RESPONDER
Linking SCP and Growth Debates

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Towards Sustainable Mobility in European Cities: System Maps

Annex to background paper

2nd Multinational Knowledge Brokerage Event on Sustainable Mobility (Bratislava, 21-22 March 2013)

RESPONDER - linking **RES**earch and **PO**licy making for managing the contradictions of sustai**N**able consumption an**D** **E**conomic g**R**owth

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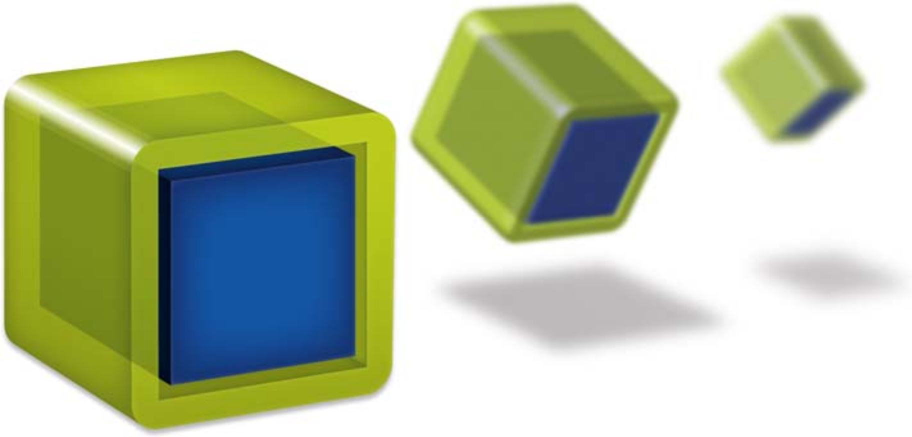

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WU Wirtschaftsuniversität Wien Vienna University of Economics and Business

University of Surrey

iöw Institute for Ecological Economy Research

SERI

CETIP Center for Transdisciplinary Study of Institutions, Evolution and Policies

Institute for Forecasting Slovak Academy of Sciences

UAB Universitat Autònoma de Barcelona

icta Institute of Environmental Science and Technology · UAB

CENSE center for environmental and sustainability research

Technical University of Denmark DTU

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Office for Spatial Development ARE

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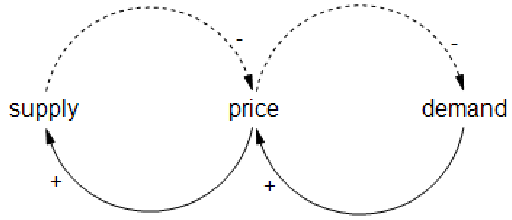
1. Systems Mapping in RESPONDER

For supporting knowledge brokerage, the RESPONDER project uses the method of systems mapping.[1] On the basis of available evidence and through a participatory process the method we produce system maps that visualise selected issues and contradictions of economic growth and sustainable consumption in an easy-to-understand language. With the maps we aim to:

- enable participants to visualise, expand and align their implicit mental models, thereby reaching a shared understanding
- structure and motivate exchange between participants, stimulate engagement and dialogue
- help participants understand the dynamic feedback structure of the system (its drivers, trends, trade-offs and unintended consequences and potential leverage points)
- helps identify knowledge gaps.

System maps use a simple and intuitive language consisting of a few building blocks, or elements. Its most important elements are variables and their interdependencies, represented by arrows.



(1) **Variables** used in system maps can be both quantitative and qualitative.[2] To keep the number of variables manageable and to foster identification of system boundaries, only variables considered relevant for explaining the behaviour of the system are entered into the map, formulated as precisely as possible.

An arrow represents a (2) **causal relationship** between two variables.[3] Relationships are either **positive** (drawn as arrows tagged with a plus sign) or **negative** (dashed arrows tagged with a minus sign).[4]

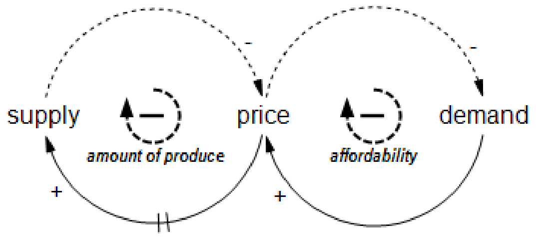
[1] Systems mapping, similarly to e.g. systems modelling, belongs to the same family of systems dynamics methods. Examples of previous system mapping usage include e.g. the UK obesity map, the human wellbeing and UK land-use map or the psychological and sociological drivers for (sustainable) consumption. The resulting system maps are also known as 'causal loop diagrams' or 'influence diagrams'.

[2] Variables (sometimes also called 'factors') must use ordinal or cardinal scales, typically from 'low' to 'high'. Therefore variables are often formulated as 'level of ...', 'number of ...', 'rate of ...'.

[3] The arrows depict **causal relations** (i.e. they represent the underlying structure of the system), **not correlations** (documenting past behaviour of the system).

[4] A **positive causal relationship** between two variables (cause X and effect Y) means that an increase in X will lead to an increase in Y above what it would otherwise have been (assuming all other variables remain constant) and, conversely, a decrease in X will lead to a decrease in Y below what it would otherwise have been. A **negative causal relationship** is inverse, i.e. an increase in X will lead to a decrease in Y below what it would otherwise have been and a decrease in X will lead to an increase in Y above what it would otherwise have been.

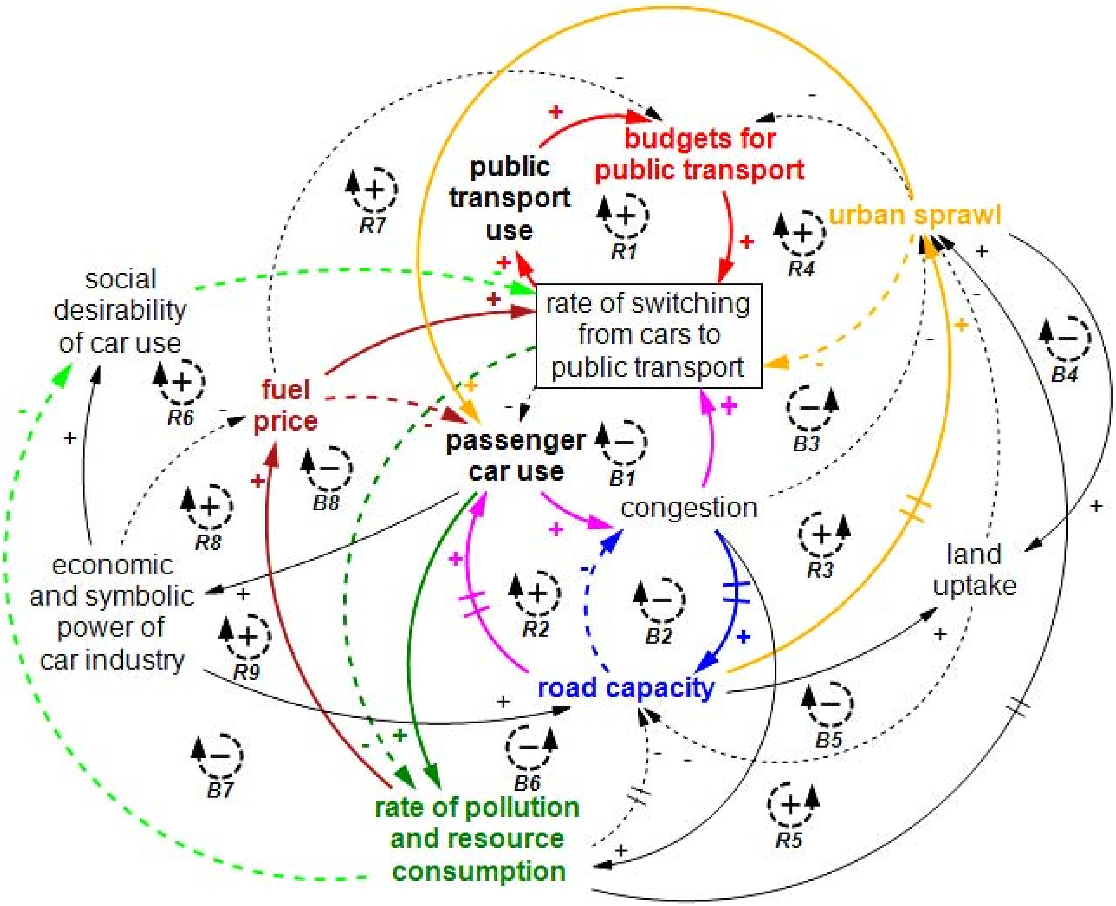
Central to our understanding of systems are the (3) **feedback loops**, i.e. circular causalities. They are either **reinforcing** (i.e. positive, leading to exponential growth) or **balancing** (negative, leading towards an equilibrium value). Feedback loops are depicted as independent and smaller circular arrows placed in the free space within a chain of variables and equipped with a plus or minus sign, sometimes they are also named.



To depict longer (4) **time delays** between a change in the cause variable X and the effect variable Y (which typically have significant implications on the dynamic behaviour of the system), the causal arrow is interrupted with a double slash sign.

2. Road construction and modal split map

Below you can see a map constructed to explore the issue “How does road construction influence transport volume and modal split?”. The map has undergone two full iterations of expert and participatory input. To enable a broad perspective and a manageable size the map is more abstract than typical urban development and transport planning models. Reflecting participants’ understanding of significance, a number of aspects was not explicitly included in the map, such as changes in mobility needs and population size (total transport volume and population are more or less constant), the possibility of different models of urban development, economic aspects of location attractiveness (income and spending opportunities), freight transport, or a detailed treatment of the different speeds of change. Also, many of the causal relationships are simplified (e.g. between budget and public transport use). As any model, a CLD is a necessary simplification of reality placing a focus on specific issues – in this case, the ‘pull’ between public transport and passenger car use (played out in the central variable of the ‘rate of switching from cars to public transport’) as well as a range of mental models and possible strategies.



Based on context it could be theorised whether (and why) the loops that increase passenger car use are together more ‘powerful’ than the loops that function as limiting factors combined. When this resulting ‘pull’ of passenger car use is stronger than of public transport use, the rate of switching from cars to public transport is negative (i.e. users switch from public transport to passenger cars). The dynamics that increases car use involves the loops B2 (willingness to expand existing road capacity as a means of combating congestion), R2 (induced car transport as a result of higher road capacity), R3 (higher urban sprawl, occurring due to better accessibility through higher road capacity, resulting in higher transport demand that is satisfied by car use), R4 (negative effect of larger area that needs to be serviced on public transport budget with the result that the quality of public transport will be lower than it would otherwise have been), R5 (increasing suburbanisation through location choice motivated by the search for higher quality of life and escape from local environmental pollution actually caused by transport), R6 (social desirability of car use), R7 (negative effect of rising fuel prices on public transport budgets), R8 (power of car industry maintaining fuel prices lower than they would otherwise have been) and R9 (influence of car industry on urban planning).

The loops that limit car use growth are R1 (quality and attractiveness of public transport), B1 (the effect of congestion on car travel times and the resulting incentive to switch to public transport, provided that public transport travel times are not affected such as in the case of preferential bus lanes or suburban trains), B3 (the effects of congestion and limited time budgets for travel on increasing attractiveness of a high-density lifestyle resulting in urban sprawl being lower than it would otherwise have been), B4 and B5 (limited availability of land for road and housing construction), B6 (the effects of environmental awareness on urban planning), B7 (the effects of environmental awareness on transport mode choices) and B8 (the effects of increasing fuel prices on car use).

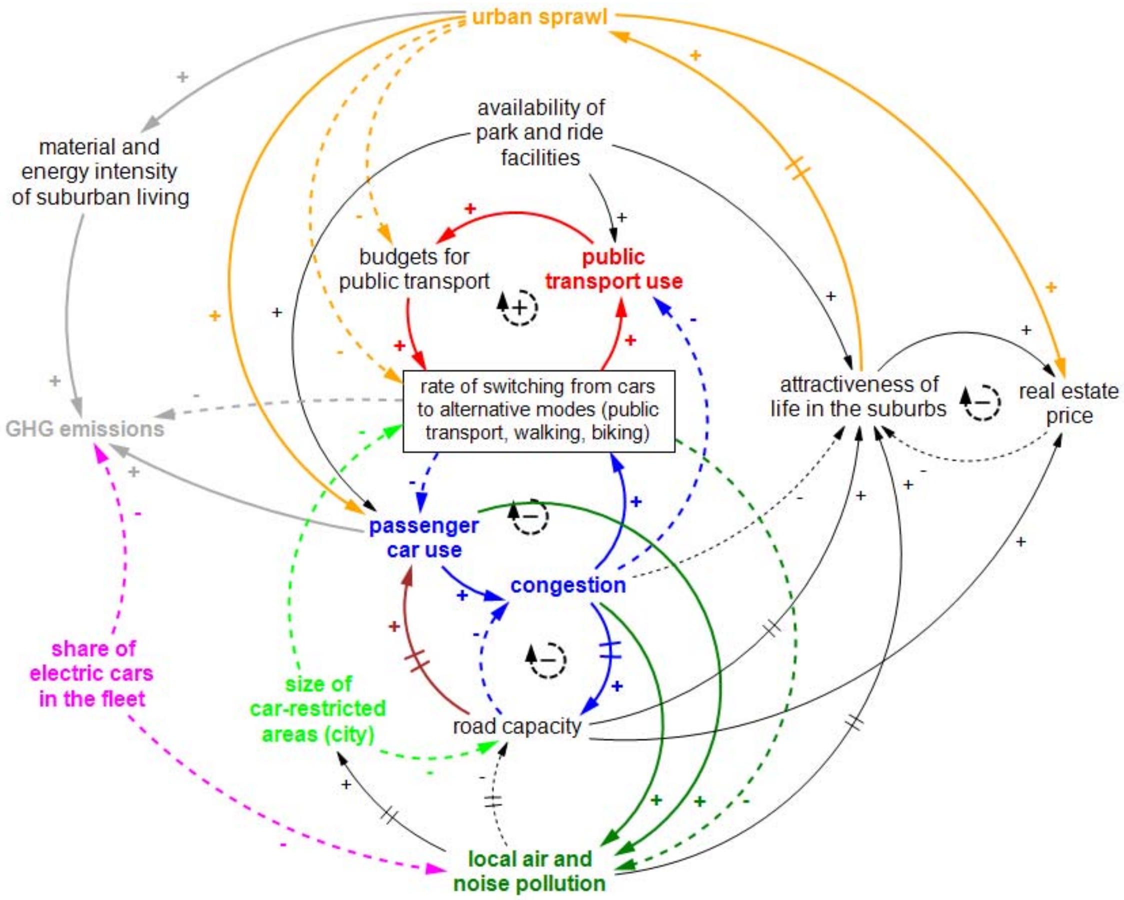
An analysis conducted with the participants explored some of the key implications of this structure. The surface size of the city would continue to grow unless land availability limits are hit or until pollution and resource consumption become so high that they have powerful effects on decision making and fuel prices. Part of the wickedness of the problem is that some of the negative side effects of increasing car use can contribute to continuing growth of car use: (i) an increase in congestion can be combated by extending the road capacity, but that induces more transport, thereby again increasing congestion; (ii) an increase in local pollution will result in more urban sprawl that what would otherwise have occurred, thereby putting strain on public transport budgets and contributing to increasing car use; (iii) the consumption of non-renewable resources affects also public transport budgets, possibly making public transport less attractive in comparison to car use; and (iv) if public transport speed is affected by congestion, this can also make public transport less attractive than car. Decreasing relative environmental impacts of car use (e.g. making car engines more efficient) could actually contribute to continuing growth of the scale of the problem, as some limiting loops would become weaker (B6, B7 and B8).

3. System maps for the 2nd Multinational Knowledge Brokerage Event on Sustainable Mobility

Based on the map above we created sketches of 6 maps that are supposed to stimulate discussion and exchange of knowledge between participants on three issues related to technical mobility infrastructure and three issues related to behavioural change.

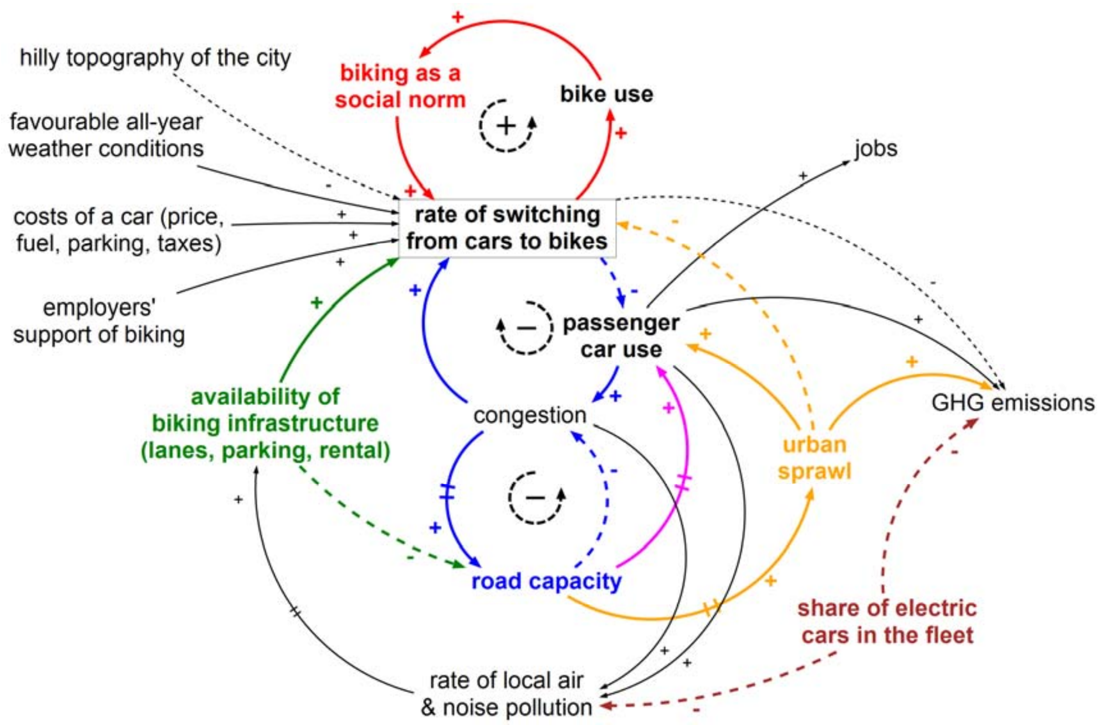
1.1 Technical mobility infrastructure issue nr. 1: 'restricted zones'

How would 'restricted zones' (such as environmental zones, pedestrian areas, car-free districts and city centres) influence greenhouse gas emissions?



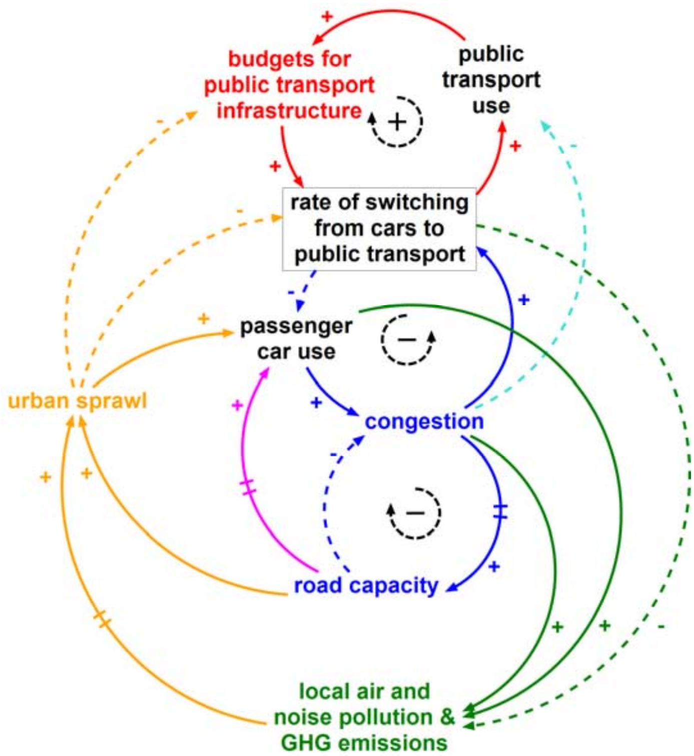
1.2 Technical mobility infrastructure issue nr. 2: biking infrastructure

How would development of urban cycling infrastructure (such as cycling lanes, bike parking and rental facilities) influence greenhouse gas emissions?



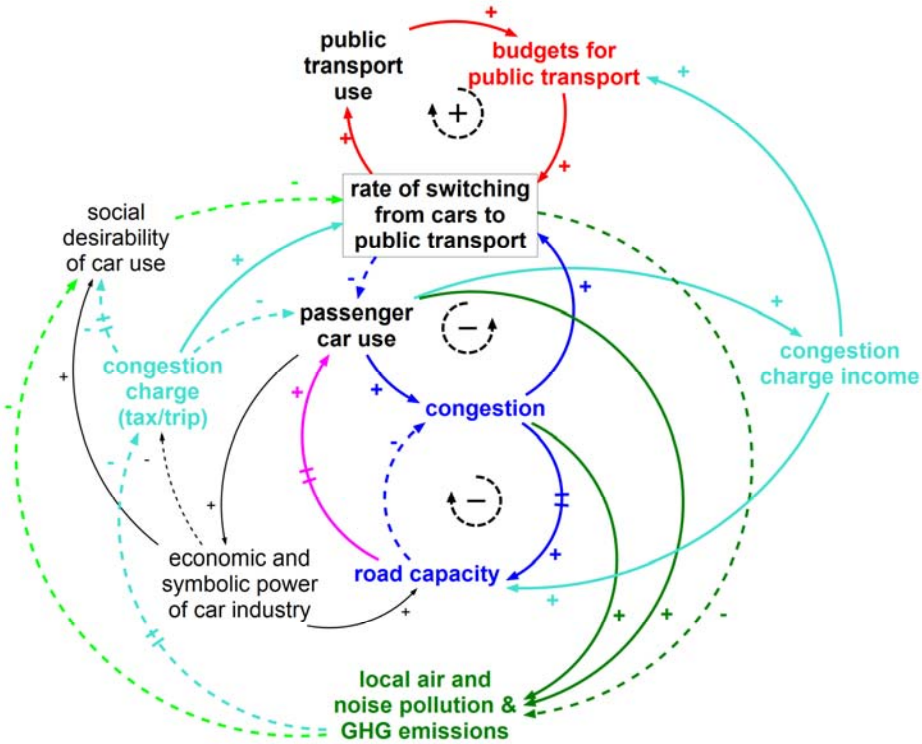
1.3 Technical mobility infrastructure issue nr. 3: public transport infrastructure

How would development of urban public transport infrastructure (such as separate public transport lanes, investment in public transport infrastructure) influence greenhouse gas emissions?



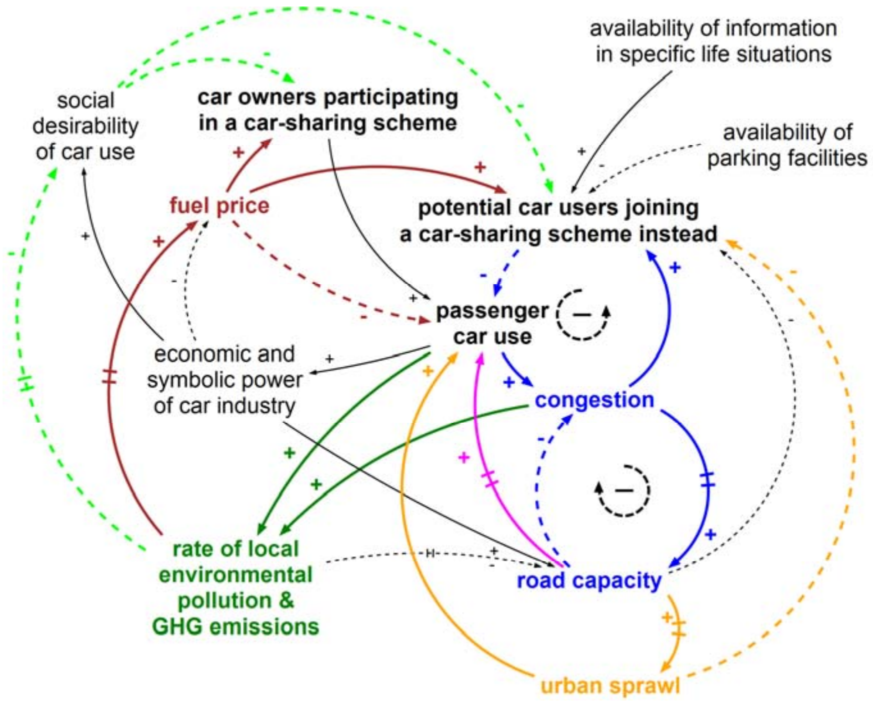
1.4 Behavioural change issue nr. 1: congestion charges

How would congestion charges (as introduced in Stockholm or London) influence greenhouse gas emissions?



1.5 Behavioural change issue nr. 2: car sharing

How would the introduction of a car-sharing scheme influence greenhouse gas emissions?



1.6 Behavioural change issue nr. 3: less-car-use campaigns

How would campaigns combining awareness raising and incentive instruments and targeting specific groups (such as the new citizens in Munich) influence greenhouse gas emissions?