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TRAFFIC BAN, A MEANS TO COMBAT SMOG?

J.G.W. Simons
H. P. Wansink

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In the summer and autumn of 1989, smog formation occured several times in the Netherlands, resulting in a discussion concerning possible controlling measures. With a view to temporary reduction of the air pollution agreements were made with the petrochemical and chemical industries regarding production restricting measures. However, these measures proved insufficient to prevent the formation of smog. Therefore a total or partial traffic ban is often advocated. The following article will go into the effects of such a measure for the economic activity. Furthermore the authors will discuss the technical and chemical aspects of the formation of smog and the legal complications of a driving ban.

Prof Dr Mr J.G.W. Simons - Drs H.P. Wansink*

Smog, a contraction of the words smoke and fog, is the name used for short periods of increased air pollution. In this context a short period is interpreted as a period of one to ten days. The serious air pollution levels occur on a national or even a European scale.
A distinction should be drawn between summer smog episodes and winter smog episodes.

* Prof Dr Mr J.G.W. Simons is a professor of transportaction economy in the Vrije Universiteit in Amsterdam, and Secretary of the Chamber of Commerce for Rotterdam and the Lower Maas; Drs H.P. Wansink is management assistant at the Transport department of the Chamber of Commerce in Rotterdam. Both authors presented introductions at the smog conference organized by the Dutch Study Centre for International Management, which was held in Maarssen (the Netherlands) on December 1st. 1989.

./2

SUMMER SMOG

Summer smog occurs predominantly with light (easterly) winds and good, i.e. warm weather. Typical components are ozone, nitrogen dioxide, aldehydes, aerosol, nitric acid, other acids and peroxide compounds (1). The first two components, ozone (O3) and nitrogen dioxide (NO2) play an important part in the discussion on smog; together these components form the so-called oxidant (Ox).
As the various processes leading to the formation of the oxidant have rather long reaction times, said formation will only occur if the above type of weather persists for some time.

Generally speaking summer smog is a supraregional problem. The Rijksinstituut voor Volksgezondheid en Milieuhygiëne (the National Institute for Public Health and Environmental Control - RIVM) has calculated to what extent pollution sources in the Netherlands, including traffic, contribute to the formation of smog(2). Dutch sources account for ten percent of the national ozone level, while approximately half of the national concentration of nitrogen oxides (NOx), including nitrogen dioxide, can be attributed to national emissions, as stated in this RIVM report. The contributions of Dutch sources were also calculated at urban and street levels, see figure 1. Figure 2 shows the effects of an elimination of the Dutch traffic at the current levels for the major components O3 and NO2.
On a national and urban scale the effect of a traffic ban on the ozone level is minor, at street level however the ozone concentration will increase significantly in case of a traffic ban. This is due to the interesting as well as surprising fact that the direct emission of nitrogen oxides (NOx) by traffic reduces the ozone level through chemical reactions with ozone (3).
During a traffic ban less ozone will be decomposed at street level, due to the decreased emission of nitrogen oxides. At this level, when driving is permitted, traffic will provide a 45% reduction in the ozone concentration! The nitrogen dioxide level, however, will decrease considerably in case of a traffic ban. At street level the NO2 concentration in the air will decrease by 80% if traffic is banned throughout the country; a local traffic ban will reduce th NO2 concentration by 50%.

WINTER SMOG

Just like summer smog, winter smog occurs in periods with little (easterly) wind, this time, however, at low temperatures; a layer of snow is conductive to the formation of winter smog. Typical components of winter smog are sulphur dioxide (SO2) and again nitrogen dioxide (NO2). In addition other nitrogen oxides and (acid) aerosols/fog also play a part.
Air pollution by sulphur dioxide originates predominantly from abroad; see figure 3. Elimination of all Dutch SO2 sources will reduce the SO2 concentration by 10% on a national scale. At urban and street level the effect is greater; around SO2 sources, e.g. near polluting factory chimneys, a 30% reduction may be achieved (4), see figure 4. The Dutch contribution to the average nitrogen oxide (NOx) level is larger; on a national scale approximately 50%, on an urban scale approximately 70% and in the streets as much as 85% (5).

Particularly on a local scale, the production of nitrogen dioxide, like that of any nitrogen oxide, can be attributed largely to Dutch sources, such as the Dutch traffic. Nationwide a traffic ban would reduce the nitrogen dioxide concentration by less than 5%. On an urban scale this will be 20% and at street level it will be 40% (see figure 4). Elimination of all Dutch NO2 sources would yield a 40% (see figure 4). Elimination of all Dutch NO2 sources would yield a 40% lower nitrogen dioxide concentration on an urban scale and a 55% lower concentration at street level. If a traffic ban would be imposed only in the cities, these figures would be 15% and 30% respectively (6).

LEGAL FRAMEWORK (7)

As stated in the introduction, a possible traffic ban received a lot of attention in the discussions within the various groups. The question remains, however, whether traffic restricting measures are legally feasible. Under article 48 of the "Air Pollution Act" the Royal Commissioners in the provinces are authorized to issue general regulations with respect to establishments, equipment, fuels and polluting activities. Road traffic is undisputedly covered by these terms, but which criteria apply? They are: "specially circumstances of a temporary nature", "provision urgently required" and "in the interest of public health". Obviously, in addition to these legal criteria, the general principles of good management also apply. Regulations will e.g. have to comply with the principle of the least pain; they will have to be announced as soon as possible and there will have to be possibilities for releases

and administrative compensation. The conclusion, therefore, should be that article 48 of the "Air Pollution Act" offers only limited possibilities. In particular the question arises whether it will be feasible to demarcate an area which is composed in such a way that an adequate check can be kept on possible offenders, while the area does not comprise any places that are not in the least affected by conditions which make it necessary, in the interest of public health, to take such measures. If it turns out that the formation of smog is not a special circumstance, but a frequently recurring condition, then consideration should be given to seeking other legal grounds on which to base any necessary measures.

Besides these legal doubts which could be cast on an traffic measure, it is also to be expected that there will not be a lot of public support, as long as the need for measures on account of health aspects and clearly visible environmental pollution is not obvious. In addition, trade and industry will also have to contend with economic losses.

AN INVESTIGATION INTO THE CONSEQUENCES FOR THE ECONOMIC ACTIVITY

After the concise discussion of the legal framework, attempts will now be made to estimate the short-term (monetary) economic consequences that ensue from traffic restricting measures. In particular we shall deal with the consequences of banning traffic in the province of South Holland; not only is this the most important province of the Netherlands in an economic sense, it is also the province with the highest smog risk within Dutch proportions.
Obviously the extent of the loss cannot be calculated exactly; however, the following estimate will provide an impression of the order of magnitude of the economic losses that are suffered directly. The following amounts are minimum estimates, as we have predominantly used figures relating to 1987; meanwhile, the economy has grown again (in 1988 by 3.0% and in 1989 by 3.8%) (8). An even more important restriction is that only the shortterm losses are calculated; there are insufficient data to quantify the long-term losses. The total economic loss obviously exceeds the short-term loss. One of the significant long-term consequences is that (foreign) customers' confidence in trade and industry will be affected. As a result the export position will deteriorate. The consequences of traffic restricting measures for the competitive position force us to enter into international consultations. The European Commission seems to be the proper authority: if the measures are taken on a European level, then disruption of the competitive relations will play a minor part.

Traffic restricting measures will have economic consequences for:

A. The road transport of freight sector;
B. All other sectors of trade and industry that depend on the normal functioning of traffic for the production of goods and services.

Re A. The economic consequences for the road transport sector.

The calculation is based on the following data: (9)

- On December 31st, 1987, the road transfer and hauling trade comprised 11,621 registered "hauling units" (these may be articulated lorries or lorries with trailers) in South Holland. (Throughout the Netherlands there were approximately 50,000 registerd hauling unites.)
- The fixed costs average Dfl. 80,- to Dfl. 90,- per hauling unit per hour (lorry plus driver).
- Per day a hauling unit is driven for an average of ten hours (the drivers can take turns if necessary).

From this we can deduce that a 24 hour traffic ban will entail a loss of

11,621 x Dfl. 85,- x 10 = Dfl. 9,877,850.-

in road transfer and hauling. In addition to professional freight transport, private road transport is also carried out. This private transport comprises approximately one third of the professional freight transport (10). The total economic loss for the road transport sector in the province of South Holland in case of a complete 24 hour traffic ban, therefore, would be at least 13 million guilders (Dfl. 9.9 million + 33%). The Ministery of Transport and Public Works has calculated that a 24 hour traffic ban would mean a loss of 7 to 9 million guilders for the road transfer and hauling trade. Multiplied by 1 1/3 this amounts to a loss of 9 to 12 million guilders for road transport plus private transport. The Ministery based its calculations on the NEI report "Economic loss as a result of traffic restricting measures" (11), issued in 1987. This report which was written by order of the Ministry for Housing, Regional Development and the Environment, contains a calculation of the consequences of a 24 hour traffic ban for the city of Amersfoort. A new calculation, drawn up in cooperation with the Centraal Planbureau (Government body for economic planning - CPB) by order of the Ministry of Transport and Public Works and

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the Ministry of Economic Affairs, yields a loss of 14 million guilders for the road transport of freight sector. In the event of a nationwide traffic ban in the Netherlands the loss is estimated at Dfl. 65 million in this calculation. Both calculations point in the same direction: a total driving ban in South Holland will cost approximately 13 million guilders per day in road transport.

In case of a partial driving ban (driving would be allowed between 20.00 or 24.00 hours and 06.00 hours) the amount of the loss will obviously be lower. However, it is not feasible to handle all the traffic during the night (fresh daily items e.g. are deliverd several times per day), and besides this would also cause problems with respect to loading and unloading. Indeed there will be some sort of a "catching up demand" on the part of the customers, but this will not be complete.
Following the Ministry of Transport and Public Works it is assumed that half of the total loss will be compensated for by the time during which driving would be allowed, while the remaining loss may be halved once more as a result of the possible catching up demand (12). In case of a partial driving ban, therefore, an economic loss remains of one quarter of the loss ensuing from a total driving ban. For the road transport sector this amounts to 1/4 x Dfl. 13 million = Dfl. 3.25 million. On the whole this sum corresponds to the amount of Dfl. 2.3 to 3 million per day which was calculated by the Ministry on the basis of the assumptions included in the NEI report.

Re B. The economic consequences for the other sectors

Besides a direct loss of production in road transport, a traffic ban will entail loss of production in other sectors. Companies working with marginal stock according to the "just-in-time" principle will have to suspend their production as they run out of stock. Economic losses may be suffered because employees can no longer get to work, products cannot be transported etc. Major losses will occur in the fruit and vegetable sectors. For example, the Commodity Board for Fruit, Vegetables and Mushrooms reports that every day some Dfl. 16 million worth of fresh products is turned over at the auctions in South Holland. This turnover is lost completely in case of a traffic ban, even if it has not been announced fully and beforehand: the organization of substitute transport will take more time than the announcement will allow; in its interim report the South Holland working group proposes that the measures which are issued not later than 13.00 hours on day one should already enter into effect the following morning at 06.00 hours. The building trade also depends on a steady supply of materials. A stagnation in this supply will imme-

diately result in high costs. For example, according to the constructors of the railroad tunnel in Rotterdam a suspension of the supply of construction materials and soil removal would mean a loss of Dfl. 750,000.- per day. Another example may be derived from the food and stimulant industry: a milk factory would be faced with major problems when the milk tanks at the farms are full and transportation is impossible. In the factory itself the consequences may be disastrous as well: if the processed milk cannot be transported and turns sour in the equipment, it would take a tremendous operation to make the entire unit suitable for production again. The superfluous milk could also create an ecological problem. Furthermore, one should bear in mind that closing down continuous working plants on account of insufficient supply may lead to a substantial loss, considering the starting up and closing down costs.

As stated above, long-term losses are not taken into consideration in the calculations, but they obviously do exist. For instance, the long-term export position of the port of Rotterdam is at issue. If the measures that are taken result in a suspension of the storage and transfer activities in the harbour, the long-term economic consequences could be extensive. In this context it should be stated that under article 48 of the Air Pollution Act the Royal Commissioner is authorized to prohibit the use of the harbour facilities. Such a prohibition implies that almost the entire harbour will go "down". As a result the reliability of the harbour will be affected and its users will be faced with higher costs, due to the longer delays. Because of this the competitive position as compared to harbours abroad will decline, taking into account that the regulations with respect to the environment vary from one country ot another. A possibly less stringent environmental legislation in foreign harbours may place these harbours in a more favourable competitive position. Particularly in the field of transport, with its delicate balances, these types of disruptions may have major consequences.

On the basis of the NEI study concerning Amersfoort the Ministry of Transport and Public Works, in cooperation with the Ministry for Housing, Regional Development and hte Environment, has calculated the loss of production and the loss of added value in case of a total traffic ban (24 hours a day) throughout the province of South Holland and in case of a traffic ban which will be limited to cities in South Holland with populations of over 40,000. A letter from - then - Minister Nijpels to the Dutch Lower Chamber dated October 17, 1989 (13) states several of these figures, see table 1.
With an increasing number of days the amounts of the losses increase more than

proportionally in the calculation based on the NEI study; the argumentation is that in some cases there is still room to improvise, in case of a one or two day traffic ban; this, however, will come to an end soon. This calculation is based on the assumption that all employees are able to reach their place of work. The latest calculation (on the basis of CPB data) arrives at higher amounts for the losses, at any rate for the first few days of the traffic ban. In the "CPB calculation" it was assumed that in case of a traffic ban employees would not be able to work for an average of 20% of the working hours on account of their being unable to reach their place of work (in time), which would also cause a 20% loss of production. In our opinion the latter seems to be a rather pessimistic view, as in some cases the loss of production may turn out smaller than the number of working hours lost, if the work is redistributed. The sizeable margins (loss in South Holland Dfl. 100 - 250 million per day) in the results of the "CPB calculation" could have been avoided if the calculations had been carried out with more accuracy; this would require a lot of computer time and involve high costs, while even then the outcome would remain an indication.

In the calculations a distinction is made - in addition to the one with respect to the road transport sector - as to loss of production value and loss of added value (14). Loss of added value on account of the smog measures forms a part of the loss of production value. Ambiguous figuring in the report on Amersfoort has caused some confusion in this respect (15).

The added value which is not realized (not being able to bring the production factors into action) leads to the loss of added value. In some cases it is doubtful whether the loss of production corresponding with this loss of added value will be incurred to the full extent. If the goods and services used in the production process keep well, such as sand or bricks, then they can still be used in a next production cycle. In this case one could maintain that the loss resulting from the smog measures would not be greater than the loss of added value, provided that the lost days can be made up. If such is not the case, the annual production will actually decrease with the production of the number of days on which no work could be done on account of the smog measures. If the goods and services used in the production process are perishalbe, such as milk, these will also be lost as a result of the smog measures. In that case th loss will certainly exceed the loss of added value and be equal to the production value.

Table 1 lists the results of the various calculations with respect to a total traffic

ban.

A partial traffic ban (driving would be allowed at night between 24.00 hours and 06.00 hours) means a reduction of the economic loss, also to the "other sectors". In this case for a limited number of days (a traffic ban for more than five days on account of smog does not seem realistic) the short-term loss will increase no more than proportionally to the number of days. During the hours that traffic is allowed there will often be sufficient opportunities to continue production on an improvised basis for five days. This yields the picture outlined in table 2, with respect to a partial traffic ban in the province of South Holland. This estimate, based on the NEI report, does not take into account any additional labour costs and organization costs, which could yet increase the amount of the loss. The city of Rotterdam roughly calculates the loss at an amount similar to the figures presented in table 2. A partial traffic ban for a period of two days in the Rijnmond area will lead to a loss of Dfl. 55 million (16).

Table 1

Short-term economic loss in case of a total traffic ban (all amounts in millions of guilders).

Duration of traffic ban (in days)		1	2	3	4	5
Throughout province of South Holland	production.[a]	58	116	203	290	405
	of which:					
	added value[b]	31	82	132	183	243
	road transport	13	26	39	52	65
Idem, according to new "CPB-calculation"	production	100-250	200-500	300-750	400-1000	500-1250
	of which:					
	added value	75-135	150-270	225-405	300-540	375-675
	road transport	14	28	42	56	70
In cities with populations over 40.000 in South Holland	production	27	54	98	143	204
	added value	17	34	56	79	101
Throughout the Netherlands	production	370-1000	740-2000	1110-3000	1480-4000	1850-5000
	of which:					
	added value	240-550	480-1100	720-1650	960-2200	1200-2750
	road transport	65	130	195	260	325

a) production is understood to mean the market value of the goods and services produced.

b) added value is the difference between the market value and the consumption of goods and services used in the production process.

Table 2

Short-term economic loss in case of a partial traffic ban (all amounts in millions of guilders).

Number of days		1	2	3	4	5
Traffic ban throughout province of South Holland	production	23	46	69	92	115
	of which:					
	added value	15	30	45	60	75
	road transport	3	6	9	12	15

THE EFFECT OF THE MEASURES

The calculations prove that banning traffic will have far-reaching economic consequences. The public can only be expected to accept such radical measures if they clearly have a positive effect, in particular by diminishing the prevailing hazards to the public health.

In its report entitled "The health risk of city dwellers as a result of exposure to air pollution during summer episodes and the effect of traffic restricting measures" (17) the RIVM (National Institute for Public Health and Environmental Control) investigates which summer smog components constitute health hazards. It is concluded that ozone (O3) should be regarded as the main component for the development of health effects. Under equal circumstances, depending on the nature of the effect under consideration, ozone is 5 to 15 times more toxic than nitrogen dioxide (18), the other major summer smog component as mentioned above.
Other simultaneously occurring air pollutants as well as factors such as increased temperature and relative humidity, can cause additional effects.

With respect to the effect of a traffic ban during summer smog episodes the RIVM concludes:

"If motorized traffic in cities with populations of over 300,000 is banned altogether, and if wind speeds do not exceed 1 m/s, the maximum 1 and 8 hour average O3 concentrations in the leeward part of the city will decrease by approximately 10%. The 1 hour average concentration of a number of other lung irritative components will decrease by 10-65%. The positive effect of traffic restricting measures on the

quality of the air in the city will be less for cities with populations of less than 300,000 and/or in case of wind speeds in excess of 1 m/s. Expectations are that if the pattern of activities of the population in the larger cities remains the same, a ban of all motorized traffic would reduce the health risk in the leeward part of the city by 15-20% at the most: approximately 10% due to the decrease of O3 effects and 5-10% due to the decrease of effects caused by other components. Although the concentration of a number of these components - including NO2 - shows a considerable decrease, it is not very likely that this will have a significant effect on the reduction of this risk, since their toxicity as compared to that of O3 is rather minor" (19).

It is remarkable that even in extremely unfavourable conditions, viz. little wind and in the leeward part of a large city, the decrease in health risk is 15-20% at most, provided still that there are no changes in the pattern of activities. The latter condition, however, does not seem very probable. It is more likely that on car-free days the behaviour of the urban population will change; chances are that this will lead to a longer and more active stay outdoors. This change in the pattern of activities can, despite the decreased O3 concentration, result in an increase of the inhaled dose, which would cause a contrary effect on the health risk!

The effects of winter smog on public health and in this respect the effect of traffic bans during winter smog episodes have not been investigated sufficiently to warrant statements similar to the ones given above in relation to summer smog. The RIVM is preparing a specific study aimed at winter smog (20).
We can conclude that traffic restricting measures, in case of summer smog anyway, will have little effect in the Netherlands; with respect to winter smog further research will be required to produce unambiguous statements.

STRUCTURAL MEASURES

Controlling smog by means of a traffic ban during smog episodes is a very costly way to treat symptoms, and one with a disputable effect as well. In our opinion structural measures aimed at preventing smog episodes are preferable. Here we can distinguish:

- technical measures; a good example is the introduction of the catalytic converter for cars. With a controlled threeway catalytic converter petrol-engined cars can

become 80-90% cleaner. Application of this technique can reduce passenger car NOx emissions by 80% in the year 2010, as compared to a situation featuring "dirty" cars only (21).
At the moment industries are working hard on the development of a clean diesel engine; since May 1989 the municipal transport company in Utrecht for example has been operating a number of diesel buses with engines whose emission of nitrogen oxides is considerably lower than that of ordinary diesel engines (22).

- international consultations; many pollutants contributing to the formation of smog originate from countries situated east of the Netherlands. It appears that the political revolutions in the Middle and Eastern European countries have created an atmosphere offering more opportunties for reduction of the air pollution originating from those regions.
- changing the pattern of mobility; this includes the reduction of the use of cars in commuter traffic and promotion of the use of collective transport, but also the reduction of the distances between place of residence and place of work.

As stated in the National Environmental Policy Plan - under action items A195a and A196 - (23), one of the possibilities to reduce the use of cars in commuter traffic is the collective transportation of commuting employees. We can distinguish public transport and company transport; the latter comprises the private transportation of groups of employees arranged by the companies themselves. In its Regional Economic Action Plan the Chamber of Commerce in Rotterdam aims to promote collective transport in the region, wherever possible (24).
In the consultations with representatives from the government, employers and employees it was decided to establish a working group which is to investigate the possibilities for collective transport around Rotterdam. Meanwhile these consultations, which are still going on, have shown that it seems a good idea to have an investigation carried out among approximately 800 companies with over 50 employees in the Rotterdam area, into the possibilities for collective transport. Eventually this will result in the drafting of kilometre reduction plans for companies.

A recent NEA study shows that company transport can contribute significantly to the reduction of commuter traffic by car (25). This study points out that in former years company transport was much more extensive than nowadays. In 1960 for instance company transport accounted for approximately 10% of the total commuter transport; by 1987 this figure had dropped to 2%. The 1970's and (especially) the 1980's showed an absolute decrease in company transport. This can be attributed to

several causes:

- the exponential growth of car ownership, in connection with the general preference among workers to use their own cars;
- the number of employees in the companies and sectors in which company transport is (could be) used most extensively has decreased considerably, in a relative as well as an absolute sense.
- smaller companies, various sectors of the service industries and the government have all introduced variable working hours. The consequent staggering of commuter transport has reduced the possibilities for company transport.
- employers have sought possibilities for cost reduction by making agreements with public transport companies in order to plan regular services in such a way that they may be used by employees. This way commuter traffic will be subsidized by the government.

TABLE 3 - National passenger traffic

	Passenger kilometers (x Dfl. 1,000,000,000)			
	1960	1970	1980	1987
Total passenger traffic	57,9	120,4	148,8	168,8
of which: by passenger car	15,9	79,7	108,1	127,9
of which: by public transport	13,9	13,4	14,8	15,5
of which: by group transport	2,2	2,6	2,6	1,7
of which: by other means of transport (tours, taxi, walking, moped etc.)	25,9	24,7	23,3	23,8
Total commuter transport ±	12,7 ±	26,5	32,7	38,8
of which: by passenger car			23,2	28,7
of which: by public transport			4,3	5,0
of which: by company transport ±	1,3	1,5	1,2	0,8
of which: by other means of transport			4,0	4,0
Total group transport	2,2	2,6	2,6	1,7
of which: by bus (seating capacity 9 - ± 55)	1,9	2,2	2,1	1,1
of which: by car/minibus (0-8)	0,3	0,4	0,5	0,6

SOURCE: CBS/NEA

The downard tendency of the company transport share in the total passenger transport can be changed into an upward one, provided government as well as trade and industry put in the required efforts. The NEA has calculated that a government contribution of 30% towards the costs of company transport in 1987 these amounted to Dfl. 111 million, so the contribution would come to some 35 million guilders - would be required to maintain company transport as it is (26). From the NEA calculations one can deduce that a 30% government contribution might be sufficient to realize of maintain, as the case may be, 3,500,000,00 (low estimate) to 5,600,000,000 (high estimate) passenger kilometres in company transport in the Netherlands. Supporting government measures, however, will be needed, in particular traffic facilities for company transport. At an average passenger car occupation of 1.1 passenger the above-mentioned increase of company transport would save 3,200,000,000 to 5,000,000,000 car kilometres in commuter traffic (27). The ecological advantages are obvious and of a structural nature.

CONCLUSIONS

The above has shown that in case of smog formation in the Netherlands traffic restricting measures will have little effect, particularly in case of summer smog, even if all traffic would be banned entirely. The question remains whether it would be feasible to demarcate an area which is composed in such a way that an adequate check can be kept on possible offenders, while the area does not comprise any places that are not affected by conditions necessitating, in the interest of public health, just these measures. It is certain, however, that the economic consequences of a traffic ban will be considerable. A 24 hour traffic ban in the province of South Holland will lead to a short-term loss of at least 58 million guilders. In view of these high costs and the minor effect on public health there will be little public support for such a measure.

With respect to the combat of smog a structural approach is preferable to a "treatment of symptoms" such as a traffic ban. Examples of possible structural solutions include technical measures such as catalytic converters in combustion engines, reducing air pollution at the source, including those abroad, and changing the pattern of mobility such as promoting collective transport in order to reduce the use of cars in commuter traffic.

NOTES

(1) This information is based on a lecture by Dr R.M. van Aalst of the Rijksinstituut voor Volksgezondheid en Milieuhygiëne (National Institute for Public Healthe and Environmental Control), which was presented at the smog conference organized by the SCIM on December 1st, 1989. Please refer to this lecture for more detailed technical information.

(2) D. Onderdelinden, RIVM-report no. 228702005, "Perioden met verhoogde luchtverontreiniging, schatting van de (verkeers)bijdrage aan concentratieniveaus" ("Periods with increased air pollution, an estimate of the (traffic) contribution to concentration levels"), Bilthoven, April 1988.

(3) For the complex chemical relation between nitorgen oxide and ozone concentrations in the air please refer to the RIVM report mentioned under note (2), e.g. on page 3.

(4) Idem, page 13.

(5) Idem, page 6.

(6) Idem, page 13.

(7) For a more detailed discussion of the legal possibilities with respect to a traffic ban please refer to the lecture by Prof Mr N.S.J. Koeman, which was presented at the smog conference of December 1st, 1989.

(8) The growth figures pertain to the domestic product, source CBS (Central Statistical Office).

(9) These data were obtained from the road transport organization NOB (National Organization for the Road Transfer and Hauling Trade).

(10) This ratio is based on data obtained from the CBS and the Ministry of Transport and Public Works. Internationally plus nationally 8.2 + 148 = 156 million tons were carried in private transport during 1988; the road transfer and hauling trade took care 251 + 42.2 = 293 million tons. To be on the safe side, a multiplier of 1/3 was used, on account of the higher average distance per run in the road transfer and hauling trade.

./17

(11) Drs. R. Voskuil and Drs. Ing. P.M. Blok of the foundation the Nederlands Economisch Instituut (the Netherlands Institute for Econimics), "Economische schade ten gevolge van verkeersbeperkende maatregelen" ("Economic loss resulting from traffic restricting measures"), Rotterdam, December 1987.

(12) Up until now, as far as we know, this topic has not been studied furhter.

(13) See Proceedings of the Dutch Lower Chamber, meeting year 1989-1990, 21 234, no. 2.

(14) As regards road transport production is equated with the added value; since this sector provides services this is a simplification which comes close to reality.

(15) See note (11), e.g. page -ii-.

(16) See memorandum "Economische schade door maatregelen bij smog-alarm" ("Economic loss resulting from measures taken in case of smog alert"), city of Rotterdam, July 1989.

(17) P.J.A. Rombout, H.C. Eerens and F.A.A.M. de Leeuw, RIVM-report no.67890-2001, "Gezondheidsrisico van stadsbewoners door blootstelling aan luchtverontreiniging tijdens zomerepisoden en het effect van verkeersbeperkende maatregelen" ("Health risk of city dwellers as a result of exposure to air pollution during summer episodes and the effect of traffic restricting measures"), Bilthoven, July 1989.

(18) Idem, page -15-.

(19) Idem, page -3- en -4-.

(20) At the smog conference Dr. R.M. van Aalst stated that the effects of winter smog are probably more serious than those of summer smog; see also note (1).

(21) See Tweede Structuurschema Verkeer en Vervoer (Second Structural Scheme Traffic and Transport), Dutch Lower Chamber, meeting year 1988-1989, 20922, no.'s 1-2, The Hague, November 1988, pages 66 and 68.

(22) Openbaar Vervoer (Public Transport) magazine, June 1989, pages 14, 15.

(23) Tweede Structuurschema Verkeer en Vervoer (Second Structural Scheme Traffic and Transport), Proceedings of the Dutch Lower Chamber, meeting year 1988-1989, 20922, no's 1-2, The Hague, November 1988, pages 66 and 68.

(24) Openbaar Vervoer (Public Transport) magazine, June 1989, pages 14,15.

(25) Nationaal Milieubeleidsplan (National Environmental Policy Plan), Proceedings of the Dutch Lower Chamber, meeting year 1988-1989, 21137, no's 1-2, The Hague, May 1989, page 202.

(26) Idem, page 11.

(27) Idem, page 18.

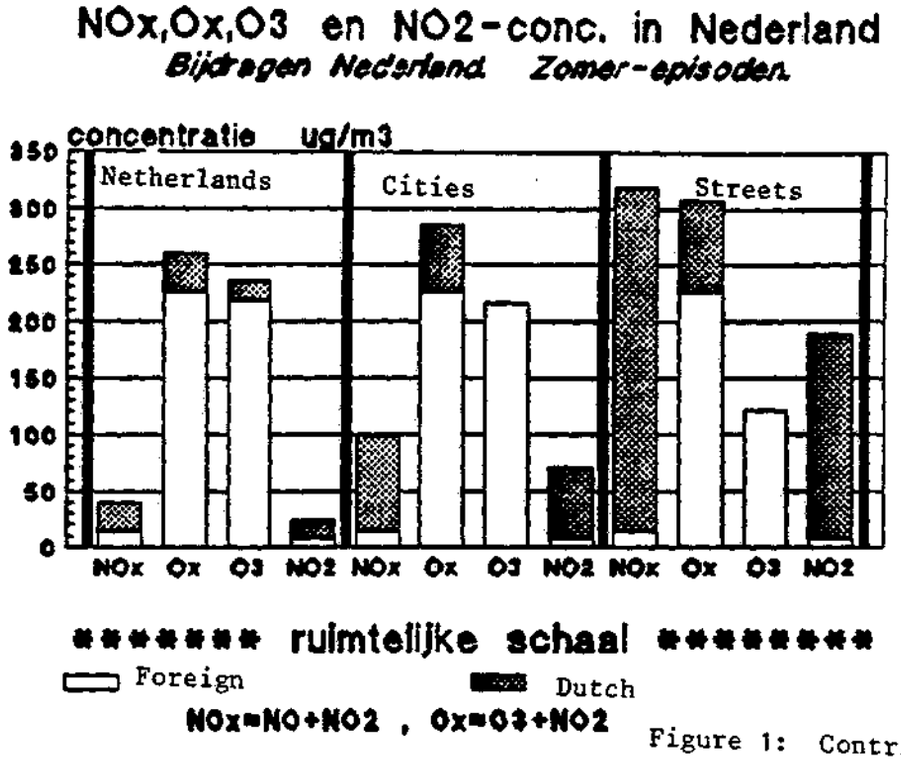

Figure 1: Contribution of Foreign and Dutch sources to smmmer smog.

Source: RIVM

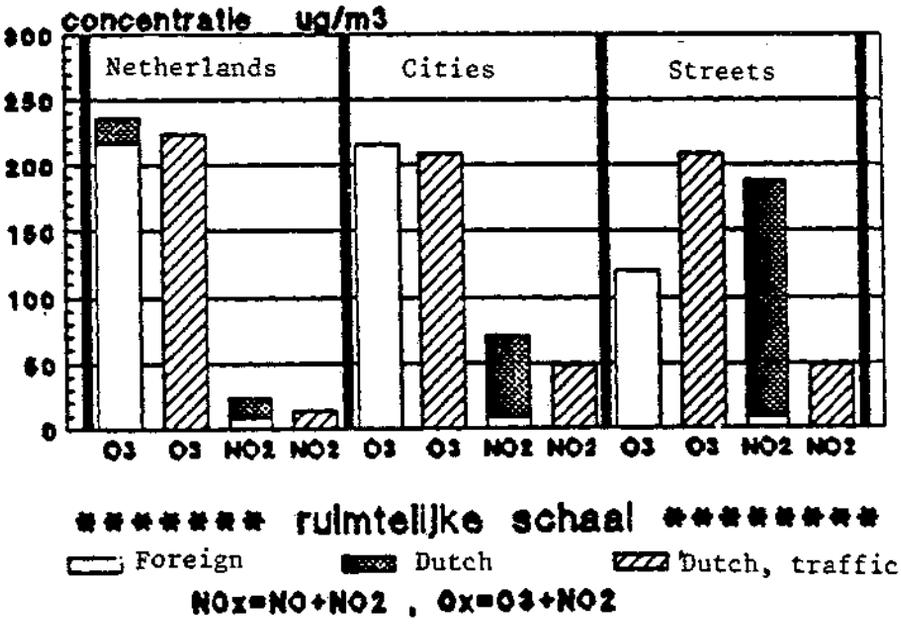

Figure 2: Effects of an elimination of the Dutch traffic at the concentrat levels of O3 and

Source: RIVM

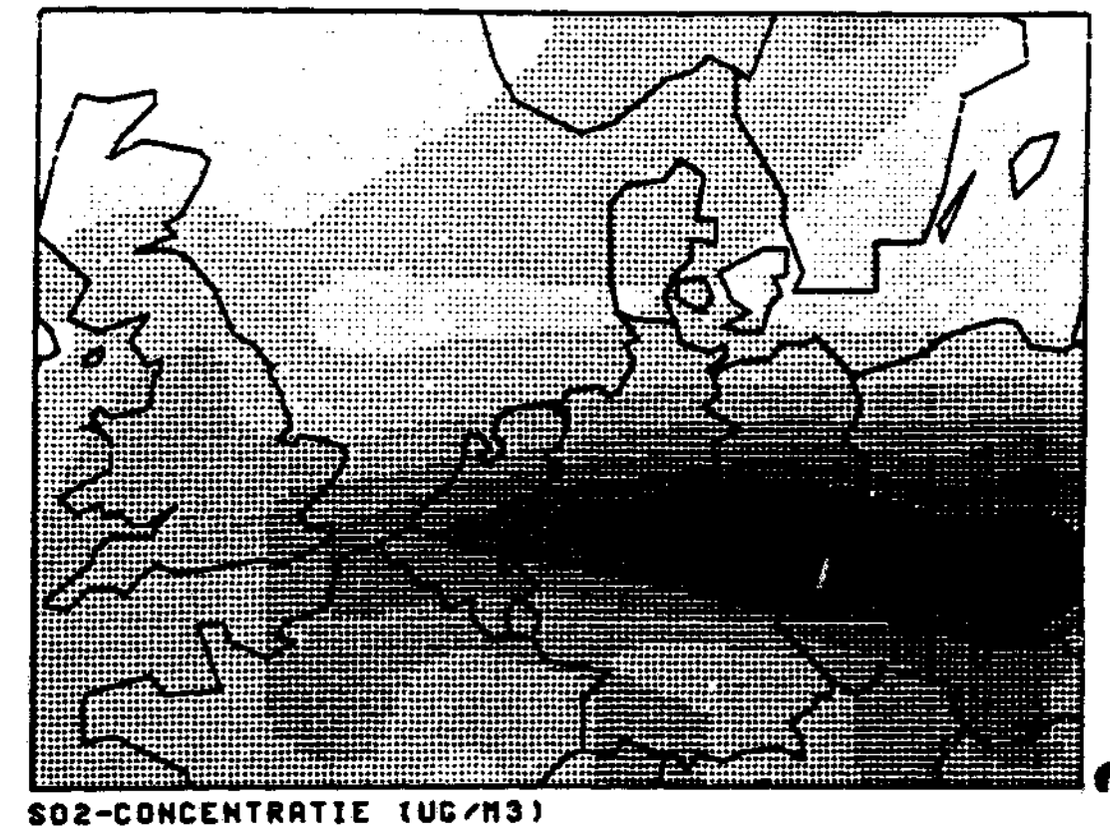

Figure 3: Air polution by sulphurdioxide.

Source: RIVM

WINTER SMOG

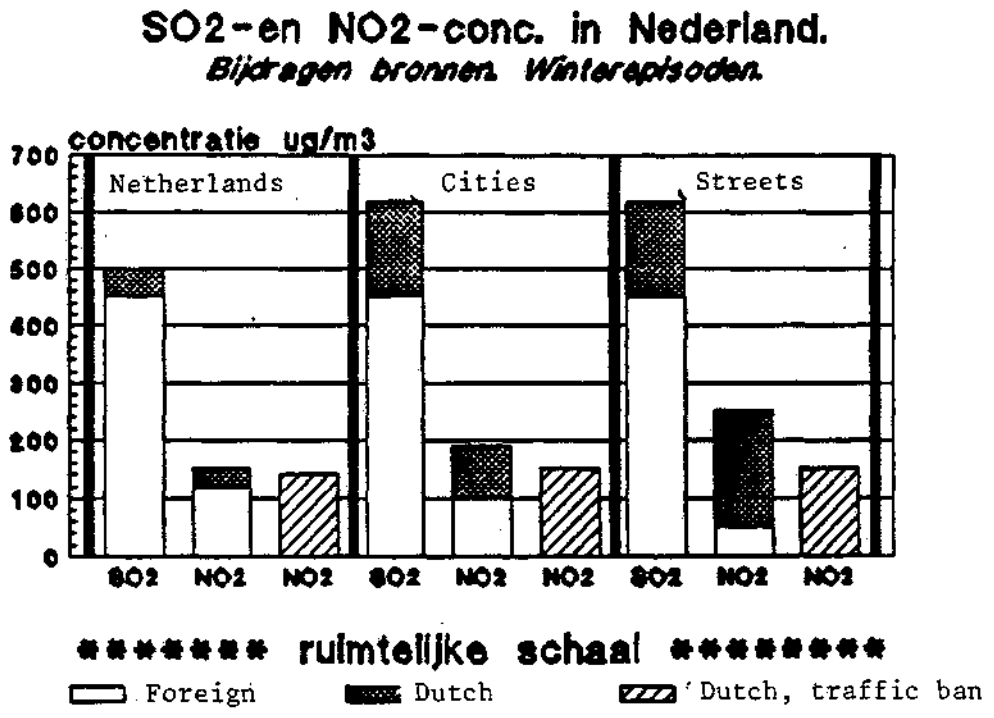

Figure 4: Contribution of Foreign and Dutch sources to winter smog.

Source: RIVM

1988-1	H. Visser	Austrian thinking on international economics
1988-2	A.H.Q.M. Merkies T. van der Meer	Theoretical foundations for the 3-C model
1988-3	H.J. Bierens J. Hartog	Nonlinear regression with discrete explanatory variables, with an application to the earnings function
1988-4	N.M. van Dijk	On Jackson's product form with 'jump-over' blocking
1988-5	N.M. van Dijk M. Rumsewicz	Networks of queues with service anticipating routing
1988-6	H. Linneman C.P. van Beers	Commodity Composition of Trade in Manufactures and South-South Trade Potential
1988-7	N.M. van Dijk	A LCFS finite buffer model with batch input and non-exponential sevices
1988-8	J.C.W. van Ommeren	Simple approximations for the batch-arrival $M^X/G/1$ queue
1988-9	H.C. Tijms	Algorithms and approximations for bath-arrival queues
1988-10	J.P. de Groot H. Clemens	Export Agriculture and Labour Market in Nicaragua
1988-11	H. Verbruggen J. Wuijts	Patterns of South-South trade in manufactures
1988-12	H.C. Tijms J.C.W. van Ommeren	Asymptotic analysis for buffer behaviour in communication systems
1988-13	N.M. van Dijk E. Smeitink	A non-exponential queueing system with batch servicing
1988-14	J. Rouwendal	Existence and uniqueness of stochastic price equilibria in heterogeneous markets
1988-15	H. Verbruggen	GSTP, the structure of protection and South-South trade in manufactures
1988-16	Mevr. H. Weijland Mevr. R. Herweijer J. de Groot	Female participation in agriculture in the Dominican Republic
1988-17	N.M. van Dijk	Product Forms for Random Access Schemes
1988-18	A.H.Q.M. Merkies I.J. Steyn	Adaptive Forecasting with Hyperfilters
1988-19	J. Rouwendal	Specification and Estimation of a Logit Model for Housing Choice in the Netherlands
1988-20	J.C.W. van Ommeren R.D. Nobel	An elementary proof of a basic result for the GI/G/1 queue
1988-21	H. Kool	A Note on Consistent Estimation of Heterostedastic and Autocorrelated Covariance Matrices
1988-22	C.P.J. Burger	Risk Aversion and the Family Farm
1988-23	N. van Dijk I.F. Akyildiz	Networks with mixed processor sharing parallel queues and common pools
1988-24	D.J.P. Kamann P. Nijkamp	Technogenesis: Incubation and Diffusion
1988-25	P. Nijkamp L. van Wissen A. Rima	A Household Life Cycle Model For the Housing Market
1988-26	P. Nijkamp M. Sonis	Qualitative Impact Analysis For Dynamic Spatial Systems
1988-27	R. Janssen P. Nijkamp	Interactive Multicriteria Decision Support For Environmental Management
1988-28	J. Rouwendal	Stochastic Market Equilibria With Rationing and Limited Price Flexibility
1988-29	P. Nijkamp A. Reggiani	Theory of Chaos in a Space-Time Perspective
1988-30	P. Nijkamp J. Poot J. Rouwendal	R & D Policy in Space and Time
1988-31	P. Nijkamp F. Soeteman	Dynamics in Land Use Patterns Socio-Economic and Environmental Aspects of the Second Agricultural Land Use Revolution
1988-32	J. Rouwendal P. Nijkamp	Endogenous Production of R & D and Stable Economic Development
1988-33	J.A. Hartog E. Hinloopen P. Nijkamp	Multicriteria Methoden: Een gevoeligheidsanalyse aan de hand van de vestigingsplaatsproblematiek van kerncentrales
1988-34	R. van der Mark P. Nijkamp	The Development Potential of High Tech Forms in Backward Areas - A Case study for the Northern Part of The Netherlands
1988-35	E.R.K. Spoor J.W.B. Vermeulen	Principes en gebruik van Envisage
1988-36	C. Gorter P. Nijkamp P. Rietveld	The Duration of Unemployment: Stocks and Flows on Regional Labour Markets in the Netherlands
1988-37	M. Hofkes	Parametrization of simplicial algorithms with an application to an empirical general equilibrium model
1988-38	J. van Daal A.H.Q.M. Merkies	A Note on the Quadratic Expenditure Model