GIS-BASED NATIONAL ROAD AND TRAFFIC DATABASE 1960-2020

Technical Report from DCE – Danish Centre for Environment and Energy No. 151 2019

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GIS-based National Road and Traffic Database 1960-2020

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Data sheet

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Abstract: This report describes the extension and update of the Danish national GIS-based road network and traffic database for 1960-2005 to the years 2005-2020. The original road network has been extended with new motorway sections that have been established since the original road network from 2007. Furthermore, some motorway sections have changed speed limit from 110 to 130 km/t. The development in traffic flow and vehicle mix has been analysed based on traffic data from the Danish Road Directorate to estimate the trend for different road types from 1995 to 2020 as 1995 is the baseline year of the original road and traffic database. This report also includes a description of the road network, all attributes and trends in traffic flow and vehicle mix for the entire period 1960-2020 to be able to read this report separately from previous documentation of the road and traffic database.

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1 Introduction

This report describes the extension and update of the Danish national GIS-based road network and traffic database for 1960-2005 to the years 2005-2020. The original road network has been extended with new motorway sections that have been established since the original road network from 2007. Furthermore, some motorway sections have changed speed limit from 110 to 130 km/t. The development in traffic flow and vehicle mix has been analysed based on traffic data from the Danish Road Directorate to estimate the trend for different road types from 1995 to 2020 as 1995 is the baseline year of the original road and traffic database. This report also includes a description of the road network, all attributes and trends in traffic flow and vehicle mix for the entire period 1960-2020 to be able to read this report separately from previous documentation of the road and traffic database.

The original GIS-based road network and traffic database for 1960-2005 is described in great detail in a Danish report with an English summary (Jensen et al., 2008). The original database was developed based on different sources of information to be able to calculate air quality levels at any address in Denmark for any period during 1960-2005. The traffic sources include traffic data from the Danish Road Directorate for all state and county roads (VIS data), traffic model data for a large part of Sealand (Copenhagen-Ringsted Traffic Model), and remaining roads were assigned traffic flow in a residual methods taking into account road type and urban/rural roads and calibrating with known distance travelled by county. Traffic data were also collected from 140 municipalities (out of about 200) covering main municipal roads, and replaced traffic data predicted by the above methods. The DEHM/UBM/AirGIS system is used to calculate traffic-related air quality levels and human exposure at address level for any user specified time period (http://envs.au.dk/en/knowledge/air/models/airgis/). The DEHM/UBM/AirGIS system encompasses air quality models, GIS maps with roads and traffic data, building footprints with buildings heights, and address locations, as well as, data on vehicle emissions factors, meteorology and regional background concentrations (Jensen et al., 2001; Khan et al., 2018). The OSPM – Operational Street Pollution Model – is the dispersion model that calculates the air pollution contribution from the specific street in question. DEHM is regional scale model and UBM is an urban scale model.

The GIS-based road network and traffic database for 1960-2005 has been a key source of traffic data for a large number of applications within research, monitoring and public sector consultancy within air pollution. It has been used in a wide range of air pollution epidemiological studies, for air quality mapping as a supplement to routine air quality monitoring, to impact assessment of policy measures, as well as to distribute national emissions for road transportation to a 1 km x 1 km grid to support calculation of background concentrations with air quality dispersion models.

In recent years, the road network and traffic database has also been used for noise calculations at address level to support epidemiological studies linking noise exposure and health outcomes. Often these studies also include air pollution exposure to adjust for possible confounding between air and noise. Furthermore, these studies seek to estimate the health risk of both air and noise pollutants in multipollutant epidemiological models.

The extended and updated GIS road network includes data for the road network and traffic data for the period 1960-2020 where primarily traffic information from 1995 to 2020 has been updated. Originally, the GIS road network is based on the TOP10DK road network of the National Survey and Cadastre from 1999 that subsequently has been transferred to the more recent KORT10 road network from 2007 from the same institution, now named Danish Geodata Agency. The road network includes five road types: motorways, expressways, roads of width over 6 m, roads 3-6 m, and other roads. The road network is supplied with information about road segment length, year of construction, speed limit and travel speed, a category for diurnal variation of traffic, and whether the road segment is digitised with two separate directions (double digitised). Annual Average Daily Traffic (AADT) for every fifth year (1960-2020) is included. Information for every fifth year about the average vehicle composition (passenger cars, vans, trucks, busses) and diurnal variation in traffic are in separate files with reference to the road segment depending on the type of diurnal variation of traffic and the year of ADT. Additional attributes used for noise calculations have also been added. The database include attributes necessary for DEHM/UBM/AirGIS, for OML-Highway – a dispersion model for modelling air quality along main roads implemented in SELMA^{GIS}, and in SoundPlan for noise calculations. Refer to Appendix A for a full description of attributes.

The GIS road network is in ESRI Shape format, and the diurnal variation of traffic and the vehicle mixes are stored in text files for air quality calculations with OSPM.

Rambøll has updated traffic data from 1995 and onwards, and Rambøll and Aarhus University have added new motorways since 2007 and related traffic data, and DCE has prepared this DCE report with inputs from Rambøll concerning trend in AADT.

2 Road network

2.1 GIS road network

The road and traffic database is based on KMS KORT10 road network from December 13, 2007. KORT10 is a geographically correct GIS dataset digitised on the basis of aerial photos. The GIS road network is in ESRI GIS shape format and projection is UTM Zone 32N ETRS 1989.

For air pollution calculations the original road network is maintained as a single shape file for AirGIS calculations whereas for OML-Highway calculations it is necessary to subdivide the road and traffic database to improve calculation efficiency. Similarly, it is also necessary to subdivide the road and traffic database for noise calculations with SoundPlan.

In the following, we have described the road and traffic database as a single file.

2.2 New motorways since 2007

New motorway sections established in the period between the original road network from 2007 and 2015 is added based on motorway sections for 2015 obtained from the Danish Road Directorate and further supplemented with newer motorway sections from Open Street Map and traffic data from MASTRA. MASTRA is a road and traffic database managed by the Danish Road Directorate that among others include traffic counts at selected location of the road network.

In Figure 2.1, motorways in the original road network from 2007 are visualised.

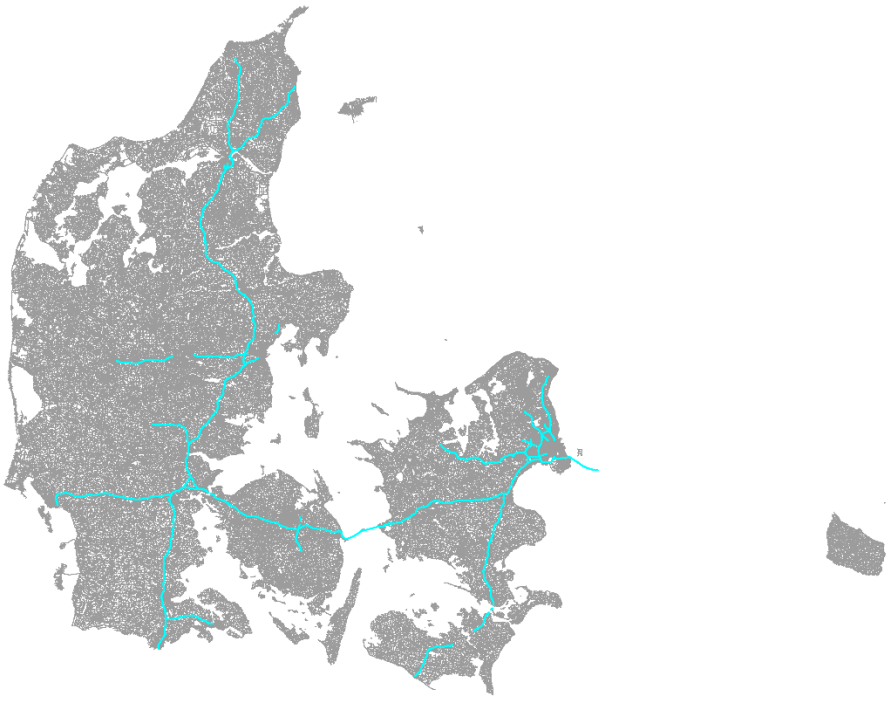

Figure 2.1. Visualization of motorways in the original road network from 2007.

In Figure 2.2, all motorways are visualised in the updated road network. It is seen that some of the existing motorway sections have been extended and a few new motorways have been established.

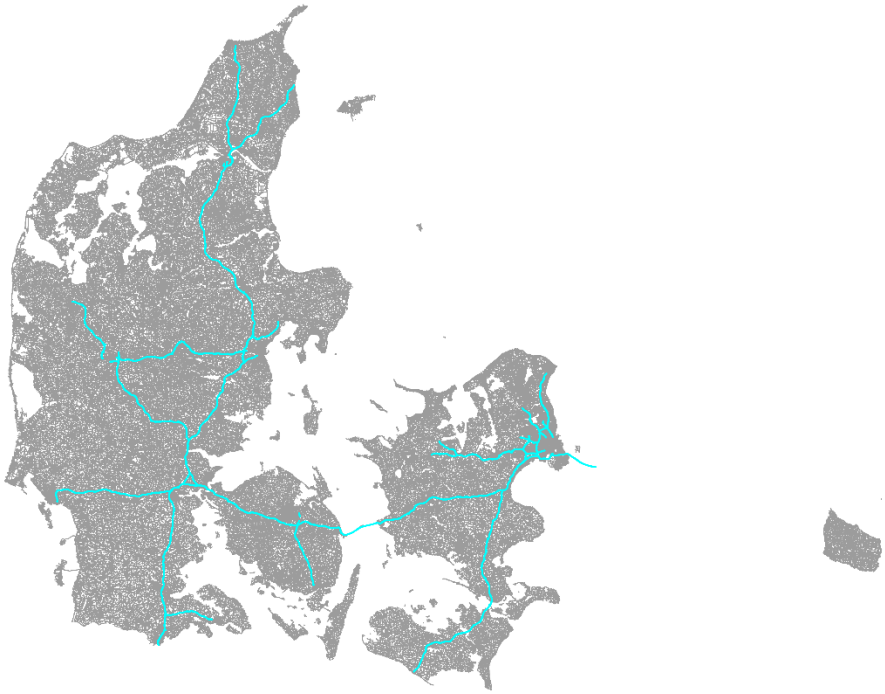

Figure 2.2. Visualization of the road network including new motorways established since 2007 and onwards. A small section around Herning is not yet included in Open Street Map and therefore missing.

New motorway segments will attract traffic from other roads that they relieve. It has not been possible to take into account this effect and traffic levels at other roads that have been relived have remained the same.

2.3 Road geometry

The digitization of the road geometry has implications on how to calculate air pollution in OML-Highway and AirGIS.

A road can be represented as a single line or "double digitised", i.e. as two parallel lines representing the two traffic directions separately. Therefore, an attribute indicates whether the road segment is double digitised or not.

During the process of preparing data for OML-Highway a road is automatically divided into multiple segments where each segment is approximated by a rectangle. This rectangle is a so-called "area source", which emits pollution uniformly over its area, as illustrated in Figure 2.3.

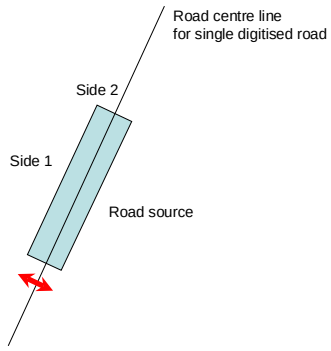

Figure 2.3. An area source (road segment) in OML-Highway.

Road segments have a unique ID number. For double digitised roads the OML-Highway software keeps track of the ID of the opposite road segment as illustrated in Figure 2.4. The track keeping of the opposite road segment is not part of the road and traffic database but generated by the OML-Highway model.

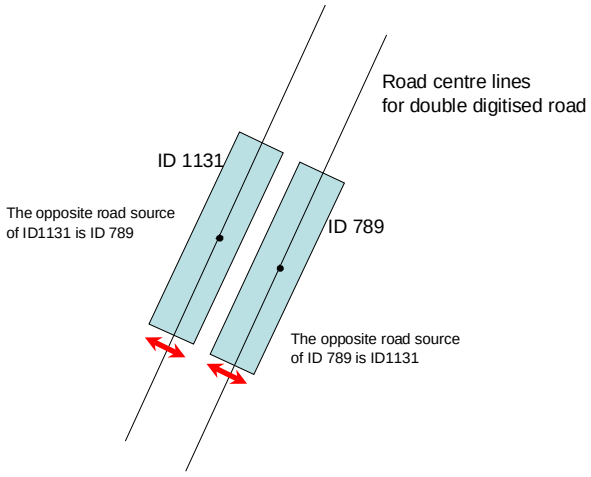

Figure 2.4. A double digitised road.

Road width is a required attribute only for target roads in OML-Highway. Target roads are defined in the section 2.4. The user specifies which roads are target roads for model calculations and makes sure the road width data is available for the selected target roads. For a single digitised road this corresponds to the red arrow in Figure 2.3. For a double digitised road a "road width" should be supplied for each of the two (approximately) parallel road segments (Figure 2.4). Internally, the program calculates a total width as the sum of these two widths plus the centre strip.

In AirGIS the road width is calculated as the distance between buildings on both sides of the road. In case there is no building on the opposite side the road width is calculated as two times the distance from the nearby road segment to the building façade of the address point. Additionally, the traffic flow of the road segment is also multiplied with two as traffic flow is attributed to each directions in case of a double digitised road. Motorways are double digitised and a few urban roads are also double digitised e.g. in the case they have a centre strip that divides the two directions.

For OML-Highway calculations double digitised roads are only relevant for target roads. Target roads are defined in the next section.

2.4 Target roads and background roads in OML-Highway

Figure 2.5, illustrates some basic concepts in the use of OML-Highway. Here we will focus on target and background roads.

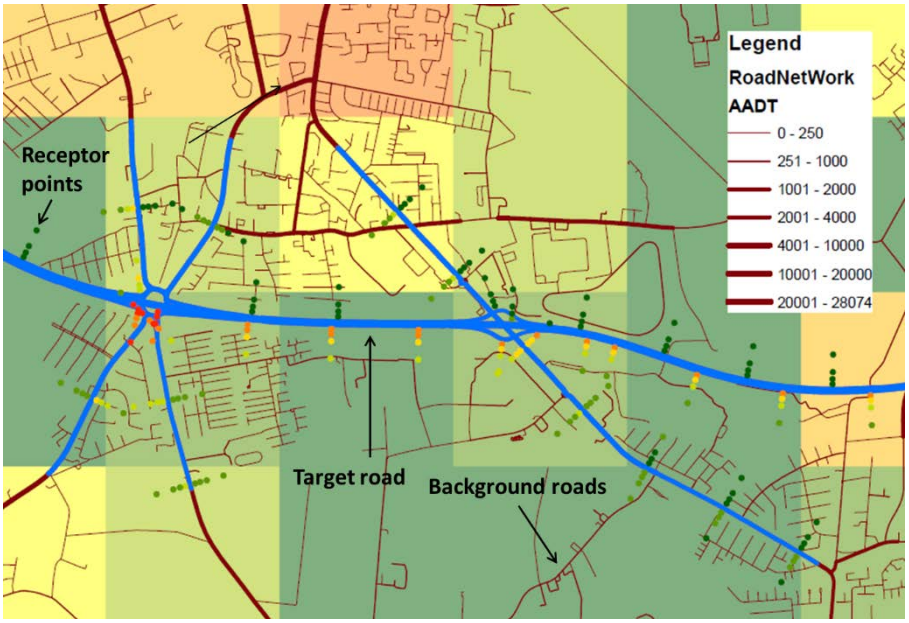

Figure 2.5. Target roads, background roads and other basic concepts. In the example presented here target roads are shown as blue lines, while background roads are brown lines. Line width indicates the traffic volume on each road, both for target roads and background roads, see legend. In this example receptor points (calculation points) are placed in short series of points perpendicular to the target roads. The emissions from background roads (aggregated in a 1km x 1km grid) are shown as coloured squares.

"Target roads" are roads where detailed traffic information is supplied. In OML-Highway it is possible to calculate concentrations along target roads at different distances from the highway that can be defined by the user in OML-Highway.

"Background roads" are the remaining roads after target roads are identified. Detailed information for such roads may be supplied but only a limited amount of details are used in the calculations. The software aggregates emissions from the individual background roads to yield a field of emissions for cells in an "emission grid". The cells can have a size of e.g. 1 km by 1 km. In Figure 2.5 the coloured squares represent cells in an emission grid, and the colour coding depicts the background emission level in each cell. The purpose of this aggregation is to reduce the number of individual sources and hereby the calculation times to a reasonable amount.

Concentrations are calculated at the receptor points. The model user can specify the locations of the receptor points.

2.5 Road types in the road network

The KORT10 road network classifies roads into five road types, as shown in Table 2.1.

This road type classification is used to specify the default diurnal variation and the default vehicle mix for different road types. The OSPM road type species this by a letter.

Table 2.1. The five possible road types for all roads in the database

Road type	Code for road type	OSPM road type
Motorway (in Danish "motorvej")	2111	B
Expressway/main roads (in Danish "motortrafikvej")	2112	B
Road > 6 m	2115	F
Road 3-6 m	2122	D
Other road	2123	C

The road network includes all public and private roads but there is no indication of whether a road is a public or private road. The only classification is the road types defined in Table 2.1.

2.6 Construction year of roads

KORT10 includes the road network as of 2007 which now has been updated with new motorways since then. We have tried to create a historic record in the development of the road network by allocating the year of construction of the roads. Information on the year of construction comes from the VIS system (Road Information System from the Danish Road Directorate) for the main road network (the former state and county roads). For the remaining roads, it is assumed that a road only exists if there are also buildings along the road, and construction years for the buildings are used to determine the year of construction on the roads. The construction year for buildings from the Building and Dwelling Register (BBR) is transferred to a national address registry. In this way, the year of construction is available for all address coordinates along the roads. The building year is linked to the roads by finding the oldest year of construction along a road using GIS buffer technic. Attributes with the value of 1 indicates that the road is before 1960.

Presently, the information about the construction year of roads is not used in air quality calculations. However, potentially it could. For the calculation of air quality at a given address, only roads that exist in the relevant calculation year should be taken into account. Furthermore, the roads that are used to calculate background emissions should only include roads that exists at the year of the exposure calculation. Presently, the background concentrations are provided using DEHM/UBM for modelling background concentrations at a spatial resolution of 1 km x 1 km based on national emissions geographically distributed based on geographic keys. For vehicle emissions these keys are derived from the road and traffic database, and these keys could potentially depend on year e.g. 1960, 1965 etc.

2.7 Diurnal variation via OSPM road type

The OSPM road type describes the patterns of the diurnal variation of traffic in a set of text files. These are the so-called *.trf-files, or "Diurnal Traffic Variation files". This is similar to how temporal variation of traffic is described in the Operational Street Pollution Model (OSPM). The diurnal variation is subdivided into Mondays to Thursdays, Fridays, Saturdays and Sundays, and further into the holiday month of July and other months. For Danish conditions eight different street types have been identified based on a comprehensive analysis of measured traffic data from different types of streets in different regions of Denmark focusing on urban roads, but also applicable for other types of roads. A road segment can be associated with a certain "OSPM road type" – meaning that the pattern of diurnal traffic

variation is defined by the corresponding *.trf file. A *.trf file describes diurnal, weekly and seasonal time variation of the fraction of each of five vehicle types (passenger cars, buses etc.). Based on this information it is possible to calculate the temporal variation of vehicle emissions hour by hour.

The trf-files also describes the vehicle mix subdivided into: Passenger cars, vans, trucks <32, trucks > 32 t, and buses. An example of a trf-file is shown in Appendix A.

2.8 Trends in vehicle mix

In AirGIS, the OSPM model requires the Annual Average Daily Traffic for the street in question and the OSPM road type specifies the diurnal variation of traffic together with the vehicles mix. The travel speed is also required as vehicle emissions depend on speed.

In OML-Highway each target road segment is classified into a limited number of groups as a combination of: (1) heavy-duty share of traffic (HD share), (2) travel speed, and (3) "OSPM road type" (A, B,....H). See Olesen et al. (2015) for details. The user has to make sure that data on heavy-duty share of traffic is available/added for the selected roads selected as target roads. OML-Highway runs air quality calculations for one specific year at the time or a period of that year, and the user must make the relevant share of heavy traffic and also AADT available for that year.

In noise calculations AADT, share of heavy-duty vehicles and travel speed are important parameters. Heavy-duty vehicles are trucks and buses larger than 3.5 tons. SoundPlan also runs noise calculations for one specific year at the time, and the user must make the relevant share of heavy traffic and also AADT available for that year.

Default OSPM road types

The OSPM road type specifies the diurnal variation of traffic together with the vehicles mix in separate text files that are not part of the road and traffic database but used by OSPM for air quality calculations. Table 2.2, gives an overview of the eight OSPM road types used in Denmark. As shown in Table 2.1 only type B, C, D and F are used.

Table 2.2. Main characteristics of the 8 "OSPM road types" used in Denmark. Default vehicle mix is shown.

OSPM road type	Description	Passenger cars (%)	Vans (%)	Trucks (<= 32 t) (%)	Trucks (> 32 t) (%)	Buses (%)
A	Transit roads in medium size or smaller cities	80.1	12.0	4.7	1.1	2.1
B	Transit roads in larger cities	81.9	10.8	2.8	1.4	3.1
C	Distribution roads in residential areas	83.2	12.1	2.5	0.74	1.6
D	Roads with a mix of residential and business area	81.9	11.7	3.0	1.5	2.0
E	Main street in center of larger cities	82.7	10.3	2.2	1.4	3.4
F	Access roads to larger cities	79.7	11.9	4.3	2.5	1.6
G	Road in larger and medium size cities outside center	82.9	12.6	2.6	0.7	1.2
H	Main street in centre of medium size city	83.2	12.4	2.3	0.7	1.4

Development in vehicle mix since 1995

The challenge is that there are no consistent traffic statistics for the development in vehicle mix for the same subdivision of vehicle categories and types of roads throughout the period 1960-2020. Therefore, it has been

necessary to piece together traffic statistics from various sources from the Danish Road Directorate in order to estimate trends in vehicle mix.

Below we focus on the development since 1995 as new data from the Danish Road Directorate has been used to establish this trend. The assumptions for the trend before 1995 are described in Jensen et al. (2008).

In Table 2.3 the development in the heavy-duty share is shown since 1995 for the different road types. Since 1995 the road types have been subdivided into three major groups: (1) Motorway, expressway (OSPM type B), (2) Road > 6 m (OSPM type F) and Road 3-6 m (OSPM type D), and (3) Other road (OSPM type C).

Note that in the national road and traffic database 1960-2005 there were only two major groups: (1) Motorway, expressway (OSPM type B), Road > 6 m (OSPM type F) and Road 3-6 m (OSPM type D), and (2) Other road (OSPM type C).

Table 2.3. Heavy-duty share (%) for different road types

Road type and OSPM type	Heavy-duty share 1995	Heavy-duty share 2000	Heavy-duty share 2005	Heavy-duty share 2010	Heavy-duty share 2015	Heavy-duty share 2020**
Motorway, expressway (OSPM type B)	7,0 %*	8,9%	9,0%	8,0%	7,3%	7,3%
Road > 6 m (OSPM type F), Road 3-6 m (OSPM type D)	5,5 %	5,5 %	5,5 %	5,5 %	5,5 %	5,5 %
Other road (OSPM type C)	1 %*	1 %*	1 %*	1 %*	1 %*	1 %*

*) Same assumptions as in the report of GIS-based national road and traffic database 1960-2005 (Jensen et al., 2008)
**) Assumed heavy-duty share in 2020 (%) based on values from 2015.

In Table 2.3, the heavy-duty share changes over time for motorways and expressways. For roads > 6m and roads 3-6 m traffic statistics shows no, or almost no changes. As in the old road and traffic database for other roads the same level is assumed.

The following assumptions described in the below sections have been made for the trend in vehicle mix before 2000 since the vehicle mix before 2000 of the old road and traffic database only had two major groups and the new road and traffic database has three major groups.

Motorways and expressways

For motorways and expressways the newly established trend in the development of heavy-duty vehicles has been used since 2000. The breakdown in the sub-categories trucks > 32 t, trucks > 32 t and buses is assumed to be as in 1995.

There is no new information about the development in vans and since 2000 the share of vans has been assumed as in 2000 of the old road and traffic database.

The share of passenger cars is the residual to ensure the total vehicle mix is 100%.

The development of the vehicle mix from 1960 to 2000 is the same as in the old road and traffic database.

In Table 2.4 the development in the vehicle mix for motorways and expressways is shown, and in Figure 2.6 the trend is visualised.

The trend of the vehicle mix from 1960 to 2020 shows that passenger cars has increased from approx. 64% to 81%, vans has decreased from approx. 18% to 12%, and heavy-duty vehicles has decreased from 18% to 7%.

Table 2.4. Vehicle mix for the motorway and expressway fraction (OSPM type B)

Vehicle type	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
Passenger car	0.6399	0.6931	0.7700	0.7874	0.7619	0.7807	0.7966	0.8110	0.8084	0.7947	0.8047	0.8116	0.8116
Van	0.1795	0.1740	0.1420	0.1522	0.1409	0.1273	0.1199	0.1126	0.1155	0.1155	0.1155	0.1155	0.1155
Truck < 32 t	0.1198	0.0825	0.0508	0.0323	0.0478	0.0407	0.0326	0.0291	0.0256	0.0342	0.0304	0.0278	0.0278
Truck > 32 t	0.0387	0.0326	0.0239	0.0162	0.0268	0.0260	0.0277	0.0244	0.0283	0.0287	0.0255	0.0233	0.0233
Bus	0.0221	0.0178	0.0133	0.0119	0.0226	0.0253	0.0232	0.0229	0.0222	0.0269	0.0239	0.0218	0.0218
Total	1	1	1	1	1	1	1	1	1	1	1	1	1

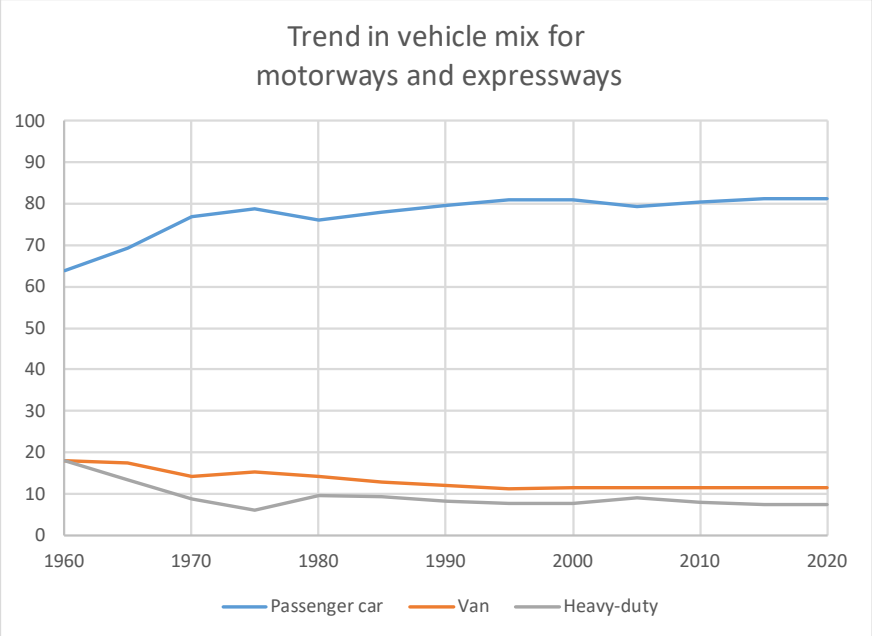

Figure 2.6. Development in the vehicle mix for motorways and expressways from 1960 to 2020 in %.

Roads > 6 m and roads 3-6 m

The analysis of traffic statistics lead to the assumption that the heavy-duty share has been constant for roads > 6 m and roads 3-6 m since 2000. The heavy-duty share is 5.5%. As there are no specific data for these road types before 2000, the same share is assumed before 2000.

There is no new information about the development in vans. Since 2000 the share of vans has been assumed as it was in 2000 in the old road and traffic database.

The share of passenger cars is the residual to ensure the total vehicle mix is 100%.

The vehicle mix for all years is therefore approx. 91% for passenger cars, 4% for vans and 5.5% for heavy-duty vehicles (Table 2.5).

Although it has been assumed that the vehicle mix for these roads is the same from 1960 to 2020, it is likely that the heavy-duty share has been higher in the early years as was seen for motorways and expressways, although it is likely to be at a lower level.

Table 2.5. Vehicle mix for roads > 6 m and roads 3-6 m fraction (OSPM type D and F)

Vehicle type	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
Passenger car	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060	0.9060
Van	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390
Truck < 32 t	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209	0.0209
Truck> 32 t	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176
Bus	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165
Total	1	1	1	1	1	1	1	1	1	1	1	1	1

Other roads

Other roads are typically roads with low traffic flows. The heavy-duty share of these roads is in the old road and traffic database assumed to be 1% in 1995, and this has also been assumed for 2000 and onwards. The vehicle mix of other vehicle categories has also been assumed to be as in 1995. The development established for 1960 to 1995 is assumed to be the same as in the old road and traffic database.

The development of the vehicle mix for other roads is shown in Table 2.6 and visualised in Figure 2.7.

The trend of the vehicle mix from 1960 to 2020 shows that passenger cars has increased from approx. 91% to 95%, vans has decreased from approx. 6% to 4%, and heavy-duty vehicles has decreased from 2.4% to 1%.

Table 2.6. Vehicle mix as a fraction for other roads (OSPM type C)

Vehicle type	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020
Passenger car	0.9141	0.9224	0.9393	0.9394	0.9384	0.9439	0.9476	0.9510	0.9510	0.9510	0.9510	0.9510	0.9510
Van	0.0621	0.0602	0.0492	0.0527	0.0488	0.0441	0.0415	0.0390	0.0390	0.0390	0.0390	0.0390	0.0390
Truck < 32 t	0.0158	0.0108	0.0067	0.0042	0.0063	0.0053	0.0043	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
Truck> 32 t	0.0051	0.0043	0.0031	0.0021	0.0035	0.0034	0.0036	0.0032	0.0032	0.0032	0.0032	0.0032	0.0032
Bus	0.0029	0.0023	0.0017	0.0016	0.0030	0.0033	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
Total	1	1	1	1	1	1	1	1	1	1	1	1	1

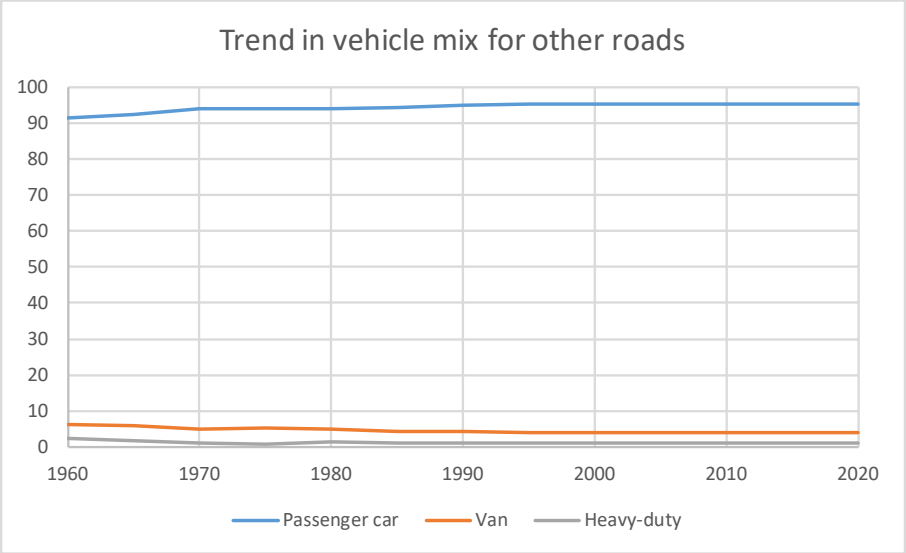

Figure 2.7. Development in the vehicle mix for other roads from 1960 to 2020 in %.

OSPM road types from 1960 to 2020

The OSPM road type describes the patterns of the diurnal variation of traffic and the vehicle mix in a set of text files. These are the so-called *.trf-files, of which an example is shown in Appendix A.

A number of different trf-files have been specified for every fifth year for the different road types to reflect that the vehicle mix changes over time from 1960 to 2020, see a summary in Table 2.7.

Table 2.7. Name of trf-files that specify vehicle mix and diurnal variation of traffic for different OSPM types and years

Road type	OSPM type	Year	File name	Passenger car	Van	Truck < 32t	Truck > 32t	Bus
2111	B	1960	N2111_1960.trf	0.6399	0.1795	0.1198	0.0387	0.0221
2112	B	1960	N2112_1960.trf	0.6399	0.1795	0.1198	0.0387	0.0221
2115	F	1960	N2115_1960.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1960	N2122_1960.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1960	N2123_1960.trf	0.9141	0.0621	0.0158	0.0051	0.0029
2111	B	1965	N2111_1965.trf	0.6931	0.1740	0.0825	0.0326	0.0178
2112	B	1965	N2112_1965.trf	0.6931	0.1740	0.0825	0.0326	0.0178
2115	F	1965	N2115_1965.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1965	N2122_1965.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1965	N2123_1965.trf	0.9224	0.0602	0.0108	0.0043	0.0023
2111	B	1970	N2111_1970.trf	0.7700	0.1420	0.0508	0.0239	0.0133
2112	B	1970	N2112_1970.trf	0.7700	0.1420	0.0508	0.0239	0.0133
2115	F	1970	N2115_1970.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1970	N2122_1970.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1970	N2123_1970.trf	0.9393	0.0492	0.0067	0.0031	0.0017
2111	B	1975	N2111_1975.trf	0.7874	0.1522	0.0323	0.0162	0.0119
2112	B	1975	N2112_1975.trf	0.7874	0.1522	0.0323	0.0162	0.0119
2115	F	1975	N2115_1975.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1975	N2122_1975.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1975	N2123_1975.trf	0.9394	0.0527	0.0042	0.0021	0.0016
2111	B	1980	N2111_1980.trf	0.7619	0.1409	0.0478	0.0268	0.0226
2112	B	1980	N2112_1980.trf	0.7619	0.1409	0.0478	0.0268	0.0226
2115	F	1980	N2115_1980.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1980	N2122_1980.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1980	N2123_1980.trf	0.9384	0.0488	0.0063	0.0035	0.0030
2111	B	1985	N2111_1985.trf	0.7807	0.1273	0.0407	0.0260	0.0253
2112	B	1985	N2112_1985.trf	0.7807	0.1273	0.0407	0.0260	0.0253
2115	F	1985	N2115_1985.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1985	N2122_1985.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1985	N2123_1985.trf	0.9439	0.0441	0.0053	0.0034	0.0033
2111	B	1990	N2111_1990.trf	0.7966	0.1199	0.0326	0.0277	0.0232
2112	B	1990	N2112_1990.trf	0.7966	0.1199	0.0326	0.0277	0.0232
2115	F	1990	N2115_1990.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1990	N2122_1990.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1990	N2123_1990.trf	0.9476	0.0415	0.0043	0.0036	0.0030
2111	B	1995	N2111_1995.trf	0.8110	0.1126	0.0291	0.0244	0.0229
2112	B	1995	N2112_1995.trf	0.8110	0.1126	0.0291	0.0244	0.0229
2115	F	1995	N2115_1995.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	1995	N2122_1995.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	1995	N2123_1995.trf	0.9510	0.0390	0.0038	0.0032	0.0030
2111	B	2000	N2111_2000.trf	0.8084	0.1155	0.0256	0.0283	0.0222
2112	B	2000	N2112_2000.trf	0.8084	0.1155	0.0256	0.0283	0.0222
2115	F	2000	N2115_2000.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	2000	N2122_2000.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	2000	N2123_2000.trf	0.9510	0.0390	0.0038	0.0032	0.0030

Road type	OSPM type	Year	File name	Passenger car	Van	Truck < 32t	Truck > 32t	Bus
2111	B	2005	N2111_2005.trf	0.7947	0.1155	0.0342	0.0287	0.0269
2112	B	2005	N2112_2005.trf	0.7947	0.1155	0.0342	0.0287	0.0269
2115	F	2005	N2115_2005.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	2005	N2122_2005.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	2005	N2123_2005.trf	0.9510	0.0390	0.0038	0.0032	0.0030
2111	B	2010	N2111_2010.trf	0.8047	0.1155	0.0304	0.0255	0.0239
2112	B	2010	N2112_2010.trf	0.8047	0.1155	0.0304	0.0255	0.0239
2115	F	2010	N2115_2010.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	2010	N2122_2010.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	2010	N2123_2010.trf	0.9510	0.0390	0.0038	0.0032	0.0030
2111	B	2015	N2111_2015.trf	0.8116	0.1155	0.0278	0.0233	0.0218
2112	B	2015	N2112_2015.trf	0.8116	0.1155	0.0278	0.0233	0.0218
2115	F	2015	N2115_2015.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	2015	N2122_2015.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	2015	N2123_2015.trf	0.9510	0.0390	0.0038	0.0032	0.0030
2111	B	2020	N2111_2020.trf	0.8116	0.1155	0.0278	0.0233	0.0218
2112	B	2020	N2112_2020.trf	0.8116	0.1155	0.0278	0.0233	0.0218
2115	F	2020	N2115_2020.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2122	D	2020	N2122_2020.trf	0.9060	0.0390	0.0209	0.0176	0.0165
2123	C	2020	N2123_2020.trf	0.9510	0.0390	0.0038	0.0032	0.0030

2.9 Trends in Annual Average Daily Traffic

As a starting point, Annual Average Daily Traffic (AADT) in the road network represents traffic flows around 1995 except for the new motorway segments added since 2007 as described in section 2.2. To be able to estimate AADT for all roads for the period 1960-2020 the trend in traffic development is established as an index where 1995 is set to 1.00. The assumption for the period 1960-1995 is described in Jensen et al. (2008), and here the focus is on 1995 to 2020 where new data have been established based on information from the Danish Road Directorate.

The trend in traffic is based on the development in total distance travelled (vehicle-km) and road length (km). Note that the development in AADT is distance travelled divided by road length for a road type. Distance travelled includes domestic as well as foreign vehicles. It has only been possible to split data into two categories: motorways and all other roads for the entire period 1960-2020. Motorways correspond to road code 2111 and all other roads to road code 2112, 2115, 2122, 2123. However, expressways (2112) are part of other roads in the analysis but in the database it is assumed that the increase in AADT follows the same pattern as for motorways as expressways are main roads. The total length of expressways is rather small compared to motorways. See the traffic development in Table 2.4 for the period 1995 to 2020. The year 2020 was not included in the analysis, and hence an index for 2020 has been extrapolated based on the previous trend. The database should be updated when new data for 2020 is available.

AADT has increased significantly on motorways whereas all other roads on average have had constant AADT. The index for all other roads have been set to 1.00 in the database although there are small changes between years.

The development in the index for AADT is shown in Table 2.8 and visualized in Figure 2.8.

Table 2.8. Trends in distance travelled, road length and AADT for motorways and all other roads

	Motorways				All other roads			
Year	**Distance travelled**	**Road length**	**Total AADT**	**Factor**	**Distance travelled**	**Road length**	**Total AADT**	**Factor**
	Billion km	**km**	**No. vehicle/day**	**Index**	**Billion km**	**km**	**No. vehicle/day**	**Index**
1995	6.54	796	0.82E+07	1.00	32.64	70459	4.63E+05	1.00
2000	10.06	922	1.09E+07	1.33	32.64	70699	4.62E+05	1.00
2005	12.08	1031	1.17E+07	1.43	33.24	71225	4.67E+05	1.01
2010	13.52	1130	1.20E+07	1.46	33.30	72444	4.60E+05	0.99
2015	16.35	1231	1.33E+07	1.62	34.18	73240	4.67E+05	1.01
2020				1.77*				1.00

*Values has been extrapolated based on previous years.

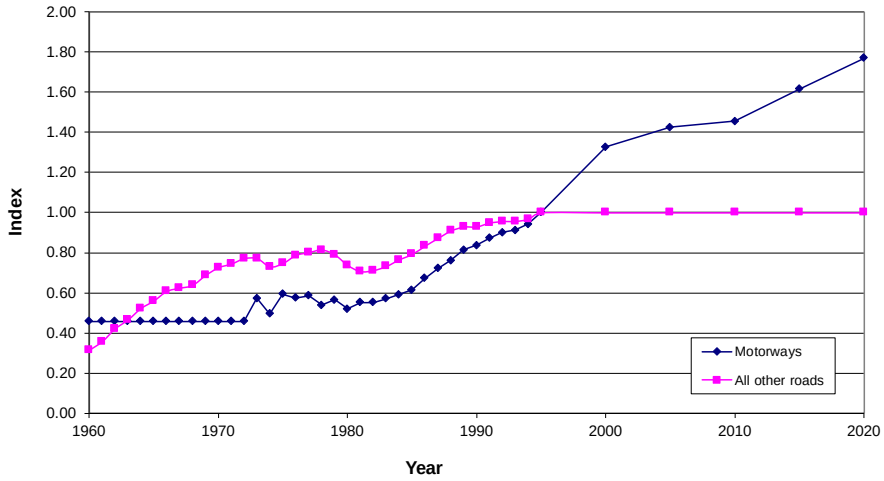

Figure 2.8. Index for development of AADT 1960-2020 for motorways and all other roads. Year 2020 has been extrapolated based on previous trends.

Minimum value for AADT

If AADT is less than 200 for any year it is set to 200 as a minimum value. For air pollution calculations low levels of AADT do not contribute much due to the contribution from background concentrations.

In fact, in AirGIS calculations only AADT more than 500 are considered for OSPM calculations to determine the street contribution to air quality to save computer time for calculations.

In noise calculations all roads equal or less than AADT of 200 has been removed from the road network to make noise calculations more efficient.

2.10 Travel speed

The maximum allowed speed on the original road network from 2007 was set to 110 km/h at motorways. However, in April 2004 the maximum allowed speed was increased to 130 km/t for selected motorways. These motorways have been identified based on a map from the Danish Road Directorate and

the speed limit has been set to 130 km/h. Some of the new motorway sections that have been added to the road network also have a speed limit of 130 km/h. To distinguish between allowed speed before and after 2004 a new attribute has been added with the name Agtrafsp04 and assigned 130 km/h in cases of relevance.

Travel speeds are set equal to the speed limit with three exceptions: (1) motorways with a speed limit of 130 km/h are assigned a travel speed of 120 km/h, (2) roads with speed limit of 50 km/h are assigned a travel speed of 40 km/h, and (3) all dead-end roads are also assigned a travel speed of 40 km/h. All dead-end roads were originally identified with a developed GIS script.

All motorway sections with a speed limit of 130 km/h are shown in Figure 2.9.

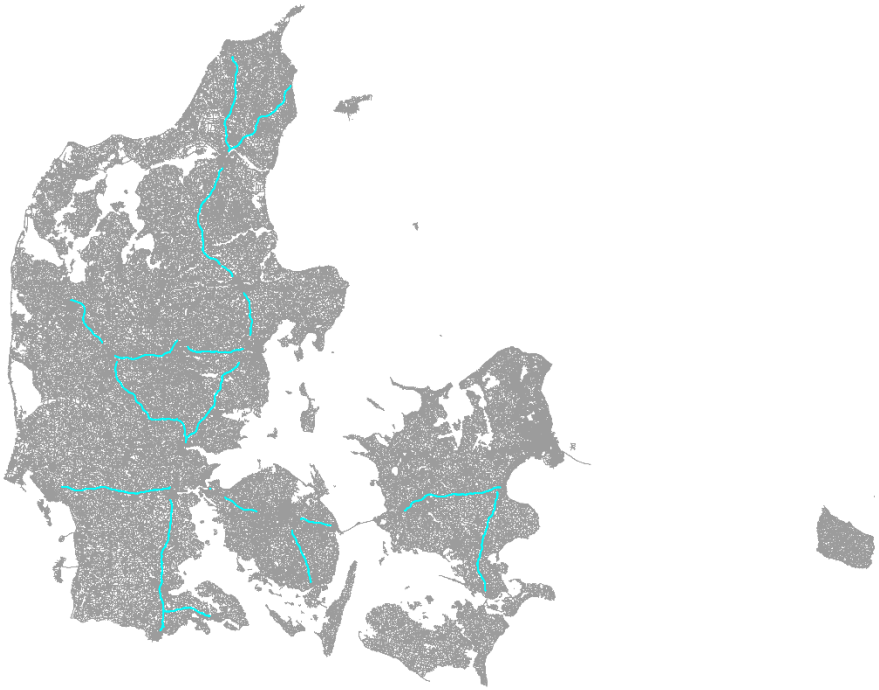

Figure 2.9. Visualisation of motorway sections with a speed limit of 130 km/h.

2.11 List of attributes

A complete list of attributes of the road and traffic database is shown in Appendix B divided into attributes used for air quality calculations in AirGIS and OML-Highway and for noise calculations in SoundPlan.

2.12 Comparison of distance travelled

Distance travelled is not an attribute that is used for air quality or noise calculations. In Appendix C we have compared the distance travelled of the Road and Traffic Database (RTD) with similar data from the Danish Road Directorate (DRD) as an overall rough quality assurance of the AADT and road segments lengths. Distance travelled is vehicle km travelled on the road network during one year.

References

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Appendix A. Example of OSPM trf-file

"Default Type"	PAS_Car	Vans	Truck_1	Truck_2	Buses			
"Type_B"	0.8192	0.1084	0.0280	0.0137	0.0307			
"<5";"<>7"	1.0925	1.1090	1.2764	1.1797	1.2179			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.01110	0.00409	0.00345	0.02300	0.01640	1.05	0.91	12
2	0.00620	0.00219	0.00330	0.01177	0.00487	1.09	1.00	12
3	0.00425	0.00178	0.00313	0.00977	0.00289	1.11	1.09	12
4	0.00355	0.00231	0.00395	0.00560	0.00211	1.09	1.03	12
5	0.00390	0.00354	0.00963	0.00812	0.00729	1.08	1.01	12
6	0.00804	0.00838	0.02484	0.02693	0.01985	1.04	0.95	12
7	0.02819	0.03389	0.05210	0.04369	0.03652	0.99	0.91	12
8	0.06585	0.07086	0.08069	0.05952	0.06827	0.93	0.87	11
9	0.08169	0.07345	0.07297	0.06146	0.08266	0.94	0.87	14
10	0.05560	0.08492	0.11069	0.06928	0.07738	0.95	0.89	12
11	0.04800	0.09024	0.11862	0.07921	0.07358	0.95	0.89	12
12	0.05048	0.08951	0.10334	0.07368	0.07299	0.95	0.89	12
13	0.05560	0.07168	0.10382	0.06647	0.06725	0.96	0.89	12
14	0.05779	0.07022	0.10244	0.06369	0.06653	0.95	0.89	12
15	0.06469	0.07495	0.08016	0.06225	0.07923	0.95	0.89	12
16	0.08048	0.09044	0.04303	0.05484	0.07417	0.94	0.89	7
17	0.08462	0.06141	0.02566	0.05219	0.05925	0.94	0.89	12
18	0.07012	0.04417	0.02014	0.05124	0.04898	0.97	0.91	12
19	0.05663	0.03499	0.01110	0.04732	0.03450	0.99	0.92	12
20	0.04317	0.02374	0.00863	0.03409	0.02936	0.99	0.90	12
21	0.03334	0.01893	0.00704	0.02525	0.02056	1.00	0.90	12
22	0.03081	0.01738	0.00536	0.02296	0.01985	1.00	0.89	12
23	0.03185	0.01613	0.00294	0.02140	0.01815	1.00	0.88	12
24	0.02406	0.01080	0.00295	0.02626	0.01737	1.03	0.88	12
"=5";"<>7"	1.1349	1.1512	1.2650	1.1528	1.2243			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.01418	0.00522	0.00500	0.02449	0.02339	1.08	0.92	12
2	0.00896	0.00316	0.00321	0.01463	0.00466	1.10	1.01	12
3	0.00610	0.00256	0.00556	0.00449	0.00506	1.14	1.04	12
4	0.00551	0.00359	0.00507	0.00522	0.00266	1.12	1.09	12
5	0.00490	0.00445	0.00886	0.00911	0.00661	1.11	1.01	12
6	0.00846	0.00882	0.02464	0.02726	0.01941	1.06	0.95	12
7	0.02687	0.03232	0.05275	0.04906	0.03645	0.99	0.91	12
8	0.06296	0.06780	0.08133	0.05304	0.06784	0.93	0.87	11
9	0.07779	0.06999	0.07956	0.06567	0.08885	0.94	0.88	14
10	0.05165	0.07894	0.11275	0.08105	0.07771	0.95	0.89	12
11	0.04789	0.09009	0.12136	0.07024	0.07422	0.95	0.89	12
12	0.05192	0.09213	0.10937	0.04771	0.07616	0.95	0.89	12
13	0.05832	0.07524	0.09851	0.05724	0.06290	0.96	0.89	12
14	0.06177	0.07511	0.09502	0.06196	0.06084	0.95	0.89	12
15	0.07239	0.08393	0.07133	0.06258	0.06951	0.94	0.89	12
16	0.07841	0.08817	0.03814	0.05037	0.06481	0.93	0.89	7
17	0.07696	0.05589	0.02483	0.05351	0.05652	0.96	0.90	12
18	0.06547	0.04128	0.02074	0.05185	0.04973	0.97	0.91	12
19	0.05633	0.03482	0.01209	0.04835	0.03705	0.99	0.91	12
20	0.04459	0.02453	0.01066	0.04305	0.03575	0.99	0.90	12
21	0.03225	0.01832	0.00696	0.03428	0.02002	1.00	0.89	12
22	0.02741	0.01547	0.00565	0.02801	0.02062	1.02	0.88	12
23	0.02935	0.01488	0.00287	0.02691	0.01752	1.01	0.89	12
24	0.02956	0.01328	0.00373	0.02990	0.02169	1.02	0.87	12
"=6";"<>7"	0.7910	0.7640	0.4702	0.6607	0.5370			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.03615	0.01399	0.00790	0.04996	0.03135	1.05	0.90	12
2	0.02584	0.00959	0.00808	0.01594	0.00995	1.08	0.96	12
3	0.02093	0.00923	0.00809	0.01979	0.00624	1.12	0.92	12
4	0.01793	0.01229	0.01033	0.00000	0.00460	1.15	1.00	12
5	0.01461	0.01393	0.01486	0.01191	0.00940	1.15	1.01	12
6	0.01259	0.01379	0.03459	0.01934	0.02310	1.11	1.01	12
7	0.01328	0.01677	0.05769	0.04351	0.03379	1.05	0.93	12
8	0.01877	0.02123	0.05398	0.03594	0.03816	1.04	0.93	11
9	0.02656	0.02510	0.06061	0.03943	0.05737	1.01	0.92	14
10	0.03942	0.06327	0.08683	0.04377	0.05072	0.98	0.91	12
11	0.04919	0.09717	0.10608	0.07751	0.05498	0.95	0.90	12
12	0.05988	0.11159	0.09577	0.04702	0.05652	0.95	0.91	12
13	0.06924	0.09382	0.09057	0.07027	0.04901	0.97	0.92	12
14	0.07170	0.09156	0.09512	0.07405	0.05161	0.98	0.91	12
15	0.07116	0.08665	0.06731	0.06576	0.05559	0.98	0.91	12
16	0.06858	0.08100	0.05571	0.05086	0.08023	0.99	0.92	7
17	0.06617	0.05047	0.03648	0.03893	0.07037	1.00	0.93	12
18	0.06502	0.04305	0.02799	0.03701	0.05687	1.00	0.93	12
19	0.05917	0.03842	0.01712	0.04504	0.04445	1.02	0.91	12
20	0.04535	0.02620	0.02122	0.04014	0.06029	1.02	0.89	12
21	0.03530	0.02106	0.01539	0.04003	0.03753	1.01	0.89	12
22	0.03447	0.02043	0.01268	0.04349	0.03921	1.02	0.85	12
23	0.03782	0.02013	0.00767	0.04449	0.03964	1.01	0.87	12
24	0.04084	0.01927	0.00793	0.04579	0.03906	1.02	0.88	12

"=7";"<>7"	0.7496	0.6911	0.3152	0.5671	0.4202			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.03783	0.01533	0.01278	0.04098	0.04345	1.04	0.91	12
2	0.03041	0.01182	0.01210	0.01638	0.01276	1.08	0.95	12
3	0.02501	0.01155	0.01265	0.02076	0.00835	1.10	0.97	12
4	0.02217	0.01592	0.00639	0.00292	0.00244	1.13	0.99	12
5	0.01841	0.01840	0.01833	0.00571	0.00993	1.16	0.98	12
6	0.01559	0.01789	0.00444	0.01471	0.00254	1.15	1.01	12
7	0.01393	0.01844	0.05306	0.05094	0.02661	1.08	0.95	12
8	0.01606	0.01903	0.04480	0.03256	0.02712	1.05	0.92	11
9	0.01914	0.01895	0.05014	0.03379	0.04065	1.03	0.95	14
10	0.02936	0.04938	0.05001	0.05862	0.02502	1.01	0.92	12
11	0.03618	0.07488	0.07416	0.06076	0.03292	0.99	0.92	12
12	0.04755	0.09283	0.09321	0.05030	0.04712	0.98	0.91	12
13	0.06164	0.08749	0.08232	0.06197	0.03816	0.99	0.91	12
14	0.07044	0.09423	0.10645	0.04828	0.04948	0.98	0.93	12
15	0.07517	0.09590	0.10019	0.04262	0.07087	0.98	0.92	12
16	0.07183	0.08888	0.06734	0.06498	0.08308	0.98	0.92	7
17	0.07049	0.05633	0.05077	0.05455	0.08389	0.99	0.91	12
18	0.07204	0.04997	0.03417	0.05688	0.05947	0.99	0.93	12
19	0.06249	0.04251	0.03204	0.03305	0.07124	1.00	0.92	12
20	0.05302	0.03210	0.02884	0.03990	0.07019	1.00	0.90	12
21	0.04491	0.02807	0.02501	0.04305	0.05226	1.00	0.91	12
22	0.04131	0.02566	0.01986	0.03643	0.05261	1.00	0.90	12
23	0.03676	0.02050	0.00754	0.06482	0.03338	1.02	0.89	12
24	0.02825	0.01397	0.01339	0.06501	0.05646	1.03	0.87	12
"<5";"=7"	1.0010	1.0240	0.9554	0.9828	1.1026			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.01505	0.00556	0.00469	0.03071	0.02220	1.05	0.91	12
2	0.00824	0.00292	0.00439	0.01539	0.00645	1.09	1.00	12
3	0.00543	0.00228	0.00399	0.01227	0.00367	1.11	1.09	12
4	0.00419	0.00274	0.00467	0.00651	0.00248	1.09	1.03	12
5	0.00436	0.00397	0.01076	0.00893	0.00813	1.08	1.01	12
6	0.00826	0.00863	0.02552	0.02722	0.02035	1.04	0.95	12
7	0.02779	0.03352	0.05139	0.04242	0.03594	0.99	0.91	12
8	0.05852	0.06317	0.07173	0.05208	0.06055	0.93	0.87	11
9	0.07132	0.06433	0.06373	0.05283	0.07203	0.94	0.87	14
10	0.05201	0.07968	0.10357	0.06380	0.07223	0.95	0.89	12
11	0.05068	0.09556	0.12526	0.08233	0.07752	0.95	0.89	12
12	0.05380	0.09569	0.11018	0.07732	0.07764	0.95	0.89	12
13	0.05797	0.07496	0.10827	0.06823	0.06997	0.96	0.89	12
14	0.05884	0.07172	0.10433	0.06385	0.06760	0.95	0.89	12
15	0.06548	0.07611	0.08117	0.06205	0.08005	0.95	0.89	12
16	0.07966	0.08980	0.04261	0.05345	0.07328	0.94	0.89	7
17	0.08266	0.06018	0.02508	0.05020	0.05776	0.94	0.89	12
18	0.06804	0.04300	0.01955	0.04896	0.04744	0.97	0.91	12
19	0.05473	0.03392	0.01073	0.04503	0.03327	0.99	0.92	12
20	0.04201	0.02317	0.00840	0.03267	0.02852	0.99	0.90	12
21	0.03603	0.02052	0.00761	0.02686	0.02217	1.00	0.90	12
22	0.03357	0.01899	0.00585	0.02463	0.02159	1.00	0.89	12
23	0.03324	0.01689	0.00307	0.02200	0.01891	1.00	0.88	12
24	0.02813	0.01267	0.00345	0.03024	0.02027	1.03	0.88	12
"=5";"=7"	1.0493	1.0772	0.9613	0.9635	1.1185			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.01654	0.00609	0.00579	0.02829	0.02723	1.08	0.92	12
2	0.00932	0.00329	0.00332	0.01508	0.00484	1.10	1.01	12
3	0.00697	0.00292	0.00632	0.00509	0.00577	1.14	1.04	12
4	0.00612	0.00399	0.00560	0.00575	0.00296	1.12	1.09	12
5	0.00567	0.00515	0.01021	0.01045	0.00765	1.11	1.01	12
6	0.00936	0.00975	0.02710	0.02986	0.02143	1.06	0.95	12
7	0.02755	0.03311	0.05379	0.04983	0.03731	0.99	0.91	12
8	0.05786	0.06224	0.07431	0.04828	0.06222	0.93	0.87	11
9	0.06809	0.06120	0.06924	0.05693	0.07762	0.94	0.88	14
10	0.05017	0.07660	0.10890	0.07797	0.07534	0.95	0.89	12
11	0.05009	0.09411	0.12619	0.07275	0.07747	0.95	0.89	12
12	0.05433	0.09630	0.11379	0.04945	0.07954	0.95	0.89	12
13	0.06146	0.07920	0.10321	0.05974	0.06616	0.96	0.89	12
14	0.06354	0.07717	0.09717	0.06312	0.06246	0.95	0.89	12
15	0.07329	0.08488	0.07180	0.06275	0.07024	0.94	0.89	12
16	0.07701	0.08651	0.03724	0.04899	0.06353	0.93	0.89	7
17	0.07341	0.05326	0.02355	0.05056	0.05381	0.96	0.90	12
18	0.06233	0.03925	0.01963	0.04889	0.04725	0.97	0.91	12
19	0.05383	0.03325	0.01149	0.04577	0.03534	0.99	0.91	12
20	0.04364	0.02398	0.01037	0.04172	0.03492	0.99	0.90	12
21	0.03535	0.02006	0.00758	0.03721	0.02190	1.00	0.89	12
22	0.03121	0.01760	0.00640	0.03159	0.02343	1.02	0.88	12
23	0.03255	0.01648	0.00317	0.02956	0.01939	1.01	0.89	12
24	0.03030	0.01360	0.00380	0.03036	0.02219	1.02	0.87	12

"=6";"=7"	0.7277	0.7034	0.3559	0.5563	0.4927			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.03832	0.01498	0.00832	0.05181	0.03285	1.05	0.90	12
2	0.02804	0.01051	0.00871	0.01692	0.01067	1.08	0.96	12
3	0.02062	0.00918	0.00792	0.01907	0.00607	1.12	0.92	12
4	0.01848	0.01280	0.01057	0.00000	0.00469	1.15	1.00	12
5	0.01510	0.01455	0.01526	0.01205	0.00961	1.15	1.01	12
6	0.01362	0.01507	0.03716	0.02046	0.02470	1.11	1.01	12
7	0.01510	0.01927	0.06519	0.04842	0.03800	1.05	0.93	12
8	0.02234	0.02553	0.06382	0.04185	0.04491	1.04	0.93	11
9	0.02740	0.02615	0.06211	0.03979	0.05851	1.01	0.92	14
10	0.03906	0.06334	0.08548	0.04243	0.04969	0.98	0.91	12
11	0.05169	0.10317	0.11076	0.07969	0.05714	0.95	0.90	12
12	0.05905	0.11116	0.09381	0.04535	0.05511	0.95	0.91	12
13	0.06526	0.08933	0.08480	0.06480	0.04568	0.97	0.92	12
14	0.06659	0.08590	0.08775	0.06728	0.04740	0.98	0.91	12
15	0.06772	0.08330	0.06363	0.06122	0.05231	0.98	0.91	12
16	0.06168	0.07360	0.04977	0.04475	0.07135	0.99	0.92	7
17	0.05823	0.04487	0.03189	0.03351	0.06123	1.00	0.93	12
18	0.05883	0.03935	0.02516	0.03276	0.05088	1.00	0.93	12
19	0.05540	0.03634	0.01592	0.04126	0.04115	1.02	0.91	12
20	0.04501	0.02628	0.02092	0.03898	0.05917	1.02	0.89	12
21	0.04371	0.02634	0.01893	0.04849	0.04595	1.01	0.89	12
22	0.03994	0.02392	0.01459	0.04929	0.04491	1.02	0.85	12
23	0.04447	0.02391	0.00896	0.05118	0.04609	1.01	0.87	12
24	0.04434	0.02114	0.00856	0.04864	0.04194	1.02	0.88	12
"=7";"=7"	0.7187	0.6518	0.2406	0.5006	0.4036			
Hour	PAS_Car	Vans	Truck_1	Truck_2	Buses	V_short	V_long	Cold_start
1	0.04210	0.01753	0.01461	0.04435	0.04761	1.04	0.91	12
2	0.03211	0.01283	0.01312	0.01682	0.01326	1.08	0.95	12
3	0.02658	0.01261	0.01380	0.02146	0.00874	1.10	0.97	12
4	0.02369	0.01748	0.00701	0.00304	0.00257	1.13	0.99	12
5	0.01939	0.01991	0.01981	0.00585	0.01030	1.16	0.98	12
6	0.01689	0.01992	0.00493	0.01550	0.00271	1.15	1.01	12
7	0.01489	0.02025	0.05822	0.05295	0.02801	1.08	0.95	12
8	0.01779	0.02167	0.05095	0.03508	0.02959	1.05	0.92	11
9	0.01878	0.01911	0.05051	0.03225	0.03928	1.03	0.95	14
10	0.02656	0.04590	0.04644	0.05157	0.02229	1.01	0.92	12
11	0.03769	0.08018	0.07933	0.06157	0.03378	0.99	0.92	12
12	0.04745	0.09520	0.09549	0.04882	0.04630	0.98	0.91	12
13	0.05879	0.08576	0.08060	0.05748	0.03583	0.99	0.91	12
14	0.06075	0.08353	0.09426	0.04050	0.04202	0.98	0.93	12
15	0.06390	0.08378	0.08744	0.03524	0.05933	0.98	0.92	12
16	0.06179	0.07857	0.05947	0.05436	0.07037	0.98	0.92	7
17	0.05840	0.04796	0.04318	0.04395	0.06843	0.99	0.91	12
18	0.06301	0.04492	0.03068	0.04839	0.05121	0.99	0.93	12
19	0.06519	0.04557	0.03431	0.03353	0.07318	1.00	0.92	12
20	0.05726	0.03563	0.03197	0.04191	0.07464	1.00	0.90	12
21	0.05390	0.03462	0.03082	0.05024	0.06175	1.00	0.91	12
22	0.05061	0.03230	0.02498	0.04340	0.06347	1.00	0.90	12
23	0.04378	0.02509	0.00922	0.07509	0.03915	1.02	0.89	12
24	0.03872	0.01967	0.01883	0.08665	0.07620	1.03	0.87	12

Appendix B. Road and traffic attributes

Road and traffic attributes for AirGIS

Table B1 Road and traffic attributes in GIS road network required for AirGIS

Attribute name	Description	Road info	Traffic info
OBJEKTTYPE	Text description of road type in KORT10	X	
OBJEKTKODE	Code for road type in KORT10	X	
VEJ_KODE	Unique 7 digit road code	X	
VEJ_NAVN	Road name (from CPR)	X	
AGTRAFCOYR	Estimated road construction year	X	
AGTRAALWSP	Speed limit (km/h)	X	X
AGTRAFSP	Travel speed (km/h)	X	X
AGOSPMSTTY	OSPM road type	X	X
AGADT1960	Annual Average Daily Traffic 1960		X
AGADT1965	Annual Average Daily Traffic 1965		X
AGADT1970	Annual Average Daily Traffic 1970		X
AGADT1975	Annual Average Daily Traffic 1975		X
AGADT1980	Annual Average Daily Traffic 1980		X
AGADT1985	Annual Average Daily Traffic 1985		X
AGADT1990	Annual Average Daily Traffic 1990		X
AGADT1995	Annual Average Daily Traffic 1995		X
AGADT2000	Annual Average Daily Traffic 2000		X
AGADT2005	Annual Average Daily Traffic 2005		X
AGADT2010	Annual Average Daily Traffic 2010		X
AGADT2015	Annual Average Daily Traffic 2015		X
AGADT2020	Annual Average Daily Traffic 2020		X
AGTRAF2DIR	ID for dobble digitalization of road	X	
AGTRAFUNIQ	Unique ID for record	X	
SHAPE_LEN	Length of road segment (m)	X	
AGALWSP04	Speed limit on motorways in 2004	X	
ROADWIDTH	Width of carriageway of road segment (m)	X	

Road and traffic attributes for OML-Highway

A network shapefile contains characteristics of either target roads, background roads, or both types of roads. The field Tflag indicates the road type. However, the two last parameters in the table (Nside and IDTRAFCCAT) are calculated by SELMA^{GIS}.

Table B2. Definition of fields in the road network shapefile used for OML-Highway. The column Target/Background indicates whether the parameter is relevant for Target roads, Background roads or both.

Attribute	Data description	Target/Background	Format
RoadID	Unique number	Both	Integer
Roadtype	ID for road type used for background roads to characterise their traffic conditions. Five types are used (2111, 2112...)	Background	Integer
DoubleD	Double digitised = 2, otherwise = 1. For double digitised roads there are two close, approximately parallel road segments, each of which carries traffic in one direction.	Target	Integer
AADT	Annual Average Daily Traffic (number)	Both	Float/Double
FPass	Fraction of passenger cars. Number between 0 and 1. The sum (FPass+FVans+FTrucks+FBus) should be 1.	Background	Float/Double
FVans	Fraction of vans. Number between 0 and 1. The sum (FPass+FVans+FTrucks+FBus) should be 1.	Background	Float/Double
FTrucks	Fraction of trucks. Number between 0 and 1. The sum (FPass+FVans+FTrucks+FBus) should be 1.	Background	Float/Double
FBus	Fraction of buses. Number between 0 and 1. The sum (FPass+FVans+FTrucks+FBus) should be 1.	Background	Float/Double
FHeavyDuty	Fraction *in percent* of heavy duty vehicles (sum of trucks and buses, but in percent).	Target	Float/Double
OSPMType	Id for traffic type used for target roads to characterise their traffic conditions. An example is Type A.trf, which is a standard OSPM diurnal type.	Target	Text
Roadwidth	Width of carriageway of road segment (m); if double digitised only one direction.	Target	Float/Double
SpeedLight	Speed of light traffic in km/h. This speed is a scaling speed which implicitly defines the speed of heavy traffic. The speed for an actual hour may be different and is computed based on information in *.trf files.	Both	Integer
DamH	Height of dam (positive) or cutting (negative) in relation to ground (m)	Target	Float/Double
WallH	Height of noise wall (m).	Target	Float/Double
EmbankH	Height of embankment (m).	Target	Float/Double
TFlag	Flag. 1 for target roads, 2 for background roads; records with other values are ignored.	Both	Integer
NDistance	Distance from road centre line to noise wall/embankment (m).	Target	Integer
NSide	Location of noise barrier in relation to the road follows the convention of OSPM (either 1 or 2); created by SELMA^{GIS}.	Target	Integer
IDTRAFCCAT	Id for traffic composition categories; created by SELMA^{GIS}. Note that SELMA^{GIS} versions distributed prior to November 15, 2014 produce files where the variable IDTRAFCCAT is named IDDIURNAL.	Target	Integer

Road and traffic attributes for SoundPlan

Table B3 Road and traffic attributes in GIS road network required for SoundPlan

Attribute name	Description
Vej_navn	Unique road code
Vej_kode	Road name
AADT	Annual Average Daily Traffic
Andel_tung	Share of heavy-duty traffic
Hast_tung	Travel speed, heavy-duty vehicles
Hast_let	Travel speed, light-duty vehicles
Agospmstty	OSPM vejtype
OSPMtype_S	SoundPlan road type based on OSPM vejtype
Vejbredde	Road width (m)
Vejbredde_	Road width/2 (m)
Afstandtil	Distance to emission line (m)

SoundPlan runs noise calculations for one specific year at the time, and the user must make the relevant AADT and share of heavy traffic available for that year.

Appendix C. Comparison of distance travelled

Distance travelled is not an attribute that is used for air quality or noise calculations. In the following we have compared the distance travelled of the Road and Traffic Database (RTD) with similar data from the Danish Road Directorate (DRD) as an overall rough quality assurance of the AADT and road segments lengths. Distance travelled is vehicle km travelled on the road network during one year.

Distance travelled in Road and Traffic Database (RTD)

In Table C.1 distance travelled based on the Road and Traffic Database (RTD) is shown.

Table C.1. Distance travelled based on the Road and Traffic Database (RTD)

Km travelled (billion km)	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	Road length (1000 x km)
Motorway	3.6	3.7	3.7	4.7	4.1	4.9	6.7	7.9	11.7	13.0	14.0	16.3	18.6	3.2
Expressway	0.3	0.5	0.7	0.7	0.7	0.7	0.8	0.9	1.2	1.2	1.3	1.4	1.5	0.4
Road > 6 m	6.4	11.5	15.1	15.5	15.3	16.3	19.2	20.6	20.6	20.6	20.6	20.6	20.6	14.0
Road 3-6 m	4.1	5.6	6.8	7.0	6.9	7.3	8.4	8.9	8.9	8.9	8.9	8.9	8.9	42.6
Other road	7.5	7.9	8.7	8.7	8.7	8.9	9.5	9.8	9.8	9.8	9.8	9.8	9.8	100.9
Grand total	22.0	29.2	34.9	36.5	35.7	38.0	44.5	48.2	52.2	53.6	54.6	57.1	59.5	161.1

*In Danish ”motorvej”, ** in Danish ”motortrafikvej”.

Comparison of distance travelled for all roads

In Figure C.1 a comparison is shown between distance travelled based on data from the Danish Road Directorate (DRD) and the road and traffic database (RTD) for all roads.

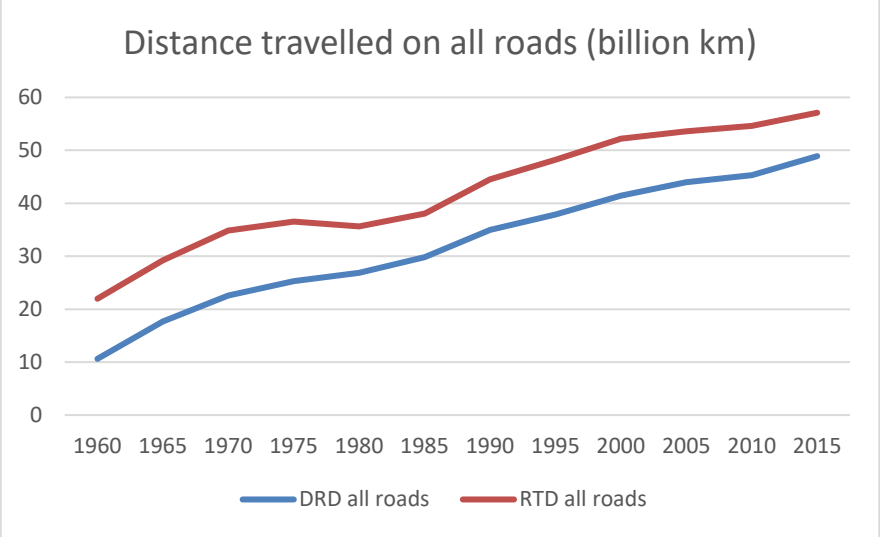


Figure C.1. Comparison between distance travellen based on data from the Danish Road Directorate (DRD) and the road and traffic database (RTD).

It is seen that the general trend is the same for distance travelled based on data from the Danish Road Directorate (DRD) and the road and traffic database (RTD) allthough RTD overestimates distance travelled compared to DRD and especially in early years compared to later years.

There are several reasons why RTD overestimates compared to DRD.

DRD only include distance travelled by domestic vehicles whereas RTD also include distance travelled by foreign vehicles passing through Denmark. The Danish Road Directorate estimates that distance travelled by foreign vehicles in 2014 is only 3% of total distance travelled. This kind of statistics is not available for the entire time periode from 1960 and onwards. Hence, the exclusion of distance travelled by foreign vehicles only partly explains why RTD overestimates distance travelled.

The main reason that RTD overestimates distance travelled compared to DRD is likely to be found in the roads included and our assignment of AADT for other roads as explained in the following. DRD only includes public roads whereas RTD includes all public and private roads, that is, all roads that can be seen on an aerial photograph.

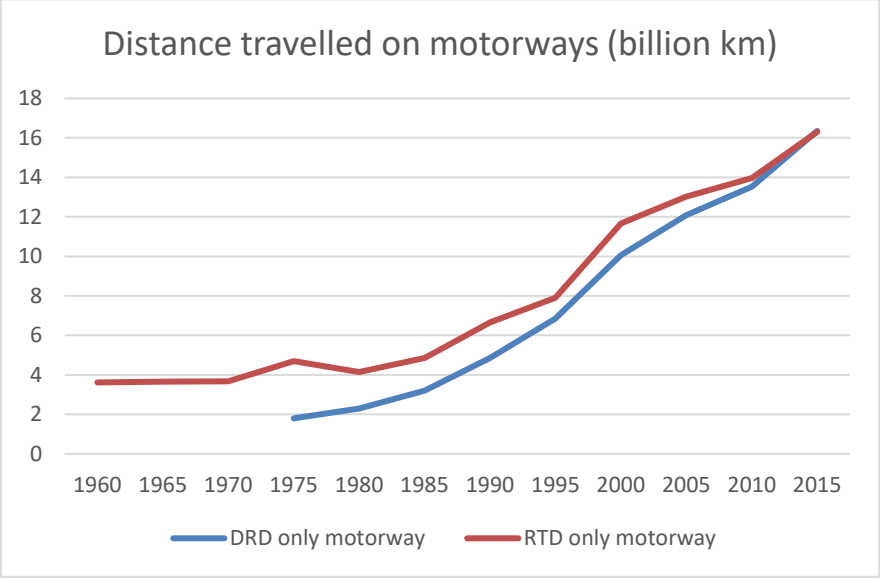
Previous comparison between the length of the public road network and the length of the road network of RTD shows that the road network of RTD is about twice as long as the public road network (Jensen et al., 2008). It is not possible to identify private roads in RTD as the road network of KORT10 does not include wheither or not a road is public or private. However, private roads are typically dead end roads, minor roads and gravel road, and typically in rural areas. These roads will typical be other roads (road type = 2123).

As seen from Table C.1 the road length of other roads is about 63% of the entire road network in RTD and distance travelled is about 18% of all km travelled. Few roads in the category of other roads were assigned traffic flow from available traffic sources and hence a default AADT of 200 were assigned for 1995 and backcasted and forecasted based on the index shown in Figure 2.8. It is very likely that this arbitary assignment of AADT of 200 for other roads is too high and the main reason for the difference between distance travelled in DRD and RTD. In principle the assignment of AADT in RTD could be calibrated to match distance travelled in DRD.

The road network of RTD is based on KORT10 from 2007 and extended with new motorways since then. This means that roads that did not exit in e.g. 1960 are still assigned AADT, and hence distance travelled on the road network is overpredicted back in time. This is also clearly seen in Figure C.1. However, distance travelled is not used for air quality and noise calculation as only AADT is used. For air pollution calculations low levels of AADT do not contribute much due to the contribution from background concentrations and only AADT more than 500 are considered for OSPM calculations to save computer time. In noise calculations all roads equal or less than AADT of 200 has been removed from the road network to make noise calculations more efficient.

Comparison of distance travelled for motorways only

In Figure C.2 a comparison is shown between distance travelled based on data from the Danish Road Directorate (DRD) and the road and traffic database (RTD) for motorways only.



Figuer C.2. Comparison between distance travellen based on data from the Danish Road Directorate (DRD) and the road and traffic database (RTD).

As expected the trends in distance travelled is similar for motorways for recent years in both datasets. This is due to the fact that motorways are well defined in both datasets. RTD over estimates back in time for the same reasons as given above, that is, all motorways in the road network from 2007 also exists in the database back in time and are assigned traffic although scaled in time.

GIS-BASED NATIONAL ROAD AND TRAFFIC DATABASE 1960-2020

This report describes the extension and update of th Danish national GIS-based road network and traffic database for 1960-2005 to the years 2005-2020. The original road network has been extended with new motorway sections that have been established since the original road network from 2007. Furthermore, some motorway sections have changed speed limit from 110 to 130 km/t. The development in traffic flow and vehicle mix has been analysed based on traffic data from the Danish Road Directorate to estimate the trend for different road types from 1995 to 2020 as 1995 is the baseline year of the original road and traffic database. This report also includes a description of the road network, all attributes and trends in traffic flow and vehicle mix for the entire period 1960-2020 to be able to read this report separately from previous documentation of the road and traffic database.

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