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THE CHALLANGE OF INCLUDING SYSTEM EFFECTS AND SYSTEM BOUNDARIES INTO THE ENVIRONMENTAL EVALUATION OF ROAD PROJECTS

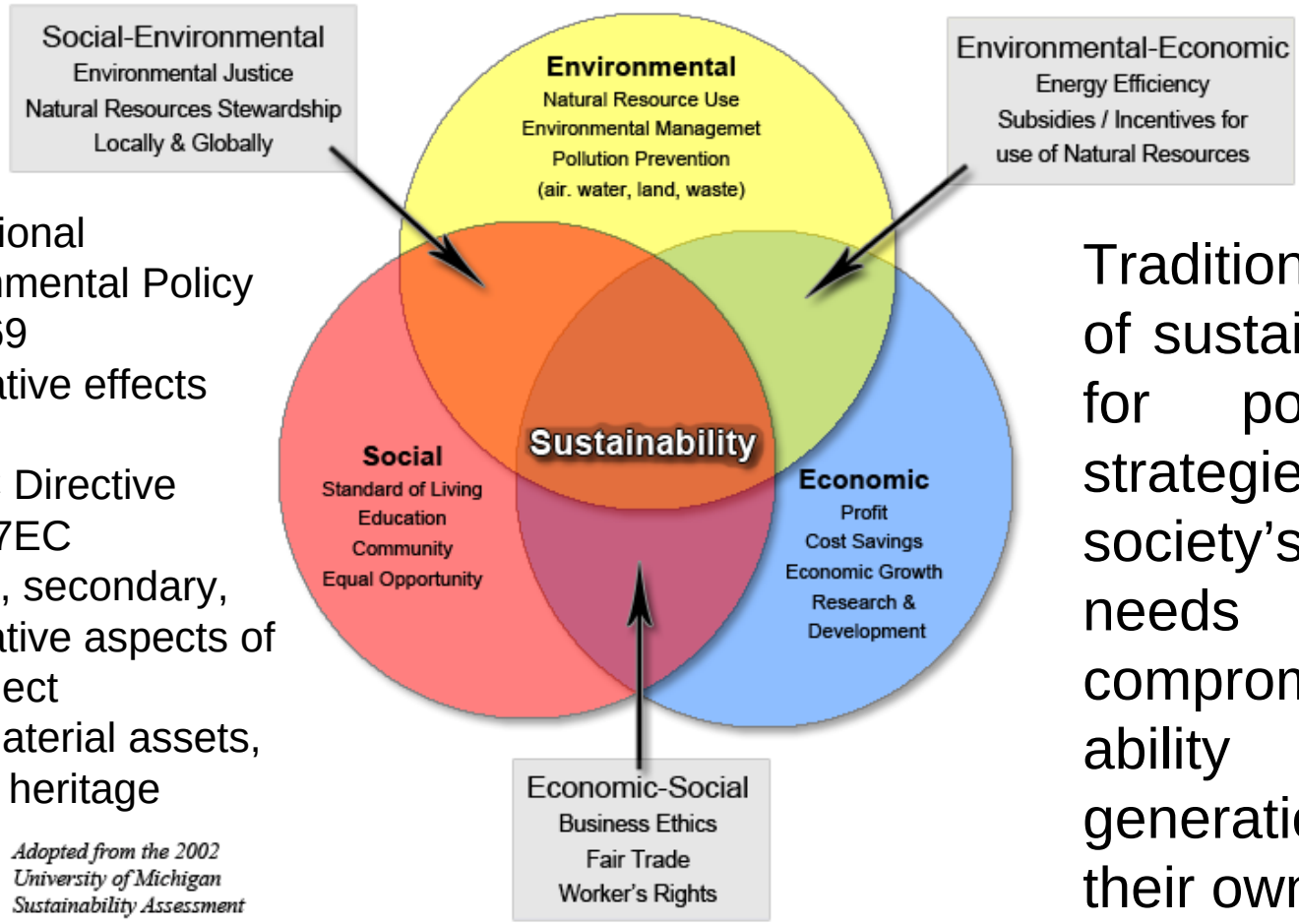
Prof. Dr. Thomas Macoun

University of Technology,
Vienna, Austria

Institute of Transportation,
Research Centre of Transportation PLanning and Traffic engineering

Email: thomas.macoun@tuwien.ac.at

THE THREE SPHERES OF SUSTAINABILITY



US National Environmental Policy Act 1969
Cumulative effects

EIA-EC Directive 85/3377EC
Indirect, secondary, Cumulative aspects of the project
1997 material assets, cultural heritage

Adopted from the 2002 University of Michigan Sustainability Assessment

Traditional definition of sustainability calls for policies and strategies that meet society's present needs without compromising the ability of future generations to meet their own needs.

A WIDER SYSTEM PERSPECTIVE HAS TO BE CONSIDERED REGARDING AS IS POSSIBLE

- Environmental, social and economic impacts collectively;
- Indirect and secondary effects (positive or negative) of developments;
- Cumulative effects of developments (e.g. combined impact of multiple projects);
- Effects whose impacts are temporally delayed (e.g. experienced by future generations);
- Effects which have a long range, transboundary of global dimensions (e.g. green house gas emission);
- Impacts by different social groups, particularly those most disadvantaged;
- Impacts on critical natural systems;
- Development alternatives which only become apparent when a wider perspective is taken (e.g. evident at the strategic but not project level).

The Occurance, Cause and Potential of different kinds of effects

	Direct effect	Indirect effect	Cumulative effects
Occurence	Over a short distance, and at the time of construction and in operation	Like a direct effect but at a later time and/or in farther distance	In general at a later time and/ or in a farther distance
Cause	Single project	Direct and indirect effect of a single project	Direct and indirect effect of a single project and effects of other activities
Possibility of prediction	Based on clear causal connections	Based on high probability	Based on high probability

CBA VERSUS MCA (Summarizing versus reducing)

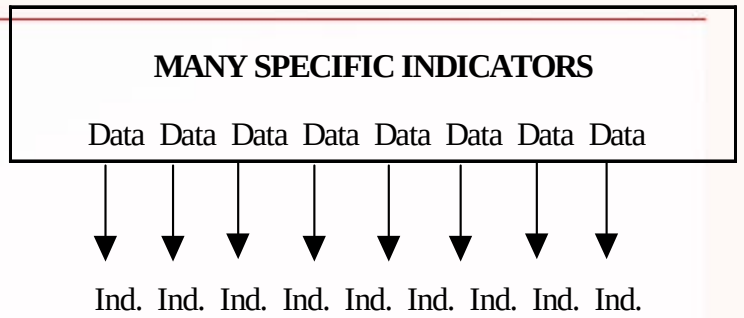
COST-BENEFIT- ANALYSIS (CBA)

Decission maxim: Maximizing the welfare of the total society (Analoguos to business investment calculations)

Proceeding:

System of objectives, Assessment by prices, Fixing discount rate,

SUMMARIZING APPROACH



MULTI-CRITERIA ANALYSIS (MCA)

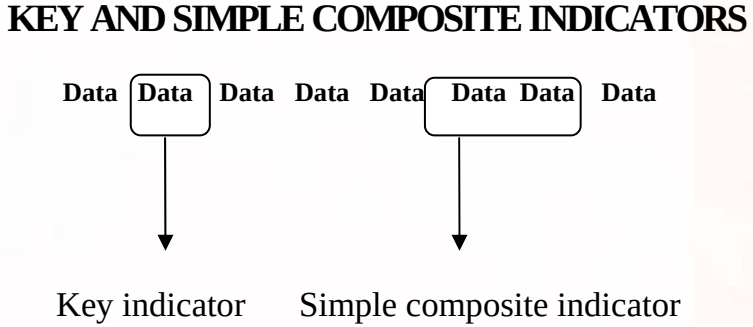
Arranges alternatives related to multiple objectives by preferences of assessers

Proceeding:

System of objectives, weight objectives, grade of fulfilling objectives,

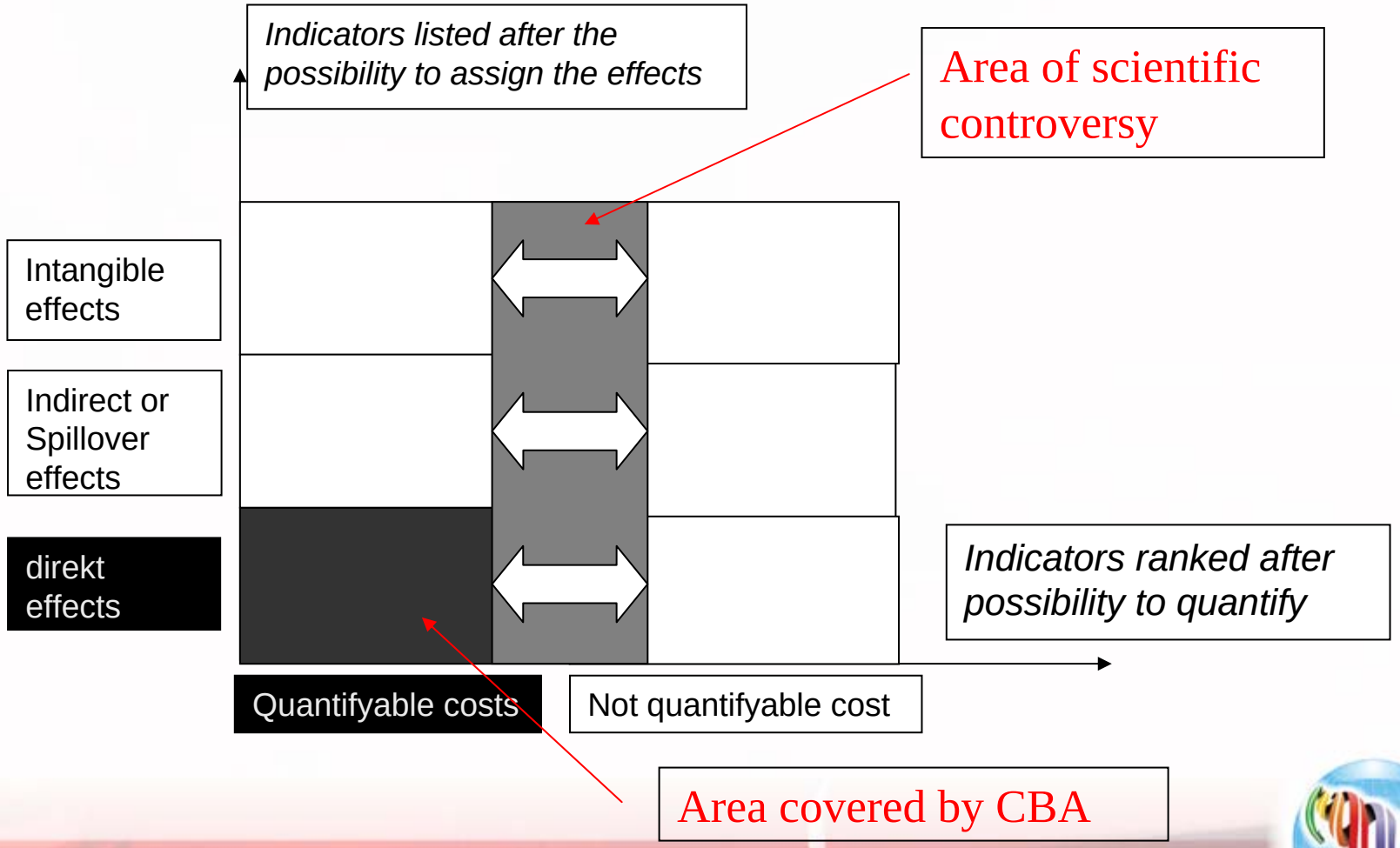
Selection of important and fitting indicators to picture a system

REDUCING APPROACH

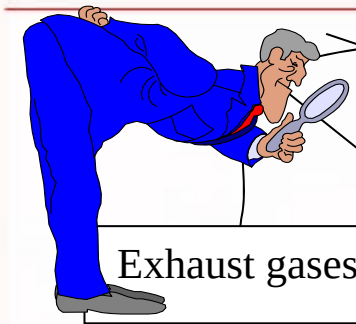


in principle: all methods of evaluation are subjective!

COVERAGE OF A COST BENEFIT ANALYSIS



PERCEPTION PRIORITIES OF HUMANS



Vegetation

Health

Safety

Exhaust gases

Waste of energy

Trip lenght

VELOCITY

Parking space problems

Traffic volume

Number of vehicles

Attraktivity

New Road construction

Waste of space

Reaction of the settlement structure

RANKING OF INDICATORS ACCORDING TO THEIR WEIGHTS IN A MCA

Environment

1. NOISE
2. CHANGE OF TRAVEL TIME
3. SAFETY
4. EXHAUST GASES

Directly effective lokal factors

getting conscious

Weighted high

Weighted poor

Sustainability

12. WASTE OF SPACE
13. FLORA AND FAUNA
14. WATER
15. ENERGY

Unconscious and indirect effective system factor

ANALYSIS OF SYSTEMS
Learning of evolutionary proved systems

SYSTEM THEORIES dealing with

- **SYSTEM EFFECTS**

Identify intelligent KEY - Indicators (System-crossing Indicators, Distance to target indicators)

Constants and **Variables** in a System of Feedbacks and Side Effects

- **SYSTEM BOUNDARIES**

Limited Resources (Global ⟺ Individual)

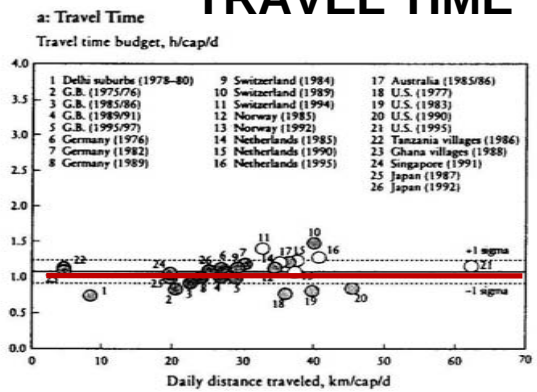
Flux balance in an ecologic sense

CONSTANTS AND VARIABLES OF MOBILITY

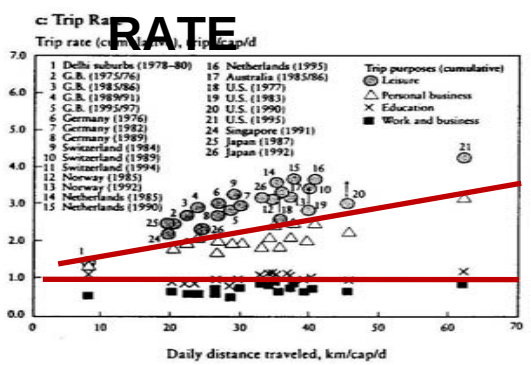
CONSTANTS
- Travel Time Budget
- Mobility

VARIABLE
- Modal Split
- Trip Length

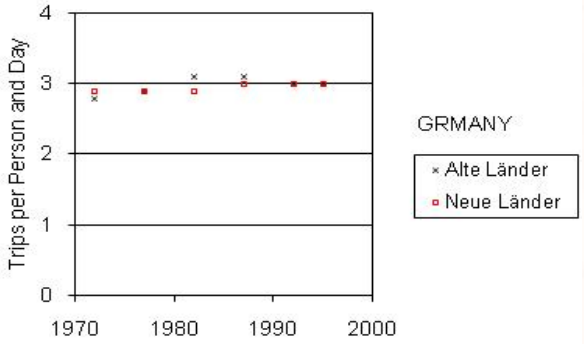
TRAVEL TIME



MOBILITY/ TRIP RATE



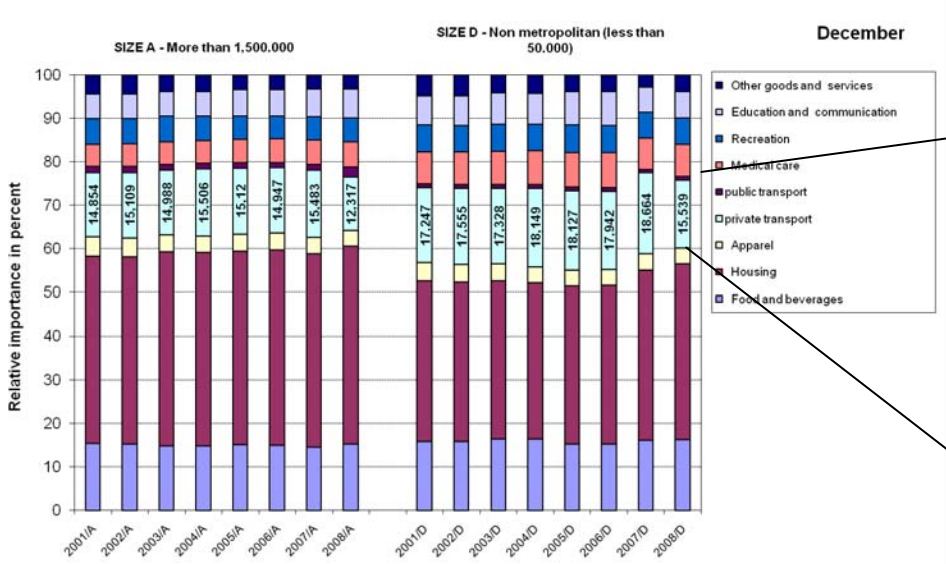
Boundaries by biological, (genetical), physical, social (practical) reasons



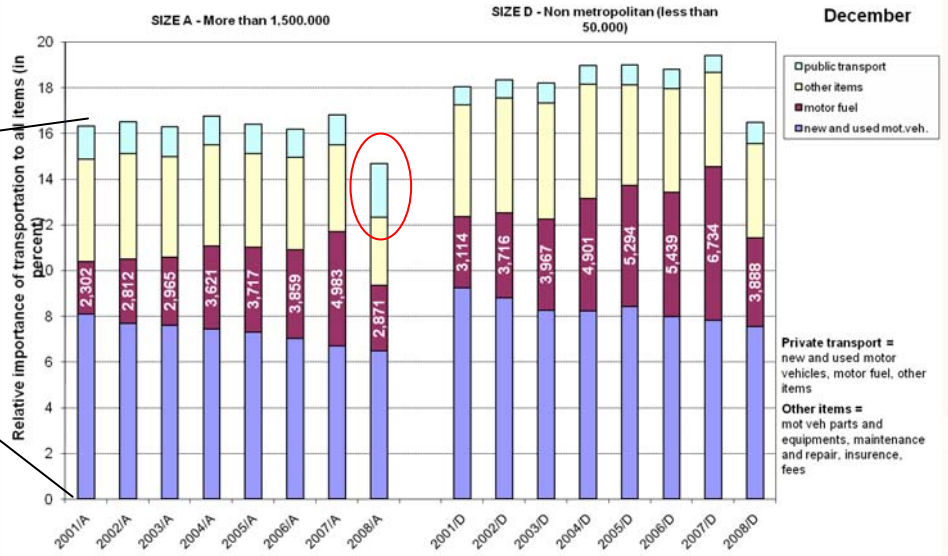
Global Borders of development
- Feedbacks
- Steering Possibilities
- Knowledge of Human Behaviour

Source: Schafer 2000, homepage; US Ministry of Transportation

IDENTIFYING WASTE OF ENERGY AS A PROBLEM OF FINANCIAL SUSTAINABILITY – Lessons from the US



Expenditures in priv. households in %



Expenditures for transportation in %

Consumer price index for all urban consumers (CPI-U), US. Average, by expenditure category and commodity and service group, Month December

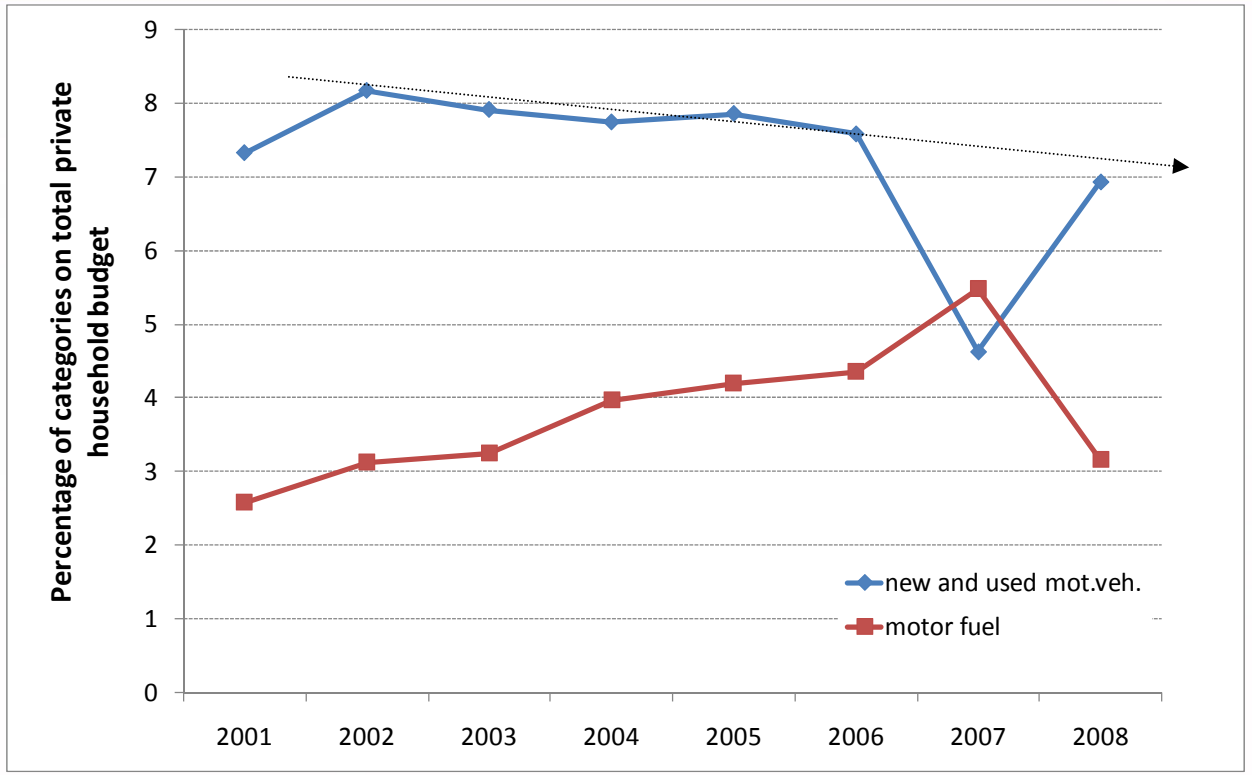
Source: US Department of Labor

Category „Motor fuel“ (2001-2007)

Metropolitan households	2,3% to 4,9%
Rural areas	3,0% to 6,7%

IDENTIFYING WASTE OF ENERGY AS A PROBLEM OF FINANCIAL SUSTAINABILITY – Lessons from the US

Expenditures for specific categories of transportation in %



Compensation Strategies of households

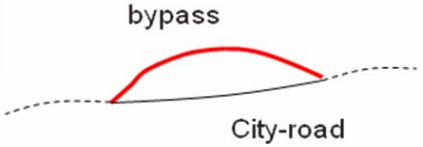
Source: Consumer price index for all urban consumers (CPI-U), US. Average, by expenditure category and commodity and service group, Month December

Source: US Department of Labor

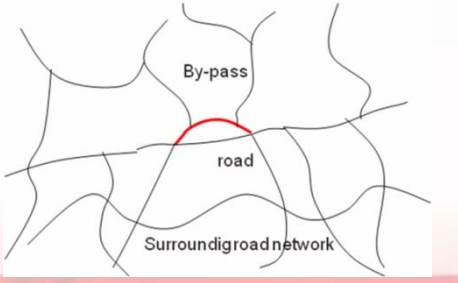
Enhancing the system boundaries step by step

1 Exclusive consideration of the bypass section

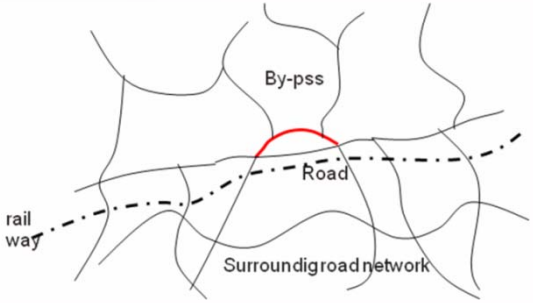
2 Including the unburdened road section



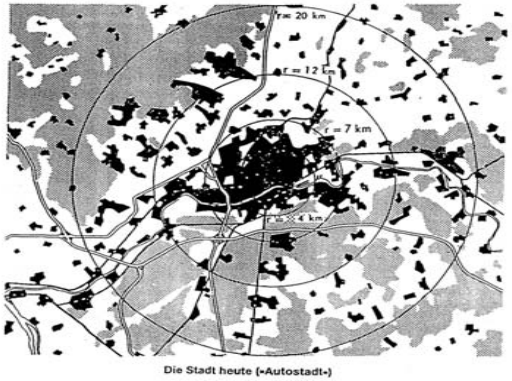
3 Including the surrounding road network



4 Including other modes



5,6 Including time and spatial structures



7 Including global aspects

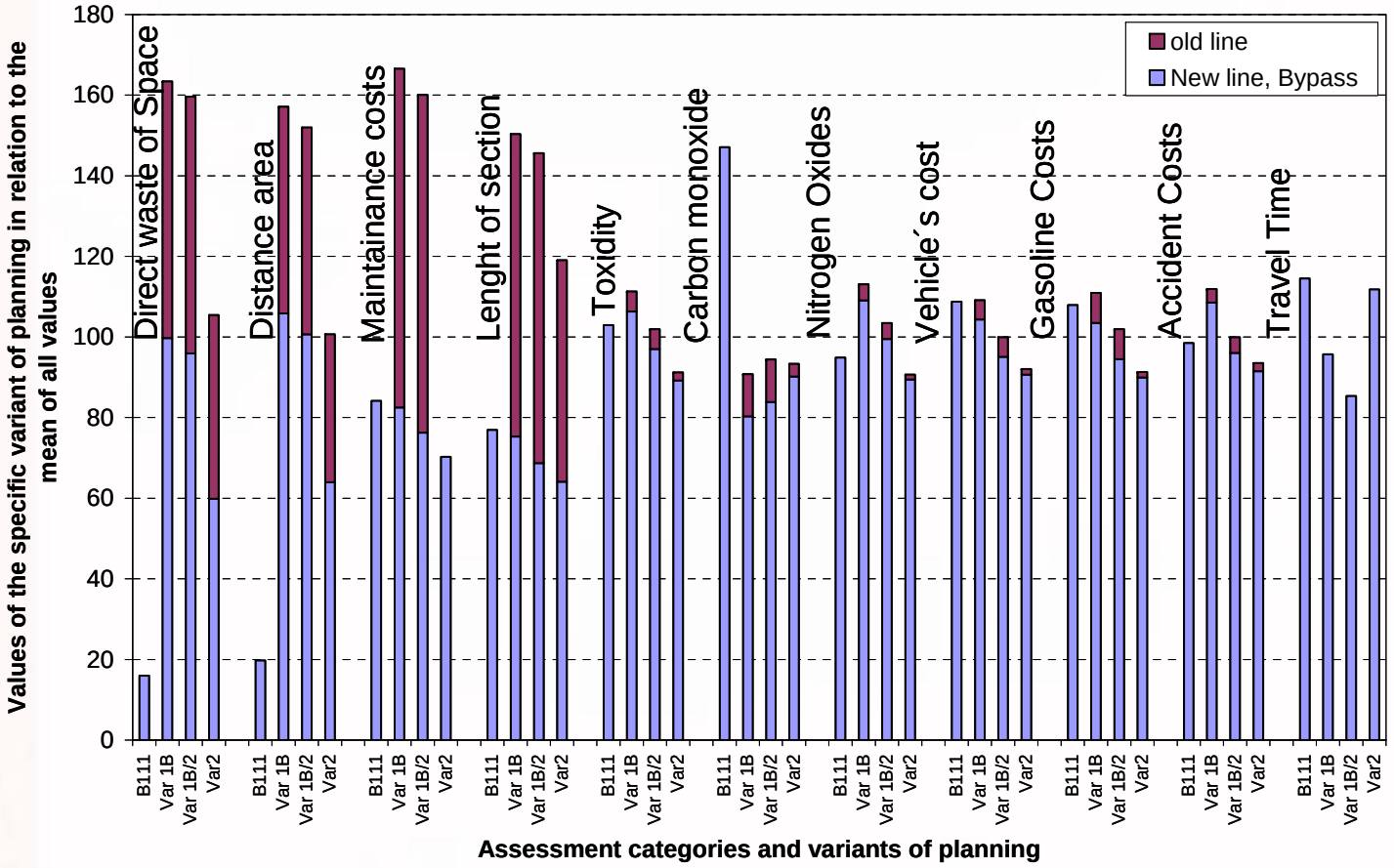
STEP BY STEP

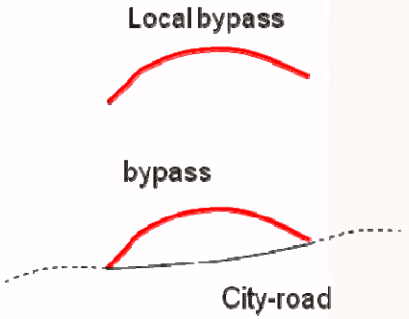
SEVEN STEPS OF ENLARGING THE VIEWED SYSTEM TOGETHER WITH CHANGING «BEST FITTING» INDICATORS

EFFECTS ON THE ASPECTS “TIME”, “SPACE” and “CAUSALITIES”

	Indikators	**Time**	**Space**	**Methods**
1	Number of vehicles	Status- quo Simulation	Street section	counts in cross sections
2	Traffic amount	Mostly Status- quo Lineare Forecasts or Motorisation rate	Corridor	counts in cross sections Calculations
3	Traffic amount	Forecasts or Motorisation rate	Borders by Distributions of trip lenght	counts in cross sections Calculations
4	Modal-split	Szenarios	Distributions of trip lenght „ecological backpack	Simulation results, Trip chains
5	Modal - split	Szenarios	Distributions of trip lenght „ ecological backpack,	Simulation results, Trip chains
6	Modal- split (Energie)	Szenarios	Settlement or regional areas	Models
7	Energy, CO_2	Szenarios	global	Models

Ratio of targeted returns for the example of the road construction project B111 (« Road Drautal»), Carinthia, Austria





CONCLUSIONS

- Between methods and criteria/ indicators as used are feedbacks given, a plenty of possibilities of affecting the results is given

- The complexity of effects is increasing with increasing system, the technical-scientific demand on exactness on the other hand leads in most cases to a very small system part taken into acount

- The choice of the system boundaries influences the choice of the most useful indicator

- Percepting, assessing and acting is done by human beings. Related to the motives and the steering of behaviour there is a high degree of unconscious levels given which are steered by the environment

- Objectives of higher theoretic systems (economical systems, social systems) are overtaken into assessment procedures by concious and unconscious reasons.

THANK YOU FOR YOUR ATTENTION

thomas.macoun@tuwien.ac.at


MEXICO

Example of a ranking of alternatives

Range	Scenario	SIM 1	SIM 2	SIM 3
1.	1A	E	**0**	**0**
2.	1B/1	2A	2A	E
3.	E	2	E	2A
4.	2A	1A	2	3B
5.	2	1B/1	3B	2
6.	1C	1C	3	3
7.	3B	**0**	3C	3C
8.	3C	3B	3A	3A
9.	3A	3C	1A	1A
10.	**0**	3	1B/1	1C
11.	3	3A	1C	1B/1

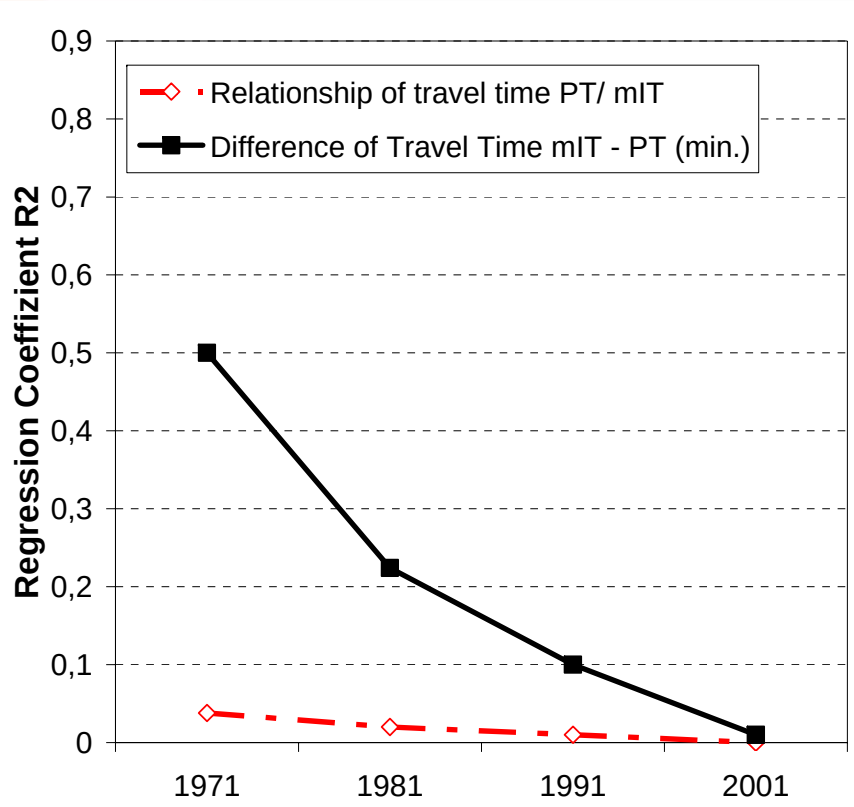
Range	Scenario	SIM 1	SIM 2	SIM 3
1.	9	9	9	**0**
2.	10	10	5	1
3.	5	5	1	5
4.	6	6	10	9
5.	1	1	**0**	2
6.	2	2	6	6
7.	3	3	2	3
8.	4	4	3	7
9.	7	**0**	4	10
10.	**0**	7	7	4
11.	8	8	8	8

(Project – Alternatives), Federal road « Drautal », Carinthia, Austria.

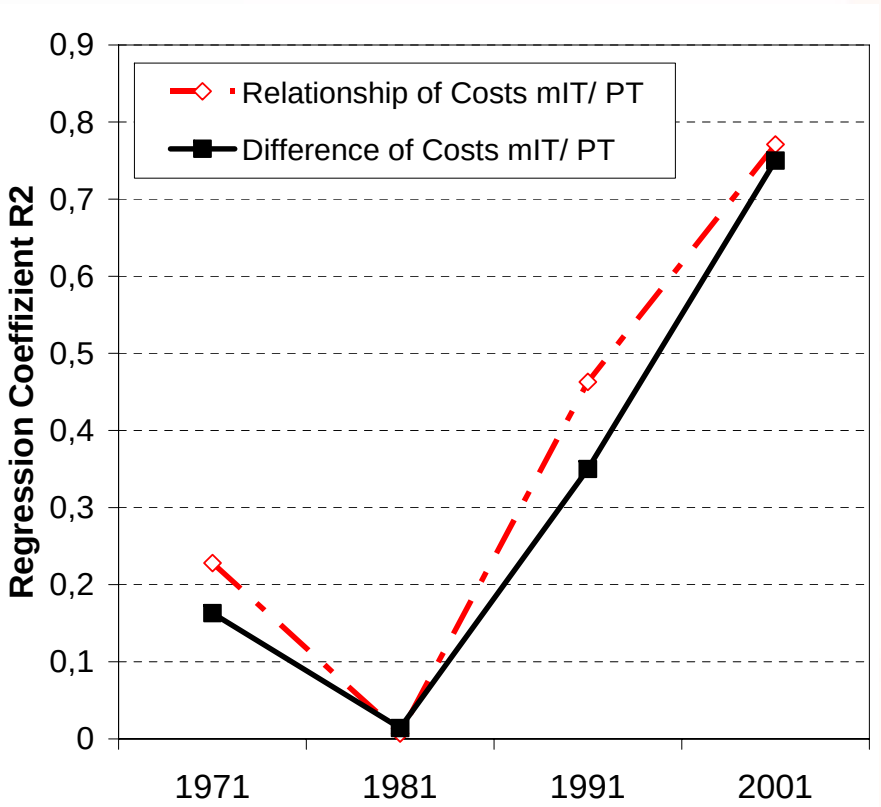
Source: Macoun PANAM 2010

EXPLANATORY POWER FOR THE MODAL SPLIT

TRAVEL TIME



TRAVEL COSTS

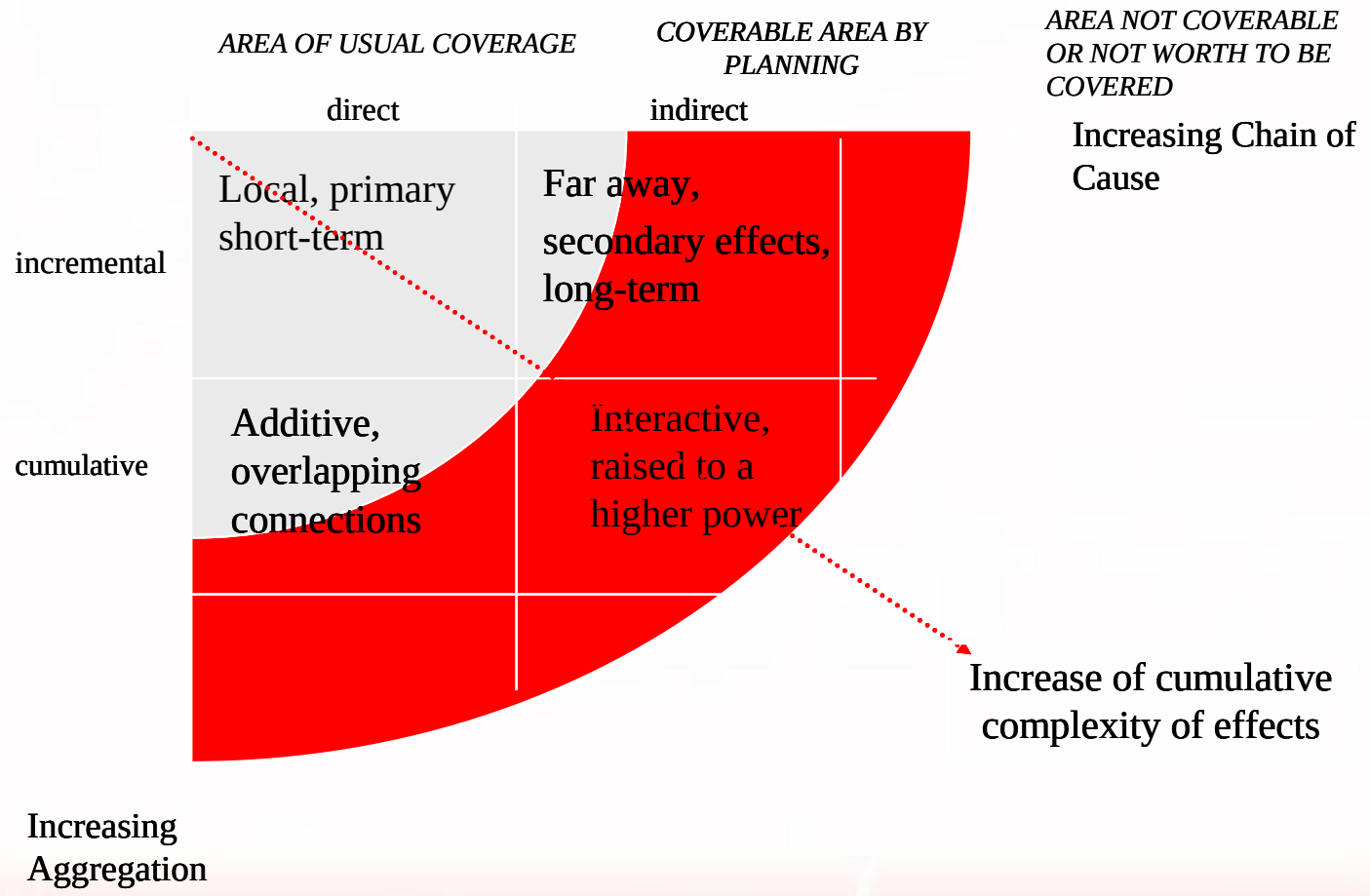


PT = Public Transport mIT = motorized Individual Transport

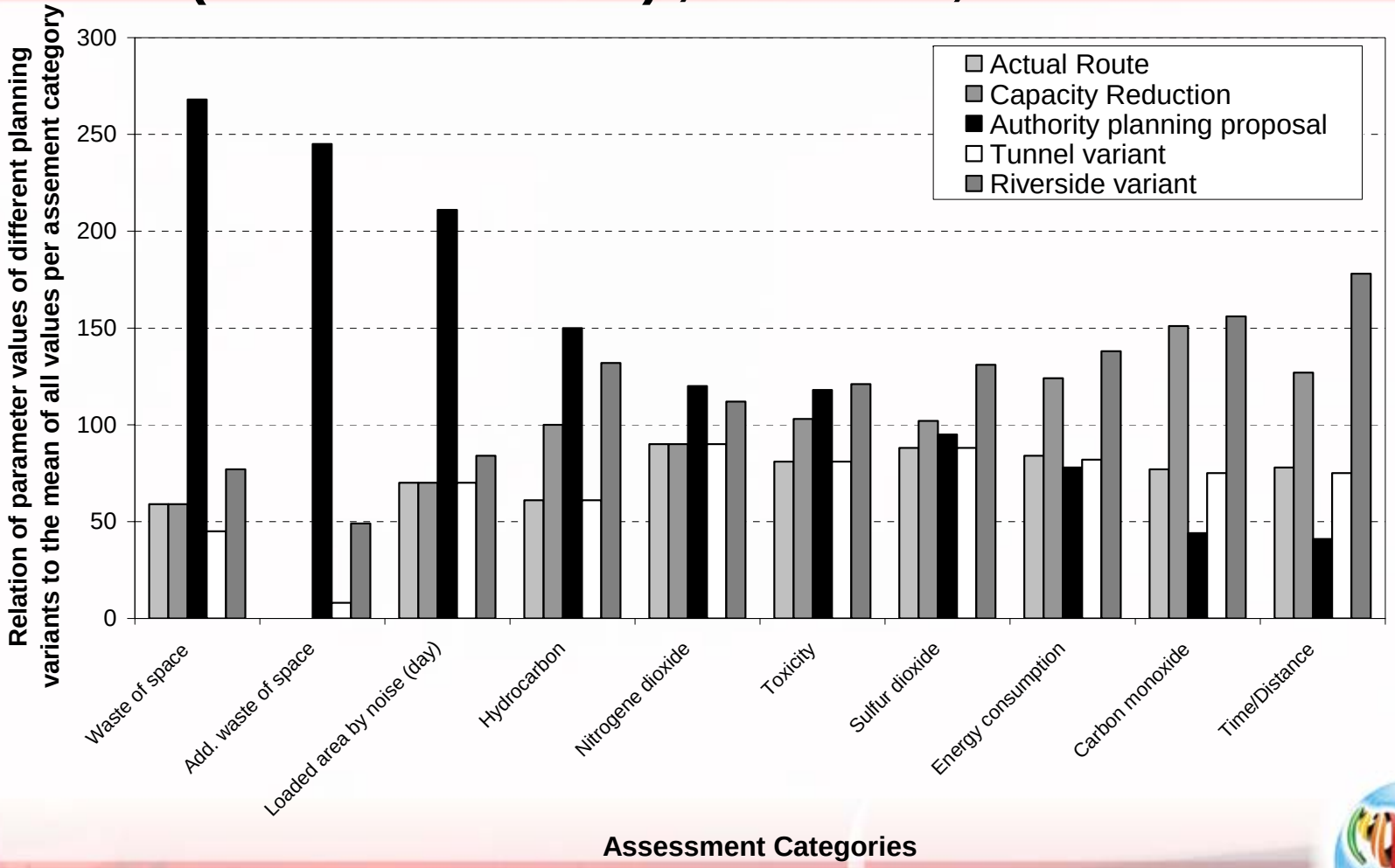
Indicators, boundaries and methods

	Indicators	Temporal boundaries	Spatial boundaries	Methods
1	Number of vehicles	Status quo simulation	Street section	Counts in cross sections
2	Traffic amount	Mainly status quo simulation, linear forecasts or motorization rate	Corridor	Counts in cross sections, calculations
3	Traffic amount	Forecasts or motorization rate	Boundaries by distribution of trip length	Counts in cross sections, calculations
4	Modal split, person flow	Scenarios	Distribution of trip lengths	Simulation results, trip chains
5	Modal split	Scenarios	Distribution of trip lengths, ecological footprint	Simulation results, trip chains
6	Modal split, Energy	Scenarios	Settlement or regional area	Models
7	Energy, CO_2	Scenarios	Global	Models

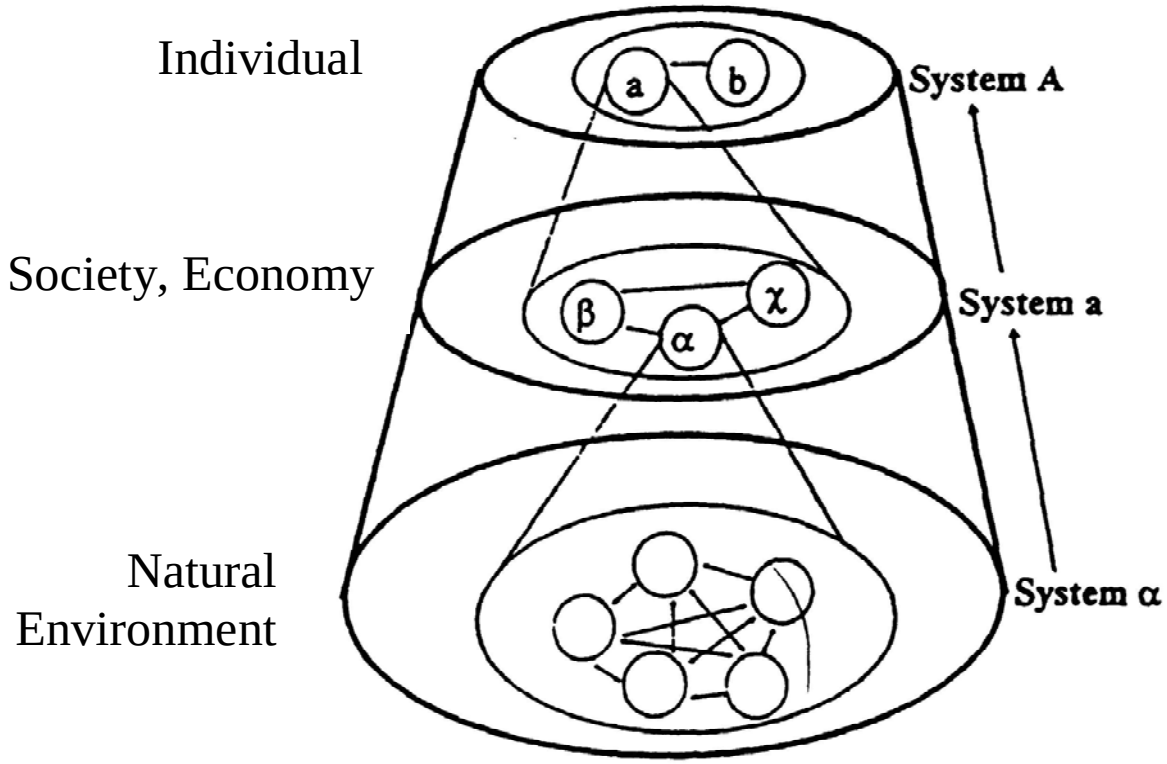
Scheme of Complexity of effects depending on the level of aggregetaion and the cause



Ratio of parameter of different planning variants compared to the mean of all values per assessment; B111 (Drautalstrasse ») , Carinthia, Austria



THE HUMAN – ENVIRONMENT SYSTEM



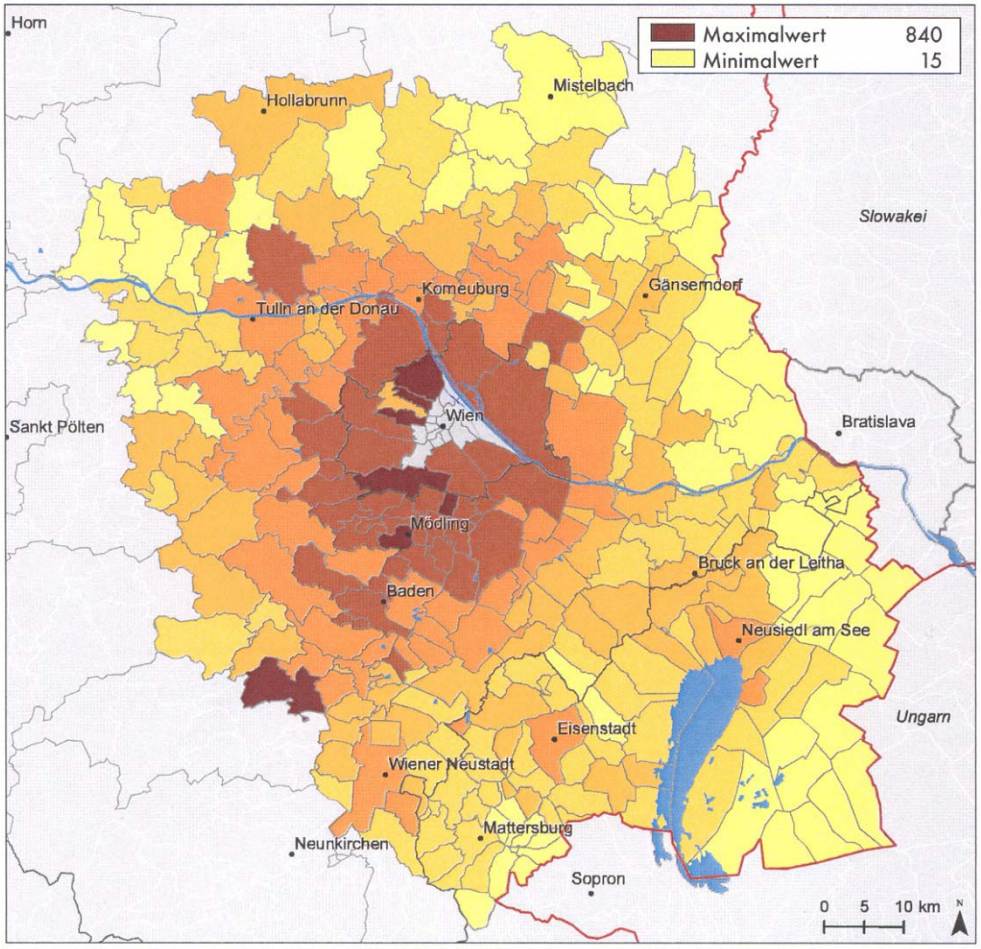
From an analytical point of view each assessment comprises three components

- The neutral model (scheme of interrelations, indicators)
- The value system (assessment criteria such as expert opinions, limits)
- The value judgment (e.g. expressed in nominal, ordinal or cardinal scales) as a result of the joining of model and value system

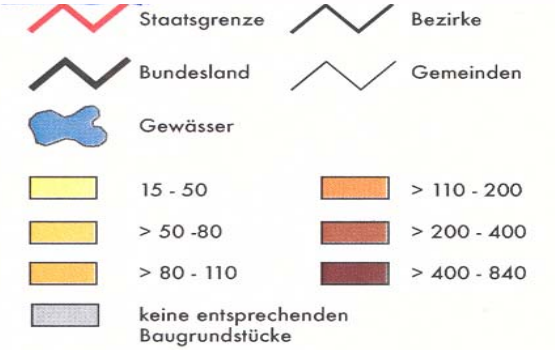
COMPARISON of EIA and SEA

	Project - EIA	SEA
Object to examine	Single projects (e.g. street section)	Politics, plans and programs (e.g. traffic concept)
Target	Optimization of single projects of one traffic mode (choice of traffic lines)	Optimization of traffic mode crossing solutions
Examined alternatives	Variants of location lines incl. Zero option	Variants of traffic solutions including several traffic modes
Frame of introduction	Local effects near the location line	Regional and global effects incl. sum and succeeding effects in the traffic system
Analysis of environmental impacts	Specific, project related statements - High grade of specification - Small scale	Principle and strategic statements - Little grade of specification - Higher scale

ANOTHER REASON OF URBAN SPRAWL
Decline of land price gradient

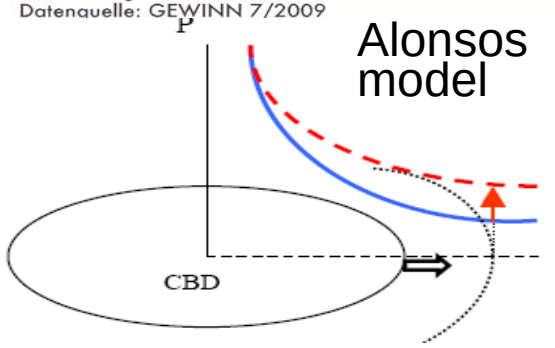


Land Price for properties suitable for one-familiy houses, 2008, in Euro/m^2



Bearbeitung: ISR / ÖAW
Datenquelle: GEWINN 7/2009

Alonsos model



CBD = Central Business District

INDIVIDUAL VERSUS SYSTEM

	System point of view	Individual	point of view
		objective	**subjecktive**
Time	Constancy of time	(physical) Time	Assessment of time
Space	Depends on speed	Habitat	Space of experience
Energy (Causality)	Total energy amount (non renewable)	Body energy	Weighted body energy (e.g. Pulse, Stress)

Comparison of System point of view with (objective und subjective) point of view of the individual represented for the problems of knowledge Time, Space and Energy/Causality (Kantsche Apriori)

Quelle: Riedl, Macoun

SAVING OF TIME IS WEIGHTED EXEPTIONALLY HIGH IN ECONOMIC THEORIES