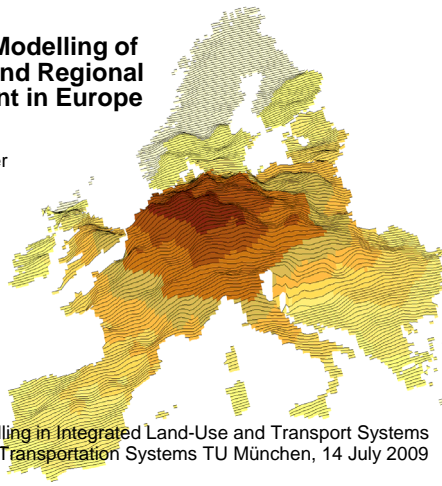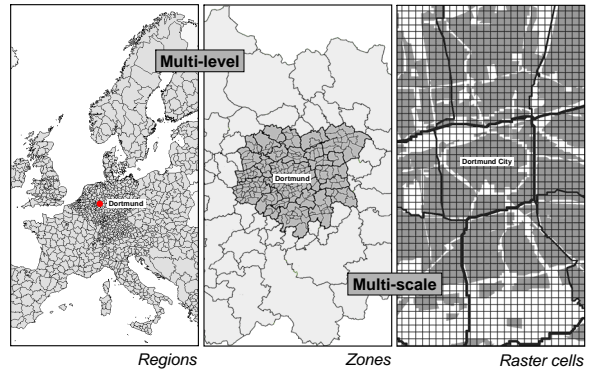## Integrated Modelling of Transport and Regional Development in Europe

Michael Wegener
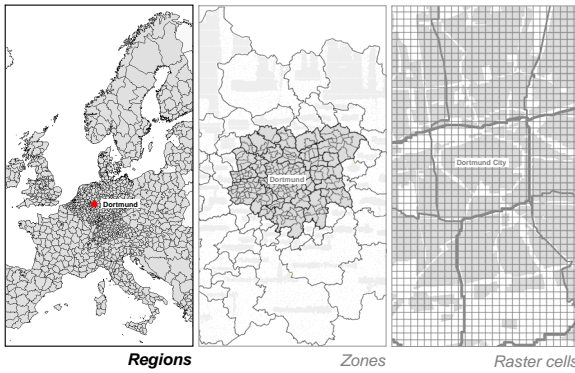

Advanced Modelling in Integrated Land-Use and Transport Systems (AMOLT) M.Sc. Transportation Systems TU München, 14 July 2009

Model levels

Multi-level

Multi-scale

Regions   *Zones*   *Raster cells*

2

Model levels

Dortmund

Dortmund City

Regions   *Zones*   *Raster cells*

3

New Challenges

Globalisation

"Old-established national industries have been destroyed or are daily being destroyed. They are dislodged by new industries, whose introduction becomes a life and death question for all civilised nations, by industries that no longer work up indigenous raw material, but raw material drawn from the remotest zones; industries whose products are consumed, not only at home, but in every quarter of the globe.."

Karl Marx and Friedrich Engels (1848):
Manifesto of the Communist Party

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Globalisation

Globalisation is characterised by a combination of technical, economic, socio-cultural and political trends:

- growing speeds and volumes of **production**, **transport** and **information** – but growing disparities in access to goods, mobility and knowledge,

- growing global **wealth** – but growing disparities in opportunities (education, health care), income and property,

- growing regional **specialisation** and **division of labour** – but growing disparities in supply of goods and jobs,

- growing international flows of **capital** – but attracted by a decreasing number of agglomerations,
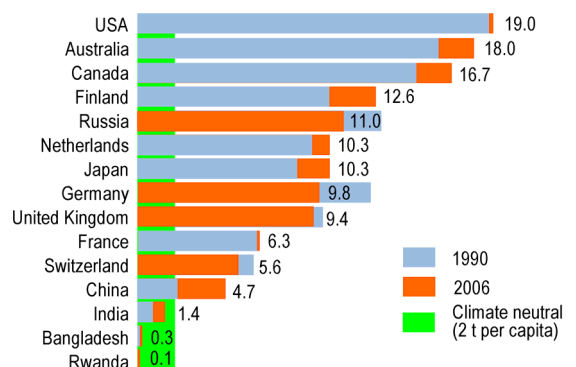
(continued)

6

Globalisation (continued)

- growing polarisation of **population growth** and **decline** but growing disparities in freedom of migration,

- growing **hierarchy** of territories with different economic and political interests – but **declining power** of central governments to propagate common goals,

- growing **competition** between territories for the same resources (investors, jobs, citizens, tourists) – but little incentives for regional co-operation,

- growing potential for exploitation of **resources**, negative **environmental impacts** and **social conflicts** – but little power of governments to counteract.
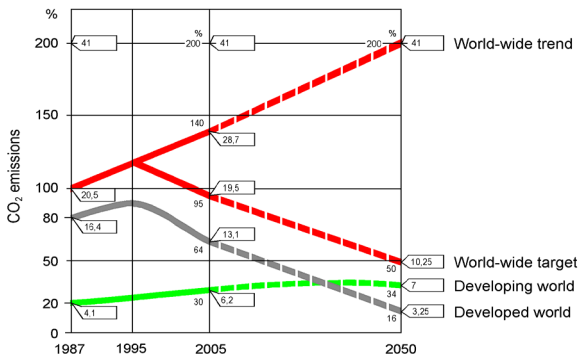
7

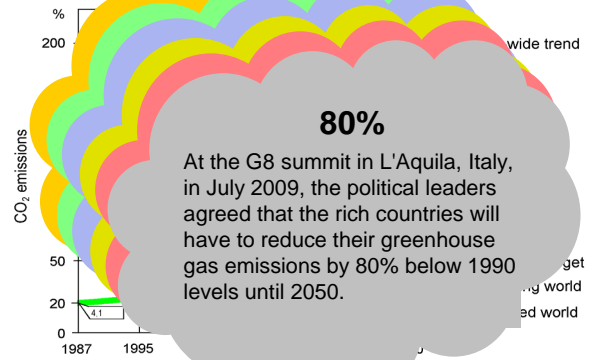### Climate change: CO_2 per capita (t) 1990-2006

USA	19.0
Australia	18.0
Canada	16.7
Finland	12.6
Russia	11.0
Netherlands	10.3
Japan	10.3
Germany	9.8
United Kingdom	9.4
France	6.3
Switzerland	5.6
China	4.7
India	1.4
Bangladesh	0.3
Rwanda	0.1

1990
2006
Climate neutral (2 t per capita)

8   Data: CDIAC (2009)

Climate change: emission targets

9

Source: Deutscher Bundestag (1990)

Climate change: emission

80%

At the G8 summit in L'Aquila, Italy, in July 2009, the political leaders agreed that the rich countries will have to reduce their greenhouse gas emissions by 80% below 1990 levels until 2050.

10

Deutscher Bundestag (1990)

Energy transition: Peak Oil

- Past discoveries
- Future discoveries
- Production
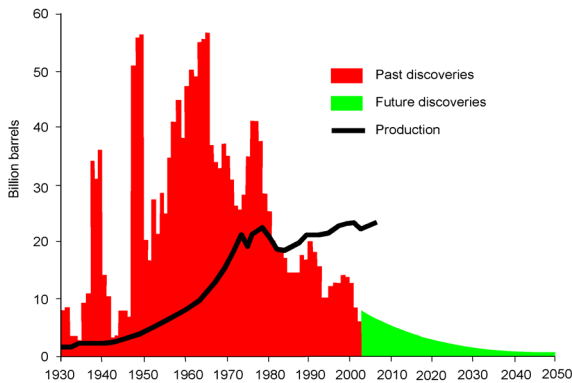
11

Source: ASPO, 2007

The end of the Oil Age

In July of 2008 the price of crude oil rose to almost *150 $ per barrel*. During the recent world-wide financial and economic crisis it went temporarily back to below *40 $ per barrel* and is now rising again.

Most experts believe that, because of the final depletion of oil resources, of political instability in the Middle East and of rising demand of fast growing developing countries, oil will *continue to become more expensive*.

This will have significant impacts on *fuel production*, *fuel types*, *fuel efficiency*, *location choice* and *mobility*.

What will be the impacts on *regions* and *cities*?

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The end of the Oil Age
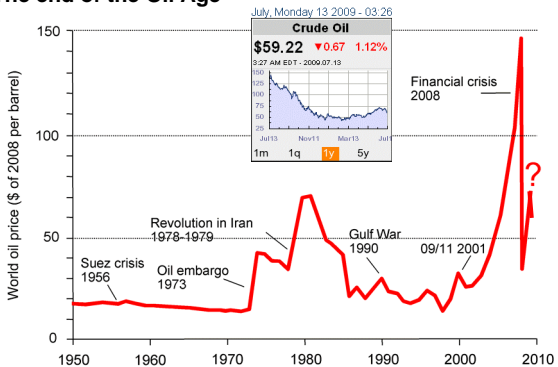
13

Source: WTRG Economics 2007 (updated)

Limits to growth

The conclusion is: another multiplication of *production*, *consumption* and *resource use* of the rich countries as in the past would *exceed* the resources of the planet:

- Even with the most optimistic assessment of the potential for energy conservation and increasing energy efficiency, the *greenhouse gas emission targets* are incompatible with continued economic growth.
- If the energy consumption of the world continues to grow as in the past, the known deposits of *fossil fuels* will be exhausted before the end of this century.
- Similar constraints apply to other *raw materials*, such as copper.

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The SASI Model

The SASI Model

There are essentially three methods to model the impacts of *transport* on regional economic development:

- *Multiplier effects* of *infrastructure investments* (Aschauer, 1993)
- *Regional production functions* incorporating *infrastructure* as production factor (Jochimsen, 1966; Biehl, 1986, 1991)
- *Interregional trade flows* as a function of interregional *transport costs* (Peschel, 1981; Bröcker, 1995), *input-output linkages* (Echenique, 1990) and *economies of scale* (Krugman, Venables,1995)

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The SASI Model

The SASI model is a *recursive-dynamic* simulation model of socio-economic development of regions in Europe under exogenous assumptions about

- the *economic* and *demographic* development of the *European Union*,
- *transport infrastructure investments* and other *transport policies*, in particular the *trans-European (TEN-T) networks*.

The SASI model differs from other regional economic models by modelling not only *production* (the *demand* side of labour markets) but also *population* (the *supply* side of labour markets).

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Regional production function

In state-of-the-art models of regional development based on the theory of production functions the classical production factors *land*, *labour* and *capital* are complemented by factors, such as:

- *Economic structure*
- *Productivity*
- *Accessibility*
- *Labour supply*
- *Services*
- *Settlement structure*
- *Research and development*
- *Education*
- *Quality of life*

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Regional production function

Extended production function:

$$Q_i = L_i^{\alpha}\, R_i^{\beta}\, K_i^{\gamma}\, A_i^{\delta}\, \ldots$$

Production — Land, Labour, Accessibility, Capital, Others

where A_i is *potential* accessibility:
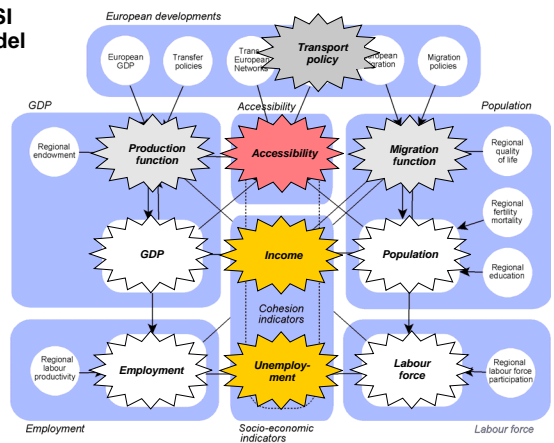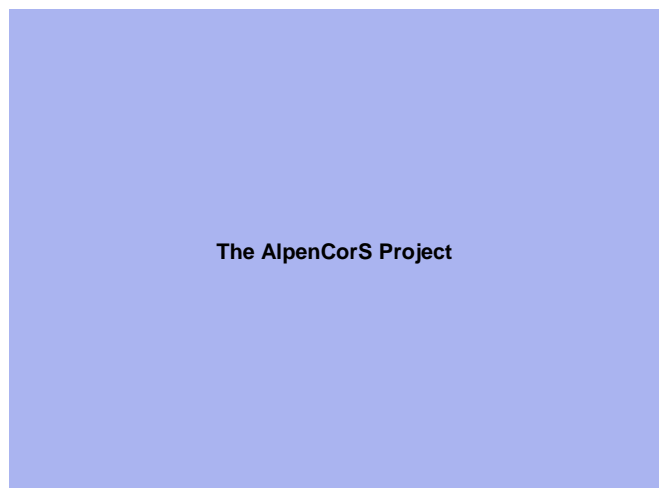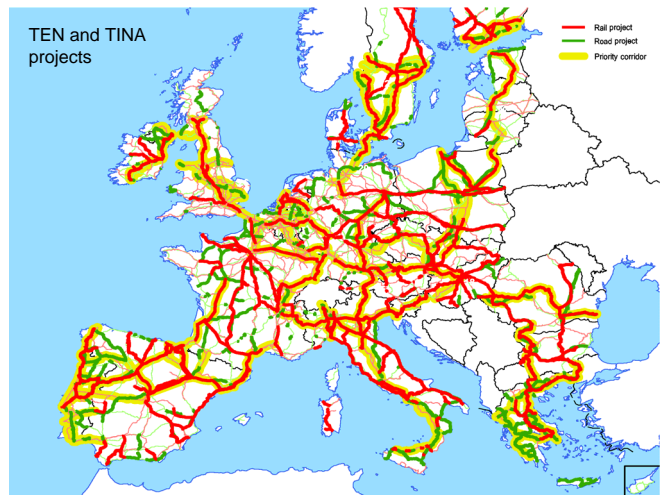
$$A_i = \sum_j W_j \exp(-\beta\, c_{ij})$$

Accessibility of region i — Destinations in region j — Travel cost between regions i and j

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SASI model

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Regions

TEN and TINA projects

Rail project
Road project
Priority corridor
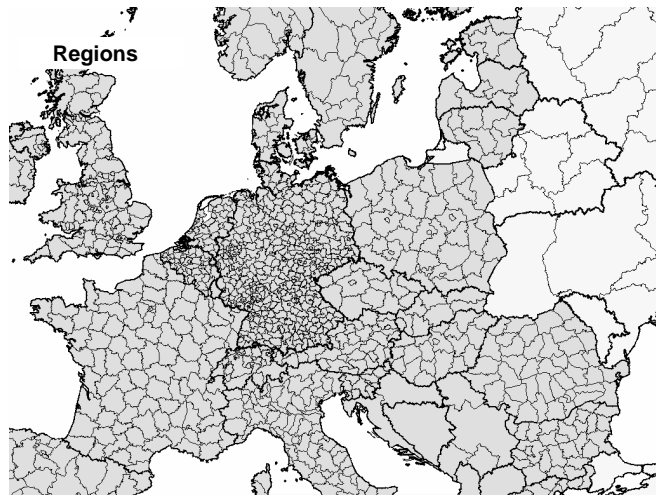
Multimodal accessibility 2031
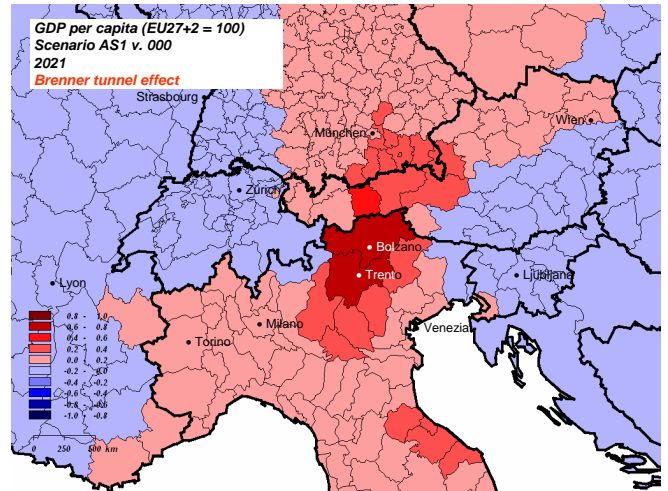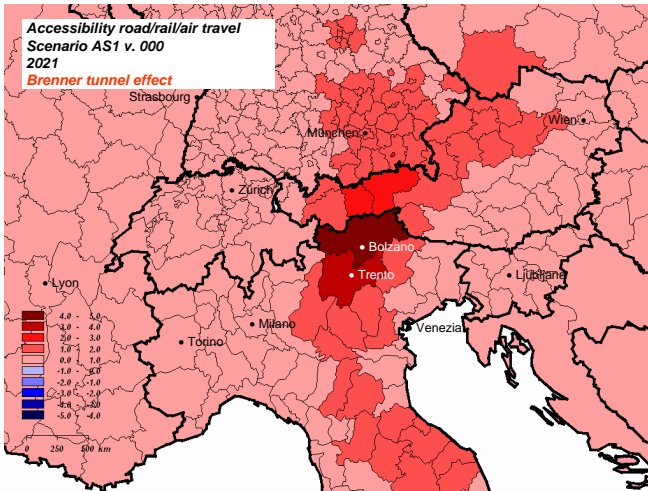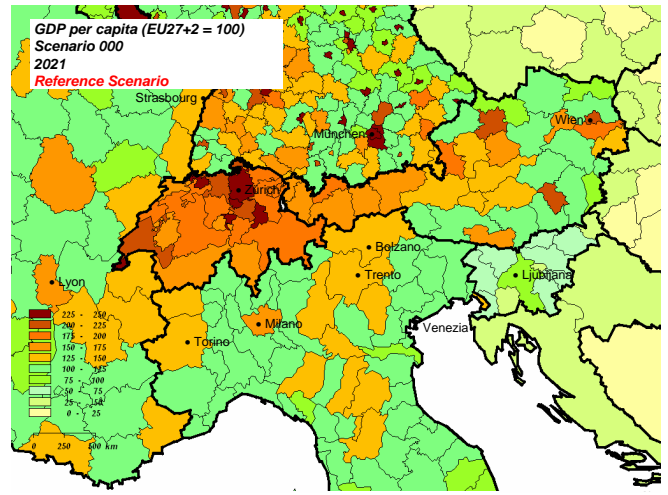

The AlpenCorS Project

The AlpenCorS project (2004-2005)

The Interreg III B programme *"Alpine Space"* (2000-2006) aimed at developing a concept for economic and spatial development in the **pan-European Corridor V** between France, Italy, Slovenia and Austria.

The project **AlpenCorS** (*"Alpen Corridor South"*) focused on the central segment of the corridors south of the Alps. The application of the SASI model was to assess the effects of the intersection with **Corridor I**, the **Brenner Corridor**.

GDP per capita (EU27+2 = 100)
Scenario 000
2021
Reference Scenario

Accessibility road/rail/air travel
Scenario AS1 v. 000
2021
Brenner tunnel effect

GDP per capita (EU27+2 = 100)
Scenario AS1 v. 000
2021
Brenner tunnel effect

**The STEPs Project:
Europe**

The STEPs project (2004-2006)

The EU 6th RTD Framework project **STEP**s (*Scenarios for the Transport System and Energy Supply and their Potential Effects*) **developed** and **assessed** possible **scenarios** for the **transport system** and **energy supply** of the future.

In the project **five urban/regional models** were applied to forecast the long-term economic, social and environmental impacts of different **scenarios** of **fuel price increases** and different combinations of **infrastructure**, **technology** and **demand regulation** policies.
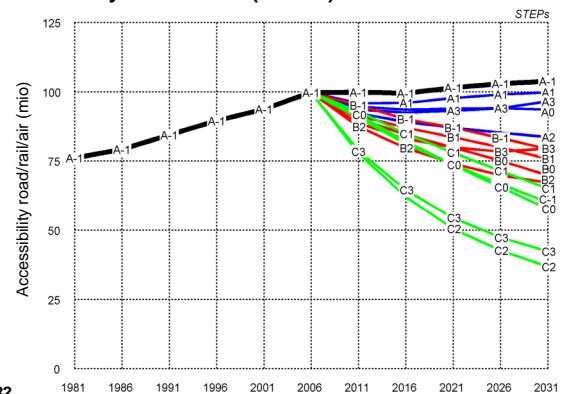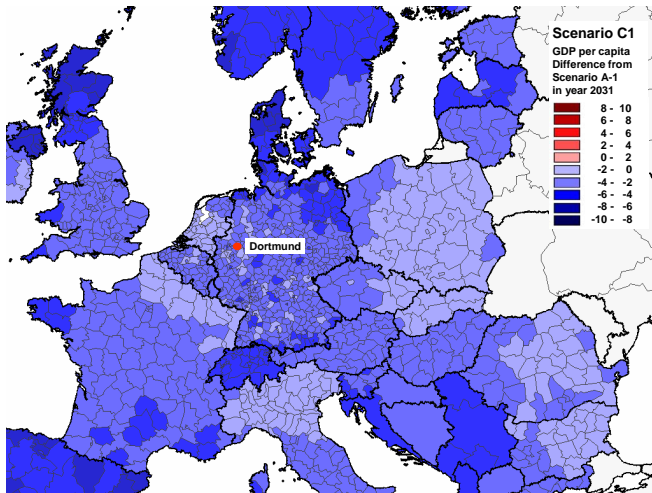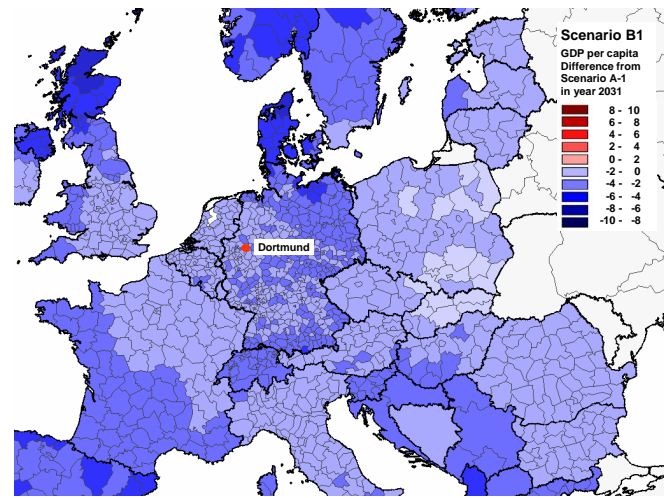
Scenarios

The STEPs scenarios combined three rates of **energy price increases** with three sets of **policies**:

	2030 1.60 €* +1% p.a.	2030 3.33 €* +4% p.a.	2030 6.80 €* +7% p.a.
Do-nothing	A-1	B-1	C-1
Business as usual	A0	B0	C0
Infrastructure & technology	A1	B1	C1
Demand regulation	A2 2030 3.35 €*	B2 2030 6.95 €*	C2 23.25 €*
All policies	A3	B3	C3

* € of 2008 per litre   A-1 *Reference Scenario*

Accessibility road/rail/air (million)

Scenario A1
GDP per capita
Difference from
Scenario A-1
in year 2031

8 - 10
6 - 8
4 - 6
2 - 4
0 - 2
-2 - 0
-4 - -2
-6 - -4
-8 - -6
-10 - -8

Dortmund

Scenario B1
GDP per capita
Difference from
Scenario A-1
in year 2031

8 - 10
6 - 8
4 - 6
2 - 4
0 - 2
-2 - 0
-4 - -2
-6 - -4
-8 - -6
-10 - -8

Dortmund

Scenario C1
GDP per capita
Difference from
Scenario A-1
in year 2031

8 - 10
6 - 8
4 - 6
2 - 4
0 - 2
-2 - 0
-4 - -2
-6 - -4
-8 - -6
-10 - -8

Dortmund
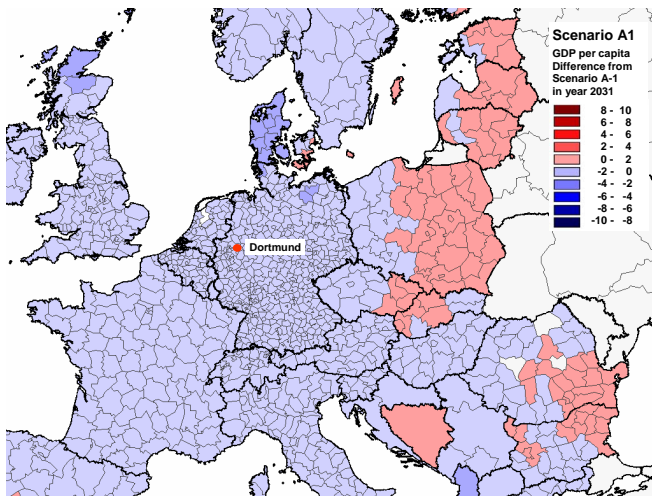
Future Work

New submodels

- *Productivity:* forecast labour productivity as a function of accessibility etc.
- *Migration:* migration flows instead of net migration as a function of regional attractiveness and jobs
- *Capital:* model mobility of capital as a function of labour productivity and accessibility
- *Competition:* model regional subsidies, corporate taxes, labour costs
- *ICT:* include information and communications technology variables in the regional production function
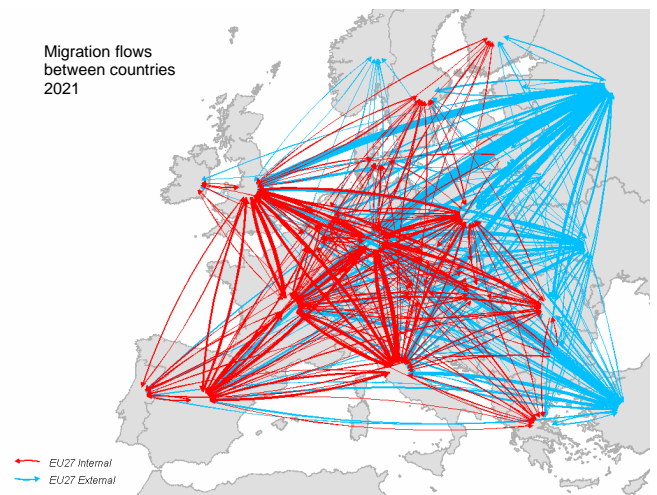- *Revenues:* model effects of revenues of transport pricing on GDP and employment

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Migration flows
between countries
2021

EU27 Internal
EU27 External

Output indicators

- *Transport:* person-kilometres and ton-kilometres by transport mode
- *Greenhouse gases:* CO_2 emissions by transport by mode per year
- *Air pollution:* NO_x and PM_{10} emissions by transport by mode per year
- *Noise:* noise emissions by transport by mode per year
- *Land take:* land area used for new transport infrastructure and landscape fragmentation
- *Revenues:* revenues of transport pricing by mode per year for reinvestment scenarios

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More information

Wegener, M., Bökemann, D. (1998): *The SASI Model: Model Structure*. Berichte aus dem Institut für Raumplanung 40. Dortmund: Institute of Spatial Planning, University of Dortmund. http://www.raumplanung.uni-dortmund.de/irpud/fileadmin/irpud/content/documents/publications/ber40.pdf.

Wegener, M. (2008): *SASI Model Description*. Working Paper 08/01. Dortmund: Spiekermann & Wegener Stadt- und Regionalforschung. http://www.spiekermann-wegener.de/mod/pdf/AP_0801.pdf.

More information on the SASI model and its applications is available at http://www.spiekermann-wegener.de/mod/sasimod_e.htm.

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