Institute of Transport Economics
Norwegian Centre for Transport Research

Summary:

Indicators for sustainable urban mobility – Norwegian relationships and comparisons

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Author(s): Vibeke Nenseth, Petter Christiansen and May Hald
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The Institute of Transport Economics (TØI) has developed an indicator set for urban transport and environment illustrating the driving forces behind the development in transport volumes and modal split, the environmental and climate footprint, and the transport and environment policy performance. The indicator set is based on available and regularly updated data for Norwegian cities – from Statistics Norway's web-site and TØI's regular national travel surveys. An active use of indicators of the drivers behind the cities' mobility patterns and transport emissions provides a broader picture of the political action space. Indicators alert and reveal the key areas where policies and measures are to be put in place. Transport data for calculated greenhouse gas emissions at city level and for local emissions still need improvement to be more easily available. In the quantification of environmental goals in transport policy, increasing emphasis is put onon the indicator relationships and distance-to-target indicators.

An indicator system for environmentally friendly urban transport

Being in charge of the Norwegian Public Roads Administration programme on Sustainable urban transport, and of the research project TEMPO[1] (transport and environment – policies and measures), TØI has developed detailed transport and environment indicators for Norwegian cities. An earlier report has documented the state of the art for urban transport and environment indicator development, suggesting an indicator set based on easily available and regularly updated transport and environment indicators for Norwegian cities (see TØI report 1029/2009). In the present report, we match the suggested indicator set with empirical data from Norway's 21 largest cities. The indicators have been discussed at seminars and workshops among the cities. These discussions have been important for the development and selection of the indicators' relevance and applicability in a practical political context.

The indicators demonstrate how the social *driving forces* behind the main *transport factors* that affect the *environment and climate conditions* vary between the cities, which in turn are influenced by the *transport and environment policies and measures* in the cities.

Indicators for status, performance, progress and efficiency

The work on environmental indicators aims to develop criteria describing the environmental footprint, the policies to meet the situation, and whether the policies are actually working, i.e. if they are relevant and efficient. Along these

[1] In collaboration between TØI and CICERO, www.tranportmiljo.no

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lines recent indicator systems are integrative in seeing environmental changes in relation with societal causes and policy response (e.g. as in LCA – life cycle analysis, and in the DPSIR model – 'Drivers-Pressure-State-Impact-Response'). Gradually, a number of requirements for well functioning environmental indicators that could work in a political context were established. As a starting point, such indicators must be:

- *Policy relevant,* i.e. composed of variables or factors that policy can actually influence, and that also puts the spotlight on the important policy challenges
- Appropriate tools for the *local utilization*, and at the same time
- *Comparable* in terms of national and international use, historically over time and across countries, cities and regions
- *Simple and straightforward*, i. e. limited in number, transparent (to verify how they are developed and calculated); they must certainly be able to communicate and convey key relationships, within both the political sphere and general public
- *Based on robust, measureable and accessible data,* collected on a regular and systematic basis and as comprehensive or representative as possible
- Compatible with scientific demands for *reliability and validity*

Environmental indicators thus have a tripartite function in satisfying *scientific* criteria, a set of *communication* needs, and a *policy governing* function.

Integrated indicators for urban sustainable transport in Norway

Whereas policy standards, technology and business development have provided reduced greenhouse gas emissions in total, the transport emissions have not yet been cut. To reduce the environmental and climate burden of urban transport, targeting the societal driving forces behind the transport development is crucial. Indicator analyses reveal and communicate significant relationships between transport and the physical, economic, political and social changes. These shed light on the sources of the transport generated environmental and climate problems. Indicators are thus above all a *communicative* policy measure, providing both facts and garners attention. An indicator system can draw attention to the origins of transport related environmental and climate challenges – these challenges are created by society and must be understood, communicated and managed, both professionally and politically, in order to bring about necessary changes. Indicators provide an updated knowledge base for policy and planning yet may also have a political liability and agenda setting feature – in that they help bring issues to the table. Thus as central role for the indicators is 'benchmarking' – contributing in a policy changing context to shape the political pressure for the required policy implementation and actions.

In this project, TØI has developed detailed transport and environment indictors for Norwegian cities. This work is illustrated in the simplified model below, where indicators were applied in each of the main blocks in the causal chain, see figure S.1. The model seeks to capture the social *driving forces* behind the main *transport factors* that affect the *environment and climate conditions*, which in turn creates social *consequences* for the population, and for urban life. The blocks and particularly the underlying driving forces are controlled or influenced by *planning and policy measures*. The purpose of the compiled transport and environment

indicators is to reveal how development features in one area are related to developments in another.

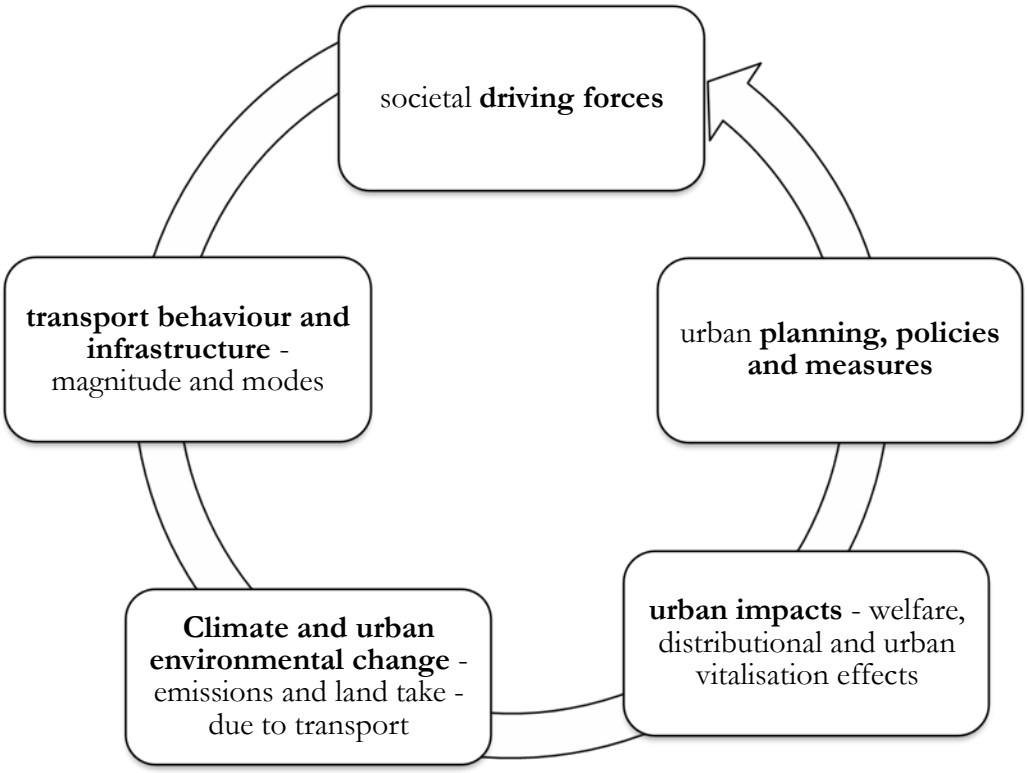

Figure S.1. Indicators for urban transport, environment and climate

Challenges connected to the indicator set urban transport and environment

Key data sources include KOSTRA (Municipality-State-Reporting system), data from the Statistics Bank, emissions data models, spatial statistics, vehicle registrations, etc. Statistics Norway and from TØI's national travel surveys. For environmentally friendly urban transport, a set of about 40 individual indicators divided into the five main lumps in the chain has been proposed, based on today's easily available data: driving forces, transportation, environment, and policy, see table S.1.

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Table S.1: Indicator set for urban transport and environment (drivers, transport, environment, policy) – for Norwegian cities

		Indicator	Unit	Data source
Drivers	Population	Population growth, last 10 years	%	SSB
		Share, high education level	%	SSB
		Personal income, average	NOK	KOSTRA
	Economy	Share of service sector of businesses	%	SSB
		Municipal finance (gross revenue)	NOK/cap	KOSTRA
		Share, registered construction projects /capita	%	KOSTRA
	Urban structure	Share inhabitants per sq km of dense urban area	%	KOSTRA
		Share urban centres (sq km) per dense urban area	%	SSB
		Ratio employed / inhabitants in urban centres	%	SSB
		Share of inhabitants (20-66 yrs) commuting out	%	SSB
		Average travel time to municipal centre	Minutes	KOSTRA
Transport		Car density	cars/cap	SSB
		Share of travels – walking	%	NTS
		Share of travels – cycling	%	NTS
		Share of travels – public transport	%	NTS
		Share of travels – by car (driver+passenger)	%	NTS
		Ratio utility cars / person cars	%	SSB
		Share of cars with alternative fuel	%	SSB
		Share of commuters /employed	%	SSB
		Daily km as a car driver	Km	NTS
		Daily minutes as a car driver	Minutes	NTS
		Daily mobility	Travels/day	NTS
		Share of the population with full access to a car	%	NTS
		Car dependency (share of daily travel time as a car driver)	%	NTS
		Daily "average speed" (car driver km/ car driver minutes)	km/minutes	NTS
Environment	Local environment	Transport infrastructure/ urban dense area	%	SSB
		Play field / recreation area / urban dense area	%	KOSTRA
		Walking / cycling pathways	Km	KOSTRA
		NOx from road traffic	Kg	SSB
		NOx per capita	kg/cap	SSB
		PM10 (particulate matter) from road traffic	Kg	SSB
		PM(particulate matter) per capita	kg/cap	SSB
	Climate	CO2-emissions from road traffic	Ton	SSB
		CO2-emissons from road per capita	kg/cap	SSB
		Amount change CO2-emissions (mobile sources), 1991-2009	Ton	SSB
		% change CO2-emissions (mobile sources) 1991-2009	%	SSB
Policy		Walking / cycling pathways per capita	km/cap	KOSTRA
		Walking / cycling pathways with municipal responsibility	Km	KOSTRA
		Share municipal road with speed limit <40km	%	KOSTRA
		Park-and-ride spaces per capita	Spaces/cap	KOSTRA
		Share of population with highest level of public transport availability	%	NTS
		Netto municipal operation costs for transport	Kr	KOSTRA
		Share of gross investment expenditure allocated to transport	%	KOSTRA

There are, however, not satisfactory data available for all the elements in the model. For example, data on transport demand and supply and on the environmental effects of transport are better documented than on the urban impacts in terms of economic, welfare and health effect. The real source of the societal consequences of transport's emission may be difficult to determine specifically: whether for instance asthmatics' burden is due to wood firing or car traffic. Such data are often provided by single case studies and evaluations after

large transport infrastructure interventions and changes, not from current statistics. Indicators for these kind of impacts, for instance on the noise nuisance share of the population, might be elaborated and derived from model calculations, also broken down to a city and municipal level. However, such representative data covering most parts of Norway are not yet available.

One aspect of the data quality is the level of measurement. A number of environmental indicators are well-established on continuous scales, which gives quantitative expression (number, proportion, volume, length, weight). However, a number of key factors – indicators – for environmental policy and condition cannot be expressed quantitatively as they are qualitative occurrences. Examples of this are certain imperative institutional arrangements that either are in place – or not in place. Such arrangements are not conducive to indicator measurement, yet they are important when it comes to the implementation of policies and solutions. Indicators pertaining to the effectiveness of planning and policy measures (response indicators) have proven difficult to incorporate in established sets of indicators. For example, the extent of public transport investments and operations do not provide a good indication of the environmental transport policy measures because it is not the input, but rather output or outcomes, which should be measured. The reality of coordinated land use and transport planning may be most crucial for sustainable urban transport, but gives little sense to report within an indicator system because this reality can only be reported dichotomously at a nominal level (yes/no). The effectiveness of planning strategies has proven difficult to measure precisely – not least because potential results or outcomes without a plan would be difficult to prove.

Some illustrations of the indicator set in use

The key point of an integrated transport and environment indicator set is to compare and reveal relationships – i.e. how development trends in one area are connected to trends in another. Our indicator relationships show for instance that the growth in the greenhouse gas emissions are inversely related to both population growth, income growth, degree of urbanization, share of service sector and education level in the city. Thus it seems like cities perceived as attractive – to dwellers as well as to developers – are also the most successful in curbing greenhouse gas emissions.

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Urbanisation reduces emission growth – and car use

Figures S.2-3 exemplify how key indicators of e.g. transport are related to significant social driving forces, such as income or urbanization, and how transport factors in turn are connected with key environmental and climate factors. The empirical data are drawn from the 21 largest cities/municipalities in Norway. Figure S.2 shows how the changes in the cities' greenhouse gas emissions over time are related to average income growth. The cities with highest growth in the greenhouse gas emissions from road transport have roughly speaking the lowest income growth, whereas the cities with best income development have relatively lower growth in greenhouse gas emissions. Figure S.3 illustrates the relationship between a central transport factor like *car use* – measured as share of daily travel time as a car driver – and a central driving force like the cities' level of education. Also degree of urbanization, in terms of share of urban centres of the urban dense area, is highly correlated with other essential transport-environment indicators, like daily travel distance as a car driver. As expected, the (inverse) relationship between car use (dependence) and the cities' public transport share is strong. That car dependency is highest in the cities where mean income level is lower runs counter to the common assumption of more car use with higher income. More puzzling is however the relationship between education level and car dependency. Education is a factor also strongly related to urbanization and centralization. Thus urbanization, not only as a characteristic of physical land use and infrastructure, but also in terms of societal, economic and cultural factors, is important for more sustainable mobility patterns. This is illustrated, e.g., by indicators for education, service businesses and income development. It seems, in short, that urbanization promotes an advantageous development in terms of both social, economic and environmental indicators.

However, population growth necessarily implies more traffic and environmental burden in absolute terms. At the same time, the carbon footprint and environmental deterioration felt by each individual is lowest in the cities, where there are most people. Even if increasingly more people contribute to – and experience the burden of – the environmental consequences of urban transport, it is in the cities that the potential of policy change is most promising. *Decoupling* the environmental burden from economic and welfare development might thus be a specific possibility in the Norwegian urban context.

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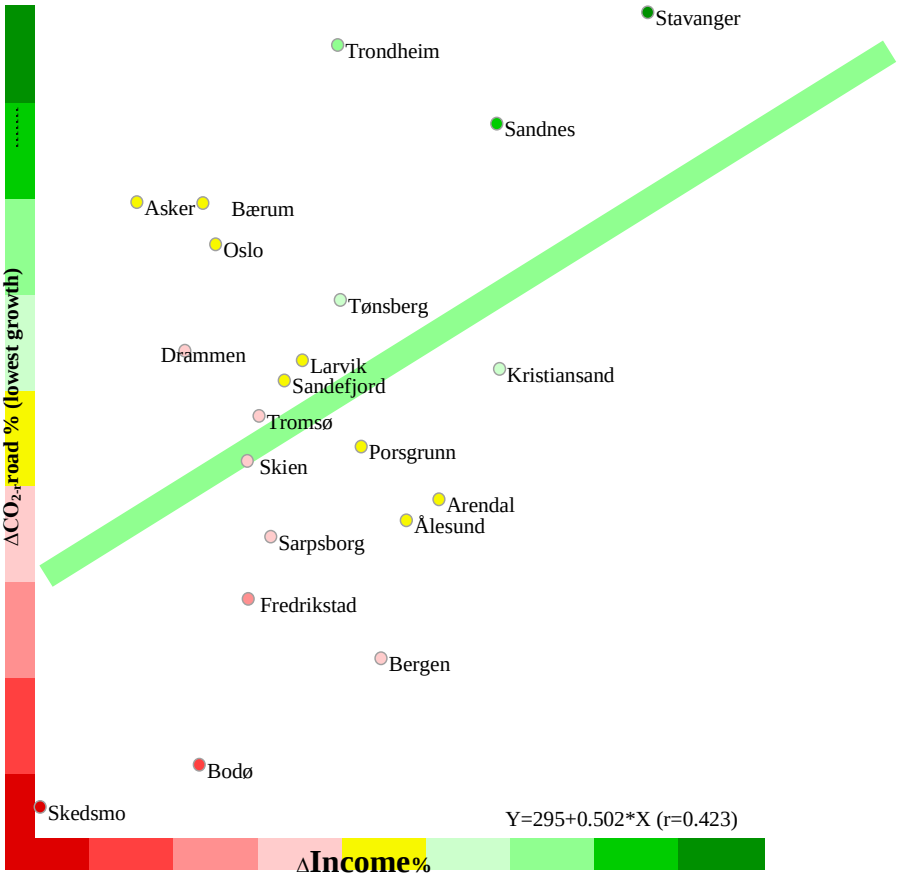

Figure S.2: Lowest growth in road GHG emissions in cities with higher growth in average personal income (1991-2009) (Green scale: lowest emission growth, highest income level)

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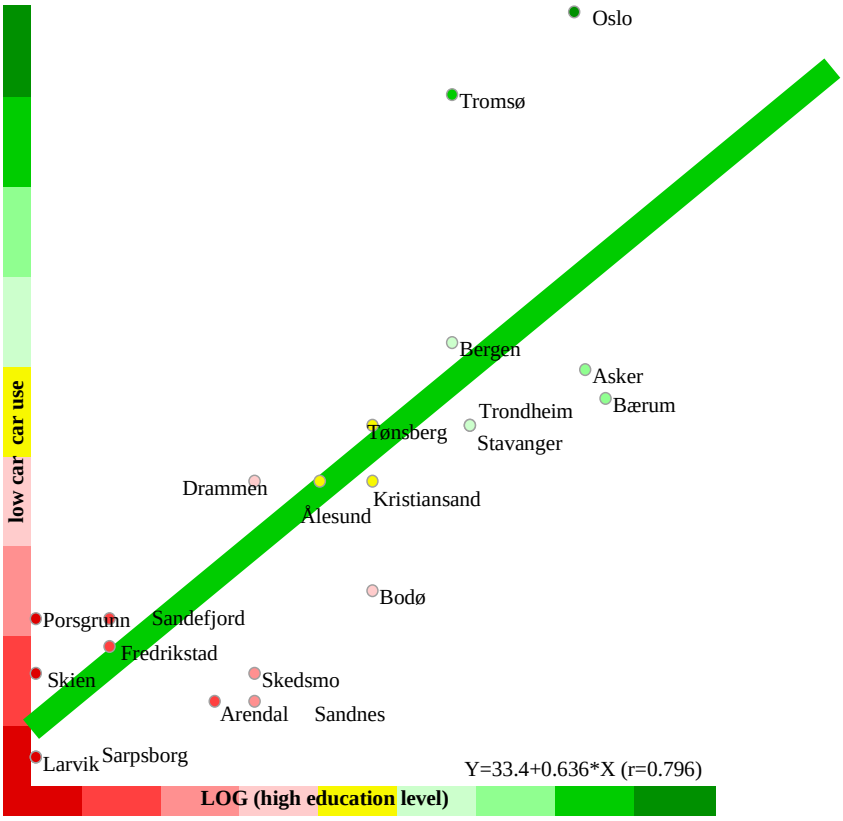

Figure S.3: Lowest car use in cities with higher educational level. 21 Norwegian cities compared. 2009. (Green scale: lower car use, higher educational level)

Indicators as governance tools – applicable in a practical policy context

The very existence of integrated environment and transport indicators can be an expression of a particular institutional capacity to address environmental and climate challenges related to transport. How effectively do, e. g. environmental management and monitoring function? Indicator development can therefore demonstrate the ability to obtain an integrated and coherent planning and policy development in the field.

Systematic, regular and representative indicator reporting could help improve case studies on transport and environment as implemented in selected cities and districts, for certain environmental problems (noise, air pollution, greenhouse gas emissions) and for certain roads, etc. Although more thorough case studies are necessary for in-depth analysis of major mechanisms and contexts, the lack of representative studies also reveals a problem in terms of resources. This is a common challenge in a developing country context, where only scattered case studies are available and statistics and data deficiency is common. In an indicator context, triangulation methods using data based on qualitative studies and as well as representative data from quantitative analyses are particularly beneficial. Our indicator analyses, based on simple bivariate correlations, illustrate some of the important factors to recognize and pay attention to in the policies for urban sustainability and sustainable mobility.