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SUSTAINABLE TRANSPORT DEVELOPMENT: AN ACHIEVABLE AIM?

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Introduction

Climate change, sustainability and increasing attention on impacts on local and global air quality

Traffic becoming the major concern that causes delays and congestion as well as the negative impacts on air quality

- World governments and local authorities attempt to reduce emissions through emission control legislation
- Increase of awareness of air quality and pollution issues
- More efforts at the local level have also been put to contribute to meeting the targets

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My research areas

1. Modelling travel behaviour
2. Travel demand management
3. Safety and Accident analysis
4. Modelling pedestrian behaviour and accidents
5. Environmental modelling and driving cycle analysis
6. Investigation of performance of transport policies (e.g. bus lanes and traffic calming) and impacts on air quality
7. ITS, land use analysis and performance of the transport system using GIS

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The Problem

Most of our research and transport policies are designed to reduce congestion or improve safety etc.,

Air quality and emission issues often come as by products

In a lot of situations, transport policies are implemented because there are:

- **Opportunities**
- **Successful implementation where else**
- **Existing expertise in these policies/ areas**

Not exactly "Horses for courses"

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The Problem

As a result we are often faced with unexpected problems:

- **Somewhere else**
- **For someone else**
- **On something else!**

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Examples: "modelled, neglected and actual impacts" of some transport policies

TDM example	Bus lanes	P & R	Traffic calming	2 wheelers
Expected impacts	•Improve bus TT •Increase bus pat. •Reduce congest. •Improve travel behaviour	•Increase P&R pat. •Reduce car use •Improve travel behaviour •improve sustainab.	•Improve safety •Reduce car use •Improve travel behaviour •Improve sustainab.	•Improve sustainab. •Reduce emissions •Reduce congestion •Improve travel behaviour
Neglected impacts	•On other traffic •Emissions •Fuel consumptions	•On bus users •Safety & security ..	•Driving modes •Fuel consumption •emissions	•Impacts on emissions •safety
Possible outcomes	• -ve on congestion & emissions •Increase fuel con. •No change on TT nor patronage nor travel behaviour	• Shift from bus to P&R •No change in car use •-ve travel behaviour	• +ve on speed reduction •-ve on fuel consum.& emissions •No change on travel behaviour	• -ve on fuel con. & emissions •No change on modal share
comments	Wrong travel behaviour modelling?			

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Congestion charging policies

RP has become popular for managing demand of travel

Charging principles: the extent of the charge should reflect negative externalities they impose on others and on the system, thus helping to reduce them

That should therefore include congestion, air quality, etc.

However, in practice congestion has been the only factor considered as the basis for any charging scheme and to a much lesser extent, if any, on air quality improvement

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Air quality charging policies

Upon the principle of "the polluter pays", investigations of transport policies which are specifically intended to reduce emissions and improve air quality are needed

However, the execution of the theoretical principles of congestion charging into practice is complex and will hardly, if ever, be met in reality

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My talk…

A framework for sustainable transport development which explicitly distinguishes the environment and air quality:

1. It is essential to use "targets setting" as the mechanism for devising transport policies
2. To investigate "policies and measures" which explicitly identify environmental impacts and the set targets
3. Modelling approaches

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Setting targets as the mechanism for devising transport policies

Transport planners are often faced with transport problems which have negative impacts on the users and non users of the transport system

Examples: congestion, delays, safety, air pollution, visual intrusion etc.

- "predict and provide" approach
- Then a shift to "predict and manage" approach

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Setting targets as the mechanism for devising transport policies

Ideally, any transport planning process:

- analysing the current situation
- identifying a problem then setting targets
- Identify solutions

The motive for target setting is to ensure that there are measurable goals to assess the implemented policies against The targets need to be tailored to solve the problems identified, and should therefore be informed by a clear plan of actions and policies to meet the local needs of the city or area

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Setting targets as the mechanism for devising transport policies

If the problem is congestion ⇒ Set targets for congestion reduction

If the problem is pollution ⇒ Set targets for pollution reduction

If the problem is revenues ⇒ Set targets for revenue increase

Seems logical but not always followed!

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Examples

Congestion charging schemes: technically optimal or politically feasible?

- In Norway for raising revenues: Succeeded
- In Singapore for congestion: Succeeded
- In the UK political feasibility is important
- In London: congestion and revenues ⇒ but was forced
- In Edinburgh for raising revenues: Failed
- in Hong Kong: for congestion: Failed
- Any scheme targeting air quality??

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Setting targets as the mechanism for devising transport policies

Transport safety is one of transport externality where setting up targets is a common practice

Another example for setting targets is in devising cycling policies

Setting targets as the mechanism for dev transport policies for air quality

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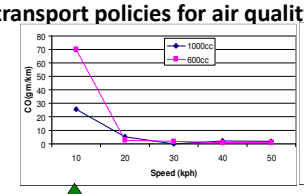

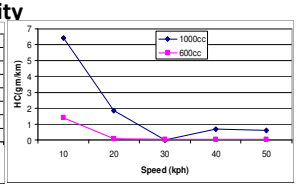

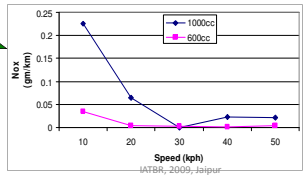

(At what speed we are green?)

25-35 kph

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Setting targets as the mechanism for devising transport policies for air quality

When it comes to setting targets for air pollution reductions and air quality, things become less clearer

These types of targets are largely dealt with at a higher, government or international level; e.g. Kyoto Protocol and the UN framework convention on climate change are examples

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Setting targets as the mechanism for devising transport policies for air quality

At the local level however, these targets have not been explicit nor stand-alone
There is a sense of responsibility
Sometimes even real responsibility
But the targets are rather implicit targets which are planned to be achieved through achieving reductions in Congestion!

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Policies and measures which internalise environmental impacts

If the target set is congestion reduction ⇒ Set policies for congestion reduction

If the target set is pollution reduction ⇒ Set policies for pollution reduction

If the target set is revenues increase⇒ Set policies for revenue increase

Again, seems logical but not always followed!

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Policies and measures which internalise environmental impacts

Policies to reduce amount of travel (TDM)

Policies to reduce emissions from vehicles (vehicles, fuels, technical)

Driving behaviour (ITS & information)

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Modelling approaches

Predictions and monitoring of impacts on air pollution and air quality are crucial if interventions in the transportation systems are to be logically investigated *before* or *after* implementation of transport policies

A prediction before implementation is useful to be carried out to maximise the efficiency of interventions

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Modelling approaches

Monitoring after implementation is useful to be carried out to learn lessons and improve future implementations

In order to perform such predictions and monitoring, two types
of models can broadly be identified:

- Simulation models (macro, micro or laboratory simulation)
- Emission modelling

Simulation models

In these types of models, the behaviour of the transport system and its users are simulated using macro or micro level models

On the macro level, the behaviour of the transport system under the policies implemented or considered for implementation, is simulated using a macro level or an aggregate approach

Simulation models

The output of these models, whether these are dynamic or static models, are in the form of traffic flows, travel times and link speeds and delays

Modelling impacts of transport policies on emissions and air quality using this approach requires the utilisation of some very crude estimates of emission factors which only enables a rough estimate of emissions and fuel consumption under a specific transport policy or traffic scenario

Simulation models

Travel demand forecasting which form the core of
such models are based on the neoclassical economic assumption
of rational decision makers and utility maximisation theory

Utility maximisation is the basic principle for most of these Models. Basically the traveller chooses the **option** from the available set of options that optimises his/her utility

$U = \alpha X + \xi$:

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Some problems with our modelling approaches

An alternative approach is micro-simulation which can be used to test and compare impacts of various policies on traffic and Emissions

In these types of models, each vehicle class can be modelled and tracked second by second

However, many inputs are required in this approach for road, signal and traffic details which if not collected directly from the field instead of using secondary sources, can result in inefficient estimates and results

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Some problems with our modelling approaches

An essential input to this approach is the model building and assignment of vehicle types over the test corridor or junction in each case or traffic
scenario

A micro simulation model will be calibrated and
Validated using real-world speed- time data which can be collected over the corridor

Again, using average values of characteristics of transport system will not produce accurate results
Instantaneous speed data can be extracted using the micro-simulation approach for any selected test corrid

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Some problems with our modelling approaches

Finally, laboratory testing and the simulation of choice decisions in the lab are useful to replicate the actual driving behaviour

For example using chassis dynamometer in the lab can be used to simulate driving cycle of any vehicle journey route in terms of vehicle speed against time, where on board measurement is not feasible

Emission estimates and fuel consumption under various policy scenarios and specifically to test various driving behaviours can also be obtained using this method

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Some problems with our modelling approaches

The exhaust emissions which are measured for a specified driving cycle (using vehicle speeds versus time trace) on a chassis dynamometer represent the tailpipe-out emission levels for a given route

The level of emissions produced at every instant can vary largely over the duration of a journey and this depends upon the nature of traffic conditions, the road network and road geometry. One major limitation of this method is that it is carried out under the controlled environment of the laboratory (see Saleh et al., 2009 for some further discussions).

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Some problems with our modelling approaches

Some assumptions are very restrictive:

- Perfect information (improve information; not only to improve users information but also modeller information)
- Rational behaviour
- The utility function (mainly time)
- Absence of explicit environmental presence in utility function
- The error term

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Some problems with our modelling approaches

- Need to largely increase explained part than unexplained
- Need to make environmental issues of relevance to the individual utility so that GHG and climate change are not by products, because are not!

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How can information provision help?

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- Information can play a significant role in changing travel behaviour and impact on GHG
- It can help the travellers making more informed decisions
- It reduces gaps between expressed attitudes and actual behaviour
- Educate travellers about climate changes and impacts of travel choices
- Increase personal interest and responsibility on climate change issues
- Increase people choices and therefore provide more opportunities for more sustainable choices
- Improve modeller's knowledge!

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- **Emission modelling**

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Emission modelling in the UK

- The National Atmospheric Emission Inventory (NAEI) is the standard reference for air emissions in UK and provides annual estimates of emissions for all pollutants including GHG
- These are calculated using factors for each vehicle type based on the composition of average vehicle fleet
- Other relevant factors are not included (eg. driving behaviour, maintenance, …
- Fuel consumption & emission factors (gm/km) for each of the six classes of vehicles and fuel type are used to estimate national fuel consumptions and emissions

Emission modelling in the

- Fuel consumption and emission rates are based on samples of in-service vehicles taken off the road and tested under controlled laboratory conditions with some expert judgements to be made when and where appropriate
- Therefore, these rates do not represent real life fleet conditions and not eligible to be used for prediction of emission estimates etc.

Other problems in road traffic emission modelling

- Air quality models typically assume that emissions are evenly distributed along the road section, it is therefore likely that such models will under-predict emissions and resulting ambient concentrations at some locations, such as in the vicinity of intersections
- A number of approaches are available for emission modelling: on board, simulation and laboratory modelling
- Big differences between the results of the three approaches and no reliable recommendations of which approach to use

Other problems in road traffic emission modelling

- Little research done on vehicle driving behaviour other than for cars private cars
- Most two wheelers' emission rates are higher than cars in a direct comparison of mean unit emissions (g/km)
- Unlike other types of vehicles, there have been no significant reductions in emissions from motorbikes brought about by new emission standards and technology

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Framework for sustainable transport development

The National Atmospheric Emission Inventory (2008) has shown that motorcycles have about twice the emissions factor (gm km–1) of NOx, PM and HC than do petrol cars

We showed in previous work that emissions (gm km–1) of CO, HC, and NOx are higher for motorcycles than cars (CO2, however, is greater for cars), and that motorcycles will generate more than 7% and 20% of CO and HC produced by road transport by 2012, if no remedial measures are taken in Europe

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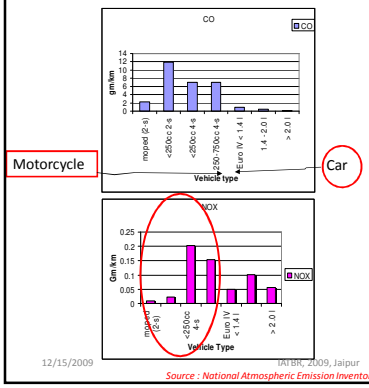
Comparison Of Emission Factor for Motorcycle & Car



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Source : National Atmospheric Emission Inventory, UK (2008)

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Measuring emissions of motorcycles using three methods

Two motorcycles driving a long a selected corridor in Edinburgh

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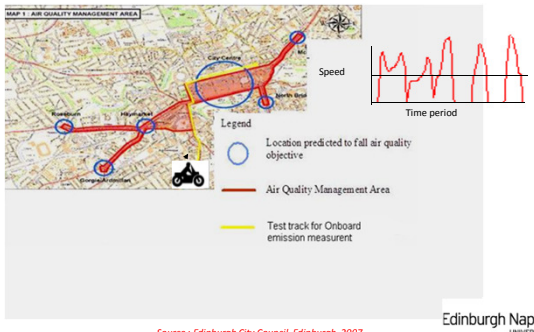
Air Quality Management Area (AQMA) Exceeding NOx European Union Limit



Source : Edinburgh City Council, Edinburgh, 2007

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Measuring emissions of motorcycles using three methods

1. Two motorcycles driving a long AQMA corridor in Edinburgh
2. Emission factors estimated using three approaches:
   - On Board
   - Laboratory
   - Micro simulation
3. Criteria for comparisons
4. Results and discussions

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Measuring emissions of motorcycles using three methods

1. Travel behaviour parameters
   - Driving behaviour (driving cycle) in on board measurement
   - Model assumptions (e.g. driving behaviour parameters in micro simulation)
   - Laboratory measurements taking into account driving characteristics
2. Results show significant differences
3. Different results usually are used to inform decision makers of policy impacts
4. Care is needed

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Conclusions- The framework

- There is an increasing attention to climate change
- Setting targets is very crucial to the success of policies
- Policies have to be devised specifically to meet objectives
- Which modelling approach to be used, how? And why?
- Air quality is a global issue, one have to watch for others

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Conclusions- Missing areas of research

- Little research on vehicle driving behaviour other (cars)
- Two wheelers emissions are higher than cars
- There have been no significant reductions in emissions from motorbikes brought about by new emission standards and technology

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Conclusions

- A need for more accurate modelling approaches
- More realistic representations of traffic
- Working on improving the explained part as well as the non explained part of the utility function

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- Thank you

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