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Road and Transport

Research for Climate and Environment

News from

Swedish National Road and Transport Research Institute (VTI)

VTI is an independent, internationally established research institute which is engaged in the transport sector. Our work covers all modes, and our core competence is in the fields of safety, economy, environment, traffic and transport analysis, public transport, behaviour and the man-vehicle-transport system interaction, and in road design, operation and maintenance. VTI is a world leader in several areas, for instance in simulator technology.

Danish Road Directorate (DRD) Danish Road Institute (DRI)

The Road Directorate, which is a part of The Ministry of Transport, Denmark, is responsible for development and management of the national highways and for servicing and facilitating traffic on the network. As part of this responsibility, the Directorate conducts R&D, the aim of which is to contribute to efficient road management and to the safe use of the network. The materials research component is carried out by the Danish Road Institute.

Technical Research Centre of Finland (VTT)

VTT Technical Research Centre of Finland is a contract research organisation with a staff of 2,800. In this joint publication, the VTT expertise areas cover research and development of transportation, logistics and road structures. The work is carried out in five research groups employing a staff of 60.

Icelandic Road Administration (ICERA)

The ICERA's mission is to provide the Icelandic society with a road system in accordance with its needs and to provide a service with the aim of smooth and safe traffic. The number of employees is about 340. Applied research and development and to some extent also basic research concerning road construction, maintenance, traffic and safety is performed or directed by the ICERA. Development division is responsible for road research in Iceland.

Norwegian Public Roads Administration (NPRA)

The Norwegian Public Roads Administration is one of the administrative agencies under the Ministry of Transport and Communications in Norway. The NPRA is responsible for the development and management of public roads and road traffic, as well as the Vehicle Department. This responsibility includes research and development of all areas related to road transport and the implementation of R&D results.

Institute of Transport Economics (TØI), Norway

The Institute of Transport Economics is the national institution for transport research and development in Norway. The main objectives of the Institute are to carry out applied research and promote the application and use of results through consultative assistance to public authorities, the transport industry and others. The Institute is an independent research foundation employing about one hundred persons.

Editorial notes

Nordic Road & Transport Research is a joint publication of six public road and transport research organisations in the Nordic countries, Denmark, Finland, Iceland, Norway, and Sweden. The main objective of the publication is to disseminate research results and news from the institutions, especially to researchers and decision makers. Each institution is responsible for the selection and presentation of the material from its own scope of activities.

Nordic Road & Transport Research is published three times a year. It is regularly sent out, free of charge, to recipients selected by the six joint publishers. Free sample copies are also sent out on special request.

Correspondence about the contents of the publication:

Please write to the author or to the respective publishing organisation.

Requests for back issues, and notification of address changes:

Readers outside the Nordic countries: please write to the Editor-in-chief at the VTI in Sweden.

Readers in the Nordic countries: please contact the publishing institution of your country.

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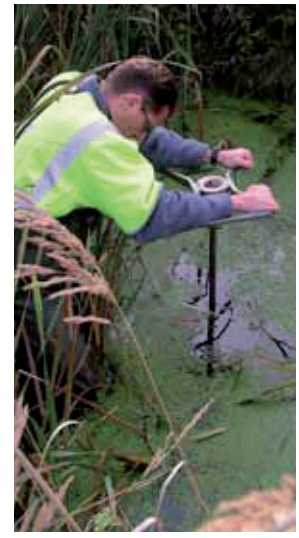


PHOTO: PHOTOS.COM

New important research project in Norway:

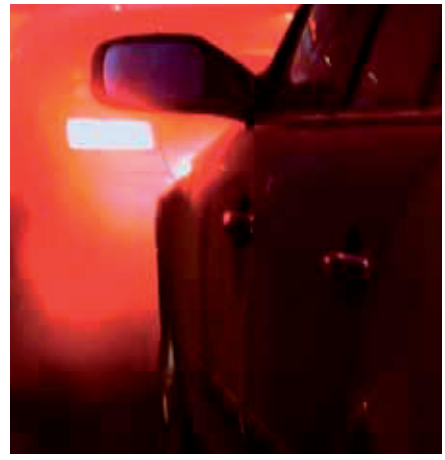
Transport and Environment – Measures and Policies (TEMPO)

Consensus is growing among governments worldwide that the man-made emissions of greenhouse gases must be reduced and eventually eliminated. The Institute of Transport Economics (TØI) in Norway is project coordinator for a new important research project named TEMPO, funded by the Research Council of Norway and with contributions from 12 user partners.

Despite this growing consensus, a gap exists between the perceived need for policy intervention in the transport sector and our knowledge of the real-world, end-of-chain environmental, economic and societal effects of the various policy measures available to governments. The main aim of the TEMPO project is to help fill this gap, i. e. to provide policy makers with the information needed for effective policy formulation.

Based on systematic, rigorous, high quality interdisciplinary research the project will identify mechanisms that inhibit and/or promote the development and implementation of policy measures that will have a significant and lasting effect on greenhouse gas emissions from transport. The project will show how the transport sector could drastically reduce emissions in the next few decades and what political and economic challenges that this would entail.

Effective, eco-friendly transport solutions will vary from one society to another. Using the Norwegian society as a case, and developing a catalogue of policy measures as applicable in Norway, TEMPO will provide transferable lessons, strategies, methodologies and subject-matter knowledge with a wide area of interest and use. These learnings will be summed up systematically in a catalogue of policy options, describing the most important measures and policy instruments by their feasibility and cost-effectiveness.



The project is funded under the RENERGI programme of the Research Council of Norway. The scientific partners are the Institute of Transport Economics (project coordinator), Centre for International Climate and Environmental Research – Oslo (CICERO), the Free University of Amsterdam, the University of California, Davis, and the Pontifical Catholic University of Chile. The user partners include the Norwegian Public Roads Administration, the National Rail Administration and the Akershus County Administration, among others

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15th International Conference

Road Safety on Four Continents

Abu Dhabi, the United Arab Emirates, 22–24 March 2010

Together with the United Arab Emirates National Transport Authority we have the pleasure of inviting you to the 15th International Conference "Road Safety on Four Continents" in Abu Dhabi 22–24 March 2010.

The conference is organized by the Swedish National Road and Transport Research Institute (VTI), together with the National Transport Authority of UAE. The conference is supported by GRSP (Global Road Safety Partnership), FERSI (Forum of European Road Safety Research Institutes), TRB (Transportation Research Board) and ECTRI (European Conference of Transport Research Institutes).

The main objective of the conference is to explore emerging research and development in the area of Road Safety. Other objectives are furthering the application of research results and involving developing countries and countries in transition to join in both as conference presenters and delegates. A special emphasis will be towards road safety challenges and problems in the region, i.e. in and around the United Arab Emirates.

The conference topics and themes will attract the international research community, national safety experts, decision makers, road safety engineers and planners, traffic law enforcement officials and many others with an interest in road safety development.

Main themes of the conference are:

- Exchange of new findings on road safety
- Transfer of road safety knowledge
- Exchange of evaluated good practises.

The Conference will cover the following topics:

1. Road safety plans and strategies
2. Safety management techniques including speed management
3. Crash recording systems, policy information systems and black spot analyses and evaluation
4. Road user education, driver licenses, special user groups: young, old, vulnerable
5. Vehicle innovations and ITS applications
6. Traffic engineering innovations including road design and behavioural issues
7. Distraction, fatigue, alcohol and drugs related adverse effects on driving
8. Economic and financial issues, cost benefit and evaluation
9. Enforcement techniques, traffic laws and self enforcing designs
10. Urban safety, traffic calming, and slow traffic
11. Interurban and rural safety, intersections, incident management
12. Preventive safety measures, audits, safety inspections
13. Modelling and evaluation techniques
14. Work-related road safety, fleet safety
15. Other related subjects: Health issues, raising awareness, campaigns

Read more at
www.vti.se/RS4C
Inquiries about the conference can be sent to
RS4C@vti.se

LIPASTO – Traffic Emission Database

LIPASTO is a free website showing total traffic emissions and their trends in Finland for all transport modes. In addition, unit emissions for hundreds of vehicle types expressed in grams per passenger- or tonne-kilometres are shown. The website is the only one of its kind.

Kari Mäkelä, VTT, Finland

The bilingual LIPASTO website on traffic emissions at http://lipasto.vtt.fi is divided into two basic sections: emission inventory and unit emissions. In the inventory section, total amounts of exhaust emissions in Finland and forecasts for all four transport modes and working machines are presented for the period 1980–2028. The unit emission section gives roughly 12 000 emission figures per transport unit covering all transport modes, including 25 ship types. Especially useful are emissions per net tonne-kilometre, as they reveal the actual energy and emissions efficiency of the relevant transport mode.

Development of the calculation systems and website has been financed by VTT and the main transport authorities in Finland. All the material on the site is public and can be cited with reference to the source.

Inventory

The inventory section of the site consists of the four transport modes — road, railway, waterways and air traffic — and working machines. The figures and graphs are based on separate calculation models developed by VTT, except for the air traffic model, which was created by the Civil Aviation Administration. At present the site covers emission amounts for the years 1980–2008 and forecasts up to 2028 (Figure 1). The road transport model is the most detailed, as emissions are calculated at the municipal level (currently there are 332 municipalities in Finland). These figures are widely used e.g. as source data for air quality studies of municipalities and provinces. Finland's official transport emission reports to the EU and UN are also based on the LIPASTO model.

The LIPASTO model has two special features. First, particular attention has been paid to the emission model for working machines, TYKO, including calculations of emissions and energy use of some fifty machine types for the period 1980–2030. Second, all leisure motorboats both big and small, amounting to half a million craft, are included in the waterborne transport model.

The emission compounds calculated are CO, HC, NOx, PM, CH4, N2O, SO2, CO2. Fuel consumption is also given. Models are updated yearly and the results are published on the website.

Unit emissions

Unit emissions are emissions from the transportation of goods or people by a specific means of transport expressed as emissions per tonne-kilometre or passenger - kilometre. Such information is needed e.g. by companies calculating the emissions of their transport services. Until now, no comprehensive, public database of unit emissions has been available. Because companies now can use the same data source, the calculation results are more comparable than those from diverse sources with emission figures produced in different circumstances. The LIPASTO website attempts to meet the need for an impartial public data source.

All transport modes are represented, as well as working machines. The main focus is on vehicle types typical to Finland, which include trucks and trailers up to 60 tonnes, icestrengthened RoPax vessels driving at high speed, ferries, etc.

There are some features in the waterborne transport model that are worth mentioning. The units used for freight ship emissions are emissions per ship-kilometre, per container-kilometre, per trailer-kilometre (onboard a ship), and per net tonne-kilometre (freight inside containers and trailers). Especially the figures expressed in net tonne-kilometres are exceptionally high and well above the figures presented elsewhere. Commonly the load factor of a ship is calculated from the total weight of the freight taking only the loaded leg. Load factors for ships are thus generally around 80% of the dead weight tonnes (DWT). In LIPASTO the figures are based on detailed statistics of actual net freight weights and both legs are taken into account. The figures show that e.g. containerships visiting Finnish ports carry on average 65% of the maximum capacity of containers (1000 TEU) of which 77% are loaded having a 9 tonne load per TEU. As a result the net load for a 14 000 DWT containership is

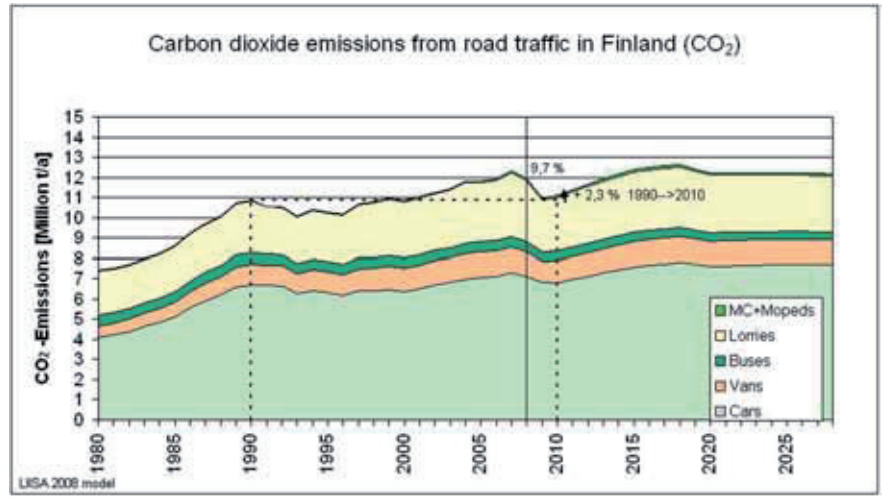

Figure1. Carbon dioxide emissions have been calculated by the road traffic model and are presented on the LIPASTO site. The trend of emissions of different vehicle types is shown on the graph (fluctuation in emissions is due to economic situations and e.g. use of biofuels).

4 500 tonnes and the load factor 32%. This is far from the above-mentioned 80% (11 200 tonnes). The same applies to RoRo ships with a small net load.

The effect of fast driving is also shown on the LIPASTO pages, e.g. the fuel consumption of a ship is doubled when driving at 24 knots instead of 18 knots.

For vehicles carrying both passengers and freight (ferries, airplanes) the allocation of emissions between passengers and freight is a very challenging task. There are many allocation methods, none of which are unquestioned. International cooperation and agreements are needed to solve this problem along with many other problems concerning unit emissions.

Ropax, 18 kn, trailer capacity 300	CO	HC	NOx	PM_{10}	$PM_{2,5}$	CH_4	N_2O	SO_2	CO_2	CO2 eq.	Fuel consumption	Energy cons. [MJ]
[g/ship km]	209	44	5 164	118	95	21	7	2 137	251 791	254 401	79 024	3 240
[g/trailer km]	0.73	0.15	18	0.41	0.33	0.07	0.026	7.5	881	890	277	11
[g/tkm]	0.06	0.013	1.5	0.035	0.028	0.006	0.0021	0.6	74	75	23	1.0

Trailer capacity [units]	GT [t]	DWT [t]	Main engines [kW]	Speed [knots]	Distance [km]	Trailers from max. [%]	Consumption Main [g/kWh]	Consumption Auxiliary [g/kWh]	Sulphur content HFO [m-%]	Sulphur content MGO [m-%]
300	40 000	9 000	44 000	18	1 300	80 %	190	210	1.45	0.1

Ropax, 24 kn, trailer capacity 300	CO	HC	NOx	PM_{10}	$PM_{2,5}$	CH_4	N_2O	SO_2	CO_2	CO2 eq.	Fuel consumption	Energy cons. [MJ]
[g/ship km]	376	77	9 364	219	176	37	13	3 999	454 182	459 907	142 504	5 843
[g/trailer km]	1.3	0.27	33	0.77	0.61	0.13	0.044	14.0	1 590	1 606	499	20
[g/tkm]	0.11	0.023	2.8	0.065	0.052	0.011	0.0037	1.2	134	135	42	1.7

Trailer capacity [units]	GT [t]	DWT [t]	Main engines [kW]	Speed [knots]	Distance [km]	Trailers from max. [%]	Consumption Main [g/kWh]	Consumption Auxiliary [g/kWh]	Sulphur content HFO [m-%]	Sulphur content MGO [m-%]
300	40 000	9 000	44 000	24	1 300	80 %	190	210	1.45	0.1

Both passengers and freight are transported in Ferries, 80% of emissions are allocated to passengers, 20% to freight.
Both passengers and freight are transported in Ropax ships, 16% of emissions are allocated to passengers, 84% to freight.
Number of transport units (truck or trailer) is 60%, one loaded transport unit contains on average 14 tonnes load, share of empty units is 15%

g/ship km = grams per ship kilometre (the transport of the entire ship over one kilometre)
g/trailer km = grams per trailer kilometre (the transport of one trailer over one kilometre)
g/tkm = grams per tonne kilometre (the transport of one tonne over one kilometre)

Standardisation

The lack of common agreements on definitions and calculation methods of emission calculation in transport services has now been recognised at EU level. The European Committee for Standardization (CEN) has established a working group for the preparation of standard CEN/TC 320/WG10 "Energy consumption and GHG emissions in relation to transport services". In tree years from now, this group will provide definitions and solutions to the many uncertainties also encountered in the LIPASTO system.

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Transnova: Established and Operating

Launching the Transnova internet homepage May 13th 2009 was a milestone and an introduction to the public for the project. This was done at the event Electric Vehicle Symposium 24 (EVS 24) in Stavanger by the Norwegian Minister of Transport and Communications, Liv Signe Navarsete. From that moment information and forms were available for applicants to apply for grants for establishing charging points for electric vehicles.

Asbjørn Johnsen, Transnova, Norway

The intention of Transnova is to give grants for projects within the transport sector that will contribute to reduction of CO_2 emissions from the transport sector and thereby enable Norway to reach the targets set by the 2008 national settlement on climate and become climate neutral by 2050. The most important objective is replacing fossil fuel with fuels with lower levels of or zero CO_2 emissions.

Electrifying the transport sector is important in order to reduce Greenhouse Gas (GHG) and other emissions. Conditions in Norway allow the use of electricity as fuel, because the entire electricity production in the country is based on renewable sources of energy. Making charging points for cars easily accessible is therefore an important part of the Government's strategy for a rapid electrification of the transport sector. An additional grant of 6 million euros in February for use in 2009 was especially made for speeding up this work by establishing a network of charging points for electric vehicles. The limited number of Transnova staff employed in April had to give this work high priority and a simple system developed for handling applications for grants is now operating well.

Transnova will in September this year announce further programs to enable the introduction of and increased use of different kinds of bio fuels and biogas in the transport sector. In addition there will be programs for use of hydrogen and electricity for the replacement of fossil fuels in vehicles. Applicants will be invited to apply for financial support for good projects with high potential for reducing CO_2 emissions. For these programs an allocated budget of 6 million euros per year up to 2011 is available.

For 2010 the number of programs will be extended. According to the objectives set for Transnova there will be programs for converting to more environmentally friendly forms of transport. The most important goal is to get increased knowledge and use of alternative transport of people and cargo, including access to transport and requisite infrastructure. Of great importance are also to perform better environmentally friendly transport planning and develop more environmentally friendly mobility patterns in the whole transport sector. Later there will be programs contributing to reduce transport volume in coordination with other instruments.

Transnova will make efforts to operate with a small number of staff. Now there are tree persons employed and this number is intended to be five in 2010. A board will be established to assist the organisation in program assessment and to give advice on best effects according to targets set for Transnova.

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Emission Taxes and Tradable Emission Permits in Climate Policy

The EU's climate policy divides emitters into two groups – one regulated through a tradable emission permit scheme, and another mainly regulated by emission taxes. This division may rightly be criticised for being a costly way of achieving the EU's emission goals. Svante Mandell, researcher in transport economics at VTI, shows in a recent article that there are nevertheless advantages in this division which in some cases outweigh the costs.

Svante Mandell, VTI, Sweden

In the Kyoto Protocol, EU is committed to limiting its total emissions of greenhouse gases to a level of 8 per cent below those in 1990. To achieve such a goal at least cost requires that all emitters in the economy face the same price for further emissions – which points towards either an emission tax that is equal for all emitters, or a tradable emission permit scheme which covers all agents in the economy.

Most scientists would agree that, for greenhouse gases, an emission tax is better from an efficiency point of view than a tradable emission permit scheme. In spite of this, the carbon dioxide emissions of the energy intensive industry are regulated by an emission permit trading system, while the other agents, for example transport and the household sector, are in all essentials regulated by emission taxes. There are reasons for the use of such a dual system, for instance because parts of the EU industries' competitors face less stringent emission requirements, but from the standpoint of cost effectiveness this solution appears to be far from optimal.

With the help of an economic model, it can be demonstrated that Svante Mandell the increase in costs due to the groups paying different prices for further emissions may be outweighed by the fact that the total emissions are closer to the desirable level. If all emissions are regulated by emission taxes, emissions will be low when abatements are cheap, and high in situations when they are expensive.

This is desirable from an efficiency perspective, but may result in emissions larger than permitted by the EU goals. By combining a taxed sector with a trading sector, whose total emissions are regulated by the number of emission rights, some of the advantages of the tax option may be achieved without risking the emission goals.

The article thus demonstrates that a division of the regulated economy may be desirable, but also that this is not always the case. Whether such a division is desirable depends, inter alia, on how strict the goals are, the cost structures of the emitters, and the importance politicians attach to future emissions.

Read more: VTI working papers in Transport Economics, http://swopec.hhs.se/vtiwps
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Reduced Car Use after Relocation

Relocation of eight research institutes changed the conditions for modal choice on travels to work. Changes of location in the urban structure, improved public transport services and worsening of parking conditions favoured other modes than the private car. The car share was reduced by almost 50 percent.

Aud Tennøy, TØI, Norway

In October 2006, eight research institutes (the CIENS-institutes) were relocated from different locations in Oslo to the same building in the research centre called Forskningsparken. Forskningsparken is located at Blindern, about four kilometres from the city centre of Oslo. Travel surveys were carried out before and after the relocation (in September 2006 and September 2007) (Tennøy and Lowry 2008).

Car share reduced

The companies moved from locations with different characteristics regarding public transport services, parking access and location in the city structure, to a situation with equal conditions. In general, the public transport services were improved and the parking access reduced. According to the theory in the field, this should cause reduced car use among employees, which it did. The car share on work travels among CIENS-employees was reduced from 36 percent to 20 percent. The public transport share increased from 30 to 39 percent and the bike share from 24 to 29 percent. 6 percent walked to and from work in both situations.

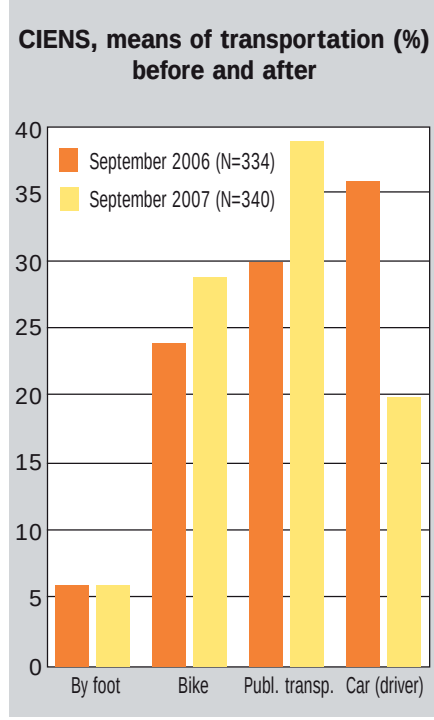

Figure 1: Changes in modal split on travels to work among CIENS- employees before and after relocation to Forskningsparken (Tennøy and Lowry 2008).

The modal split of the various CIENS-institutes became more equal after the relocation to the same building. Analyses carried out in order to discuss what caused the changes, based on analyses of changes in the different research institutes showed that changes in all the three conditions: location in the urban structure, public transport services and parking access, contributed to the reduction of the car share. It was concluded that the combination of all three changes explained why the reduction was so large (the car share was reduced by almost 50 percent).

Content employees

The surveys showed that employees in the CIENS-institutes were more content with their new work travel than they expected to be before the relocation (reduced parking access was seen as negative by many). More employees reported that the work travel had become better than before than reported that it had become worse than before. We also found that those who walked were most content with their work travel, followed by the ones bicycling, using public transport and at last the ones driving their car.

PHOTO: HARALD AAS

The author of the article, Aud Tennøy, use her bike to work at CIENS.

Residential location matters

We found clear differences in travel behaviour among CIENS-employees living at different residential locations. Those walking most were the ones living closest to Forskningsparken. Those using bike the most, are the ones that live in Oslo inner east (57 percent bike), Oslo inner west and Oslo outer north. This is also logical in relation to travel lengths. Those using public transport the most are the ones that live outside of Oslo and Akershus and in the outer parts of Oslo and Akershus. The exceptions are the ones that live in Oslo outer north (how bike a lot) and the ones that live in Akershus west and Oslo outer west. The two latter groups use private cars to a much higher degree than other CIENS-employees (47 percent car share among those living in Oslo outer west). The relations between residential location and choice of transport mode is thus as expected.

Conclusion

We thus found that location of working place in relation to the residential location (land use), together with the qualities of the transport systems, influence travel behaviour on travels to work substantially. This confirms the theories in this field.

The interesting news here are that 'city centre' like travel behaviour also can be achieved in outer parts of the inner city, as long as 'city centre like' conditions: good public transport services, low parking accessibility, are established.

References

Tennøy, Aud and Mike Lowry (2008): Travel survey among employees in the CIENS-institutes before and after relocation to Forskningsparken. TØI report 997/2008. Language: Norwegian with English summary

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Iceland's Wild Climate Gets Wilder

A saying in Iceland tells "if you don´t like the weather, just wait a few moments". Although dealing with harsh and rapidly changing weather is an everyday task for Icelandic road owners, the projected climate change in the 21st century demands a new way of thinking.

Skuli Thordarson,
Vegsyn ConsultIceland,
Iceland

Dealing with harsh and fluctuating climate is no news to the Icelandic Road Administration (ICERA). During the 20th century Iceland has gone through periods of both increasing and decreasing temperatures lasting several decades due to natural fluctuations. The temperature trend the last two centuries gives an increase of 0,7° C per century. A possible climate scenario for the 21st century suggests a temperature increase of up to 2,4°C. This is less than the projected figures for many continental northern hemisphere areas, thanks to the maritime climate of the island. One of the most prominent consequences of altered mean temperature is glacier retreat or advance, which in turn can define if rivers stay in their channel or find a new one. This is a lesson learned in the past and is one of key issues on the ICERA agenda for climate adaption. The Heinabergsvötn bridge is a lasting evidence of how future climate may affect transport infrastructure in the coming century. Shortly after the introduction of the bridge in 1946 the river joined another river following the retreating glacier, leaving the previous riverbed dry.

Defining ICERA's climate adaption strategy

A working group of ICERA specialists is assigned the task of systematically identifying the threats and vulnerable assets that need to be included in future climate adaption. Furthermore the need for new research is to be defined. ICERA is collaborating with a multidisciplinary network of Icelandic scientists dealing with the overall impacts of climate change on Iceland's nature, infrastructure and society. Apart from the unique glaciological challenges, ICERA shares many common challenges with colleagues in the neighbouring countries, specially other Nordic countries where knowledge on climate change has e.g. been exchanged under the umbrella of the Nordic Road Association (NVF). ICERA keeps a close eye on the progress of other research programmes and adaption strategies such as the Norwegian Climate and Transport project and the recent ERA Net Road initiatives launched under the Road Owners Getting to Grips with Climate Change call.

Main challenges

We consider that the main adverse effects of climate change on the road transport infrastructure will be the results of increased mean winter temperatures, leading to more frequent freeze-thaw cycles locally. Increased precipitation and indications for more winter storms are also considered. The following topics are in focus:

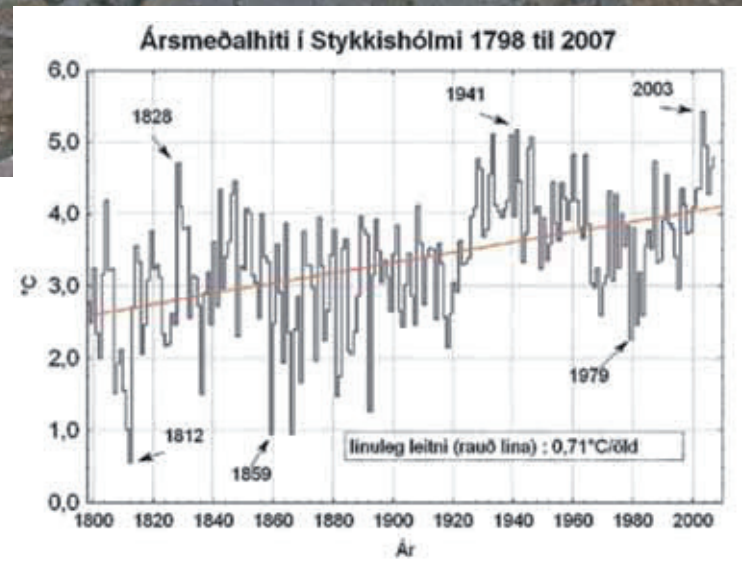
Glacier retreat

Glacier monitoring and bedrock topography mapping under glaciers gives information on possible future river channel changes. Furthermore the inevitable melting of glaciers in the 21st century will increase the

PHOTO: HELGI JÓHANNESSON.

The bridge on Heinabergsvötn river in South-Iceland. Shortly after its introduction in 1948 the river changed channel following a retreating glacier.

Road damage due to sudden snow-melt on February 18th 2008. National road no.1 near Borgarnes, West-Iceland.



Mean annual temperature1798–2007 in Stykkishólmur, West-Iceland. Average trend corresponds to a temperature increase of 0,71°C per century. A noticeable warmer period from 1920 to 1965 followed by an abrupt cooler period 1965 to 1985. Source: Icelandic Meteorological Office, Trausti Jónsson.

annual runoff by up to 100% during the next 40 to 60 years.

Road bearing capacity

Since late 1990s, the frequency of mid-winter "spring thaw" events has increased substantially. The resulting failure in bearing capacity of roads and excessive deterioration has inspired the development of an automatic monitoring network for frost depth in the road sub-base, and a daily prognosis model based on weather forecast. This allows for a sound axle-load management on the road network.

Spring thaw flooding

Recent experience calls upon more alertness towards sudden snow melt episodes in mid winter integrated with intense precipitation. Occurring in mid-winter when the soil is frozen and impermeable this can lead to extreme flooding exceeding the drainage capacity of bridges and culverts.

Sea level rise

Several roads in low land coastal regions and fjord-crossings may be subject to increased wave loading and rise in ground water level due to global sea level rise. ICERA has already adopted a routine for a projected sea level rise of 50 cm.

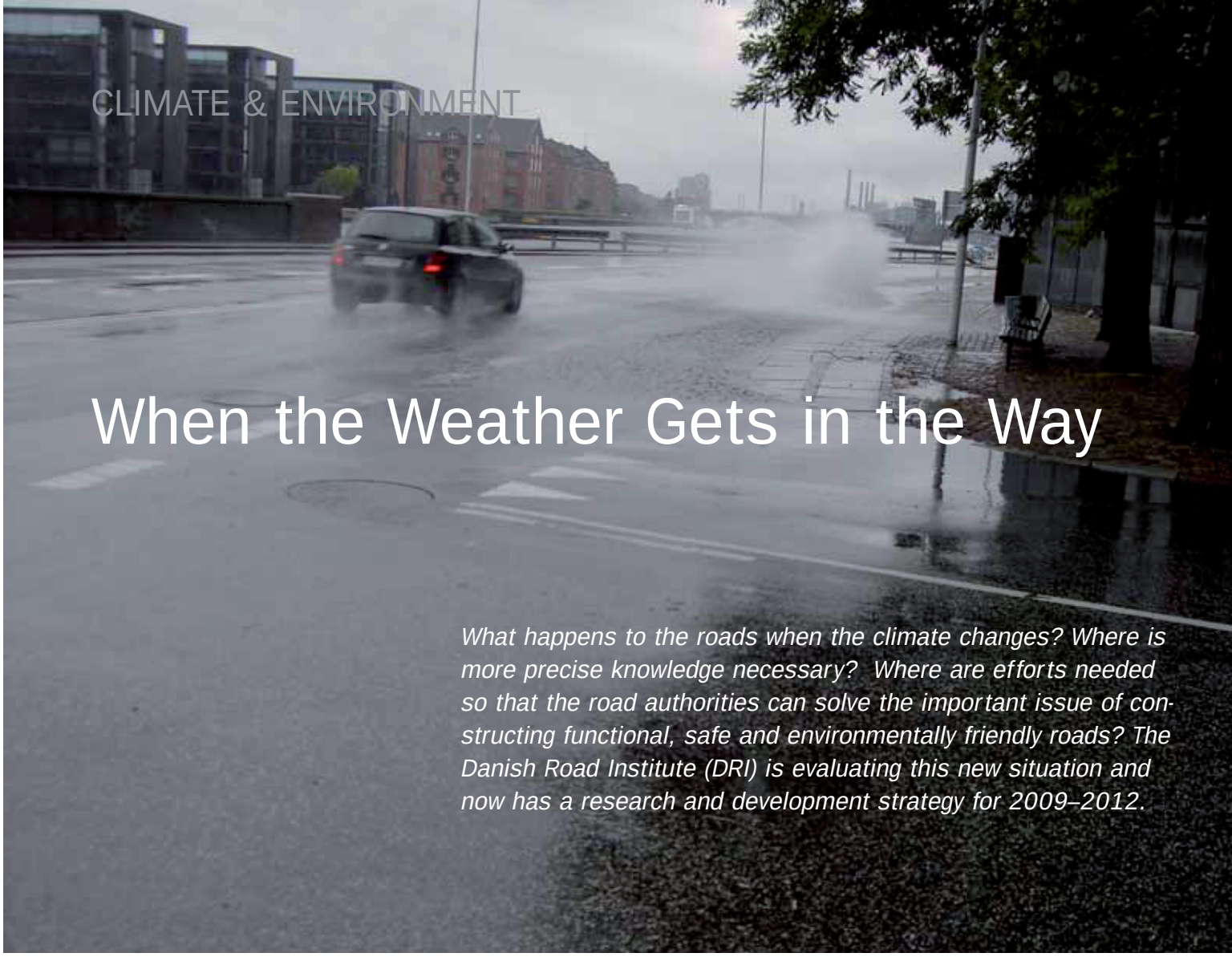
Other challenges

Road winter service will change with changing climate. In general, shorter winter and less snowfall in the lowlands should demand less service. However, uncertain impacts remain concerning the frequency of winter storms, snowfall amount in the highlands and the frequency of sub-zero temperature fluctuations. Snow avalanche, mud slides and rock-fall need also to be considered. Increased precipitation is likely to raise ground water levels in some places. This means more water in the road structure leading to higher deterioration rate and less bearing capacity. Substantial part of Iceland's original wetlands was transformed for agricultural purposes during the last century. Plans for wetland reclamation need to consider future precipitation and ground water development with respect to road infrastructure.

Vision

The goal for ICERA screening and adaption programme is to enhance climate awareness within the organisation and promote a new way of thinking. For optimum road management in the future, we need climate adaption to be a pillar for future long term development in planning, construction and maintenance of road infrastructure. Knowledge is a dynamic figure in a rapidly changing world and we should ensure that new learning is put into practice.

Contact: Project coordinator, Dr. Skuli Thordarson, Vegsyn Consult, skuli@vegsyn.is

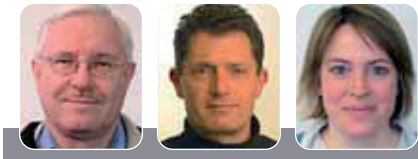


When the Weather Gets in the Way

What happens to the roads when the climate changes? Where is more precise knowledge necessary? Where are efforts needed so that the road authorities can solve the important issue of constructing functional, safe and environmentally friendly roads? The Danish Road Institute (DRI) is evaluating this new situation and now has a research and development strategy for 2009–2012.

Intense rain on an urban road in Copenhagen on 11 July 2008.

PHOTO: JØRGEN VALENTINER



Knud A. Pihl, DRI, Denmark
Michael Larsen, DRI, Denmark
Marianne Grauert, DRI, Denmark

The road sector is well aware of climate questions which arise when constructing roads; there is increased focus on this subject now, since there are more frequent storms and more intense rain. The effects of the climatic changes have therefore become a focus area in the Danish Road Directorate.

The Danish Road Institute's (DRI) theme on climate and environment collects research and development projects which should produce results in roads that are suitable for the new climatic conditions and are environmentally friendly. Such roads are robust and functional and take safety, mobility and durability into account. The effects and damage are already seen and future climatic changes should be minimised. This means that roads and signs must be protected from collapse and an alert should be set up to deal with special situations to ensure that the infrastructure can continue to function. The environment surrounding the roads should be studied as well as environmentally friendly materials, such as recycled and local materials and also their use with regard to the lowest possible energy consumption.

Occasionally things go wrong – and the water cannot run off from the road into the drainage systems and everything stops. Several centimetres of water collect and suddenly it becomes very dangerous to drive on the road. In extreme cases, the road must be closed – a problem for all road users and road owners. Such events already take place in Denmark at the present time.

Floods on the road are called "blue spots". Such "blue spots" are being studied at DRI, and in a new research project, an attempt will be made to predict the places where there is a big risk that "blue spots" may form in heavy special rain situations. By obtaining a register of particularly critical locations, it will be possible to prioritise the efforts made at these specific spots, instead of starting at a random place.

Along the main road network there are a great number of retention ponds and

they will be examined closely. The examination should clarify whether the retention ponds can collect and store the amount of water which may be expected in the future. Also the sediment will be examined for various pollutants, so that the basins can be cleaned in a way so it will not be a threat to the environment. Finally, the examination shall clarify whether the basins live up to the demands made in EU's Directive on Flood Risk Management. The requirements mean that the amount of water, which may be led from the basins to the surrounding environment, will be less than today's discharge.

There are a number of scenarios for future climatic changes, which can have influence on roads and their surroundings.

Taking samples in a retention pond.

PHOTO: MARIANNE GRAUERT

The influence of climatic changes on the road

Precipitation: In the future there may be more precipitation and it is assumed that it will come with greater intensity. This means that roads in periods will be flooded and it will not be possible to drive. This may mean that drainage systems must be adjusted and the position of the road should perhaps be changed.

Wind: More frequent and stronger storms can have consequences for the passability of bridges. An increased wind effect can also have a destructive influence on road signs, road portals, masts as well as trees and other high constructions along the roads, which will cause a safety issue.

Sea level rise: Increases in the sea levels can have influence for roads which already today are close to the coast line. Future storm surges will flood road stretches to such an extent as has not been seen to this date.

Ground water: The ground water level can vary more due to wetter autumns, winters and springs and bring a risk of water intrusion to existing road sub-construction. In combination with the sea level rise, the sub-construction of the roads near the coastline will be in greater risk for intrusion.

Experience shows that problems with precipitation and drainage of roads create difficulties. The strategy for the coming years will therefore presumably have the following projects as focal point.

- Upgrading of road drainage systems
- New rules for construction of roads, better foundations and higher levels in exposed places.
- Predict and prevent landslides from slopes on roads, as a result of intensive precipitation.
- Systems for surveillance and preparedness.
- Mapping of places where problems arise with flooding of roads..

It is important to point out that due to the long durability of roads and the high costs involved for reconstruction, it is necessary to take careful considerations prior to taking decisions.

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Indicators for Sustainable Urban Transport

Developing indicators for sustainable transport is important in simplifying information and in promoting a broader understanding of the issue, both for policymakers and the public at large.

Vibeke Nenseth, TØI, Norway

The Institute of Transport Economics (TØI) has developed a set of indicators for urban transport, communicating transport data and state of the environment within a common framework. Current trends and significant relationships between transport volumes and modes and their environmental impacts are in focus.

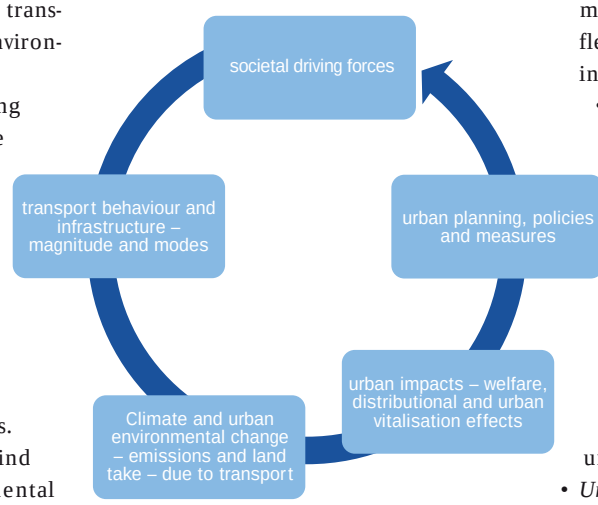
Policy relevance and agenda-setting are essential characteristics of the indicators and make comparison possible. Development trends can be monitored over time and influential benchmarking between cities and regions can be made.

The indicators also make it possible to measure and communicate *policy performance* in comparing between policy goals and results. Emphasising the driving forces behind mobility pattern and environmental effects promotes the proactive policies and measures that influence drivers in the direction of more sustainable urban mobility.

Charged with carrying out the policy programme of 'Sustainable Urban Transport' in the Norwegian Public Roads Administration, TØI is conducting a three-year project on developing and testing indicators for environmentally friendly urban transport.

The *DPSIR* model (the causal chain from Drivers, Pressure, State, Impact to (policy) Response) is being used. This is a common analytical framework illustrating the explanatory factors and important linkages between transport, emissions and policy measures.

An important criterion when selecting an indicator is that it encompasses both time and space, i.e. it is applicable over time and in various urban regions. The indicators are organised thematically (cf. figure) in order to be utilised for further indicator-based analyses of key driving forces and regional variation in sustainable urban transport. In large part, they are available at the level of cities (urban municipals with more than 20 000 inhabitants) and are organised in the following categories:



The DPSIR model is used as an analytical framework illustrating the explanatory factors and important linkages between transport, emissions and policy measures.

- *Driving forces* (demographical data; income, business structure and employment; commuting and urban structure (density, centrality)).
- *Transport factors* (travel behaviour, modal split, car use and density, vehicle fleet (size, fuel), transport supply and infrastructure).
- *Climate and urban environmental change* (CO_2 emissions from road traffic, land-take share of urban area for transport infrastructure, particle emissions (PM10), NOx emissions from road traffic).
- *Urban and societal impacts from transport* (traffic accidents, health effects/(noise and air pollution exposure, the share of inhabitants and employees in urban centres, urban centre trade/vitality).
- *Urban planning, policies and measures* (integrated transport and land-use, planning, car-use and parking restrictions, toll rings, congestion charging, transport infrastructure investments, mobility centres/planning, and so on.

Report: Indicators for sustainable urban transport. Authors: Vibeke Nenseth and Gustav Nielsen. TØI report 1029/2009, Language: Norwegian with English summary.
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Concrete Roads Save Fuel

PHOTO: PHOTOS.COM

Fuel consumption will be cut by 1.1 per cent if the road surfacing consists of concrete instead of asphalt. This is shown by a study VTI has performed on fuel consumption on asphalt and concrete surfacings.

Tarja Magnusson, VTI, Sweden

Measurements were made at rural road, speed 90 km/h, on a section of road outside Uppsala. This is a road with two types of surfacing, asphalt and concrete.

– An earlier VTI study provided indications that there is a difference in fuel consumption between an asphalt surfacing and a concrete surfacing. Extended measurements were therefore started at the beginning of June 2008, says research engineer Bengt-Åke Hultqvist of VTI.

Sections of asphalt and concrete were chosen so that alignment and inclination should be as similar as possible. Both sections are on a slight bend and have a slight inclination to the north. In order that the cause of any differences between the asphalt and concrete surfacings may be reliably identified, the surface characteristics of each surfacing were also investigated.

The results of mesurements have shown that fuel consumption on the concrete surfacing was 1.1% lower than that on the asphalt surfacing. It was established that this difference was statistically significant throughout the analysis. The main reason for the lower fuel consumption on the concrete surfacing is its lower rolling resistance which can, in turn, be associated with the measured differences in longitudinal surface evenness and macro texture.

Calculations with the fuel model VETO which takes into consideration the state of the surfacing also give a difference of about 1% in fuel consumption between the surfacings. This is in good agreement with the fuel measurements made on the road sections.

– Which, in turn, confirms that the VETO model can be used in making forecasts of fuel consumption for other road sections with asphalt and concrete surfacings, where the longitudinal surface evenness and macro texture are known.

Read more: Measurement of fuel consumption on asphalt and concrete pavements north of Uppsala, N31-2008

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Urban Containment Policy in Oslo Reduces Car Traffic

Since the mid 1980s Oslo has followed an urban containment policy and has broken a long-lasting trend of spatial expansion. The concentrated urban development has clearly contributed to more sustainable mobility and reduced growth in car traffic, according to a study conducted by the Institute of Transport Economics.

Petter Næss, TØI, Norway

The study focuses on the ways planners and decision-makers in Oslo Metropolitan Area have understood, interpreted, formulated policies and finally acted in relation to transport and land use in a sustainability context during the period since the 1990s.

Within the municipality of Oslo, the urban population density increased by more than 11 percent from 2000 to 2009, from 38 persons per hectare in 2000 to 42 persons per hectare in 2009.

The increase in population density has been going on since the late 1980s. The concentrated urban development in Oslo Metropolitan Area has contributed to more sustainable mobility. A strong focus on coordinated land use and transport planning in order to reduce energy use and emissions from transport is an important part of the explanation of Oslo's fare-well to urban sprawl. In addition, social and cultural conditions necessary for implementing such a strategy have to a high extent been present.

During the whole period since the 1990s, there has been a high degree of professional and political consensus about urban densification as an overall strategy for urban development. Within the Norwegian profession of spatial planners, the compact city has obtained hegemonic status as a model for sustainable urban development. There has also been a considerable market demand for more intensive land use within existing urban areas, especially in the central parts of the region. Market agents have sometimes also pushed for greenfield development at locations poorly served by public transport in the outer parts of the region, but the amount of such development has been moderate.

Although competition for inward investment makes up an incentive for outer-area municipalities to accept such location preferences, national and regional land use planning instruments have been able to limit the establishment of new car-dependent residential and workplace areas. In particular, the greenbelt policy for protecting the forest areas surrounding Oslo (the Marka border) and the National Policy Provisions for Coordinated Land Use and Transport Planning have been important. There is still a widespread opinion among planners and policy-makers that the regional coordination of spatial development in the Oslo region should be improved.

Whereas land use development has to a high extent been in line with principles of sustainable urban development, the development of transport infrastructure has been more ambiguous, judged against sustainability goals. Along with important improvements in the public transport system (a new metro ring, new streetcar lines and bus lanes, and more frequent departures for streetcar and metro trains) there has also been considerable expansion of the road capacity. Seen from the perspective of sustainability, this combined, and

PHOTO: HARALD AAS

Within the municipality of Oslo, the urban population density increased by more than 11 percent from 2000 to 2009.

quite costly, strategy has been similar to stepping on the accelerator and the brake at the same time. The general level of mobility has been enhanced, but the shares of car drivers and travelers by other modes have remained more or less the same.

Public transport improvement has been backed by broad political consensus. Road capacity increases have been contested among professionals but widely supported by politicians, apart from those on the left wing. In particular, there has been skepticism against urban highway development among land use planners and environmental organizations.

Transport authorities and planners involved in transport infrastructure development in the Oslo region have generally considered road development as a measure to combat congestion; the transport planners have, however, at the same time often argued that better roads must be combined with road pricing in order to avoid traffic increase leading to new congestion. During most of the investigated period, road pricing was not on the political agenda, but the latest transport policy deal (Oslo Package 3) opens for higher tolls on urban motoring.

The Oslo region has experienced strong economic growth (for a European city) as well as population growth since the 1990s. Within the fields affected by land use and transport planning, this growth has taken place with relatively moderate impacts on nature and the environment, compared to a sprawling and car-based development. Yet, the decoupling between growth and negative environmental impacts is relative, not absolute. The city is still moving away from important goals of sustainable mobility, albeit at a considerably slower pace than earlier.

Report: The challenge of sustainable mobility in urban planning and development in Oslo Metropolitan Area. TØI report 1024/2009. Authors: Petter Næss, Teresa Næss and Arvid Strand. Language: English
Contact: Petter Næss, pan@toi.no

Avalanche Risk in a Changing Climate

Approximately 2000 landslides and avalanches affect the Norwegian road network every year. Projected climate changes will give a milder and wetter climate with more extreme weather events. Changes in temperature and precipitation are important factors when it comes to the release and frequency of most types of landslides and avalanches.

Heidi Bjordal, NPRA, Norway

Higher winter temperatures will lead to less snow in lower and coastal areas. We can already observe a reduction in the frequency of snow avalanches in some areas. On the other hand, an increasing precipitation and increasing storm frequency will give a higher probability for snow avalanches in higher mountain areas where the temperatures still remain cold. These effects could also trigger avalanches with increasing mass/volume giving a longer run out than already recorded.

In order to improve the basis for studying how changes in weather will affect landslide and avalanche risk, we decided to develop a landslide and avalanche risk model. One of the conditions in the development of the model was to go beyond the statistics and create a tool that can be used independently of where landslides, rock falls and avalanches have occurred up to now. This will give a model more robust to climatic variations that might lead to higher hazard in some areas, and lower hazard in other areas.

In the risk model, landslides and avalanches are described by factors affecting the probability of a landslide or an avalanche.

PHOTO: NPRA

The factors represent exposed terrain, geological conditions, weather conditions and others. Each of them is given a score and weight factor that contribute to the total risk value in a particular road section. Consequences are similarly described with factors representing the amount of traffic, importance of the road and consequences for road users.

The first use of the risk model will be to compare different road sections regarding risk level. The model will further on be used to develop a proposal for classification of probability and consequence. Finally, in order to evaluate climate change, the model can be used to consider changes in hazard due to climatic variations.

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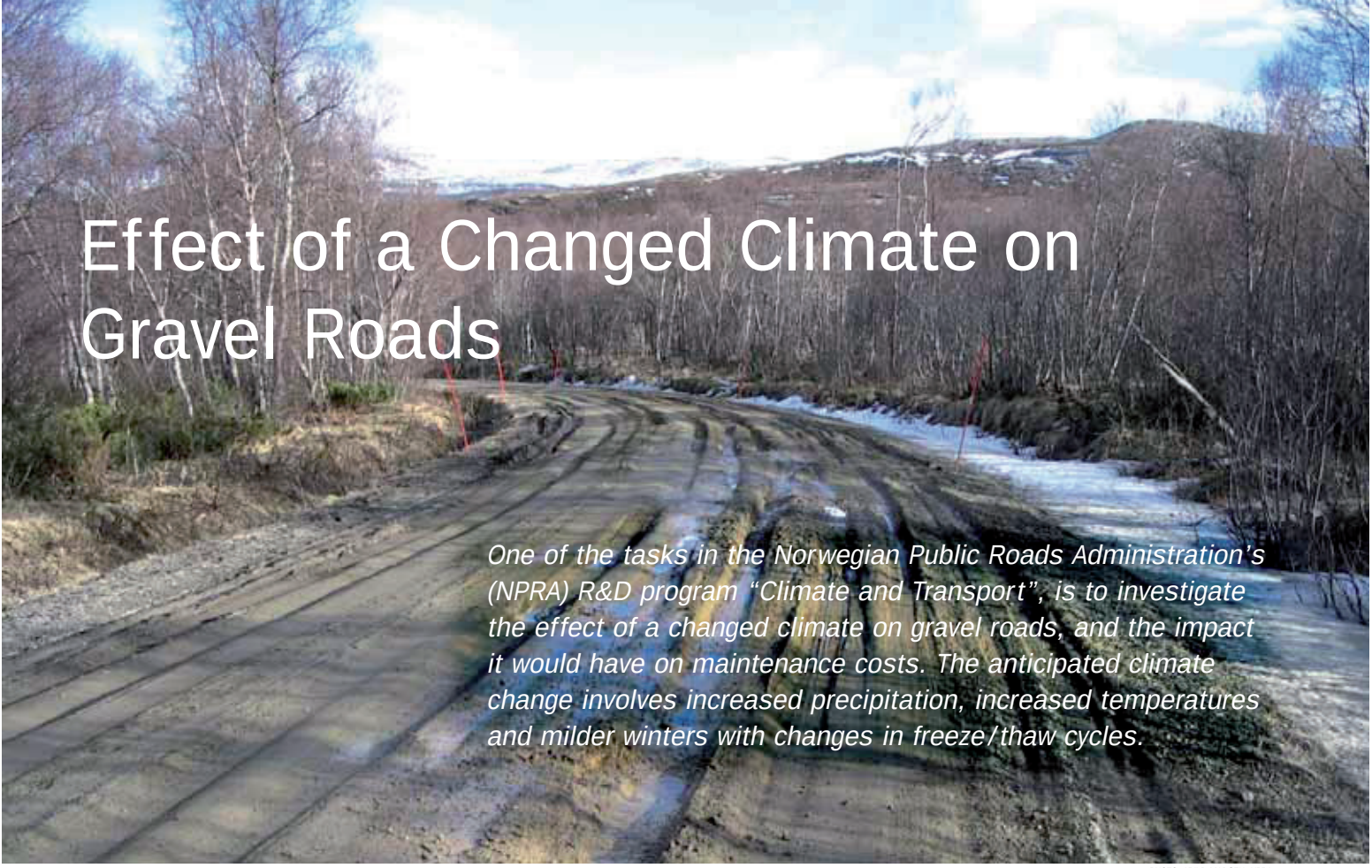

Effect of a Changed Climate on Gravel Roads

One of the tasks in the Norwegian Public Roads Administration's (NPRA) R&D program "Climate and Transport", is to investigate the effect of a changed climate on gravel roads, and the impact it would have on maintenance costs. The anticipated climate change involves increased precipitation, increased temperatures and milder winters with changes in freeze/thaw cycles.

County road 553 in Nordland, Northern Norway during the spring thaw period. This kind of situations could also possibly occur during winter time through a climate change.

PHOTO: ARILD MADSEN, NPRA

Per Otto Aursand, NPRA, Norway

The condition of a gravel road is influenced by traffic, material properties, drainage conditions and climate. The most important climatic factors for gravel roads are temperature (frost, freeze/thaw-cycles, spring thaw weakening) and precipitation (total rainfall, intensity).

A state-of-the-art study by Lerfald & Hoff (2007) shows that unbound materials are mostly affected by temperature changes around 0° C. An increase in the number of freeze-thaw cycles and mild periods during the winter season will increase the accumulated length of the thawing period leading to increased deterioration. Gravel surfaces are also sensitive to rainfall when the road is unfrozen. Heavy rainfall will lead to washing of materials implying development of potholes, corrugation and unevenness. Long-lasting rain will soak the surface, raise the ground water table and thus reducing the E-modulus. A change in climate will therefore change the maintenance needs and costs.

The main maintenance actions on a gravel road pavement are gravel surfacing, grading, dust control, ditch clearing and in some cases stabilization (e.g. bitumen). The maintenance costs have been estimated through the use of a revised model (MOTIV) used by the Norwegian Public Roads Administration for budget estimations, Evensen & Holen (2008). In these models there is some trade-off between climate data and maintenance costs. In addition, some other estimations of links between climate and maintenance frequencies have been used. The calculated changes in maintenance costs are done with respect to the climate in the two norm periods of 1960-1990 and 2070-2100, representing todays and future climate, respectively.

The yearly maintenance costs for the county gravel road network within the norm period of 2070-2100 will, according to these calculations, increase with 3 million EURO or 19 % compared to the present maintenance needs. LCC calculations in this study also indicates that it will be cost efficient to do drainage and strengthening upgrading of the gravel road network to reduce the excessive maintenance costs due to climate change.

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Campaign for Less Car-use

In Kristiansand, the fifth largest city in Norway, the problem of how to get commuters to reject car-use has led to a campaign targeting employees in the twelve largest firms in the city. Employees can choose between two options: free access to the bus system for a month or bicycling equipment worth about 120 euro. During the campaign, four out of five chose the bicycle package, with one of five choosing free public transport. After the campaign, 60 percent say they will continue cycling.

Arvid Strand, TØI, Norway

The land-use and transport project (areal- og transportprosjektet) in the region of Kristiansand has a strategic goal to change modal split. The campaign "Jeg kjører grønt" (I'm driving green) is part of this strategy and an experiment to get employees who use their car daily to work to reduce its use in favour of walking, cycling or going by bus.

In order to get employees to change their travelling behaviour, those at twelve large firms in Kristiansand were given the opportunity to get either a free seat on the bus in Kristiansand or a bicycle package to the value of about Euro 120.

Almost 400 joined the campaign, with four out of five choosing the bicycle package. We believe that the campaign has had a good effect on changing the travel habits of those who elected to cycle. Participants take a very positive view of the campaign and all agree that it should be repeated. A rough estimate of the costs of the campaign compared to the positive health effects, plus positive climate gas effects, indicates that the campaign will have a net gain.

Four of five chose the bicycle

Kristiansand has about 80 000 inhabitants and is the fifth largest city in Norway. For employees, the distance between dwelling and workplace is, on average, 10 kilometers. In this situation, four out of five choose to cycle. The argument for deciding on the bicycle package is mainly that this is seen as the most convenient choice. The bus is too infrequent, takes too much time and is assumed to be too expensive. The public transport system seems to have difficulty competing with other travel options, at least up to the point where distance between dwelling and workplace is quite long.

Mixed users

The goal of the campaign was to get employees travelling to work most of the time by car to turn to other possibilities. While the investigations in November 2007 and April 2008 show that, before the campaign, most of the participants travelled to and from work by car, we recognize that among them were some who were primarily 'mixed users', i.e. employees who drove to work on some days in the week, while on other days cycled, went on foot or were picked up by a friend or colleague using their car. Even during the campaign period, just as before it, there were lots of mixed users among the participants. On one or even several days, nearly half of the participants in the campaign used modes of transport other than the one they chose in the campaign (bicycle or bus).

Travel behaviour is also changed

The responses from participants indicate that there has been a certain amount of change in the travel habits of the most enthusiastic car-users before the campaign. The number reporting that they wanted to cycle rather than drive was greater (80 percent) among those using the car three to five days a week than among those who used the car every day in the week (45 percent). A lesson to learn from this is that

PHOTO: HARALD AAS

After the campaign 60 percent say they will continue cycling.

mixed users are those most likely to change through campaigns such as this.

Only one-fourth claim that participation in the campaign did not give them the incentive to change their travel habits. The biggest change is in those choosing the bicycle package over the bus. Participants opting for the bicycle package claim that it is easy to cycle, that the cycle lanes are good and, not least, that they themselves are getting into better physical shape. Opinions differ, however, when it comes to time-use. The experiences of those travelling by bus are much more differentiated. Bus passengers are generally dissatisfied with the frequency of the system, i.e. with the stop structure and with the geographical locations of the routes. Coordination between the different routes is not good and the passenger who has to change often is inconvenienced. Lower prices and a more frequent and reliable 'bus supply' are terms summarizing statements from participants about areas that have to be followed up if travelling by bus is to become more attractive.

Conclusions

The "I'm driving green" campaign directly targeted employees in certain firms. An invitation was sent to companies along with an economic stimulus aimed at the employee willing to change to more environmentally friendly transport for a shorter, or longer, period of time. In this respect, the campaign fulfilled two of the central conditions established as factors of success, i.e. reaching individuals in special groups and providing incentives. Not mentioned here, but fulfilling the condition on not drawing out time, "I'm driving green" should theoretically have the potential to change the travel behaviour of participants. As far as we can see, this is indeed the case!

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Language: Norwegian with English summary.
Contact: Arvid Strand, ast@toi.no

Road-building Increases Climate Gas Emissions

Building better roads does little to improve our climate. A report from the Institute of Transport Economics in Norway (TØI) concludes that, in large part, CO_2 emissions increase with more road-building.

Arvid Strand, TØI, Norway

In Norway, there has been much discussion over the past one or two years about road-building as an effective climate policy measure. In a report presented two years ago, it was concluded that there would be less climate gas emissions in Norway when the Norwegian road network improved (Knudsen and Bang 2007). This has been reiterated in the political debate in Norway since it was published, but it has also been seriously challenged.

Increased emissions

On behalf of the Norwegian Public Roads Administration, the Institute of Transport Economics in Norway (TØI) has examined this relationship and has come up with another conclusion. Road-building, in large part, increases climate gas emissions, mainly because improved quality of the road network will increase the average speed, i.e. an increase in the speed interval where the emissions rise the most (above 80 km/h).

Emissions also rise due to increased amount of traffic (each traveller going further and more often) and because the modal split will change (more car-use and less use of public transport and bicycles) due to relatively better conditions for car-use.

Exceptions

In certain situations, there will be exceptions. One example could be when building a road connection across a fjord to replace the existing ferry. This can result in less emission. Building a tunnel through terrain, thus alleviating the need to climb the hill, can be another example -- although there could be much emission during construction of the tunnel. But those examples do not influence the general conclusion that road-building largely increases climate gas emissions.

The main conclusion is that in most situations road-building and the maintenance of new and better roads will, together with direct and indirect consequences of new generated traffic, result in increased climate gas emissions. In the larger cities, in particular, increased road capacity will result in significant increased emissions.

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Strand, Arvid m.fl 2009: Gir bedre veger mindre klimagassutslipp? TØI rapport 1027/2009, Language: Norwegian

Contact: Arvid Strand, ast@toi,no

The Cost of Premature Deaths Caused by Emissions of Particulate Matter

It has been known for a long time that emissions from road traffic have a harmful impact on human health. The research undertaken in recent years shows that the principal cause are the emissions of particulate matter (PM). This harmful impact on human health is a cost to society that should be accounted for in the design and use of the transport system, i.e. it should be reflected in the prices for transport. If not, decisions will be made that are not optimal and thus welfare losses will result.

Tarja Magnusson, VTI, Sweden

Lena Nerhagen of VTI has, in collaboration with other researchers, performed a study with the aim of investigating how high the health costs of road traffic caused by PM are in comparison with those caused by PM from other sources.

– In order to do this, we studied how population exposure differs between different sources in Stockholm, and also if it is reasonable to assume that the heath impact of PM of different origin is the same, explains Lena.

This latter question is of special interest for the situation in Sweden, since PM from road wear are an important cause of the high concentrations of PM10 in larger cities.

– In the study we made calculations for Stockholm. The health effect we have studied is the number of premature deaths since, in other studies, this effect has been found to have the greatest impact on the estimated cost.

The results show that there is not a one to one association between emissions and costs.

– The reason for this is that costs are based on the estimated health impacts, which are, in turn, dependent on the estimated population exposure.

For example, combustion PM from road traffic and residential heating give rise to higher costs than those from energy plants, in spite of the fact that their total amount of emissions are lower, because they are emitted in the vicinity of residential buildings.

– As regards PM from road wear, the costs are lower than those caused by combustion PM from road traffic. This is mainly due to the different assumptions with regard to health effect relationships, where road wear PM has been found to have a lower impact on mortality.

PHOTO: PHOTOS.COM

Read more: The mortality cost of particulate matter due to emissions in the Stockholm area – an investigation into harmfulness, sources and the geographical dimension of their impact, R635A
Contact: Lena Nerhagen, VTI, lena.nerhagen@vti.se

Web Maps for Extreme Weather and Hazard Mitigation

In the Norwegian Public Roads Administration's "Climate and transport" R&D programme, a work package aims to improve the accessibility of data related to weather situations and weather related hazards on the road and railway networks. Attempts have been made to develop and test a beta version of a web map system for awareness of extreme weather situations and hazard mitigation. The beta version is named "Före var".

Tore Humstad, NPRA, Norway

On a web based and dynamic map, developed by the Norwegian Water Resources and Energy Directorate, Norwegian Meteorological Institute and Norwegian Mapping and Cadastre Authority, Norway's weather situation is presented in a map of 1x1 km^2 grid cells. For each cell, chosen weather parameters are generated based on interpolations from data on precipitation, temperature and snow depth. The data sources are 155-455 weather stations through out the country. Based on combinations of these data, one distinguishes between precipitation as snow and as rain fall. In addition, derived data, such as ground water level, snowmelt and snow cover conditions, are appointed to each cell based on hydrological models. All these data are presented as absolute values in the web portal which is named "SeNorge" . Both observations (analysis tool) and prognosis (awareness tool) are presented in 1-day resolution.

The Norwegian Public Road Administration has, together with the National Rail Administration, made a specification on how to use the above mentioned data from the same platform, but with reference to relative threshold values instead of absolute data. This is done trough the "Före var" web portal. The idea of presenting the weather parameters relative to different threshold values is to identify extreme weather condition and weather conditions unfortunate for keeping roads and railways operating. These threshold values are mainly related to weather that empirically has lead to avalanches, snow disasters, landslides and rock falls. Achieved threshold values are presented by a colour scale of yellow, orange and red, where red corresponds to the greatest hazard. A green colour on the- map shows that the weather condition exists to a low degree. Grey grid cells shows that the unfortunate weather condition is non-existing.

During 2009, themes mentioned in the table below are introduced:

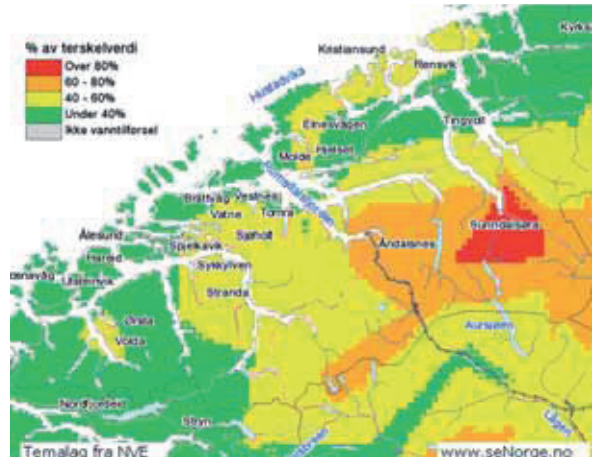
Experiences so far show that the there are clear relations between the some of the map themes and registered problems on the roads and railways. Other themes are less clear. It has also proved to be necessary to level the inter-relationship of the different threshold values, so that the same colours represent more or less the same risk level in the different themes that are introduced.

	Themes	Data sources	Possible hazard mitigation related to:
1	Water supply last day	Precipitation/rainfall, snowmelt and snow cover	Debris flows
2	Water supply last 3 days	Precipitation/rainfall, snowmelt and snow cover	Debris flows
3	Snowfall last day	Precipitation/snowfall	Snow disaster
4	Snowfall last 3 days	Precipitation/snowfall	Snow disaster and snow avalanches
5	Freezing and thawing last 10 days	Temperature variation, precipitation/ rainfall, snowmelt and snow cover	Rockfalls and rockslides
6	Wetting of fresh snow cover last day	Snowfall last 3 days, precipitation/rainfall, snowmelt	Wet snow avalanches and winter floods

PHOTO: PHOTOS.COM

For the autumn 2009, there are plans to enable download of time series directly from the weather stations on both 1-day and 1-hour resolution. These will also include wind data. In addition, attempts will be made to combine observed time series with meteograms for each station and to generate wind roses from available wind data.

The figure below is an example of a map of "Water supply last 3 days" from a rainy day that gave several debris flows in the red and orange area.



The figure is an example of a map of "Water supply last 3 days" from a rainy day that gave several debris flows in the red and orange area.

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Ungtrafikk – The Norwegian ISA Field Trial

The Norwegian Intelligent Speed Adaptation (ISA) field trial "Ungtrafikk" had an explicit focus on young drivers. Following the launch in June 2006, costumers in the insurance company Gjensidige Forsikring BA between 18 and 25 years and living in the municipality Karmøy, were invited to participate in the project. The participants received a 30 % discount on their car insurance premium during the 17 months test period.

Christin Berg, IRIS, NORWAY

Both Norwegian and international statistics show that young drivers are especially exposed to road accidents. Constituting about 10 percent of the Norwegian population, the age group 18–25 years was involved in about 23 percent of the serious road accidents. This shows the need for learning more about young peoples driving, and to find new ways to reduce accidents. A cost-benefit analysis of ISA estimated a 36 percent general reduction in accidents with injuries and accordingly 59 percent in fatal accidents. For advisory ISA (as used in the Norwegian trial), less reduction was estimated. A major focus of the Norwegian trial was to further investigate the effect ISA has on different categories of young drivers in general, and within the infrastructure and climate in Norway.

The ISA was installed in the participants' cars and informed the driver through a sound and a flashing screen when she/he exceeded current speed limit. As expected based on previous ISA-trials, analysis of the data shows that young drivers overrode the speed limit despite being informed t by the ISA unit and knowing the speeding was registered.

At lower speed limits female drivers override more than male drivers

During the trial the current speed limit was overridden by 5 km/h or more on 20 percent of the recorded trips. For 3 percent of the recorded trips current speed limit was overridden by 20 km/h or more. There is however significant differences under which speed limits overriding occur. The majority of speeding violations took place at lower speed limits, where the speed limit was 30–40 km/h. For this speed category, 38.8 percent of the recorded distance the speed limit was overridden by 5 km/h or more and for 14 percent of the recorded distance the speed limit was overridden by 20 km/h or more.

Data shows no significant gender difference on average amount of speeding. However, as presented in figure 1, young male drivers override to a larger extent higher speed limits than young female drivers, while young female drivers override to larger extent lower speed limits than young male drivers. The differences are significant. The data shows the need for studying female drivers and overriding at lower

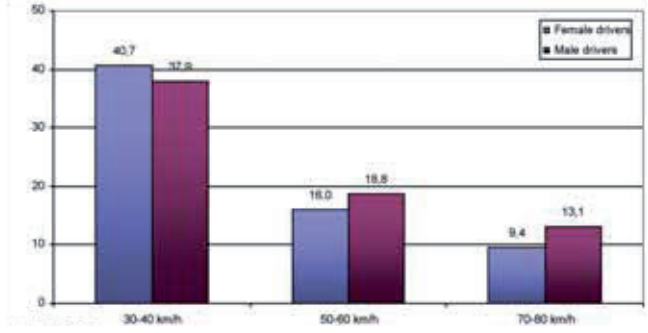

Figure 1. Amount of speeding 5 km/h or more above speed limit, divided by speed categories. Source: IRIS 2009.

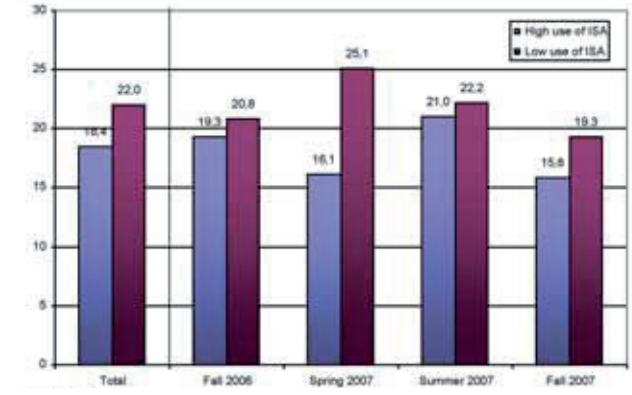

Figure 2. Average share of distance driven 5 km/h or above current speed limit in general with and without ISA and at different periods in the field trial; fall of 2006 and spring, summer and fall of 2007.
Source: IRIS 2009.

speed limits as well as male drivers and overriding at higher speed limits.

Safety Motivated Drivers Drive Safer

On the basis of the participants' motivation for participating in the trial, the participants were divided into three groups:

- participants motivated by traffic safety,
- participants motivated by the 30 percent discount on the car insurance, and
- participants motivated by both.

The recorded driving showed that the safety-motivated young drivers in general had a more moderate driving style than the drivers motivated by reduced insurance. Specific driving styles for drivers motivated by both reduced insurance premium and traffic safety were not found.. The analysis shows however that the driver's motivation to participate in such a trial gives an important indication of drivers' attitudes and how they drive.

Does ISA have an Effect?

The main intention in the project was to prevent young drivers from overriding the speed limit. Well aware of being monitored, the trial data shows that the average young driver override current speed limit on 1/5 of distance driven. The data also shows that there is a seasonal pattern in how young drivers drive, both in terms of driving style (acceleration, strong braking etc., strong curb movement etc.) and the amount of overriding the speed limit. In general driving is more moderate towards in the winter season than towards the summer and summer season.

The ISA used in the trial was portable. The participants with high ISA use (more than eight out of ten trips) had a lower degree of overriding the speed limit than participants with low ISA use (less than two out of then trips). The significant difference among the participants with high and low PDA use shows that voluntary ISA has an effect on young drivers and their driving in spite of the amount of the recorded speeding. ISA is thus a driving assistant system that promotes safer driving.

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Multifunctional Ditches

Roadside areas must perform many functions. The ditch must remove water from the road surface and drain the road structure. But a ditch must also be safe for traffic if an accident occurs, and it must therefore be constructed with care.

Göran Blomqvist, VTI, Sweden

The inner slope and bottom of a ditch are excellent areas for the collection of as much as possible of the pollutants that derive from the road and traffic. But the roadside areas often have large natural and cultural values which have special needs for protection against spoliation. The requirements that must be posed for the road structure, such as the inclination of the slopes, the depth of the ditch and the composition of the construction materials, must therefore also be combined with the needs of other interests. For some years, in collaboration with SGI, Swedish Geotechnical Institute, VTI has been running a project under the umbrella title "The multifunctional ditch".

A report will be published this autumn which is, inter alia, a review system that is to support road management authorities in identifying potential improvements in the functions of a ditch. A demonstration ditch has also been constructed in Sweden.

Contact: Göran Blomqvist, VTI, goran.blomqvist@vti.se

BEFORE: There is a great need here for a new surface. Potholes have been repaired and, over short sections, the road pavement has been replaced in order to improve the freezing characteristics of the road pavement. In conjunction with resurfacing it may be appropriate to survey and repair the ditches. There may also be certain ditch functions that can be improved.

AFTER: The new wearing course has been spread. The kerb has been laid, the bottom of the ditch has been cleaned out and the culverts have been checked, cleaned and adjusted. The intention is that most of the functions of the ditch should last as many years as the surfacing. In this way, management and maintenance efforts are saved.

Urban Thin Quiet SMA Pavements

Title: Urban Thin Quiet SMA Pavements
Institute: RDD, Denmark
Author: Hans Bendtsen
Language: English
Link: www.vejdirektoratet.dk/publikationer/Vlrap167

In the EU project SILENCE, work has been carried out to optimize the noise reduction of different types of pavements for urban roads. Danish Road Institute/Danish Road Di-rectorate (DRI) has in cooperation with the municipality of Copenhagen and the Colas road construction company tested series of Stone Mastics Asphalt pavements and an open graded pavement, optimized for noise reduction by using small aggregate size of 4 to 6 mm and a relatively high percentage of built-in air voids as well as by using a small proportion of oversize aggregate. Eight different pavements were constructed in June 2007 on Kastrupvej in Copenhagen. DRI has conducted Statistical Pass By noise measurements and performed spectral analyses. An initial noise reduction for passen-ger cars of 4.3 dB in relation to a DAC 11 reference pavement of the same age has been obtained.

Older car drivers in Norway and Sweden

Title: Older car drivers in Norway and Sweden – studies of accident involvement, visual search behaviour, attention and hazard perception
Institute: VTI, Sweden
Author: Lena Levin, Tania Dukic, Per Henriksson, Selina Mårdh and Fridulv Sagberg
Series: VTI rapport 656A
Language: English
Avalible at: www.nordicroads.com/publications
Name: Older car drivers

Hazardous situations for older drivers and older drivers' accident involvement and visual behaviour in complex traffic situations have been studied in the reported research project. Three main methods have been used: 1) a thorough accident analysis of police reported accidents in

Norway, 2) a literature study on existing research on older drivers' behaviour (i.e. cognitive aspects on car driving) and accident in¬volvement, and 3) experimental studies comprising visual and perception tests accomplished in Norway and Sweden and a field study on the road, accomplished in Sweden.

In the experimental study and in the field study it was found significantly more individual differences among the older than among the younger drivers in the samples from Norway and Sweden. From in depth analyses of fatal crashes in Norway during the years 2005–2007 it was found that tiredness was the most often suspected cause of the accident among the group aged 35–55 years (28 %) and the second most often suspected cause in the group aged 75+ (19 %). Illness could be the cause of the accident twice as often among the older drivers (28 %) as in the younger control group (14 %). Concerning suicide, the situation could be the reverse with more deliberate actions among the younger (11 %) compared to the older drivers (6 %).

The definition of older people as a problem (e.g. risky car drivers), and as a homogeneous group based on chronological age, may obscure the differences between groups and individuals based on variations in health, gender, ethnicity, living or economy. There is nothing in the results from this research project that supports age based limitations for renewal of driving license for otherwise healthy older people. Instead the study strengthens arguments for further research and refining of methods for identifying hazardous behaviour in complex situations, i.e. testing of drivers in complex situations; behaviour due to temporary illness or tiredness; and in depth studies of drivers' perspectives, experiences and strategies to avoid road accidents. Furthermore research on intelligent technical systems (e.g. information access, and recom¬mended route and speed) plus other adaptive systems in the vehicles that support older car drivers, are suggested. Also, how the ageing drivers give priority to and afford new technological solutions.

Car ownership and car use in Sweden

Title: Empirical analyses of car ownership and car use in Sweden
Institute: VTI, Sweden
Author: Roger Pyddoke
Series: VTI rapport 653A
Language: English
Avalible at: www.nordicroads.com/publications
Name: Car ownership and use

This purpose of this report is to describe and analyse how individual car ownership and car use in Sweden are affected by costs,

income, sex and the place of residence of the individual and further to investigate whether inhabitants of rural areas close to urban areas or sparsely populated areas are more sensitive to costs and income with regard to car ownership and car use than other individuals in Sweden.

The report uses register data for the whole of the Swedish population, meter readings from the vehicle inspection, and the area categorisation of the National Rural Development Agency: urban area, rural area close to an urban area and sparsely populated area.

Some of the new descriptive results are that: inhabitants of urban areas own and use cars to a lesser extent than inhabitants of rural areas. The difference in driven distances, however, is small. The difference between rural areas close to urban areas and sparsely populated areas is less.

In the model analyses we find small differences between the area types in the sensitivity of the use of privately-owned cars due to changes in disposable income and costs. In the analysis of the model for individual car ownership the most important result is that car ownership in Sweden is slow to change. The most important factor to explain car ownership in a particular year is whether the individual owned or did not own a car the previous year. Inhabitants of rural areas are slightly less inclined to cease car ownership and more inclined to increase car ownership to several cars compared with comparable individuals in urban areas. Men are also considerably more inclined to acquire a car when they do not own one than women, and this probability is greater in rural areas for both sexes. Changes in income are estimated to have negligible effects on car ownership. Changes in cost have both expected and unexpected effects on the likelihood of car ownership levels.

Traffic safety among immigrants

Title: Traffic safety among immigrants in Sweden
Institute: VTI, Sweden
Author: Sonja Forward, Jonna Nyberg, Gunilla Sörensen, Susanne Gustafsson and Peter Loukopoulos
Series: VTI rapport 640
Language: Swedish with English abstract
Avalible at: www.nordicroads.com/publications
Name: Traffic safety among immigrants

Swedish traffic accident statistics have previously shown that involvement in accidents differs for people born in Sweden and people born abroad.

The main aim of this report is to further illuminate this area through the use of four different studies. The introductory study is a literature review examining ethnicity and different aspects of traffic safety, focussing primarily on speed, accidents, use of seatbelts, alcohol and vulnerable road users. The term ethnicity was defined in different ways in the literature, if it was defined at all, and the term ethnic minorities was used as a collective term. The ways those terms are used complicate comparisons. Nevertheless, certain conclusions could be drawn. For example, the traffic behaviour of immigrants bore the imprint of the traffic norms prevalent in the country in which they grew up. Cultural values, the importance of language and socio-economical factors are dimensions of interest with regard to measures that can improve the traffic safety of immigrants living in Sweden. The second study identified the risk of a traffic accident for people who are born abroad but registered residents of Sweden. The results show that if the population is divided into nine zones, based on the country of birth, there are groups both with a higher risk of accidents than the Swedish-born and groups with a lower risk. Thus, immigrants should not be viewed as a homogeneous group. Furthermore, large parts of the differences can be explained by exposure, education, age and gender, through the use of logistical regression. In the third study a survey based on an extended version of the Theory of Planned Behaviour to predict the intention to speed, use seatbelt and use child restraints. The results show that previous behaviour and the perception of how others behave in traffic were the variables that best explained the intent to break speed regulations. This survey also indicates differences between groups, where the intent to use the seatbelt and protect children in the car was lower amongst some of the immigrants, while the intent to respect the speed limit was lower among the Swedish-born. The results of the survey could thus not unequivocally explain why certain groups identified by the accident analysis ran greater risks. In the fourth study interviews were carried out with seven men born in Iran but residing in Sweden. The subjects discussed were driving, speeding, alcohol and seatbelt use. The results showed that they experienced cultural differences in attitudes and behaviour in traffic, but that these differences gradually faded away. They showed zero tolerance when it came to drinking and driving. However, when it came to speeding and the use of seatbelts this was seen as unacceptable only in some contexts. Based on the compiled results recommendations are given, detailing specific actions that may increase the level of traffic safety among immigrants living in Sweden.

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