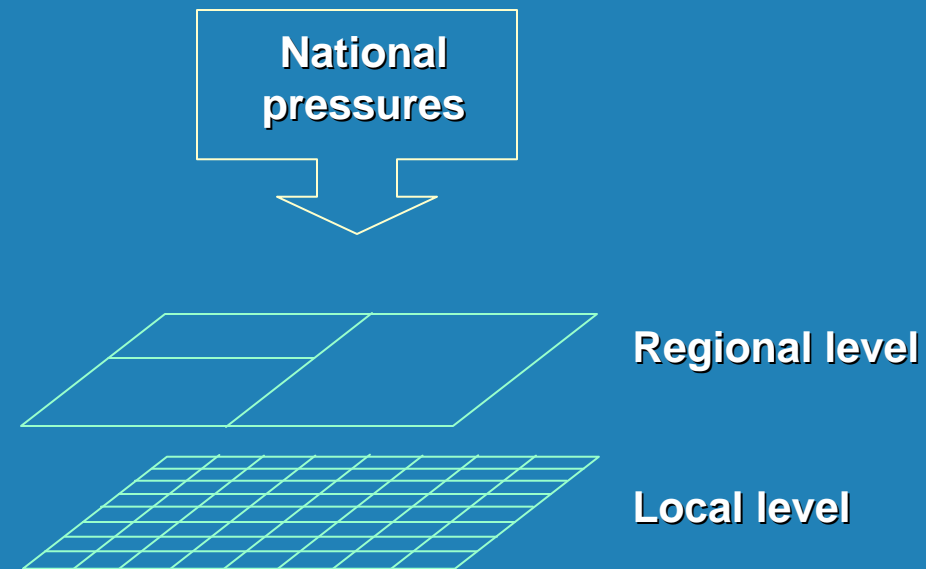
- The current project is an follow up activity from the former Forum Skagerrak III project
- A simple land-use simulation model was developed during this project – and this prototype was later on developed into the LUCIA modelling framework
- The current aim has been to involve the emergent global warming into our decision support system

LUCIA - Land-Use Change Impact Analysis

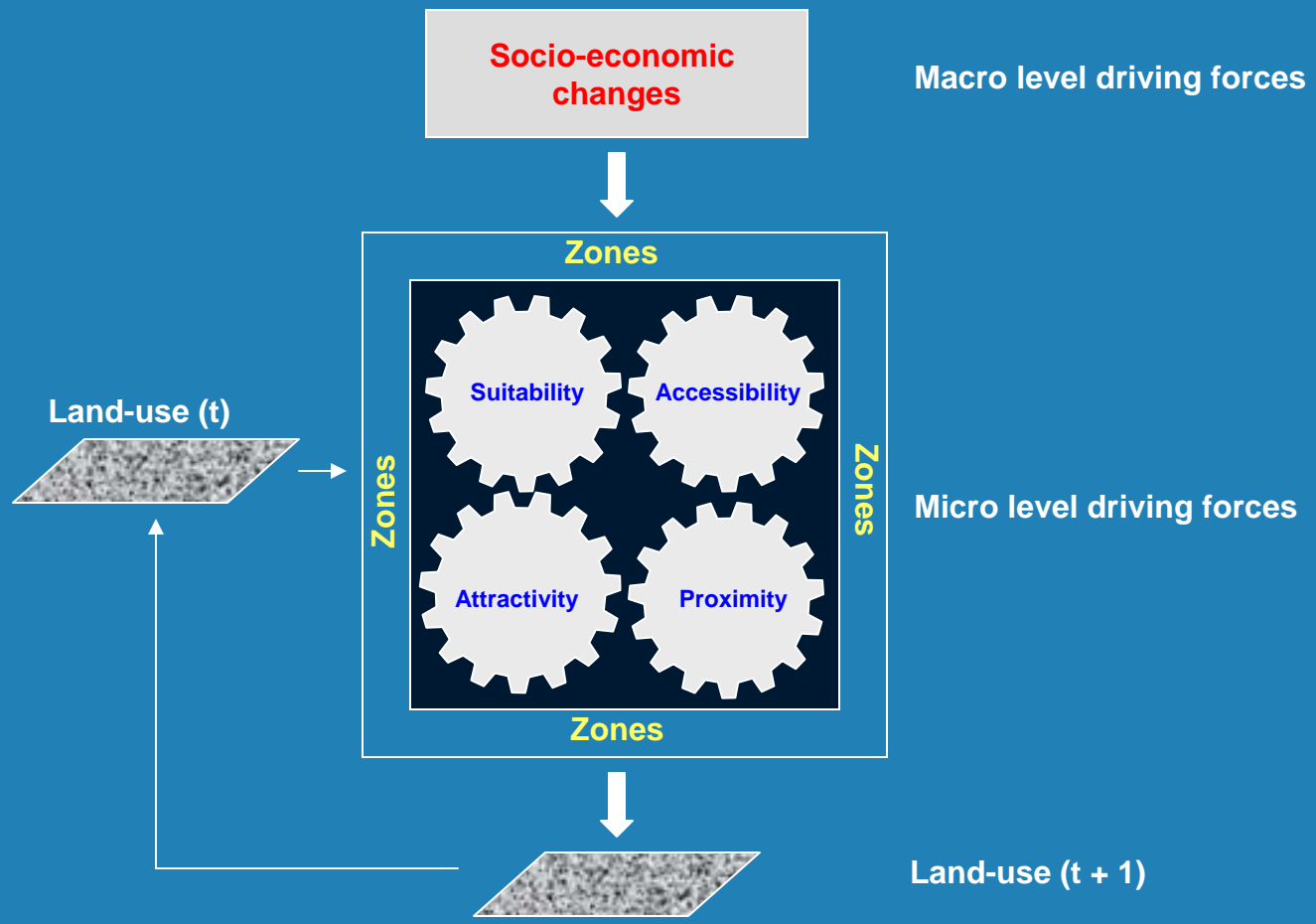


Multi-level structure

- The model is structured hierarchically taking multiple levels into account
- Population and economic development change the demand for different the active land-use types at the regional levels whereas the precise location of change is determined by local conditions

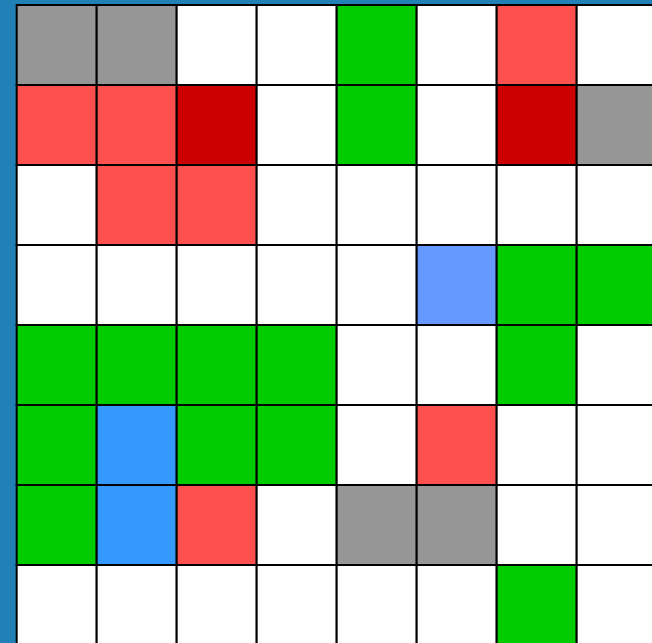


Conceptual land-use model



Land-use dynamics

- The *States* represents the various land-use classes
 - Active classes
 - Passive classes
 - Static features



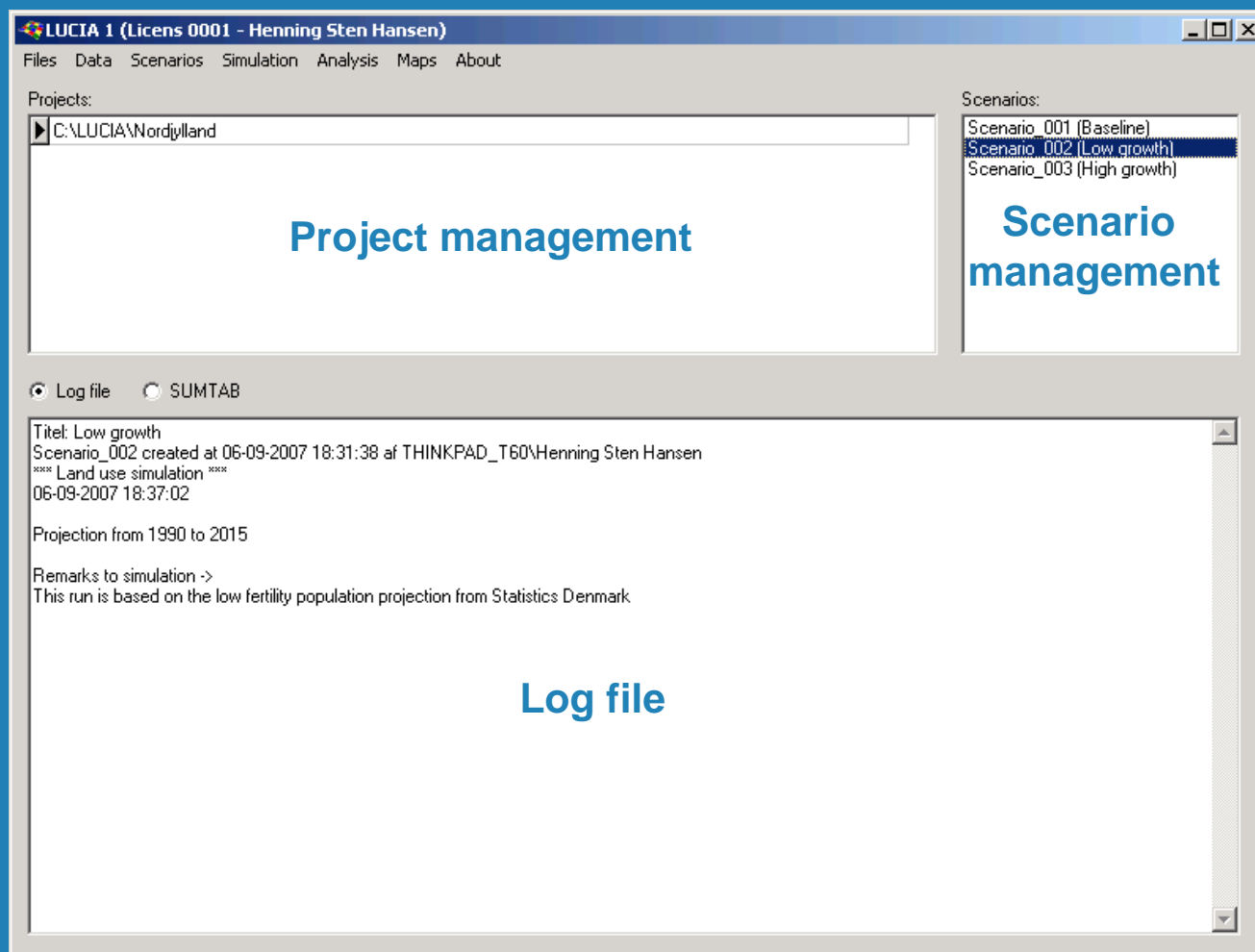
Driving forces for land-use changes

- Demography (population development, migration)
- Economic development
- Technological development (information society)
- Spatial planning (environmental legislation, energy policy)
- Environmental impacts (emissions, climate changes)
- Values of the society (quality of life, concern about the environment)

Regional driving forces - population

- The global and regional demand for land for population driven land-use classes is a function of
 - The population level which represents the thinning out effect
 - The population change which represents growth or decline and accordingly increased or reduced need for land

LUCIA User Interface

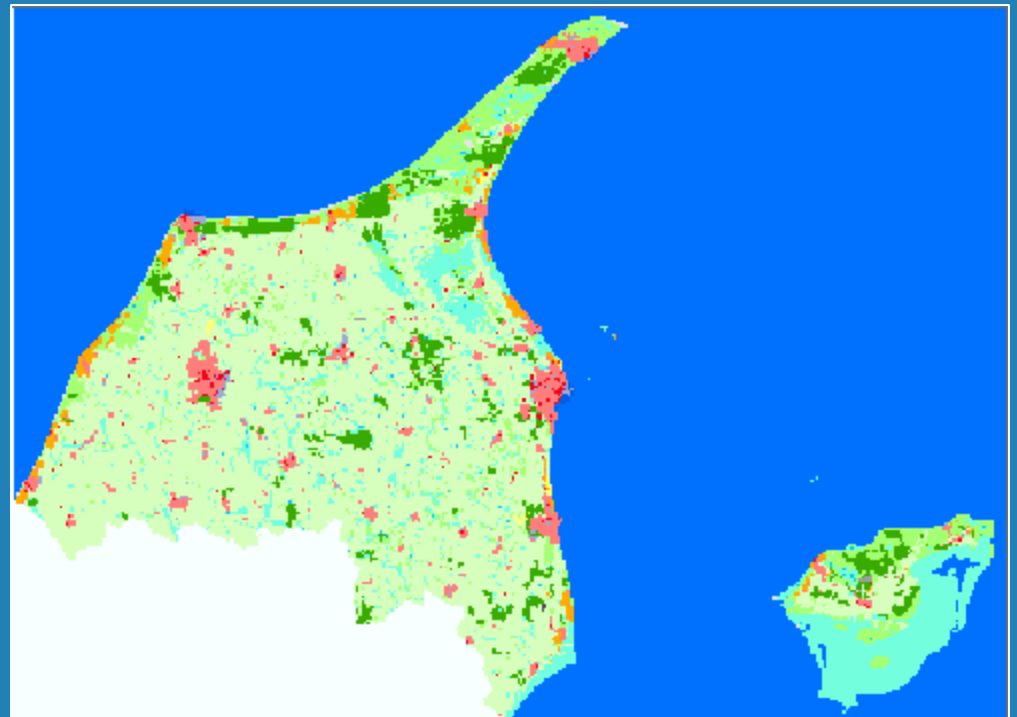


Land-use map

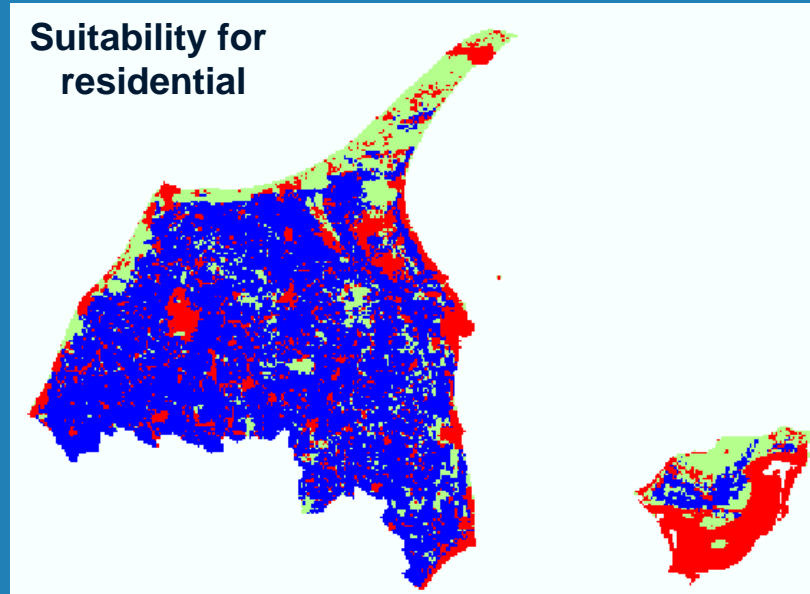
**CORINE
1990**

**Building and
Housing Register**

**Protected
Nature areas**

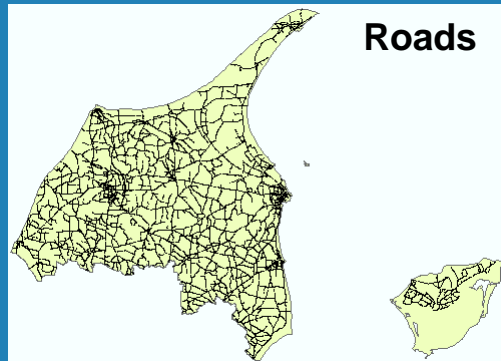


Suitability

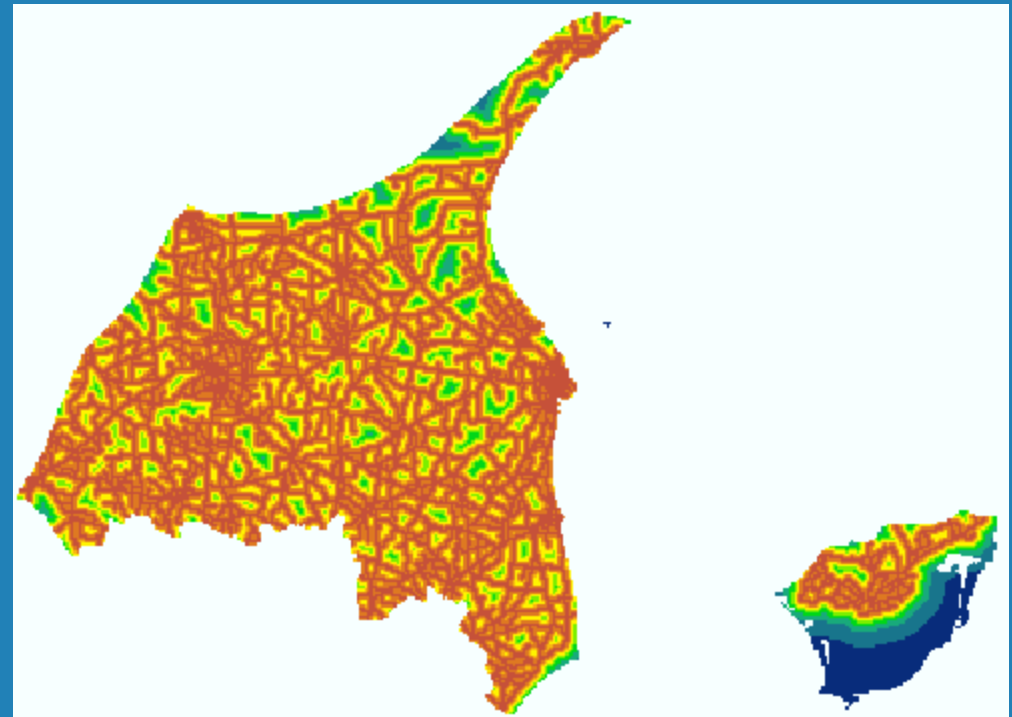


- Suitability is based on
 - Existing land-use
 - Soil type
 - Terrain
 - More can be added !

Accessibility



$$A_{K,x,y}^t = \frac{1}{1 + \frac{D}{a_K}}$$

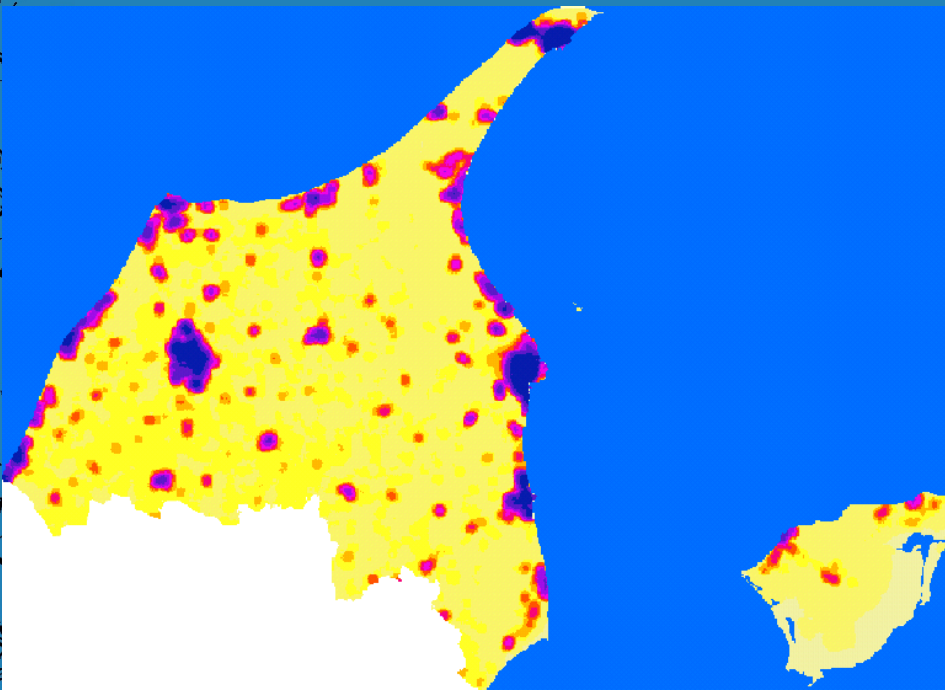


High

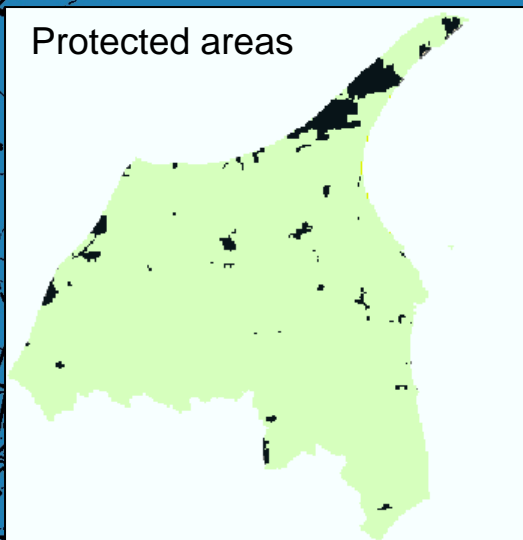
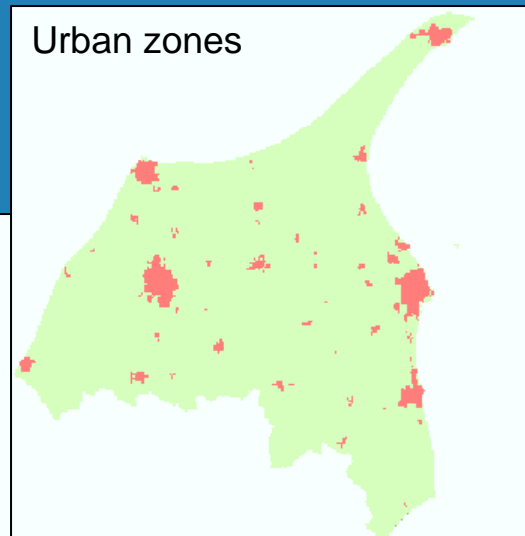
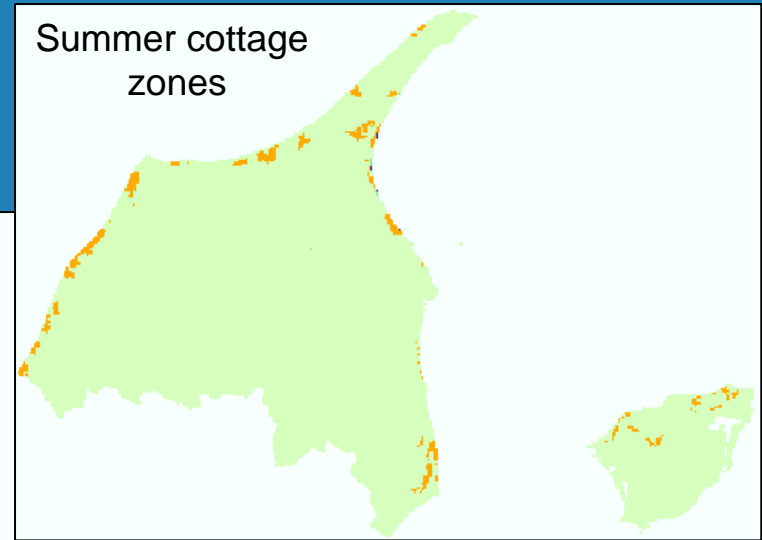
Low

Attractivity

- Price of land could be a possible indicator for the attractiveness of a specific location
- The price of land for each Danish parcel is available from the Danish Property Register





Spatial planning zones

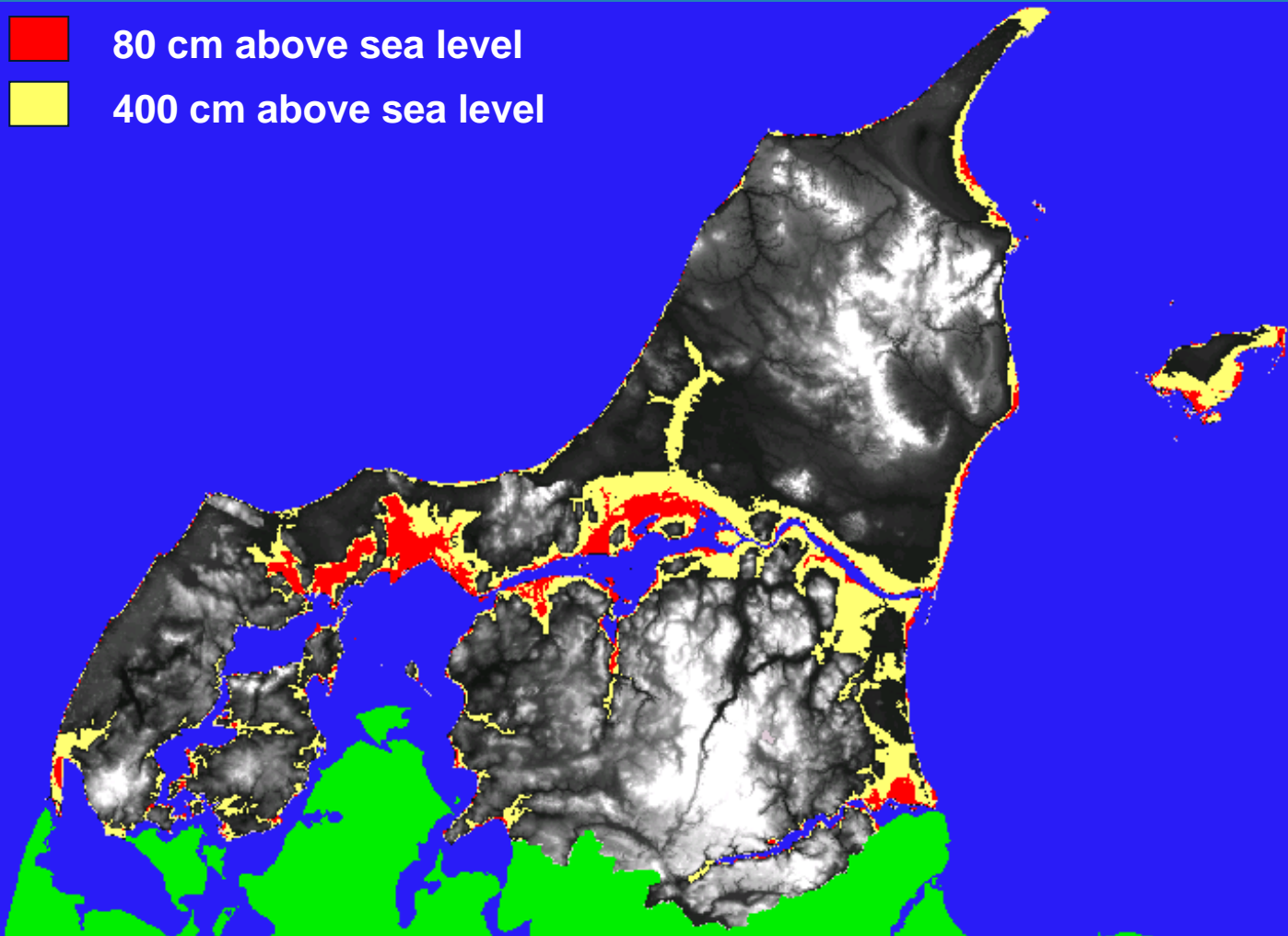


Active, passive and static classes

Active land-use classes	Passive land-use classes	Static land-use classes
Residential areas	Grass and arable land	Harbour
Industry areas	Forest	Airport
Private & public service areas	Semi-nature	Waste and extraction sites
Summer cottage areas	Wetlands	Lakes
	Recreational areas	Sea

Potential flooding

-  80 cm above sea level
-  400 cm above sea level



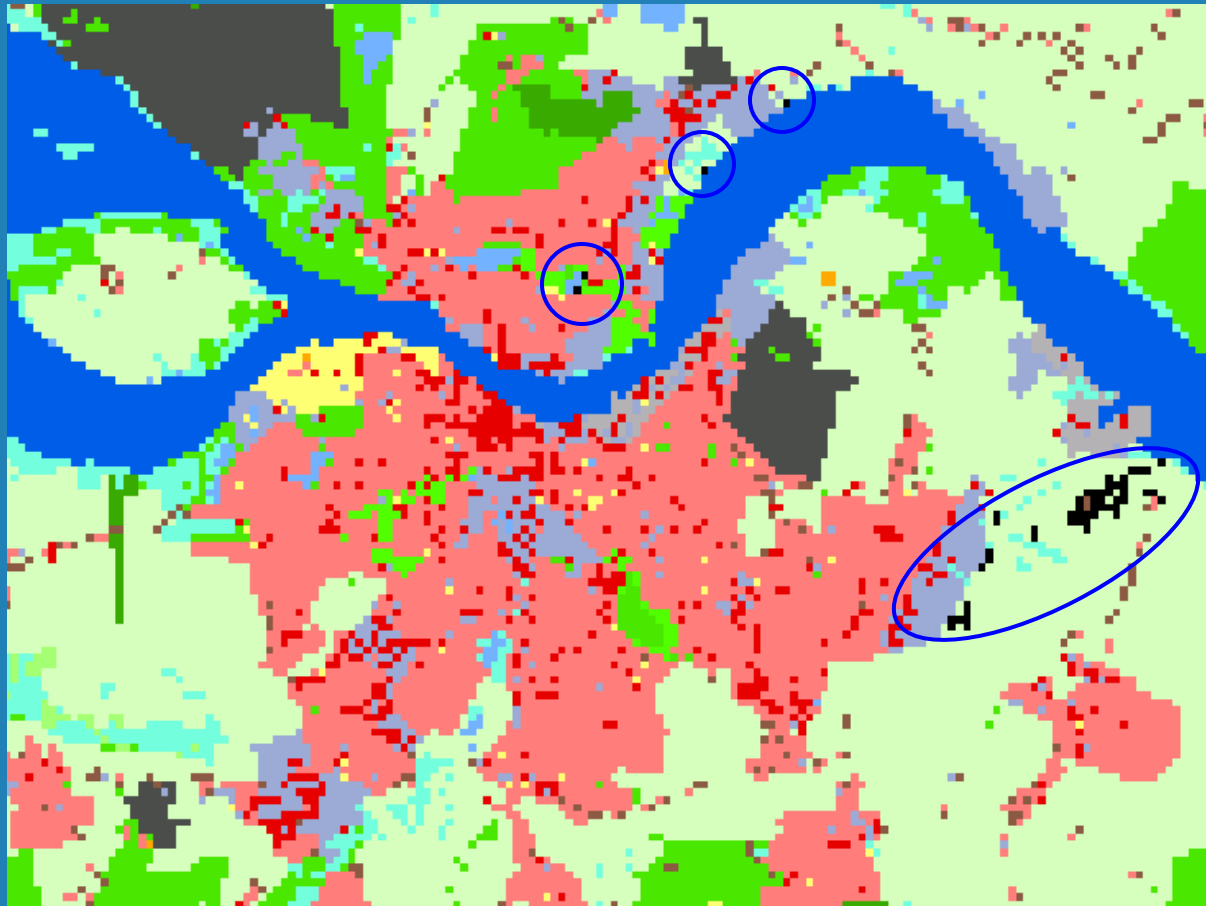
Built-up areas within 80 cm zone

- According to IPCC we can expect a sea level rise of about 80 cm before the end of this century considering the worst case scenario

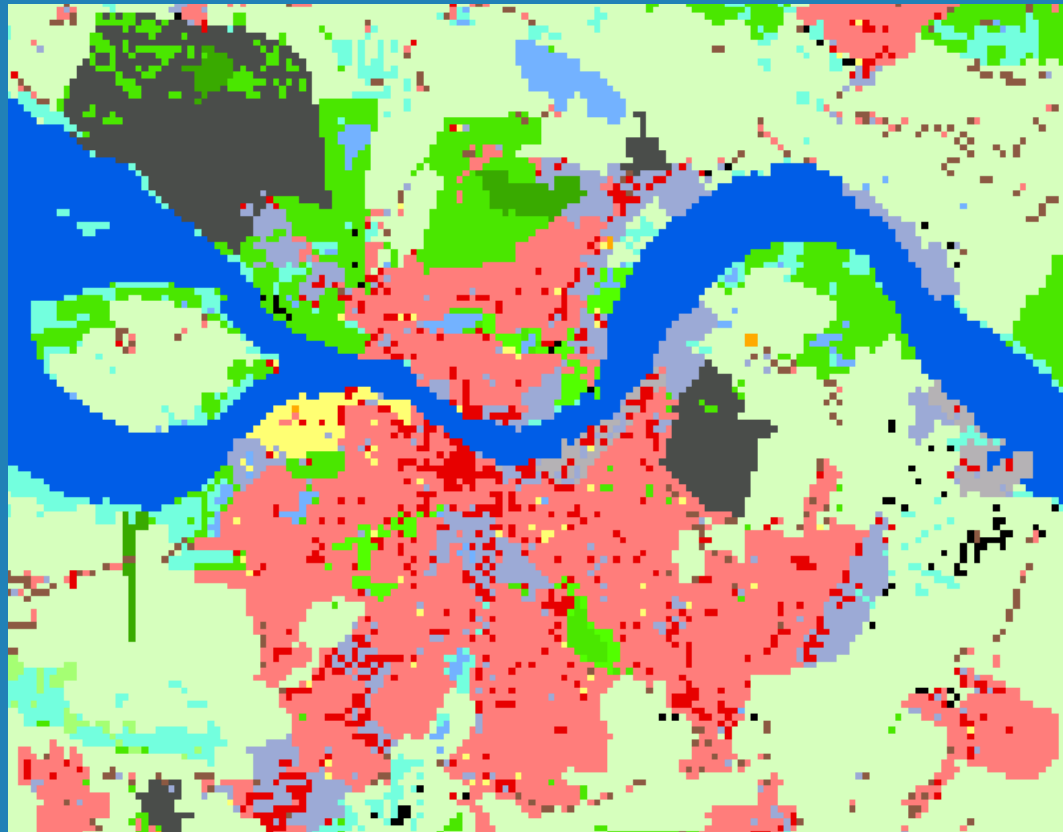
Landuse	Y2005	Y2010	Y2015	Y2020	Y2025	Y2030	%
Residential	143	145	145	145	146	147	3
Industrial	69	70	70	72	81	83	20
Service	23	23	23	23	26	26	13
Summer cottage	176	178	183	191	192	192	9
Total	411	416	421	431	445	448	9

NB: The numbers refer to hectares

Simulated built-up areas within a 80 cm zone



Simulated relocation of built-up areas



Black squares indicates relocated cells
 $154 / 3917 \approx 4\%$

Built-up areas within 4 m zone

- Besides the general sea level rise, an enhanced frequency and strength of storms are expected
- Therefore, some Danish authorities recommend the consider a 4 m potential flooding zone

Landuse	Y2005	Y2010	Y2015	Y2020	Y2025	Y2030	%
Residential	3543	3580	3591	3621	3634	3663	3
Industrial	1170	1223	1269	1315	1369	1415	21
Service	599	612	630	644	656	668	12
Summer cottage	2504	2527	2561	2589	2603	2609	4
Total	7816	7942	8051	8169	8262	8355	7

Conclusion

- Simulation studies are important tools for decision making regarding climate change adaptation
- The current example is our first attempt to analyse climate change adaptation using a land-use simulation model
- Next step will be to analyse the consequences of a relocation of human activities – will adaptation efforts work against adaptation?

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THANK YOU FOR YOUR ATTENTION !

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