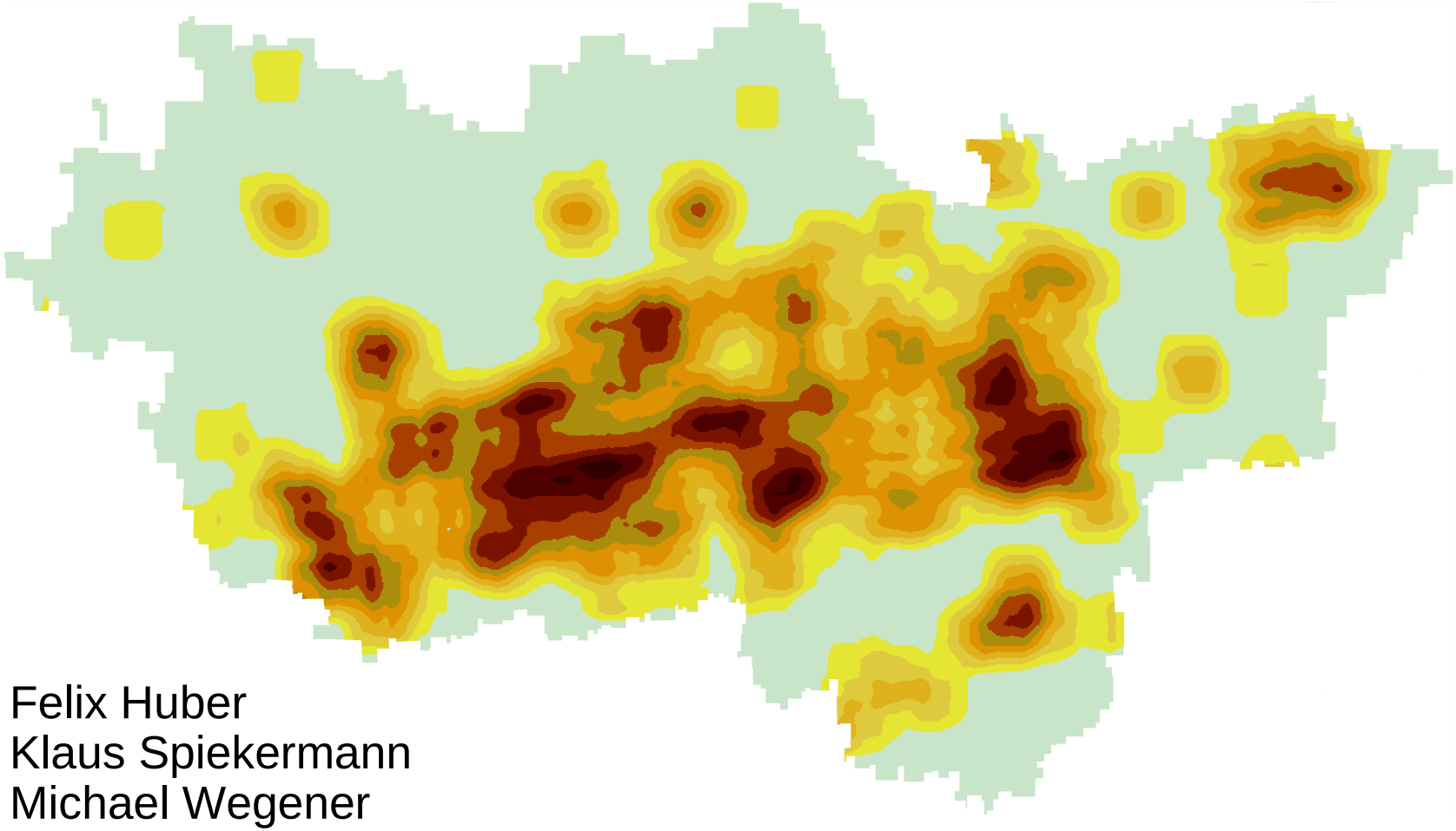
Cities and Climate Change

A Simulation Model for the Ruhr Area in 2050



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REAL CORP 2011, Essen, 18-20 May 2011

New Challenges

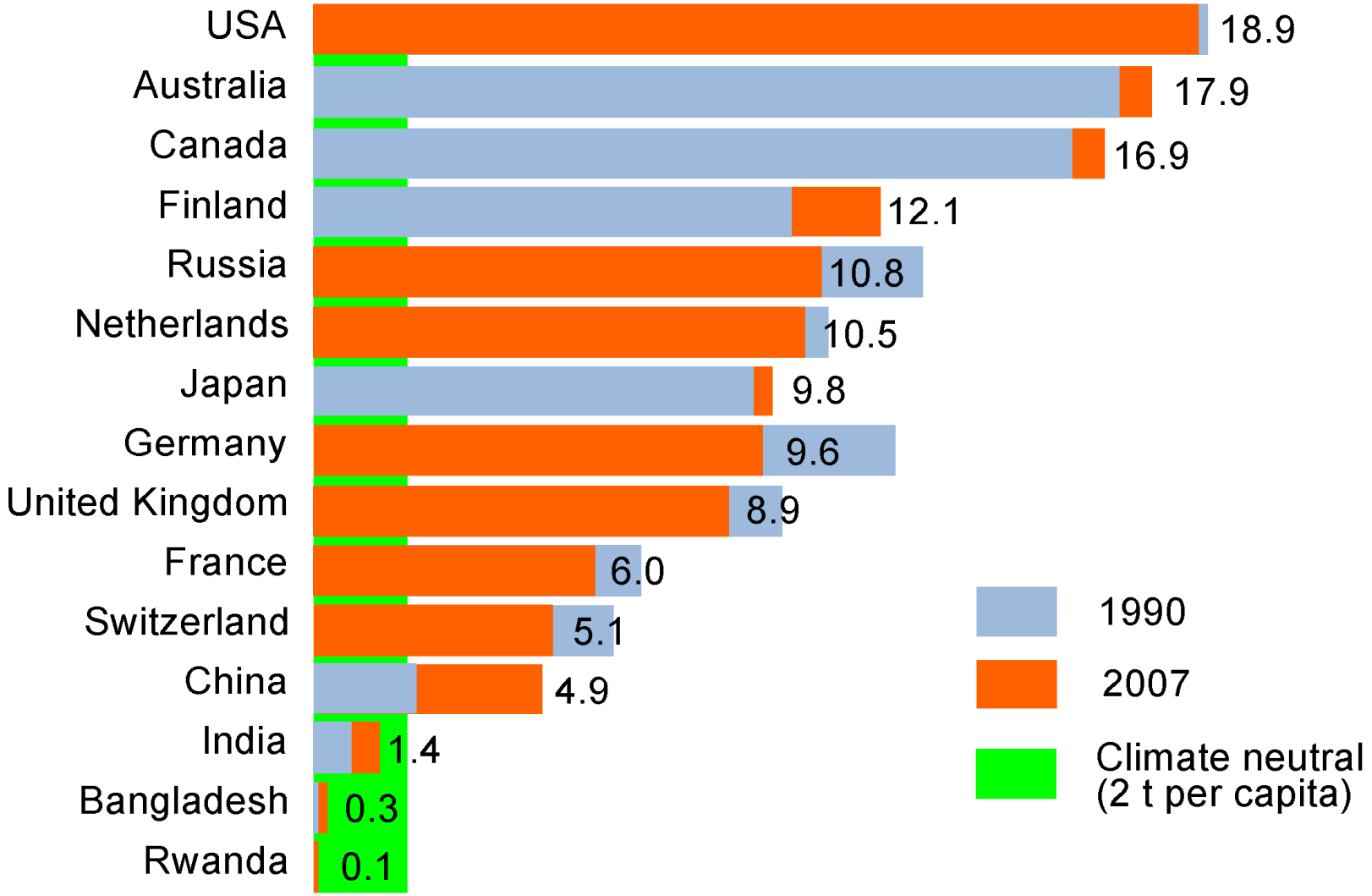
New challenges (1)

Twenty percent of mankind command ***eighty*** percent of the world's wealth and are responsible for ***eighty*** percent of the world's energy use and greenhouse gas emissions.

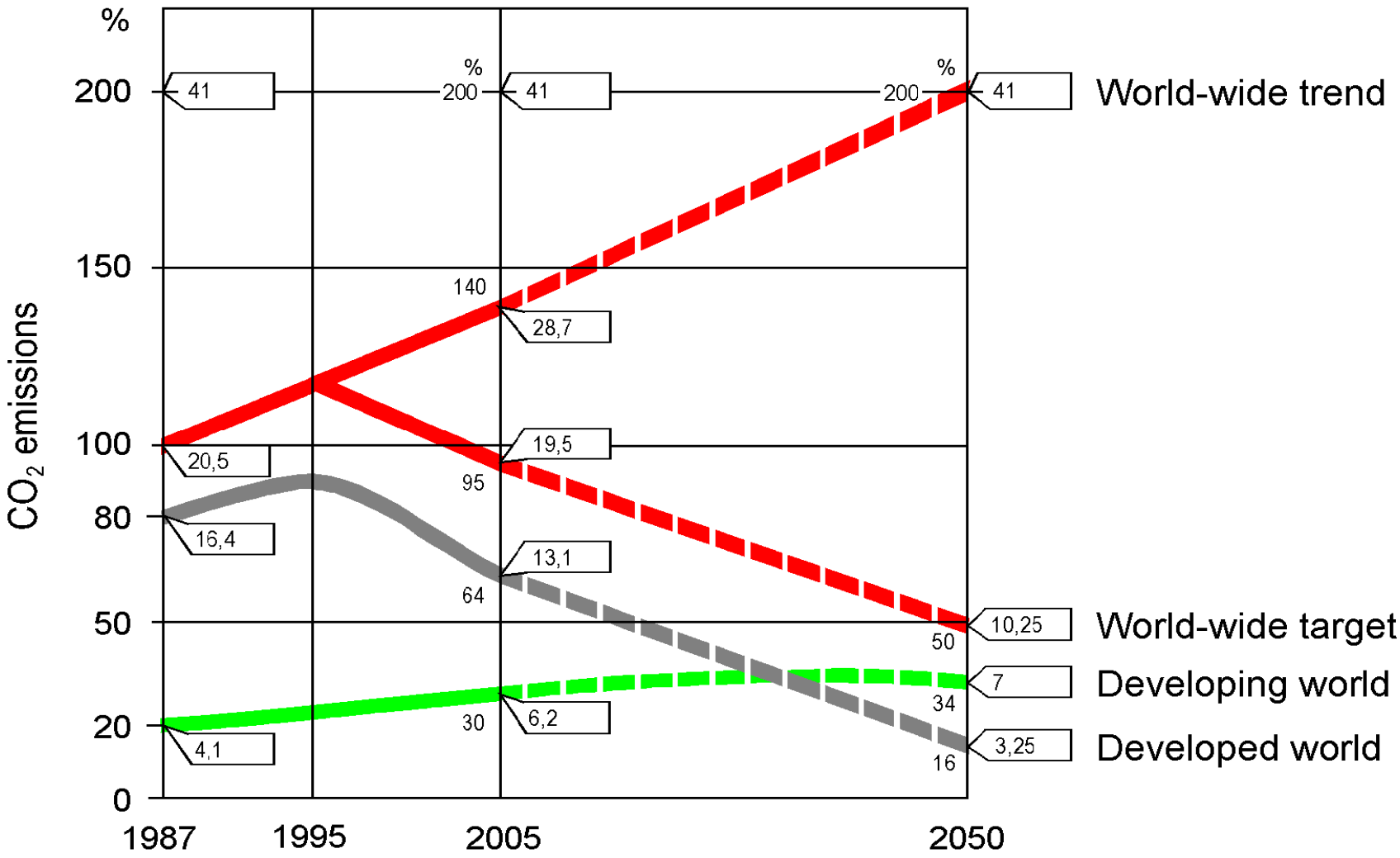
This inequality is growing. Since the 1970s, the per capita income of the industrialised countries has grown by a factor of ***ten***, whereas that of the developing countries has only ***tripled***.

But another multiplication of production, consumption and resource use of the rich countries as in the last thirty years would ***exceed*** the resources of the earth.

CO_2 emission per capita per year (t)

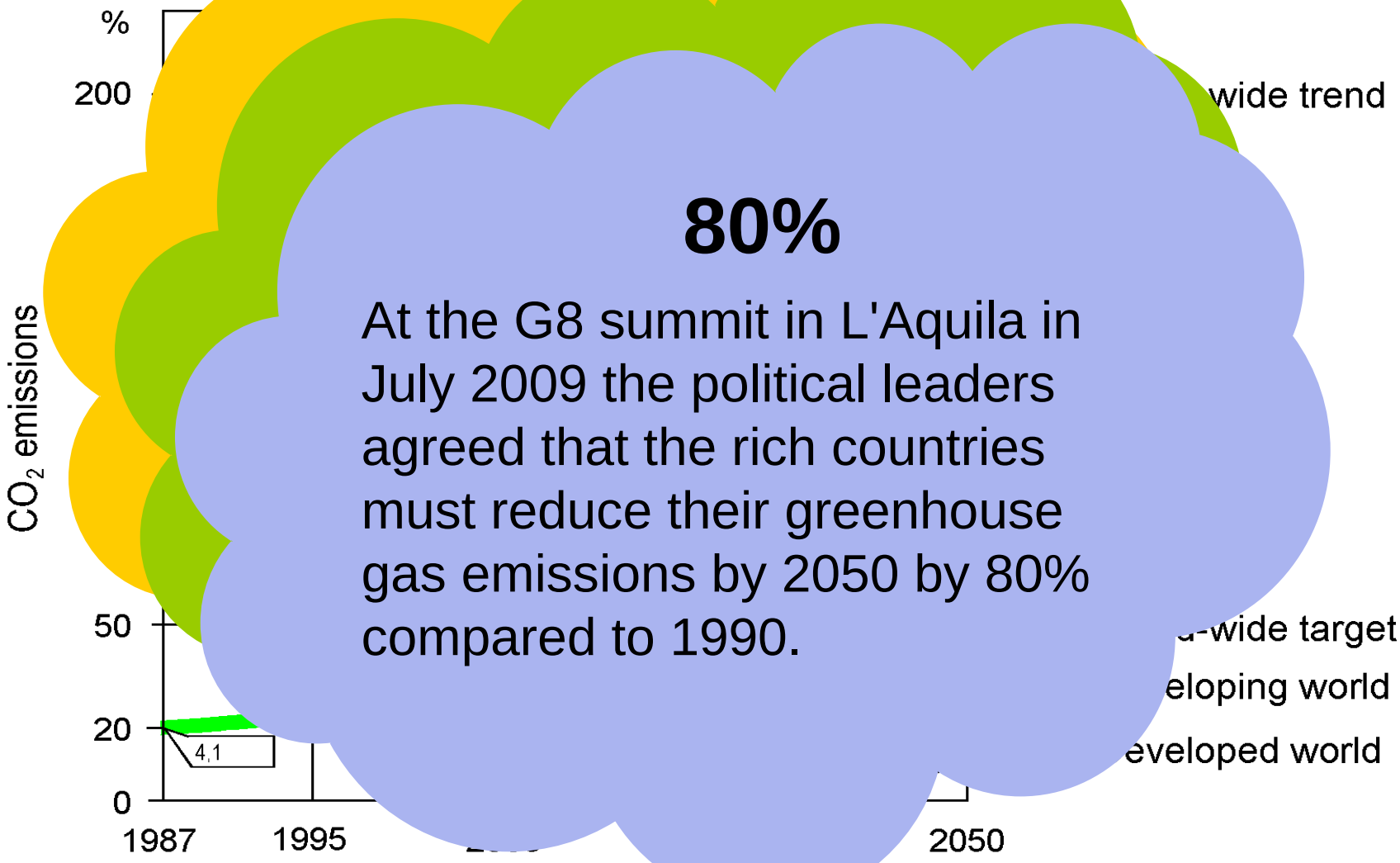


Emission targets



Source: Deutscher Bundestag (1990)

Emission targets



80%

At the G8 summit in L'Aquila in July 2009 the political leaders agreed that the rich countries must reduce their greenhouse gas emissions by 2050 by 80% compared to 1990.

Source: Deutscher Bundestag (1990)

New challenges (3)

The growing awareness of the challenge of climate change has led to ambitious ***greenhouse gas emission reduction targets***.

However, current policy approaches in regions and cities focus on ***incremental short-term*** measures to ***adapt*** to the consequences of no longer avoidable climate change.

They ***neglect*** necessary measures of ***climate protection***, i.e. measures to avoid or ***mitigate*** still avoidable climate change by reducing greenhouse gas emissions according to government reduction targets.

New challenges (4)

There are many reasons for the neglect of climate protection measures by regions and cities:

- ***Energy savings in buildings*** are not profitable in the short term with continued low energy prices.
- ***Constraints on mobility*** to reduce greenhouse gas emissions of transport are perceived as a serious loss of quality of life.

However, one important reason is the ***lack of knowledge*** about the likely ***impacts*** of climate protection policies on ***economy***, ***mobility***, ***environment*** and ***quality of life***.

New challenges (5)

In particular missing are ***methods*** to ***assess in advance*** the ***interactions*** between possible policies from different policy fields:

- ***Climate protection:***
  - ***CO_2-taxes*** and ***emission trading***
  - ***Road user charges*** and ***parking charges***
  - Promotion of ***alternative vehicles/fuels***
  - Promotion of ***telework*** and ***car-sharing***
  - Promotion of ***public transport***
  - ***Anti-sprawl*** policies

Adaptation to climate change:

  - Measures against ***flooding***
  - Measures to avoid ***heat islands***

continued →

New challenges (6)
(continued)

- ***Energy scarcity:***
  - Promotion of ***alternative vehicles/fuels***
  - Promotion of ***alternative energies*** (solar, geothermic, combined heat and power)
  - Promotion of better ***heat insulation of buildings***
- ***Social conflicts:***
  - ***Identification*** of population groups ***most affected*** by climate change and energy scarcity
  - ***Compensation*** of ***most affected*** groups
  - ***Definition*** and maintenance of ***minimum standards*** of ***access to basic services*** and ***participation in social and cultural life***

New challenges (7)

The ***methodological deficits*** are particularly relevant in the field of transport. Many ***transport models*** used in the planning practice cannot predict the effects of strong ***fuel price increases***:

- Many models do not consider ***transport costs*** in trip generation, trip distribution and modal split.
- Many model do not consider ***induced*** or ***suppressed*** trips.
- Many models use ***price elasticities*** estimated in times of cheap energy.
- Many models do not consider ***household budgets*** for housing and transport.

Cities and Climate Change:
Ruhr 2050

Cities and climate change: Ruhr 2050

The project presented here aims at the development and application of an ***integrated model system*** to assess and evaluate the impacts of policies to ***mitigate*** climate change and to ***adapt*** to the impacts of climate change no longer avoidable in urban regions ***until 2050*** using the ***Ruhr area*** as a case study region.

Cities are the ***largest emitters*** of ***greenhouse gas emissions*** trough ***heating***, ***air conditioning***, ***manufacturing*** and ***transport*** and are particularly vulnerable to the consequences of climate change like ***floods***, ***droughts***, ***storms*** or ***heat waves***.

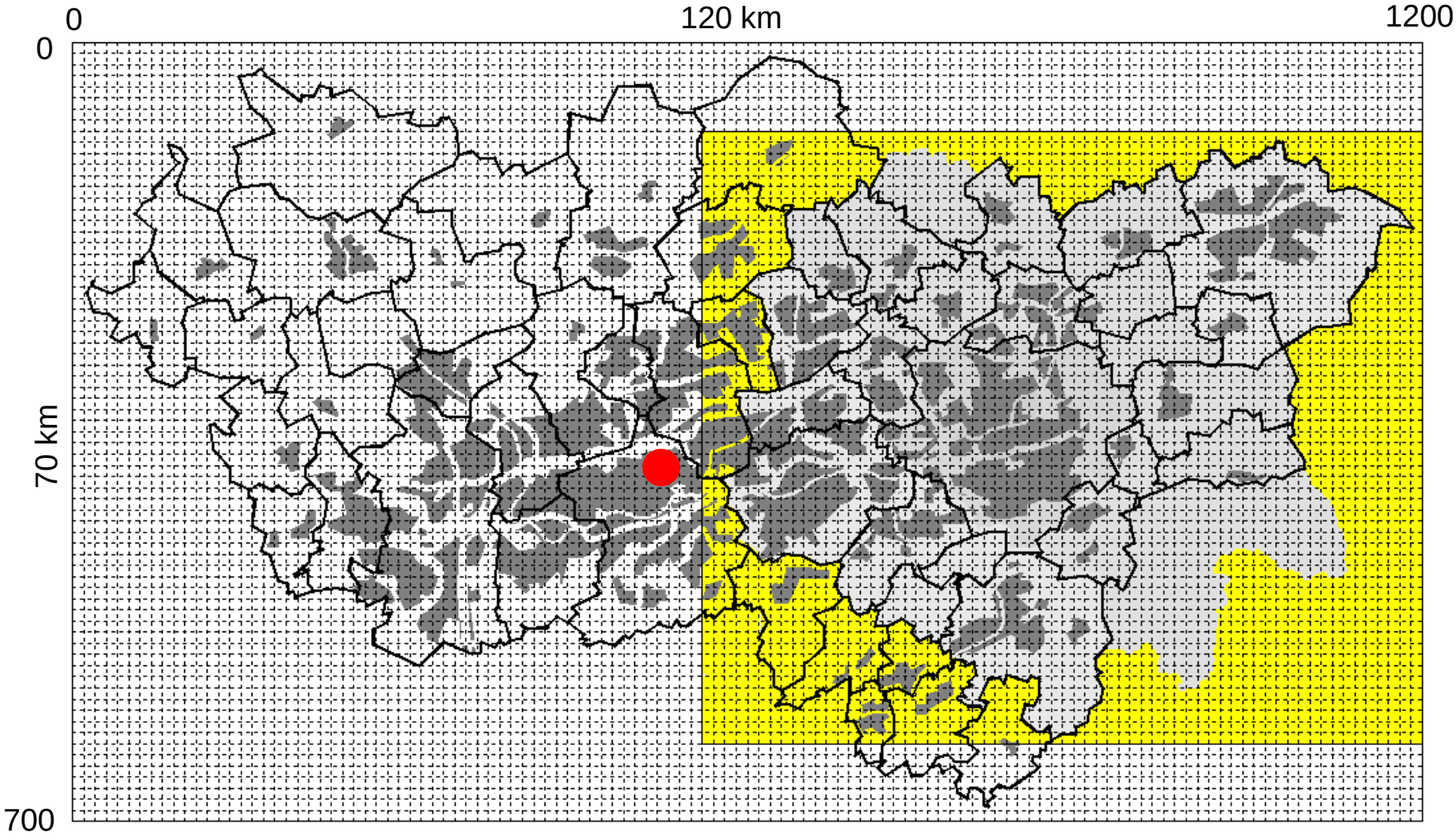
Study area (1)

As study area of the Ruhr 2050 project is the ***Ruhr area***.

With a population of more than 5 million, the Ruhr area is one of the ***largest urban agglomerations*** in Europe.

Through its ***industrial past*** and ***polycentric*** urban system it has a special potential to convert ***former industrial*** sites to ***high-density mixed-use*** developments with ***little land take***, ***small energy use*** and ***short travel distances***.

Study area (2)



Methodology (1)

In the project a ***simulation model*** of urban ***land use***, ***mobility and environment*** developed at the Institute of Spatial Planning of the University of Dortmund is to be extended to cover the ***whole Ruhr area***.

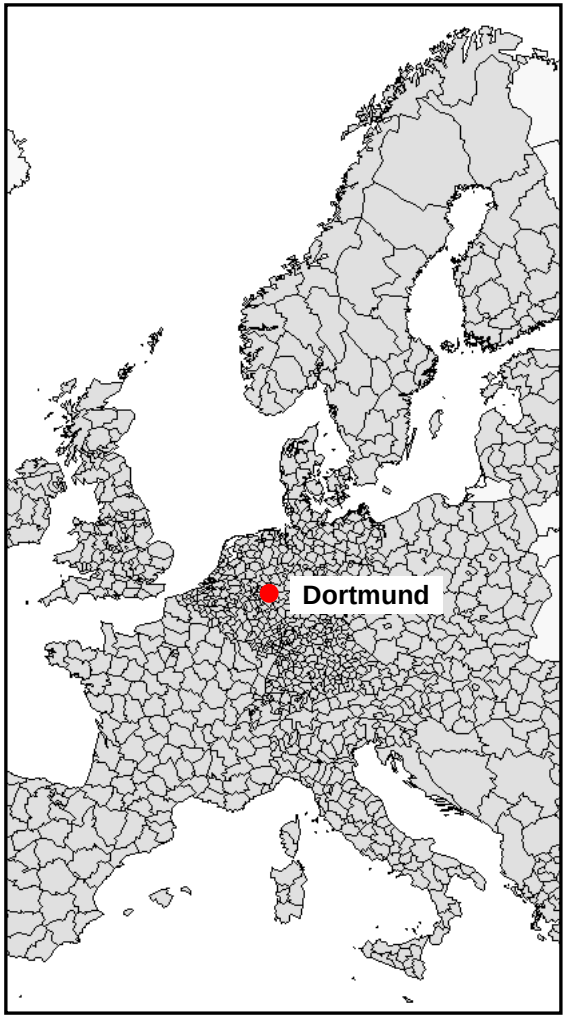
The model predicts for each period intraregional ***location*** decisions of ***industry***, ***developers*** and ***households***, the resulting ***migration*** and ***travel patterns***, ***construction*** and ***land use*** development and the impacts of ***public policies*** in the fields of ***economic promotion***, ***housing***, ***public facilities*** and ***transport***.

Methodology (2)

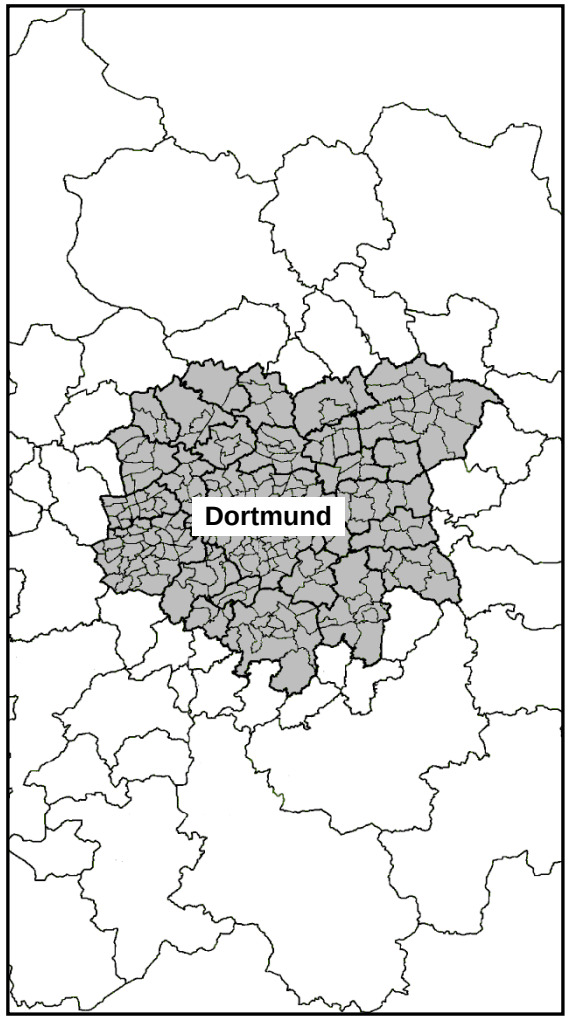
The extended model is to be linked with ***high-resolution models*** of ***environmental impacts*** of land use and transport. It predicts not only environmental ***impacts*** but also their effects on the ***location decisions*** of households and firms (***environmental feedback***).

The ***environmental impact*** submodels needed for this are partly already available (***air quality***, ***traffic noise***, ***biodiversity***) and partly will be developed (***building energy***, ***process energy***, ***solar/wind energy***, ***floods*** and ***heat waves***).

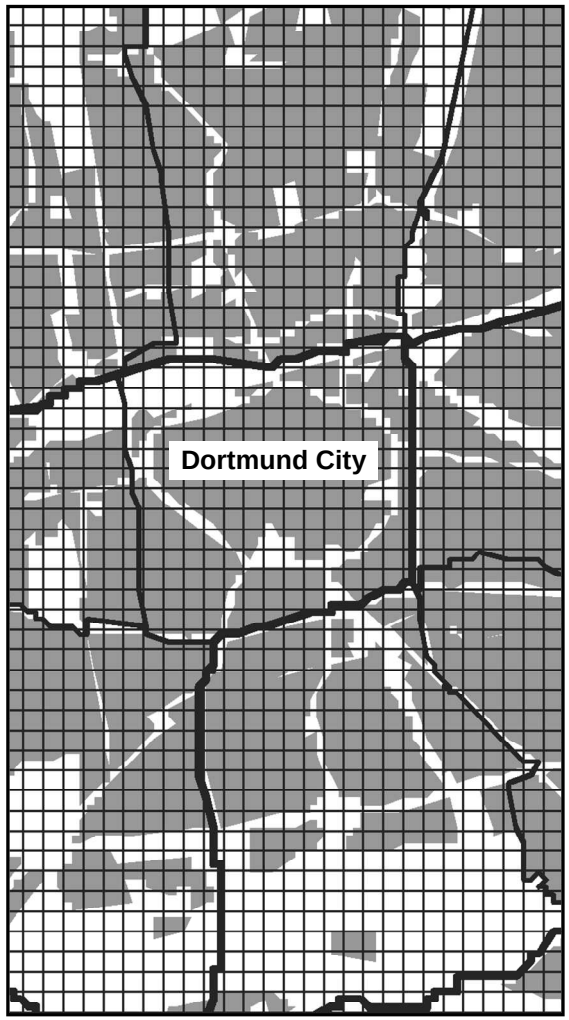
Model levels



SASI model

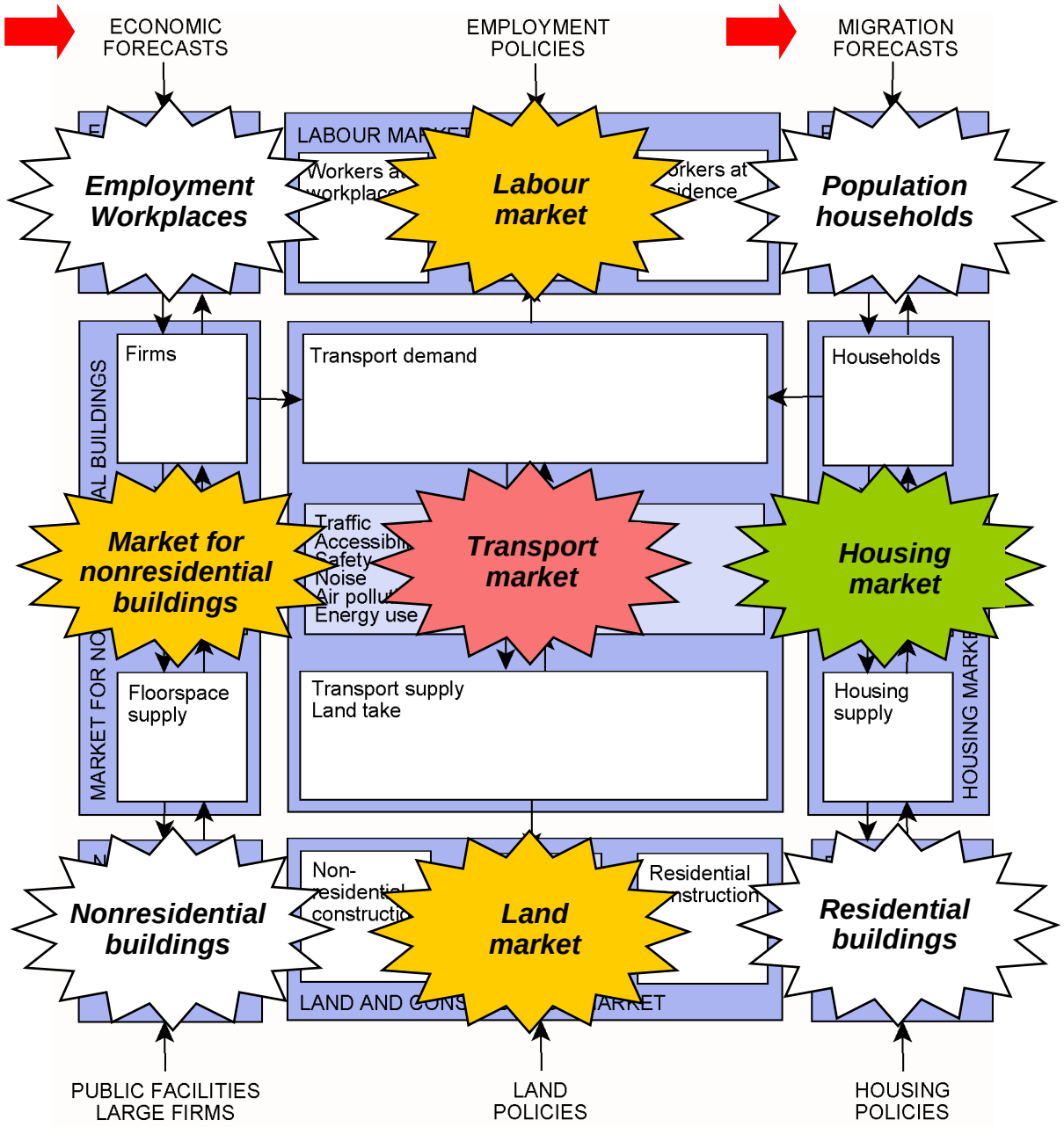


IRPUD model



Raster model

IRPUD model subsystems



SASI model results

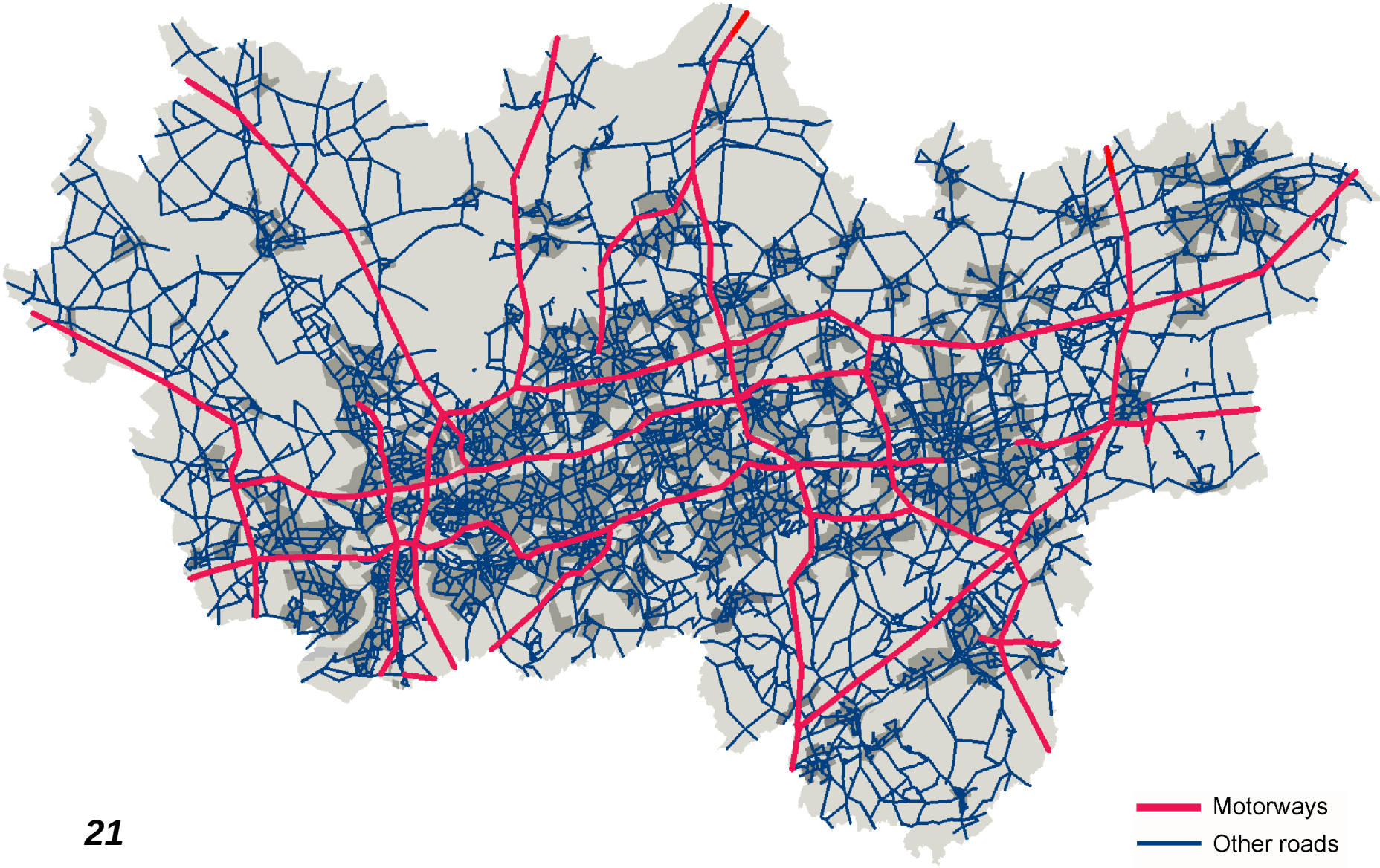
Microsimulation

Interactions between land use and environment

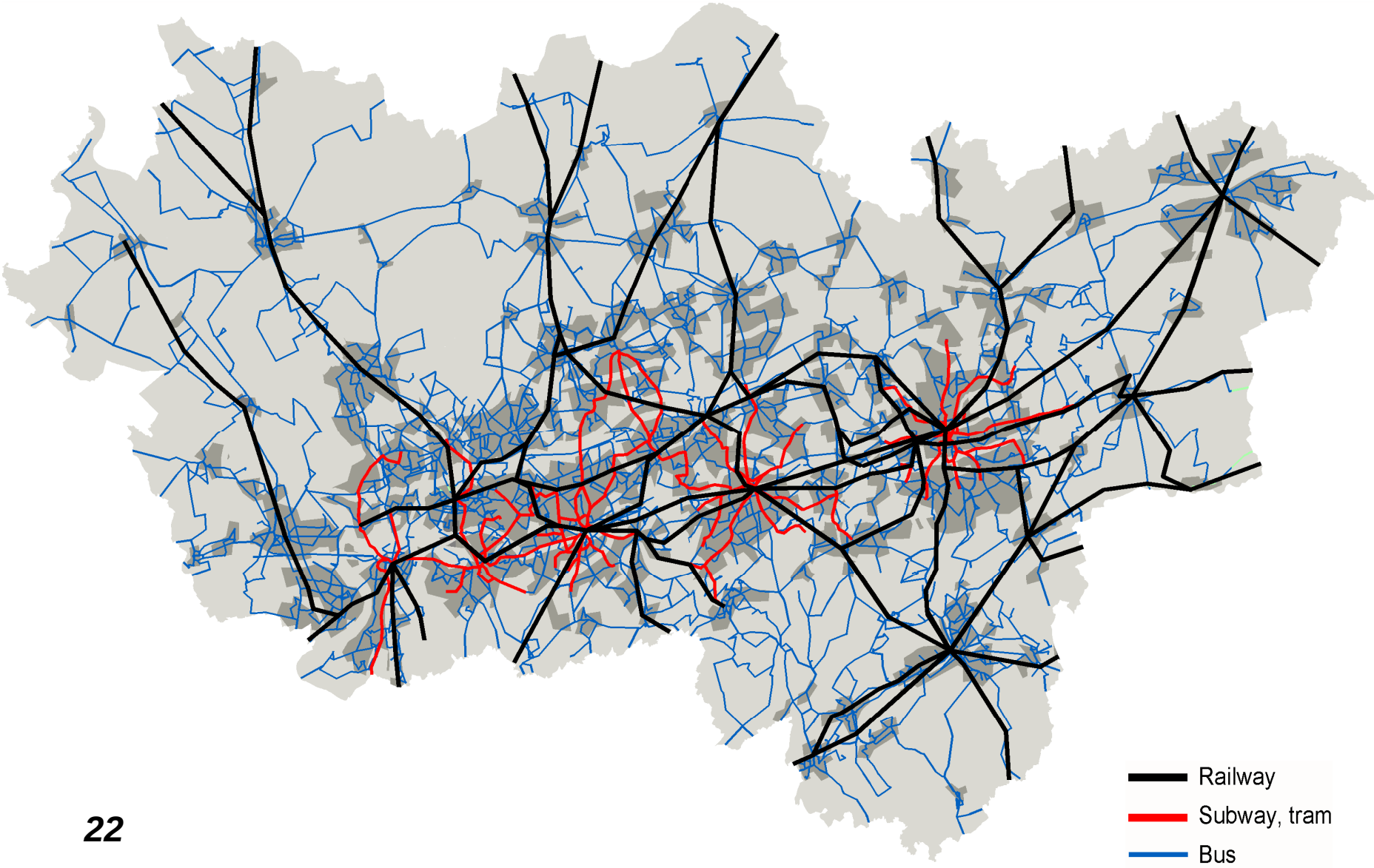
Cause	Effect	Land use	Transport	Energy	Water	Land	Vegetation	Wildlife	Microclimate	Greenhouse gases	Air pollution	Water pollution	Soil contamination	Solid waste	Noise	Air quality	Surface water flows	Ground water flows	Noise propagation
		Resources		Resources						Emissions						Exposure			
Land use		●	●	●	●	●	●	●	●	●	●	○	●	●	●	●	●	●	●
Transport		●	●	●		●	○	○		●	●	○	○	○	●	●			●
Energy	Resources	○	○	●						●	●					●			
Water	Resources				●												●	●	
Land	Resources	●			●	●	●	●	●								●	●	○
Vegetation	Resources	○			○		●	●	●	●									●
Wildlife	Resources							●											
Microclimate	Resources	○					○	○	●										
Greenhouse gases	Emissions									●									
Air pollution	Emissions								●		●					●			
Water pollution	Emissions				●		●	●				●					●	●	
Soil contamination	Emissions	○				●	●	●				●	●						
Solid waste	Emissions	○			○	○							●	●			●	●	
Noise	Emissions														●				●
Air quality	Exposure	●					●	○	●			○	○			●			
Surface water flows	Exposure				●		●	●	●								●		●
Ground water flows	Exposure				●		●	●	●									●	
Noise propagation	Exposure	●						●											●

○ weak impact ● strong impact

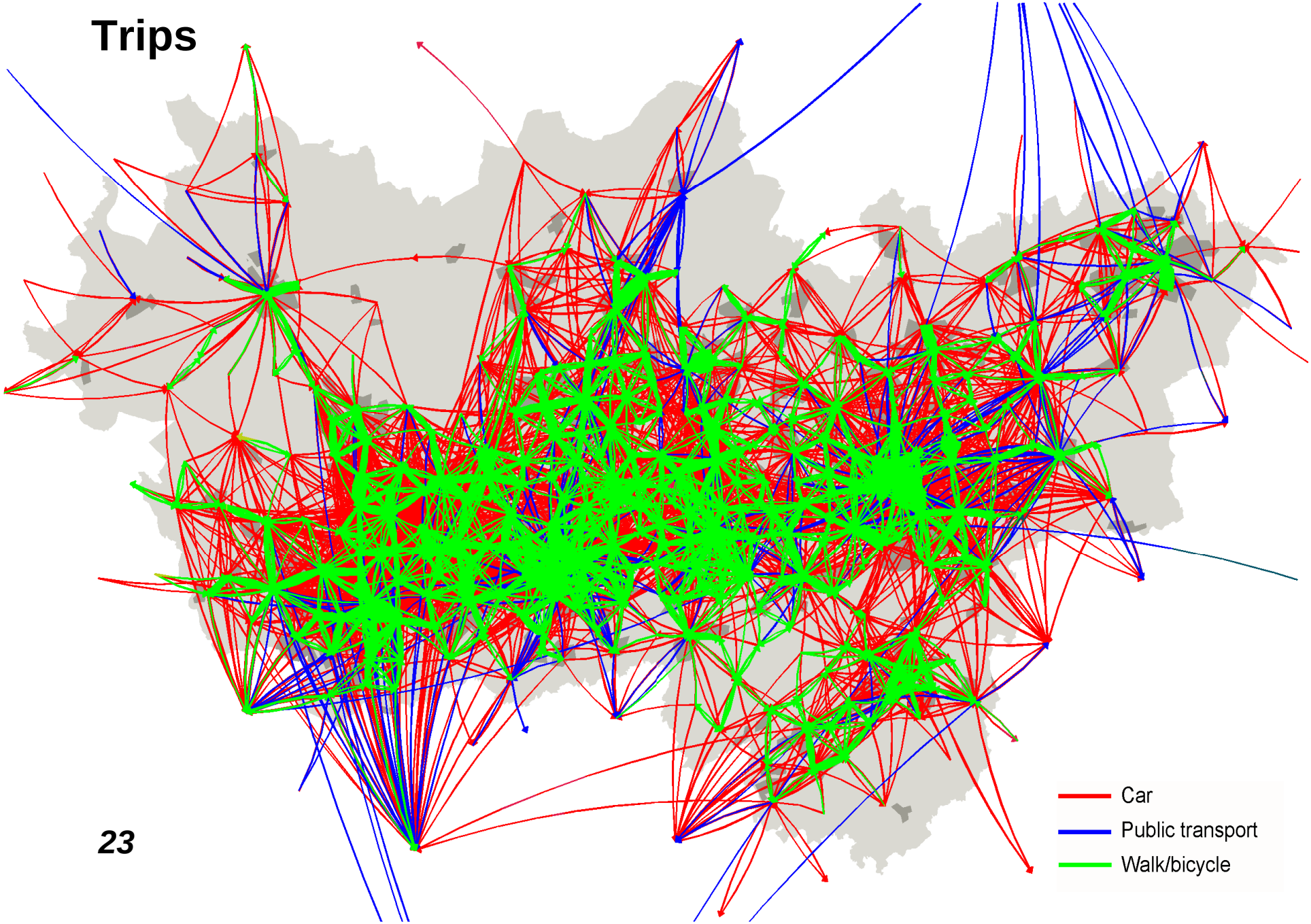
Road network



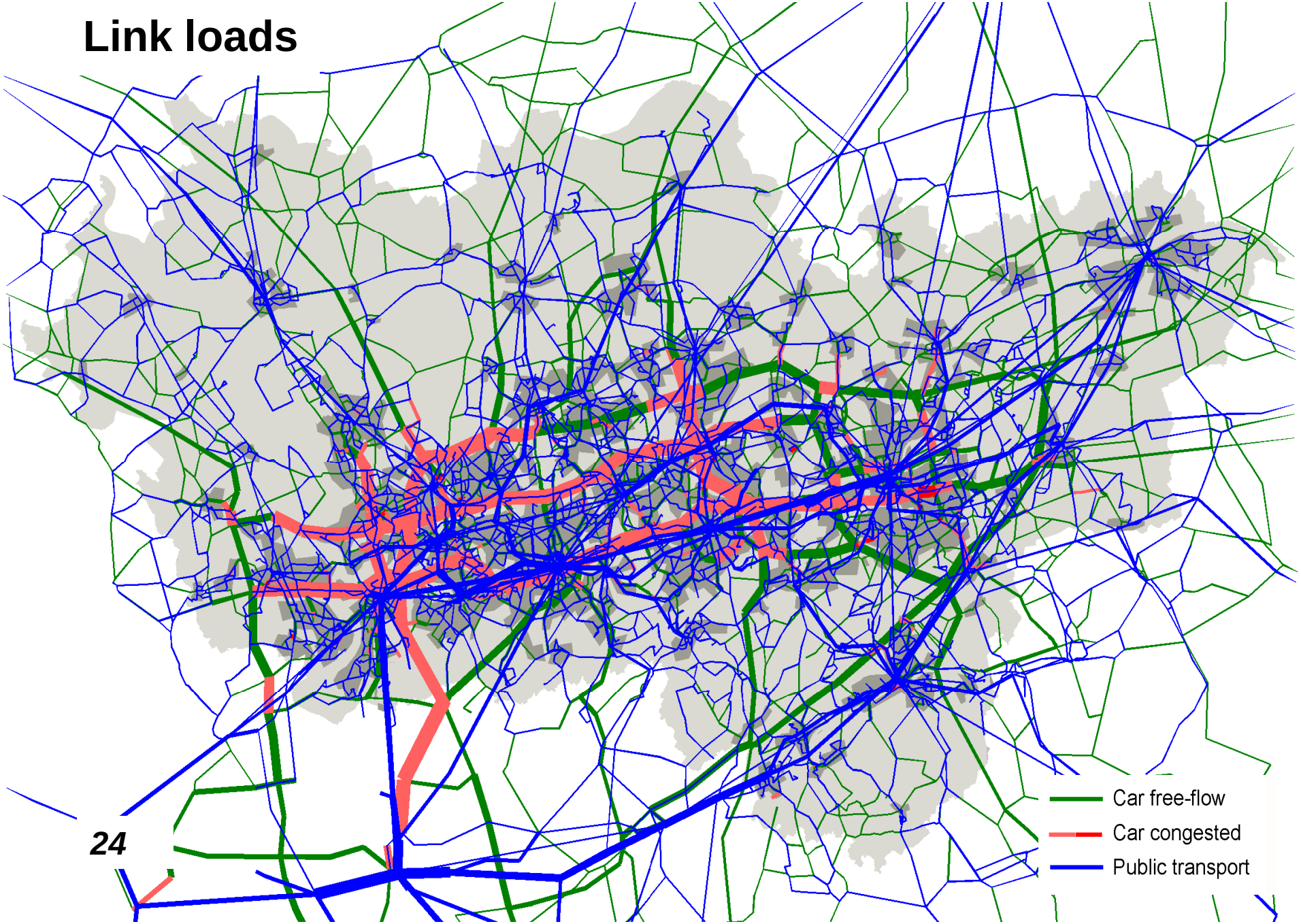
Public transport network



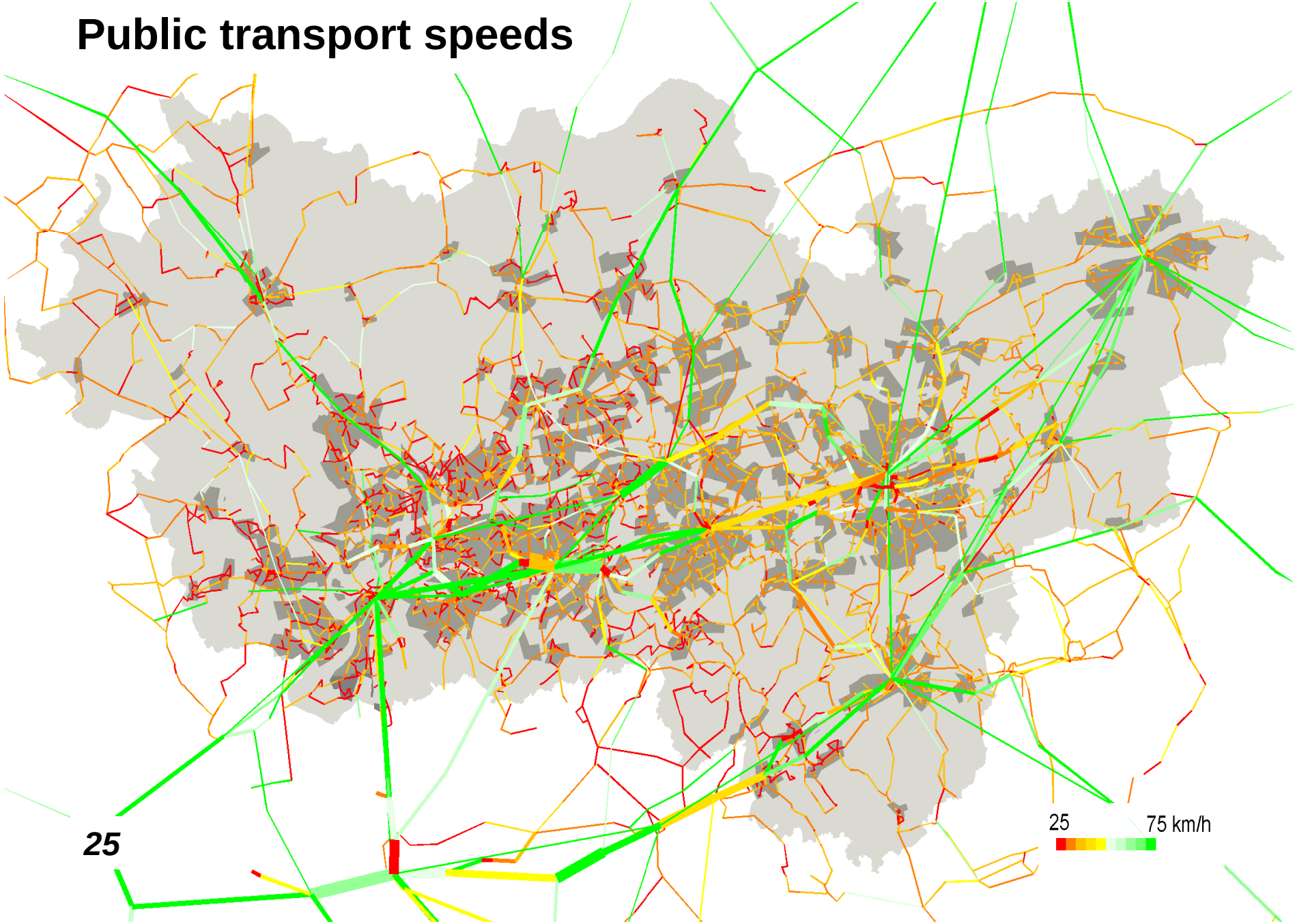
Trips



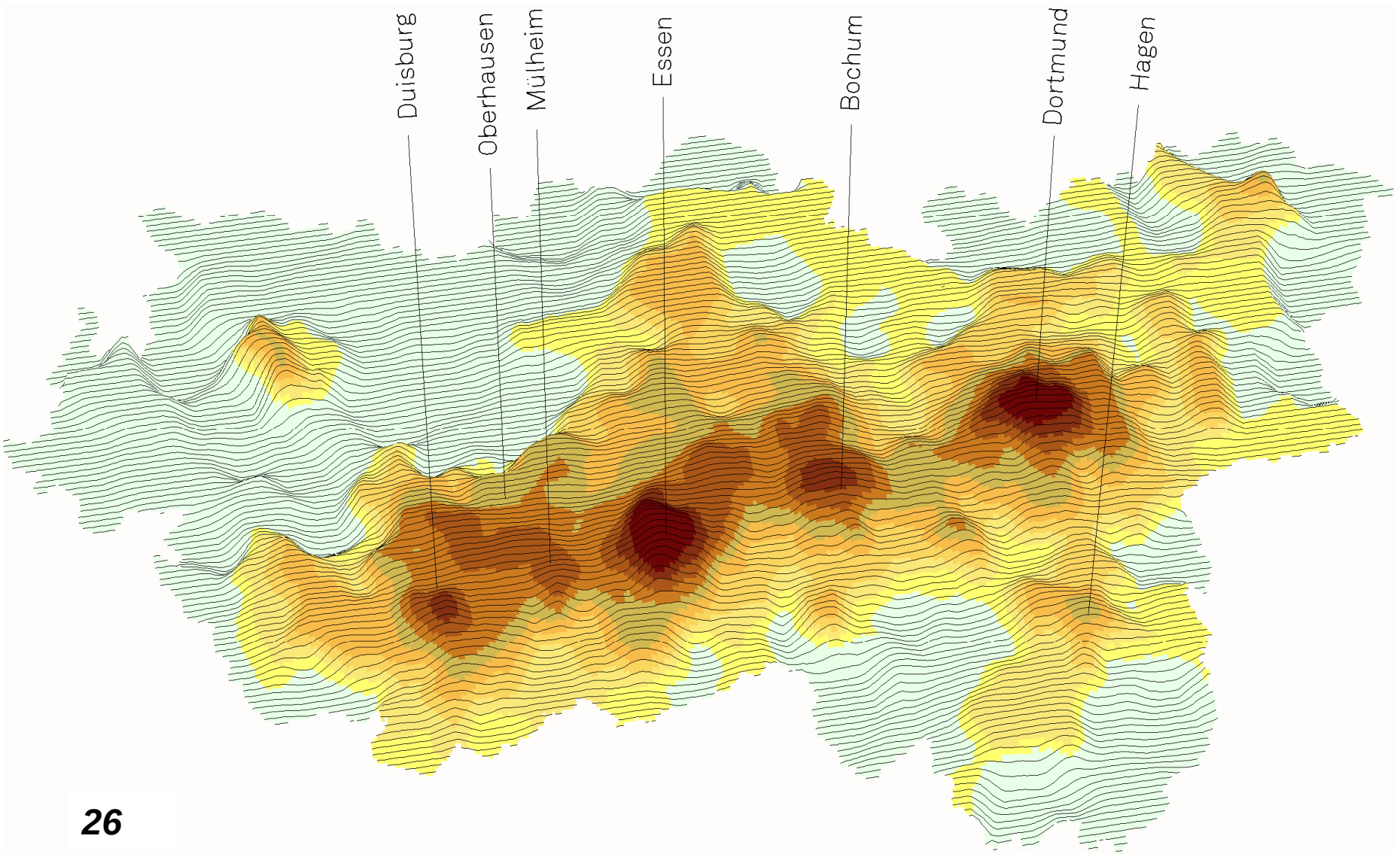
Link loads



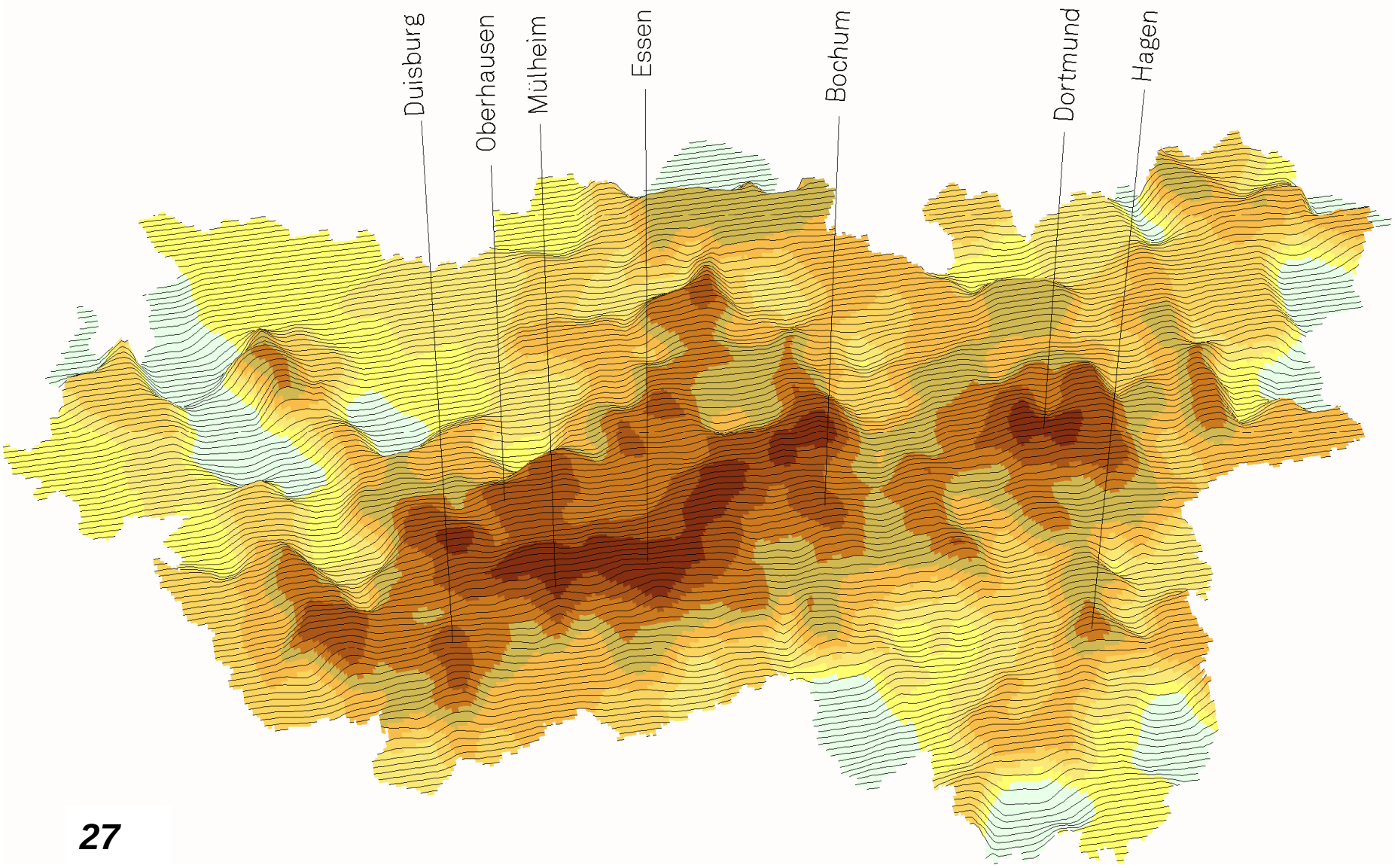
Public transport speeds



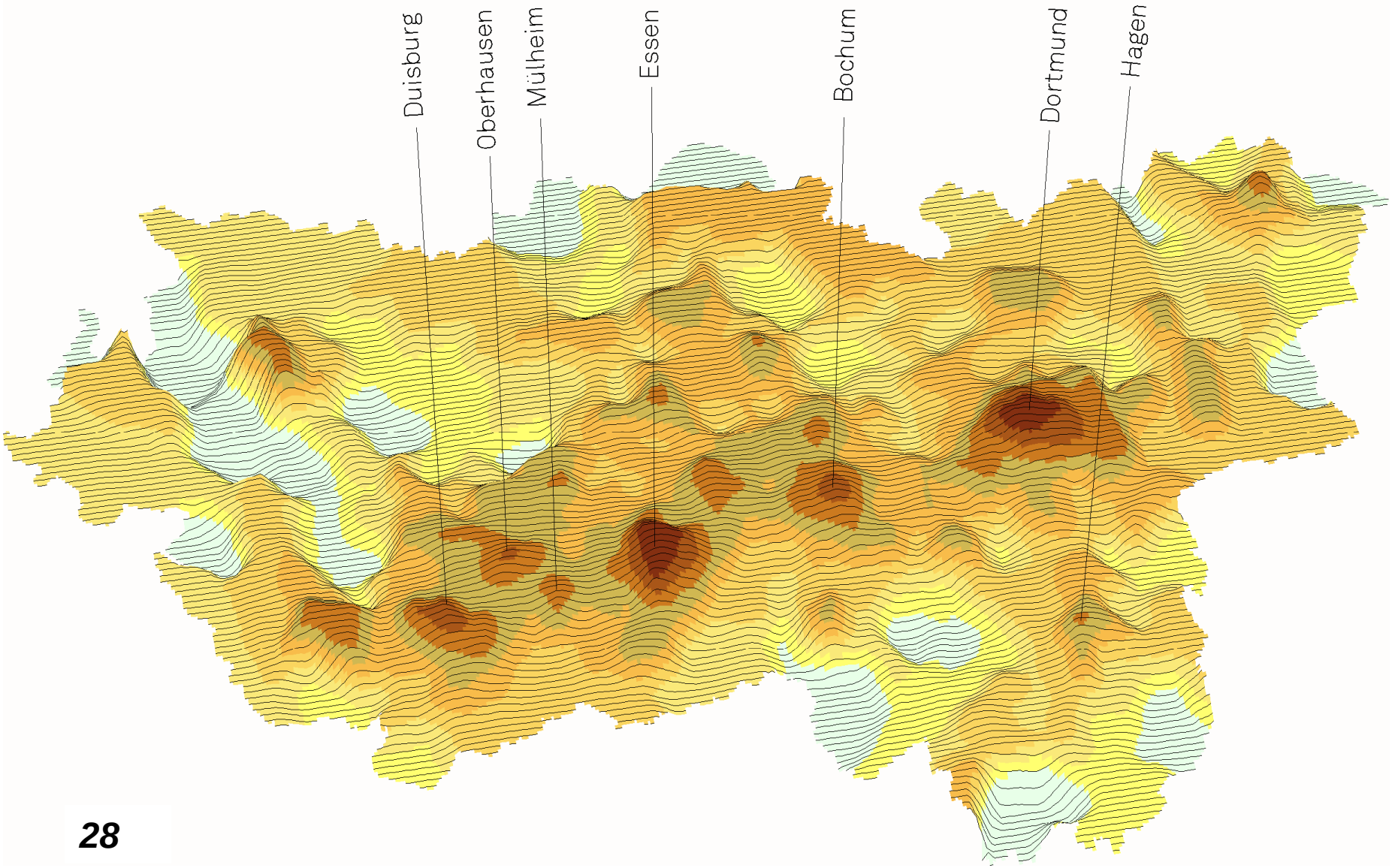
Accessibility of workplaces



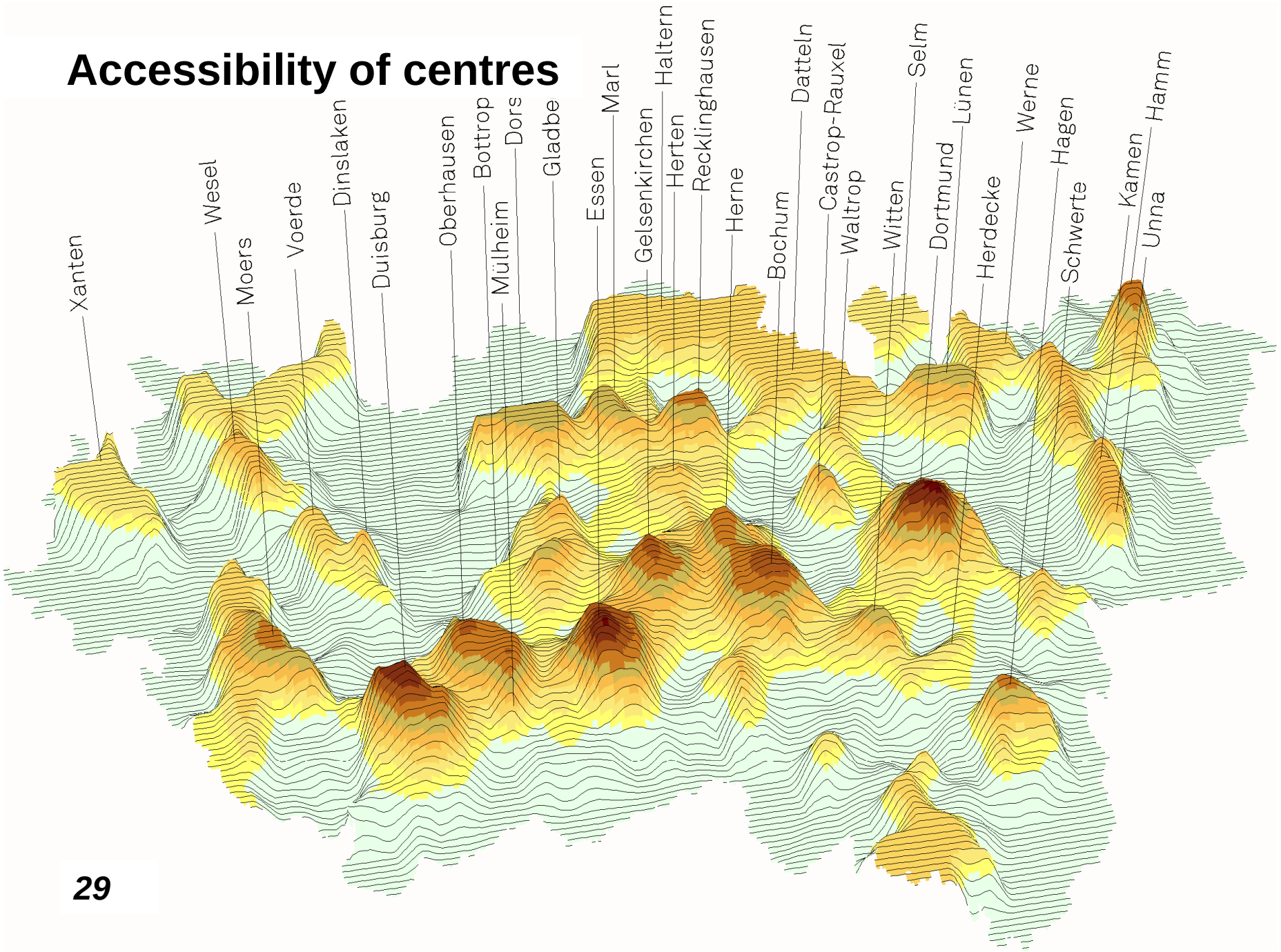
Accessibility of population



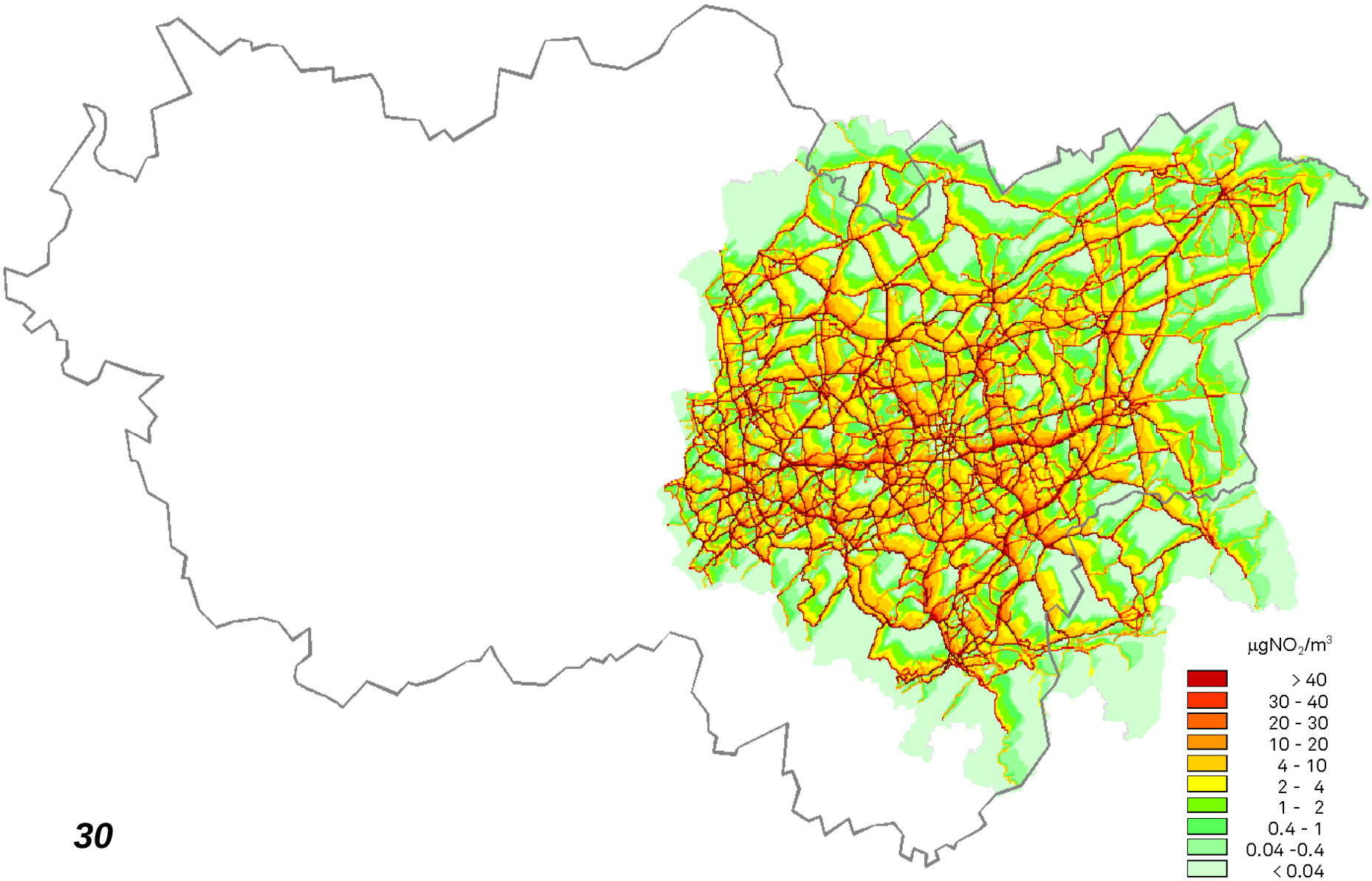
Accessibility of retail



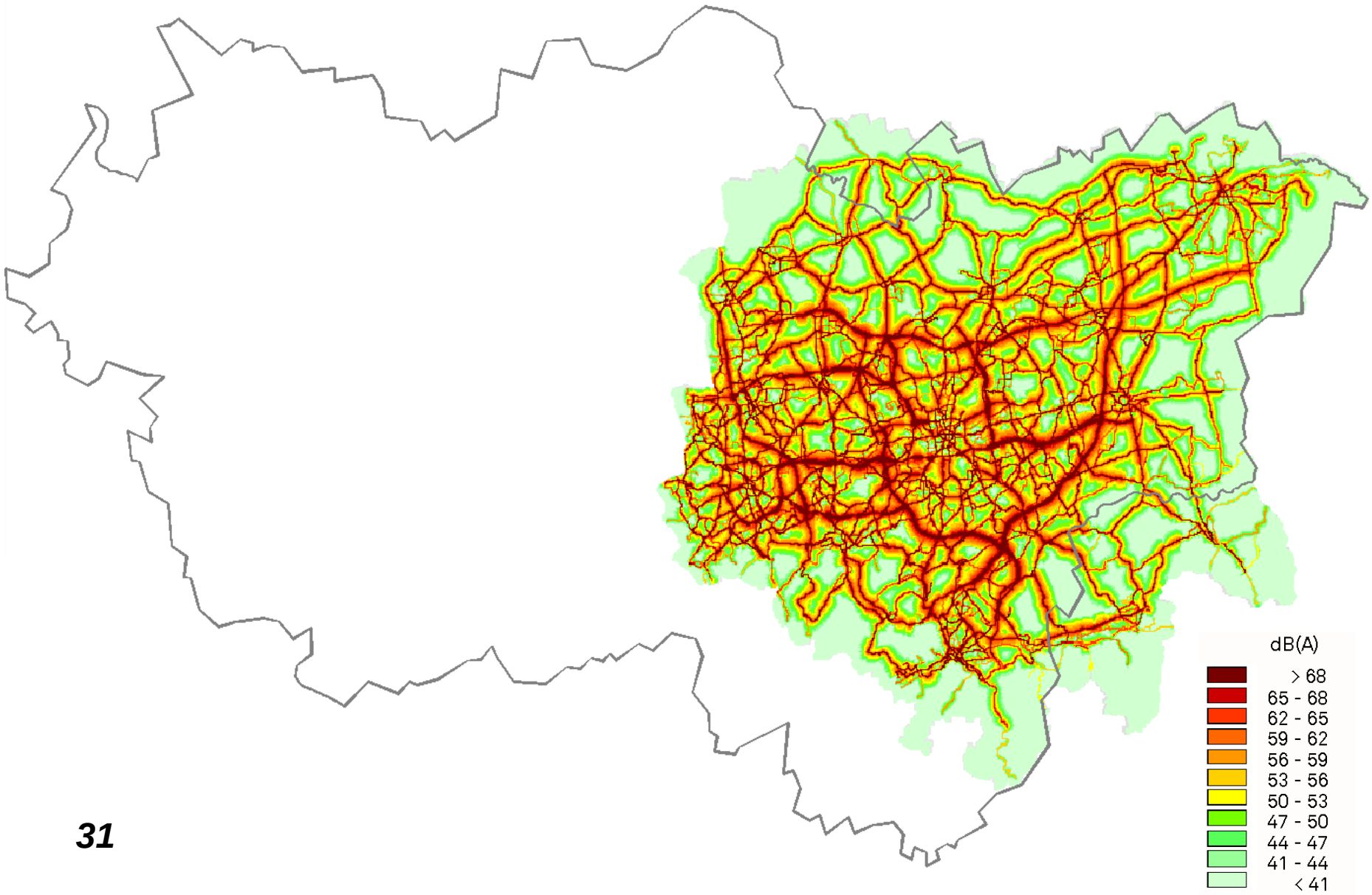
Accessibility of centres



Air quality



Traffic noise



The STEPs Project

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 STEPs ***five urban models*** were applied to forecast the long-term economic, social and environmental impacts of ***scenarios*** of ***fuel price increases*** and ***infrastructure***, ***technology*** and ***demand regulation*** policies.

Here the results of the ***IRPUD model*** for the urban region of ***Dortmund*** are summarised.

Scenarios

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

	2030 1.60 €*	2030 3.33 €*	2030 6.80 €*
	+1% p.a.	**+4% p.a.**	**+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** (2030 23.25 €*)
All policies	**A3**	**B3**	**C3**

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

Policy scenarios

A1-C1 Infrastructure and technology

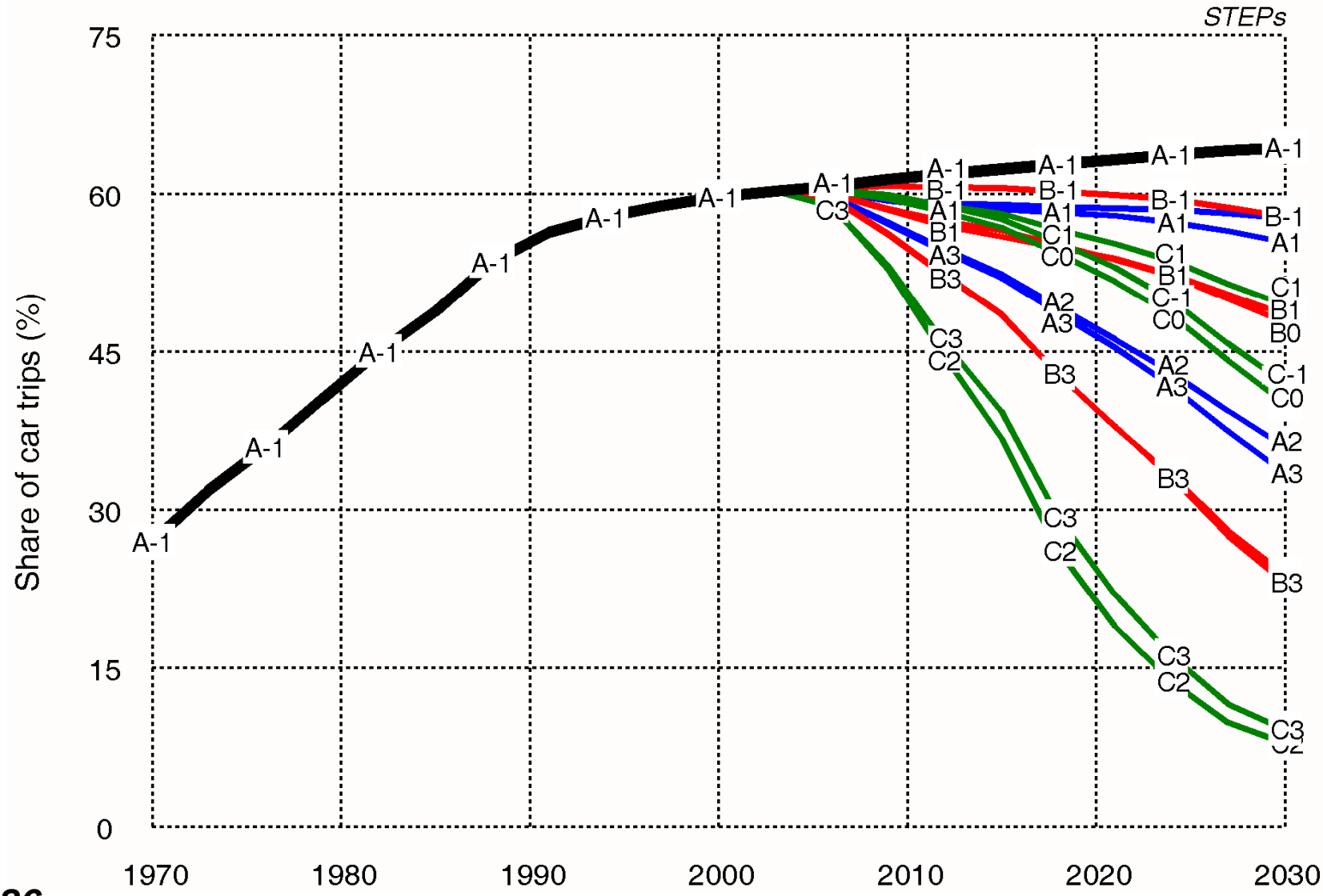
- More energy-efficient cars (fuel -0.5% to -3.0% p.a.)
- Alternative vehicles/fuels (2% to 30% in 2030)
- Public transport speed (up to +1.7% p.a.)

A2-C2 Demand regulation

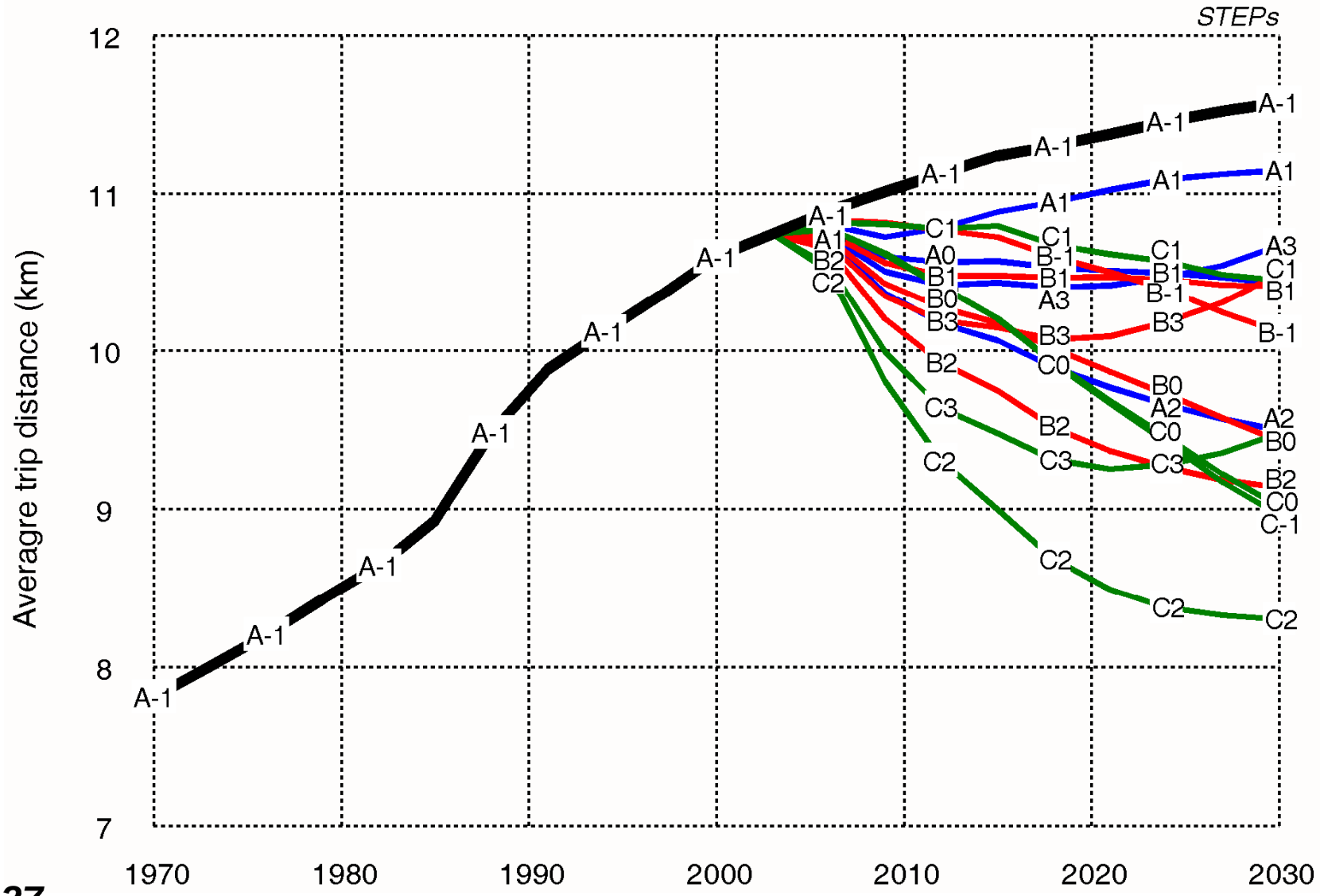
- Fuel tax (up to +4.7 p.a.)
- Road pricing (+2% to +6% p.a.)
- Traffic calming (car speed up to -2.0% p.a.)
- Car-sharing (cars up to -0.6% p.a.)
- Telework (up to -0.3% less work trips in 2030)
- Land use planning (polycentric/compact)
- Public transport fares (up to -1.7% p.a.)

A3-C3 All policies

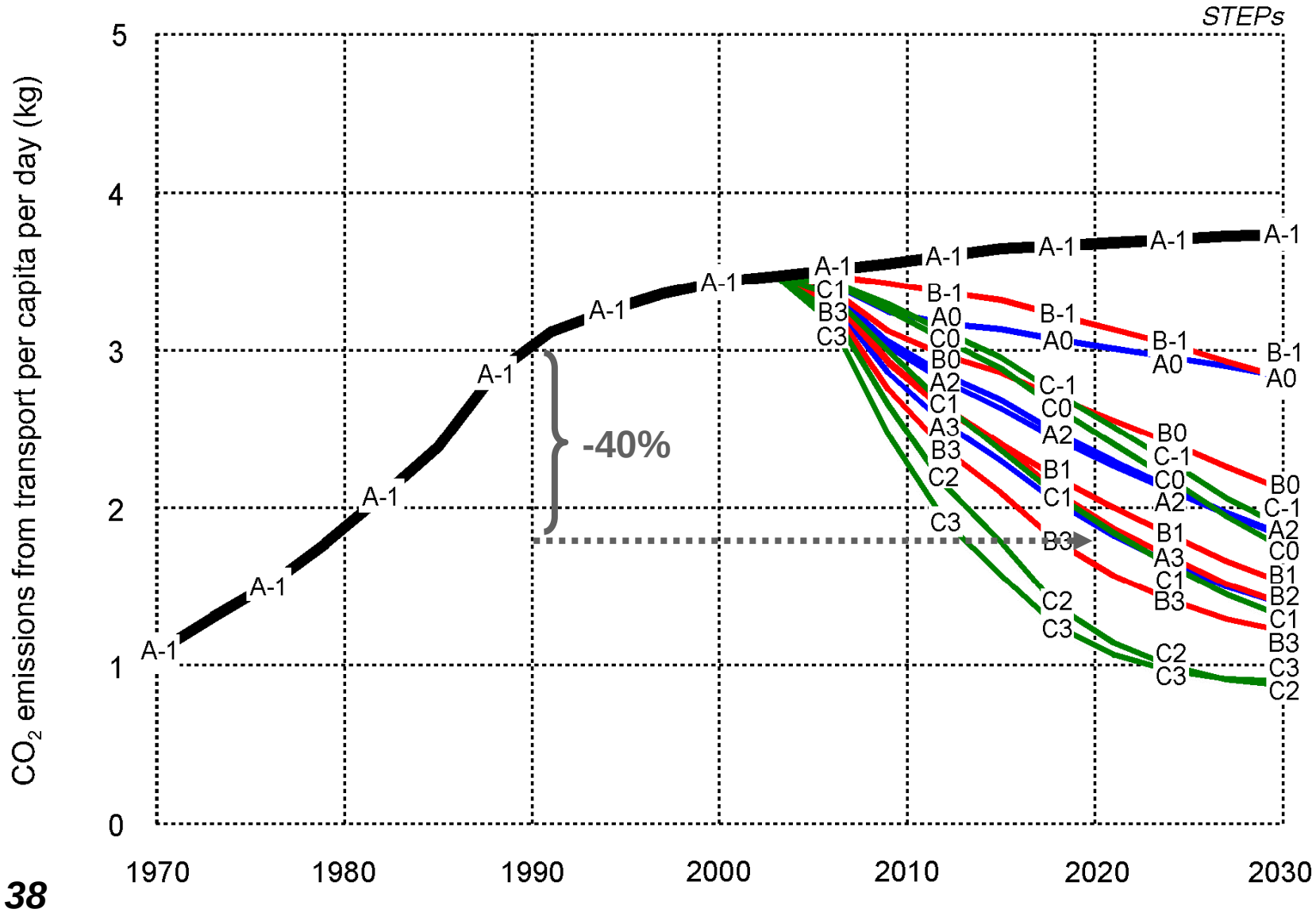
Share of car trips (%)



Average trip distance (km)



CO_2 emission by transport per capita per day (kg)



Scenarios Ruhr 2050

Scenarios Ruhr 2050 (1)

The model system will be used for the ***simulation*** and ***evaluation*** of spatial scenarios of future development of ***land use***, ***transport*** and ***environment*** in the Ruhr area ***until 2050***:

Trend scenarios:

- "business as usual" ***without*** climate change
- "business as usual" ***with*** climate change

Policy scenarios:

- ***local*** policies for the adaptation to climate change
- ***European/national*** policies for climate protection
- ***local*** polices for climate protection
- ***integrated strategies*** (combinations of policies)

Scenarios Ruhr 2050 (2)

The policy scenarios differ in the policies or policy combinations implemented from the following policy areas:

- ***Economy:*** investment programmes, taxes, user charges, emission trading
- ***Land use:*** high-density mixed-use developments, land use restrictions
- ***Transport:*** prices, infrastructure improvements, speed limits, alternative vehicles/fuels
- ***Water:*** retention basins, dykes
- ***Buildings:*** heat insulation, combined heat and power, solar energy

Scenarios Ruhr 2050 (3)

In the scenario simulations both conditional forecasting and backcasting techniques will be used:

- ***Conditional forecasts***: "Which impacts are to be expected if this combination of policies is implemented?"
- ***Backcasting***: "Which combination of policies needs to be implemented if the government greenhouse gas reduction targets are to be achieved?"

In both cases different assumptions about decision processes and implementation strategies in the Ruhr area can be made.

Scenarios Ruhr 2050 (4)

Target year of the simulation will be the year ***2050***. The model will produce for each scenario and for each year of the simulation detailed information about

- the spatial development of ***population***, ***work places***, ***land use*** and ***buildings***,
- the number of daily ***trips*** by ***travel time***, ***travel distance*** and ***mode*** used,
- environmental impacts in terms of ***energy consumption***, ***greenhouse gas emissions***, ***air quality***, ***traffic noise***, ***land take***, ***biodiversity***, ***flood risks*** and ***heat islands***.

More information

Fiorello, D., Huismans, G., López, E., Marques, C., Steenberghen, T., Wegener, M., Zografos, G. (2006): *Transport Strategies under the Scarcity of Energy Supply*. Final Report of the EU project "STEPs" edited by A. Monzon and A. Nuijten. Den Haag: Buck Consultants International. *http://www.steps-eu.com/reports.htm*.

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