Climate Change Research: Evaluation and Policy Implications
S. Zwerver, R.S.A.R. van Rompaey, M.T.J. Kok and M.M. Berk, (Eds.)

ASSESSMENT REPORT ON SUBTHEME

"MOBILITY AND MOTORISED TRANSPORT IN RELATION TO SUSTAINABLE DEVELOPMENT"

C.A.J. Vlek
Department of Psychology, University of Groningen
Grote Kruisstraat 2/1
9712 TS Groningen
The Netherlands

With contributions by:

P. Kooreman, J. Rouwendal, L. van Staalduinen — LUW, Agricultural University of Wageningen

A.J. Rooijers, E.M. Steg — RUG, University of Groningen

I.M. de Boer, D. van Kreveld, P.G. Swanborn, G. Tertoolen, E.C.H. Verstraten — RUU, University of Utrecht

P. Nijkamp, S.A. Rienstra, J.M. Vleugel — VUA, Free University of Amsterdam

Contents

ABSTRACT

The seemingly irresistible growth of motorised transport and its environmental effects have led the NRP to also put mobility and transport (M&T) on its agenda. NRP questions are focused on psychosocial factors and mechanisms underlying the popularity of motorised transport, and on technical as well as behavioural measures and strategies to reduce global air pollution stemming from mobility and the use of motor vehicles. In Phase 1 of the programme, five NRP-funded M&T projects have been conducted. Together with one or two related projects, these will be briefly summarised and commented upon. General observations, conclusions and some suggestions will be provided at the end of this paper.

1. INTRODUCTION

In western societies, the second half of the twentieth century is characterised by rapid expansion of human mobility and motorised transport. Motor-cars, vans and trucks have become available in large numbers. Many airlines are being operated through a multitude of airplanes. Although transport markets in the wealthiest countries are not even satisfied yet, the opening-up of Central and Eastern Europe and further "economisation" elsewhere in the world imply that motorised transport of persons and goods will further intensify, particularly through the air. "The private car," say Rouwendal, Van Staalduinen and Kooreman in their project

summary (this volume), "is an ambiguous symbol of western society in the late twentieth century. On the one hand it reflects its success in providing a high level of material wellbeing to a large majority of the population. On the other hand, it brings out the failure of the same society to solve the environmental problems evoked by its success."

Some pertinent data - quoted from (Vlek et al., 1992) are as follows. Over six hundred million cars, vans and trucks populate the world's roads of today: about 70% in the Western industrialized countries, and roughly 10% in Japan, 12% in the less industrialized countries and 8% in Eastern Europe and the Soviet Union (Low, 1990 and Bleviss et al., 1990). Worldwide some 35 million cars are being produced each year; a net total of about 20 million cars is added to the world's fleet of automobiles (Low, 1990, MacKenzie, 1990 and Walsh, 1990).

Currently there are more than five million motor vehicles in the Netherlands and the projected figures for the year 2010 lie around 8 million (EZ & VWS, 1987 and VWS, 1989). A third of the Dutch population of 15 million now owns a car; this might well be 50% in 2010; there currently are about 130 motor vehicles per square km. For the wealthy western part of Germany a figure of 70% car ownership (700 cars for 1000 inhabitants) is foreseen for the year 2010. Not only does the number of available cars go up steadily, also the size and the engine capacity of the average car are increasing (EZ & VWS, 1987 and Lenz, 1990). If a third of all the world's population in the year 2010 would drive cars, there would be two billion motor vehicles altogether. At 50% and 70% worldwide car ownership in 2010 these total numbers of cars would be three and four billion, respectively, for the projected world population of six billion people. This seems unbelievable. But it does not seem unrealistic to expect a doubling of the number of motor vehicles worldwide within the next decade; around 2030 there might well be two billion of such vehicles altogether (Bleviss et al., 1990, MacKenzie et al., 1990 and MacKay, 1990).

By now, the negative external effects of all this are well known. Motor vehicles involve large amounts of direct and indirect (embodied) energy consumption and greenhouse gas emissions. Their use periodically contributes to urban smog, and it is dominantly responsible for urban noise and traffic accidents. The enormous volume of motor vehicles in many countries has necessitated the construction of extensive systems of roads, motorways, parking places and traffic regulation. The growth in air transport is involving more and bigger airports, more and more intensely used air routes and an increasing infrastructure of various service industries, which have their own patterns of energy consumption and greenhouse gas emissions. All this has already significantly reduced the peace and quiet of natural and urban areas, and it is threatening basic environmental qualities.

These developments are worrying policy makers and citizens alike. The quality of life in and around cities, the protection of our natural environment, and the accessibility of important destinations together may well require that the use of motor vehicles be significantly reduced in the years to come, so that, e.g., motorized transport is limited to serving only the essential needs of society. This would fit into the concept of sustainable development as applied to the area of human mobility and transportation: "(This) involves more than growth. It requires

a change in the content of growth, to make it less material- and energy-intensive and more equitable in its impact" (WCED, 1987).

NRP-questions concerning mobility and transport are aimed at obtaining a better view of the social and psychological determinants of travel mode choice, of the physical and technical options for environmentally less harmful mobility and transport, and of the relative effectiveness of various policy strategies for encouraging people to move around and transport their goods in socially and environmentally sustainable manners. In the following, five NRP-funded projects and related research are briefly presented and discussed. In commenting upon the various projects, the author has attempted to draw general conclusions about sustainable-transport policies and to pinpoint further research and policy questions. Table 1 provides an overview of the various research projects to be discussed.

Table 1.1
List of projects in NRP subtheme "Mobility and motorised transport in relation to sustainable development"

Title	Project leader	Number
Attitudes and behaviours toward the environment	D. van Kreveld	850013
A behaviour analysis of private car use by households	J. Rouwendal	852081
Environmentally relevant differences among car user groups and the effectiveness of policy measures	L. Hendrickx	852092
Comparative analysis of options for sustainable transport and traffic systems in the 21st century	P. Nijkamp	853102
Non-NRP project		
Problem awareness & behaviour change	Steg et al.	

2. BEHAVIOURAL DETERMINANTS OF TRAVEL MODE CHOICE

De Boer, Van Kreveld and Swanborn, (NRP project no. 850013) collected questionnaire responses from about 500 regular car drivers in the city of

Hilversum, who first recorded their own transportation behaviour for a period of four days. Respondents filled in a comprehensive questionnaire containing items measuring their personal attitude, perceived social norms and the "opportunity structure" - their needs and means - for using a motor-car, particularly for commuting. Questions about attitude salience, knowledge about pros and cons of car use and their personal image of using a car were also asked. It appeared that travelling time is crucial for explaining car use preferences, while commuting distance and income explain a great deal of habitual transportation behaviour. Personal attitudes add significantly to this, in contrast to perceived social norms which do not seem to be very influential.

In a second survey, the authors studied the relationship between transportation behaviour and several personal variables such as feelings of alienation and powerlessness, self-enhancement with respect to environmental behaviour, and willingness to care for the environment under certain "pulling" or "pushing" policy measures. Completed questionnaires were returned by some 330 inhabitants of the city of Utrecht, half of them "always", the other half "sometimes" going to their work by car; within each group half of the respondents lived further away, the other half closer by than 15 kms from their job location, a distance which (in The Netherlands) conditions the possibility of considering to use a bicycle for commuting. It was revealed that the habit of commuting by car goes along with a self-enhancing view of one's behaviour toward the environment ("I am not polluting very much myself"). Respondents seemed willing to reduce their car use if they would be encouraged to do so on a voluntary basis. No correlations could be observed between personal feelings of alienation and powerlessness on the one hand, and habitual car use and willingness to reduce this, on the other. In view of the modest study results, the authors conclude that ingrained personal habits play a significant role in transportation behaviour, which they consider to originate primarily in various external, i.e., sociostructural and organisational factors.

Comments on De Boer et al's project

The design of De Boer et al's two survey studies typically reflects the cognitivistic (as opposed to behaviouristic) psychological view that human behaviour is "reasoned" and emanates from beliefs and evaluations, social norms and perceived instrumentalities for achieving personal goals. For a culturally and socio-economically strongly embedded behaviour domain such as mobility and transport, this view may well be overpersonalised. That is, given the enormous availability of means and facilities, everyday needs and desires and the socioeconomic system pressures related to the use of motor-cars, little additional variance in people's habits, preferences and choices with respect to using the car can be explained by variations in personal attitudes, perceived social norms and feelings of alienation and powerlessness. On the contrary, as the authors conclude, the massive use of cars has developed into a social and economic and (therefore) cultural habit for most people. And behaviouristic - not cognitivistic - psychologists well know that deeply ingrained habits are automated behaviour mechanisms which can only be modified via significant changes in the incentive structure of the physical and social environment which provokes such habits and perpetuates them.

3. EFFECTS OF COST AND/OR ENVIRONMENTAL FEEDBACK ON CAR USE

In a carefully designed field experiment supervised by Van Kreveld, Tertoolen and Verstraten (NRP project no. 850013-2), also in Utrecht, have evaluated the effects on travel mode choice and frequency of car use, of providing feedback information on the financial costs of one's own car driving, of providing information about one's "own" environmental effects of car travel, and of providing both kinds of feedback simultaneously. Control groups of respondents received no information whatsoever; one group did (like the three experimental groups) and one did not systematically record their own travel behaviour for a certain period of time. Altogether 350 people participated in the experiment; all of them were asked to use their car as little as possible during the experimental period. This approach, tailored to the individual, contrasts with current government approaches designed to address larger segments of the general public via mass media campaigns and general pricing measures.
Results of both a pilot study and the main experiment revealed that subjects did express changes in attitude as a result of feedback information. However, no significant *behavioural* effects (as recorded in transport diaries) could be observed in relation to feedback about either cost and/or environmental effects. Respondents rated speed, comfort and independence to be the most important advantages of using a motor-car and they stated that neither the financial nor the environmental costs of car driving weighed heavily when they were travelling. The authors conclude that attempts to influence car use behaviour arouse psychological resistance, often expressed through dissonance reduction and reactance (counter-behaviour). As a result of dissonance-enhancing information about environmental effects, intensive car users originally having a positive environmental attitude, may start thinking that environmental pollution is not that bad after all, and that others bear a greater responsibility for environmental problems than they themselves do. Information about the financial costs of car use especially leads to reactance. Car users seem to experience financial policy measures as a restriction of their individual freedom. They therefore tend to have a dim view of both such measures and the authorities contemplating to implement them.

Comments on Tertoolen and Verstraten's project
The field experiment by Tertoolen and colleagues is unusual both in its purpose and scope, and in the care with which it has been prepared and conducted. As the authors expected themselves, the intensive and personalised procedure followed should have had greater effects than any generalised mass media campaign urging car users to moderate their behaviour. The fact that, nevertheless, respondents in all three feedback conditions did not reduce the use of their car, gives little encouragement for public authorities contemplating mass media attempts at motorists' behaviour change. This conclusion is in line with the earlier one about the difficulty of changing frequently reinforced, habitual car use without modifying socio-economic system characteristics. Another conclusion worth noting is that little progress on the way toward less motorised mobility can be expected from policy makers having too much respect for individual car users' freedom of travel mode choice. Individual behaviour change of everyone's own free will seems only plausible to the extent that a general positive attitude toward preserving

environmental qualities becomes central in most people's view of the world and their own lives.

4. PROBLEM AWARENESS, WILLINGNESS TO CHANGE, EVALUATION OF POLICY MEASURES

Funded by the University of Groningen and the Ministry of Housing, Physical Planning and Environmental Affairs, Steg, Vlek and Rooijers (see project summary and Steg et al., 1995) have carried out a related project on personal mobility and possible behaviour change. Steg et al. collected home interview responses from 539 regular car drivers in and around the cities of Amsterdam, Eindhoven and Groningen. A field-experimental design was followed in which respondents were categorised a priori by region (as indicated above), distance to their city centre (0-7, 7-15 and over 15 kms) and whether or not they had been presented with a brochure providing balanced information on the pros and cons of the massive use of motor-cars in The Netherlands. Respondents kept personal transport diaries for four days prior to the interview. The latter was conducted by a trained interviewer and contained item sets designed to assess respondents' problem awareness, their willingness to reduce car use and their evaluation of 17 different policy measures all regarding the use of private motor-cars.

It appeared that, on average, massive car use was perceived to be "a problem" (not a small nor a particularly big one), but significantly less so in and around Groningen than in the more densely motorised areas of Amsterdam and Eindhoven. Also, city dwellers are more problem-aware than people living at 7 or more kms away from the city centre. The information brochure did not affect respondents' problem awareness very much, probably because the pros and cons of massive car use were quite well known already through regular media coverage over the years. With regard to behaviour change, less than one third of all respondents declared to be willing to reduce their car use. In this respect Eindhoven stood out more positively than either Amsterdam or Groningen, as did city dwellers compared to people living beyond 7 kms from the city centre. Of seventeen actual or contemplated policy measures to reduce the use of private motor-cars, none was rated as significantly effective, Groningers proving to be even more sceptical than inhabitants of the Amsterdam and Eindhoven regions. So-called push measures such as increasing fuel prices or parking rates, were evaluated as hardly acceptable, while pull measures such as improving public transport or bicycling facilities, were judged to be acceptable. A post hoc categorisation of the 539 respondents into a "low", "middle" and "high" problem awareness group, respectively, yielded the conclusion that the extent of problem awareness correlates significantly with people's willingness to reduce their own car use and their evaluation of the relative effectiveness (or rather: non-ineffectiveness) and acceptability of policy measures aimed at a reduction of private car use. The authors conclude that increasing collective problem awareness is a pre-requisite for getting motorists to change their behaviour for the common interest. Apart from this, clear policy goals and consistent government strategies are essential.

Comments on Steg et al.'s project
This research demonstrates again that using a private motor-car is highly attractive and important to most people. Nevertheless people throughout The Netherlands perceive the collective disadvantages of car use to be a problem about which the government should do something. This problem awareness, which varies both between and within diverse regions of the country - as well as between sex and age groups of respondents - significantly covers with people's (limited) willingness to change their transport behaviour and with their (sceptical) evaluation of various policy measures. According to the authors, increasing public problem awareness and providing feasible transport alternatives would be essential ingredients of any serious government policy designed to reduce the intensity of car traffic. Official Dutch policy goals are: to save energy and diminish environmental pollution, to enhance the accessibility of important destinations and to keep cities worth while to live in or visit. Given that policy makers currently know fairly well why and how to effectively influence individual people's transportation behaviour, the essential question now is: under what environmental, social and/or economic conditions could the car driving population (top politicians included) be "moved" to vote for and accept restrictive policy measures aimed at reducing the use of motor-cars in order to preserve and promote vital collective goods and qualities?

5. CAR USER DIFFERENCES IN ENVIRONMENTAL POLLUTION AND POLICY SUSCEPTIBILITY

Building upon previous research by Rooijers (1990) on speed differences among different types of car drivers, Cavalini, Hendrickx and Rooijers (NRP project no. 852092) at the University of Groningen have analyzed and described systematic differences among distinct car user groups, with respect to their usual speed, fuel consumption and environmental effects. The latter were taken as depending upon various types of decisions or behaviour. Five categories were distinguished: car purchase, choice of car type, car use, timing and routing of trips, and driving behaviour. The idea here is that net environmental effects may be directly as well as indirectly related to current behaviour, so that emission reductions could be attempted at various points in the above sequence.

Through questionnaire, interview and field observation research, the authors were able to classify car drivers in terms of car possession, car characteristics, number of kilometres driven annually, average occupation rate, type of (either or not congested) roads used, and driving speed and style. Three main car user groups could be identified, viz. private drivers, commuters and business drivers. The latter were subdivided into business drivers using their own car and those having a company car at their disposal. The first field study addressed four issues: the usefulness of the distinction among the four car user groups, the size of these groups in the total Dutch population, environmental parameter differences among the four groups, and the combination of user group and environmental parameter type so as to identify significant possibilities for emission reductions. Raw data were collected via mailed questionnaires returned by an apparently representative sample of 1150 respondents.

It appeared possible and useful to segment the driver population in terms of car user group, as defined above. Forty-two percent of all car users drives for private reasons and represents 23% of all car kilometres driven. Commuters represent 37% of all drivers and cover 40% of all car kilometres. Business drivers with private car and business drivers using a company car make up 13% and 8% of the driver population, respectively, and they each represent 18% of all kilometres driven by car. With respect to *all* parameters studied there appear to be large differences among car user groups. Business drivers using a company car turn out to be the most energy-consuming and environment-polluting group, while private drivers are doing the (relatively) least harm to the environment. By focusing on particular combinations of user group and type of behaviour or decision (see above), it seems possible to achieve CO_2 emission reductions of about 5%, per combination, so that the overall CO_2 emission reduction potential should be substantial.

The second field study by Cavalini et al. was aimed at clarifying the potential of various policy strategies when applied to different car user groups in relation to different types of behaviour or decision (see above). Six categories of policy instruments were distinguished for inducing changes in environmental parameters of car use. These are, respectively, physical alternatives and rearrangements, regulation and enforcement, financial-economic stimulation, providing information and communication, social modelling and support, and institutional and organisational change. The main research questions were:

1. To what extent are the different car user groups able to change various types of behaviour or decision regarding car use?
2. How sensitive are the various behaviours and decisions of the four user groups to the application of different policy instruments?
3. To significantly reduce CO_2 emissions, which type of policy instrument may best be applied to which group and in connection with which type of behaviour or decision concerning car use?

To collect raw data, first some 4000 roadside observations were made of passing cars, whilst car type, license number and speed were recorded. Then, car owners were identified via the national car registration system and they were invited by telephone to participate in the study. When 50 confirmations for each user group (see above) had been obtained, personal interviews were conducted. The latter were focused on possible changes in car use and on the respondent's evaluation of various policy measures. Some main results are the following.

All car drivers indicated that they would have less personal control over possible changes - like giving up their car, changing type of car or reducing car kilometrage - to the extent that these would have far-reaching consequences for their mobility and daily life. The majority of drivers could take a smaller car, decrease their number of "private" kilometres or drive more slowly and quietly. Private drivers and commuters are generally more inclined to change their behaviour than either group of business drivers. For achieving reductions in harmful car emissions, communicative and educational measures seem to be less effective than legal and financial measures as well as infrastructural and organisational measures. Financial measures would be more effective in changing the behaviour of private drivers and commuters than they would be affecting the behaviour of business

drivers. Also, financial measures are most effective in making people to give up their car and to make them drive fewer "private" or "commuting" kilometres. Finally, the reasons given for not changing behaviour or decisions about car use, under any of the presented policy measures, reveal similarities with the reasons provided in relation to personal control, as mentioned above.

Comments on Cavalini et al.'s project

The methodological approach ventured in this project proved to be successful in identifying distinctly different car user groups and demonstrating their differential energy consumption and environmental pollution, as well as their differing sensitivities to various policy measures. Moreover, a comparison of the two studies yields the conclusion that those who consume the most energy and produce the most harmful emissions, also are the least sensitive to current policy measures. Such information provides a useful basis for designing and targeting specific measures and strategies for reducing the harmful effects of mobility and motorised transport. The major policy conclusion from this research is that management policies for motorised mobility should be designed to fit the personal motives, habits and mobility needs of possible target groups of car users. Cavalini et al.'s respondents clearly signalled that reducing the environmental effects of their mobility would also reduce the (perceived) "control" over their daily lives, if it would involve giving up their car or driving significantly less than usual. Thus, fundamental thought must be given to policies designed to compensate for this feared "loss of control" when the use of private motor vehicles is to be diminished for reasons of collective importance. This means that target groups should be investigated a priori, to determine the potential impact of contemplated policy measures on their daily lives and the extent of "cooperative power" that they could, or would, have. "Cooperative power" (i.e. sufficient - remaining - personal control) under changing conditions for mobility and transport could be enhanced by decreasing people's structural needs and desires for motorised mobility, by helping people to better organize their daily or weekly travel patterns, and/or by providing alternative transport modes known to be socially and environmentally less harmful.

6. ECONOMETRIC ANALYSIS OF PRIVATE CAR USE BY HOUSEHOLDS

At the Agricultural University of Wageningen, Rouwendal, Van Staalduinen and Kooreman (NRP project no. 852081) have systematically looked into the dependence of car ownership and car use upon variations over time in the price of cars and of car fuel. Their aim was to find out the extent to which car users are actually sensitive to the "price mechanism", and in what respect (e.g., type of car, kind of trip or driving style) such sensitivity would be manifested in their behaviour. Knowing this is important for applying financial policy measures to reduce the volume of car traffic and/or the purchase and efficient use of smaller cars. On the basis of econometric analyses of some 3759 observations about 1379 motorists from the "private car panel" of the Central Bureau of Statistics (a continuous, time-variable sample of respondents), the authors have estimated various model parameters. This research is still in progress. Some preliminary results and conclusions are as follows.

Automobile drivers do change their short-term "demand" for car kilometres in response to changes in fuel prices, especially when they do not receive an employer compensation for automobile costs. Demand-price elasticities (behavioural sensitivities) appeared to be different for different age groups, male versus female car users, and for summer versus winter periods. Older, male and "winter" drivers appear to be less price-responsive than younger, female or "summer" drivers. It also appeared that higher income, greater commuting distance, being a company director, holiday driving and getting a car-use allowance, constitute circumstances under which car driving is intensified and less price-sensitive. The authors state that, although short-term demand-price elasticities are significant, the demand for cars and car kilometres has steadily grown over the past 15 years. This seems due to powerful other factors than the variable costs of car driving. For instance, an increased general income level has made car ownership and car use relatively cheaper, women's increased participation in the labour market has enhanced their share of the car driving population, and backward developments in public transport have "forced" many people to equip themselves with private motor-cars.

Comments on Rouwendal et al.'s project

In the past, demand-price elasticities for car ownership and car use have hardly been studied systematically in sufficient detail to understand which type of behaviour change occurs in response to certain price changes. Rouwendal and colleagues have demonstrated that fuel price changes affect particular kinds of car use (e.g., social-recreational trips) more than others, and that certain categories of people (e.g., middle-aged men) are less price-sensitive than others. In this respect Rouwendal et al.'s project goes nicely along with the work on distinguishing car user groups, conducted by Cavalini et al. (see above). Naturally, a fuel price change means different things to different people, to the extent that their "substitution behaviour" - what they can and will do instead of their higher-priced current car use - turns out to be different. Looking more closely (and perhaps prospectively instead of retrospectively as many econometrists do) into subjects' likely substitution behaviour may reveal their reasons for manifesting different patterns of reactions. Another problem in demand-price elasticity research lies in the distinction between short-term and long-term behavioural adaptations to price changes. A sudden change of price may yield a short-term behaviour change all right, but what happens on the longer term is often revealing of more fundamental driving forces underlying a given category of behaviours, as the authors themselves acknowledge. Factors discussed by the Dutch Physical Planning Service (Allsop, 1993), for example, are the increased physical separation of living and working locations in the 1970s and 1980s, the growth in the labour market for women, the larger number of one- and two-persons households emerging from "individualisation", and growing immigration from abroad. Such long-term developments and trends raise the question of the significance for car ownership and car travel of the variable costs of car driving as a factor by itself. With reference to Tertoolen and Verstraten's project (see above) we might say that altering car ownership and car use via the "price mechanism" would require fairly drastic financial policy measures. The project by Steg et al. (see above) has revealed that this would be unacceptable for most people, unless certain key conditions for feasible behaviour change would be fulfilled.

7. SUSTAINABLE TRANSPORT AND TRAFFIC SYSTEMS FOR THE 21ST CENTURY

The mobility and transport research results so far may leave the reader with reserved feelings about the possibilities to control the growth of motorised traffic and reduce harmful emissions. One long-term policy strategy, therefore, could be to go more deeply into the structural determinants of mobility and attempt to adapt or to change social systems so as to reduce the inherent demand for mobility. An other policy strategy could be to acknowledge the need and the desire for greater mobility of persons and goods, and to design sophisticated transportation modes and systems whose environmental effects stay within ecological limits.

Working towards the latter policy strategy, economists Nijkamp, Rienstra and Vleugel (NRP project no. 853102) at the Free University of Amsterdam have conducted a "comparative analysis of options for sustainable transport and traffic systems in the 21st century". Other research associates are at the Technical University of Delft, the University of Groningen, the Energy Research Centre in Petten, and University College London. The project has been conducted in two parts, one focused on exploring separate transport modes, the second directed at the construction and evaluation of diverse national transport scenarios.

In their report of Part 1, after an analysis of various problems of transport in relation to environmental quality, the authors systematically describe current trends in transport demand and supply. They point at the quest for higher transport quality and discuss various factors underlying the growth in mobility, such as rising incomes, spatial spreading of homes and work places, population growth and individualisation (leading to more and smaller households). They also discuss several types of market failure yielding undesirable "externalities", and they indicate failures in government policy to manage societal demand for mobility.

On the basis of interviews and workshops with international experts, the authors then present a list of technical, economic, spatial, institutional and socio-psychological factors that would be important for future developments in transportation. Subsequently, selected (new) transportation modes are systematically evaluated against these various factors. The authors' analysis goes along the advanced automobile, the high-speed train, low-speed Maglev (magnetic levitation) systems for urban transport, the electronically guided vehicle, subterranean transport and liquid hydrogen aircraft.

Conclusions from Part 1 are that there are many possibilities for future reductions of greenhouse gas emissions from transportation. Three general strategies for emission-reduction are: cleaner transport technology, changing the modal split between polluting and (relatively) clean transport modes, and reducing the demand for mobility. Focusing on the first and second strategies mentioned, the authors conclude that the most likely technologies seem to be improvements of the private car, the high-speed train and the use of telematics for increasing transport efficiency. It seems unlikely that Maglev high- and low-speed transport will be introduced at any large scale. The third general strategy, reducing mobility demand, has received less attention in this project.

In the second stage of the project, two reference scenarios, a "regulatory" and a "market" scenario, have been constructed which reflect extreme profiles in a "spider model" comprising eight major dimensions. The latter are categorised in pairs as spatial, institutional, economic and social/psychological, respectively. Against this background an "expected" and a "desired" scenario were constructed on the basis of questionnaire responses from various Dutch transport experts. Subsequently, these two scenarios were discussed by an international group of experts. In the "expected" scenario which comes close to the "market" scenario just mentioned, it is assumed that current trends will continue, and that therefore the private motor-car will remain the dominant transport mode. Its freedom of use would, however, be restricted by regulatory measures such as fuel price increases and higher parking rates. In the "desired" scenario more stringent policy measures to discourage the use of private cars would be introduced, together with policies aimed at developing higher-quality means of collective transport. The authors conclude that the expected scenario is, of course, more plausible, but that it could not be called "sustainable" unless an environmentally much less harmful mode of private transport would be developed than seems technically feasible for quite some time. The "desired" scenario, on the other hand, would involve considerable social behaviour change, together with stricter government policies and fairly big investments in rather different infrastructure than the sort which is underlying the private car system.

Comments on Nijkamp et al.'s project

Although the scenario study has not yet been definitely reported, it may be concluded that this project has been a useful exercise on the possibilities of sustainable mobility and transport. With a focus on The Netherlands and with inputs from experts from European countries facing similar transport developments, a multidisciplinary picture has been sketched of the main technical options and several distinct societal scenarios for mobility and transport in the early 21st century. It has become clear - once again, we might say - that western industrial society is strongly tuned toward the free-market system and toward meeting the demand for individual transport by motor-car for any person at any time and in almost any place. Reducing the social, economic and environmental costs of this transport system, which many people find no longer sustainable, would seem to require principal decisions by government policy makers. It would also require far-reaching social attitude and behaviour changes, which are conditioned by problem perception and the availability of behaviour alternatives in relation to mobility and transport (see e.g., the projects by Tertoolen and Verstraten and by Steg et al., above). Methodologically, Nijkamp et al.'s project relies heavily on expert assessments and opinions (e.g., about the "desired" scenario). It was not designed to analyze the fundamental societal factors and individual motives underlying the increased demand for motorised transport. Nor was the project aimed at collecting attitude and behavioural data from diverse sectors and groups in society, so that an assessment could have been made of the social and economic viability of particular transport options in relation to specific behaviour changes. Finally, it appeared that the experts themselves, too, may be of different opinion when it comes to designing and recommending "sustainable" transport scenarios for the near future. One point of discussion, for example, was to what extent government could at all come to grips with the collective problems

of private car use, given the degree of organization and the economic capabilities of the car industry.

8. GENERAL OBSERVATIONS, CONCLUSIONS AND SUGGESTIONS

NRP-funded research on mobility and transport so far has primarily addressed the massive use of private cars. Research on freight transport on the roads has not been undertaken in phase 1 of the NRP, nor have any studies been started on air transportation. The private-car mobility research carried out has, on the one hand, been focused on the individual car user, to assess his or her motives, attitudes, behaviour and sensitivity to policy measures and/or feedback information. On the other hand, long-term physical and technical alternatives to the private motor-car have been explored and evaluated, under the premise that the demand for mobility is there and could not (or should not) be influenced. Both lines of investigation seem to underrate the importance of social and economic system factors underlying the demand for mobility and the need for motor vehicles. System factors strongly influence and shape individual motives and preferences to the extent that individuals may be brought in a forced position to acquire and use a motor-car. Also, the fate of physical and technical alternatives for the private motor-car seems strongly dependent upon the nature of economic and social activities and upon the way in which social and economic interaction is organised. In this respect, there seems to be room for more fundamental studies into non-transport factors residing in various social and economic domains, whereby mobility and the need for motorised transport may be generated, or may be reduced.

At the Dutch national level, the NRP research on mobility and transport complements the research initiated and funded by the Advisory Service for Traffic and Transportation of the Ministry of Traffic and Waterways. This Service's programme of "anticipating research" for 1995 (VWS, 1995), for example, lists such topics as "green" transport scenarios, effects of changes in government administration, possibilities and consequences of improved transport informatics, electronic vehicle guidance, fast waterborne transport and improvement of government communication strategies. This government-directed research still largely evolves from the Second Structural Scheme on Traffic and Transportation (1988-1990) and it is designed to yield results potentially supporting current government policy. It is therefore still very much in line with Nijkamp et al.'s "market scenario" (see above) which reflects a societal as well as large-scale individual preference for privately organised mobility and transportation.
Internationally, NRP research in phase 1 links up with the concerns and intentions expressed in various programmes, conferences and workshops. For example, in 1992 the European Commission published a "Green paper on the Impact of Transport on the Environment" (CEC, 1992); also, its Directorate-General XII funds several projects on "the integration of environmental concerns into transport policy" EC, 1994), perhaps a modest beginning but something that could fly-wheel itself up. The Human Dimensions of Global Environmental Change Programme (HDP, 1994) of the International Social Science Council has not yet identified a separate line of research on mobility and transport, although it has indicated "industrial transformation and energy use" to be a key area for research. More importantly, ISIRT, the International Scientific Initiatives on Road Traffic group

since 1988, has conducted three international "round tables" on mobility and transport in relation to environmental problems. A summary report entitled "Agenda for safe access to a stable environment" was prepared by Allsop (1993). His final conclusion - on behalf on the ISIRT steering committee - reads: "Radical changes in road traffic and its uses, whether the changes be technical, institutional, behavioural, regulatory, financial or fiscal, are likely to be uncomfortable at least for some people in the short term. But they should be brought about because the alternative is to continue to put up with the many and severe adverse effects of road traffic in its present form, and thus fail to use it to the best advantage" (Allsop, 1993, p. 6).

Another pertinent meeting, organised in September 1992 by the European Ministers of Transport (ECMT) Conference, was held at the OECD headquarters in Paris. On page 237 of the conference proceedings, titled "Transport policy and global warming" (ECMT, 1993), a summary and conclusions section is phrased in ten points. The first four of these "messages for ministers" read as follows. "(1) Current trends are clearly inconsistent with the Rio (UNCED 2; Ch.V.) aspirations. (2) New technology can improve matters, but there is no complete technological fix immediately available. (3) Nevertheless it is possible to reduce transport's contribution to global warming; what is necessary is the political will to introduce the necessary measures. (4) Existing technology is not being put to best advantage because of the freedom of transport users to adapt their behaviour to convert potential environmental amelioration into more transport service. (5) Controlling this adaptive behaviour should begin immediately by seriously addressing the issues of reducing the specific power, performance and speed of vehicles" (ECMT, 1993, p. 237).

In view of this assessment of NRPI-research and the wider conclusions mentioned above, mobility and transport remain on the NRP agenda. For phase 2 of the NRP, covering the period of 1995 through 2001, societal causes and solutions of potential climate problems will again also be sought in cleaning up and/or reducing mobility and transport by motor vehicles. Relevant themes are: economic and social-cultural determinants of mobility and transport, options for limiting the need for mobility and transport, and sustainable mobility and transport policies and strategies for society. Thus more attention is being asked for mobility-generating developments and trends in society, such as, e.g., international tourism, development of the labour market and upscaling of the educational system. Also, a focus is being laid on social implementation and acceptance problems in relation to sustainable-transport options and strategies. Finally, mobility and transport are being linked to consumption patterns and lifestyles, in an attempt to clarify the potential effects on the quality of producers' and consumers' life of low-mobility activity patterns and collective- transport scenarios for society as a whole.

9. REFERENCES

Allsop, R.E., 1993. "Agenda for safe access to a stable environment; issues for decision makers as identified at ISIRT Round Tables 1989-1991". International Association of Traffic and Safety Sciences (IATSS), Tokyo, 29 pp.

Bleviss, D.L. and Walzer, P., 1990. Energy for motor vehicles. Scientific American, 263 (September): 55-61.

CEC, 1992. Green paper on the Impact of Transport on the Environment. COM (92)46. Commission for the European Community, Brussels.

EC, 1994. Project summaries; research on economic and societal aspects of environmental issues. European Commission, Directorate-General XII, Brussels.

ECMT, 1993. Transport policy and global warming. Proceedings of a European Ministers of Transport seminar in Paris. ECMT Series 75 93 10 1, OECD Publications.

EZ&VWS: Dutch Ministries of Environmental Affairs and Traffic and Waterways, 1987. Verkeer en Milieu (Traffic and Environment) Policy Document for Second Chamber of Parliament. Ministry of VROM, Division of Public Information, The Hague, 66 pp.

EZ, Ministry of Environmental Affairs, 1991. Ruimtelijke verkenningen. (Spatial explorations). Yearbook of the National Physical Planning Service of The Netherlands (Rijksplanologische Dienst). Ministerie van VROM, The Hague.

HDP, Human Dimensions of Global Environmental Change Programme, 1994. Work Plan 1994-1995. International Social Science Council, Paris.

Lenz, K.-H., 1990. Motorization and trends in road traffic. In Väg- och Trafikinstitutet Linköping: Proceedings of "Road safety and traffic environment in Europe". September 1990, VTI-Report no. 362a.

Lowe, M.D., 1990. Alternatives to the automobile: transport for livable cities. Paper 98, Worldwatch Institute, Washington D.C.,49 pp.

MacKay, M., 1990. Towards a unified traffic science. IATSS Research: Journal of the International Association of Traffic and Safety Sciences 14: 19-26.

MacKenzie,J.J. and Walsh, M.P., 1990. Driving forces; motor vehicle trends and their implications for global warming, energy strategies, and transportation planning. World Resources Institute, Washington D.C.

Rooijers, A.J., 1990. Drivers' attitudes and beliefs towards speed limits and speeding on Dutch motorways. In Väg- och Trafikinstitutet Linköping: Proceedings of "Road safety and traffic environment in Europe", September 1990. VTI-Report no. 363a.

Steg, L., Vlek, C.A.J. and Rooijers, T., 1995, in press. Gedragsverandering ter vermindering van het autogebruik: probleembesef, verminderingsbereidheid en beoordeling van beleidsmaatregelen. (Behaviour change for diminishing car use: problem awareness, willingness to change and evaluation of policy measures). In: F. Siero, E., van Schie, D. Daamen and A. Pruyn (Red.). Sociale psychologie en haar toepassingen. Deel IX, Eburon, Delft.

Vlek, C.A.J. and Michon, J.A., 1992. Why we should and how we could reduce the use of motor vehicles in the near future. IATSS Research: Journal of the International Association of Traffic and Safety Sciences, 15: 82-93.

VWS: Ministry of Traffic and Waterways: Advisory Service for Traffic and Transportation, 1995. Anticiperend onderzoek; projecten 1995. (Anticipating research; projects-1995). Directoraat-Generaal Rijkswaterstaat, AVV, Rotterdam.

VWS: Dutch Ministry of Traffic and Waterways, 1989. Tweede Structuurschema Verkeer en Vervoer. Deel A: Beleidsvoornemen. (Second Structural Scheme on Traffic and Transportation: Part A: Policy Intentions). SDU, The Hague.

Walsh, M.P., 1990. Global trends in motor vehicle use and emissions. Annual Review of Energy 15: 217-243.
WCED: World Commission on Environment and Development, 1987. Brundtland-Report: Our common future. Oxford University Press, Oxford/New York.