ESTIMATION OF WORLDWIDE CO-, NMVOC-, NOX- AND PM-EMISSIONS

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OUTLINE

With global biogenic and anthropogenic emission budgets for CO, NMVOC, NOx and Particles trends in different countries will be forecasted. As an example the contribution of differnet sources to global biogenic and anthropogenic NOx emissions is given in figure 1:

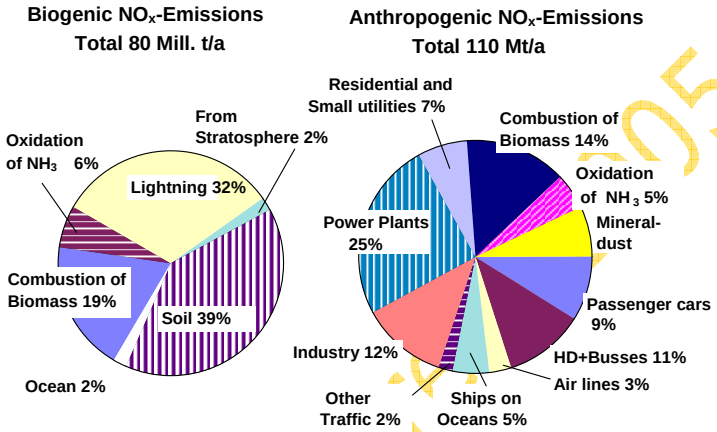

Figure 1: Global biogenic and anthropogenic NOx-Emissions

The basis for the distribution of worldwide emissions are global EDGAR emission inventories for 1990, 1995 and 2000 from Olivier et al.. Estimates are assisted by OECD-Data for 13 different regions and international shipping together with data from national emission inventories. Missing data in some regions are calculated on emissions per capita for industrial, developing and emerging countries. Forecasts are based on trends in the past, on the growth of population, gross net product and estimations of the political stability, see figure 2 for NOx.

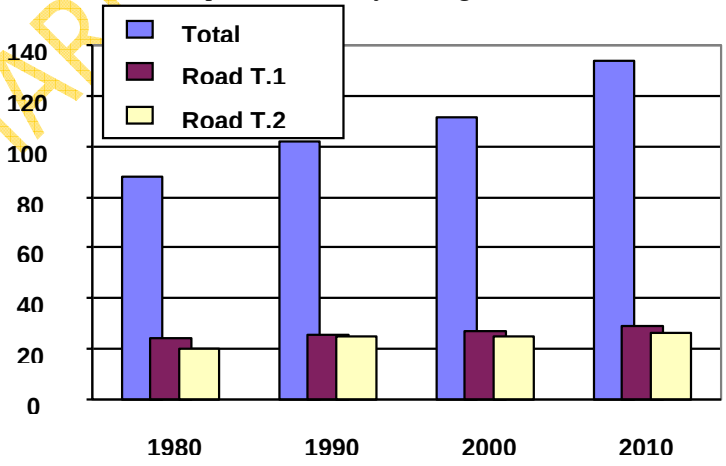

Figure 2: Trend of worldwide NOx-Emissions from road transport and all sources

Total global emissions for CO, NMVOC and NOx are increasing. Particle emission remain almost constant.
Mobile source emissions were estimated with a top down and a bottom up approach.

1. Top down approach

$$E_{RoadTransport,year} = E_{Total,\ year} * (E_{RoadTransport\ 1990} / E_{Total\ 1990})$$

- **Extrapolation from 1980 to 2000 on the basis of available OECD Data**
- **Forecast from 2000 to 2010 on the basis of experience of the past, Growth of population, of gross net product and political stability**

2. Bottom up approach

$$E_{Veh.} = \sum (E_{Canada}+E_{USA}+E_{Latinamer.}+E_{Africa}+E_{West\ Europe}+ \ldots + E_{Int.Ship.})$$

$$E_{PC_{USA}} = \text{reg. cars}_{USA} * \text{average annual mileage}_{USA} * \text{relat. E-factor}_{USA}$$

Registered Passenger Car and goods vehicle numbers and average annual mileage from World Road statistics 1980 to 2002 of International Road Federation.
Emission-Factors partly from measurements in some countries and literature survey.

Forecast from 2003 to 2010 on the basis of experience of the past, Growth of population, of gross net product and political stability.

Figure 3: Top down and bottom up approach

With the relation of the emissions per each component and state in 1990, 1995 and 2000 on the basis of the EDGAR-Data for the top down approach the value for the past and all future years were derived, assuming a certain slight change in this relation in the relevant years. For the past for some states OECD-Data and EPA-Data could be used additionally.

For future trends an increase in vehicles numbers and mileages on the basis of population trends and economic growth together with political stability assumptions were estimated for 13 regions seperately. Figure 4 show the contribution for passenger cars in 2005 as an example.

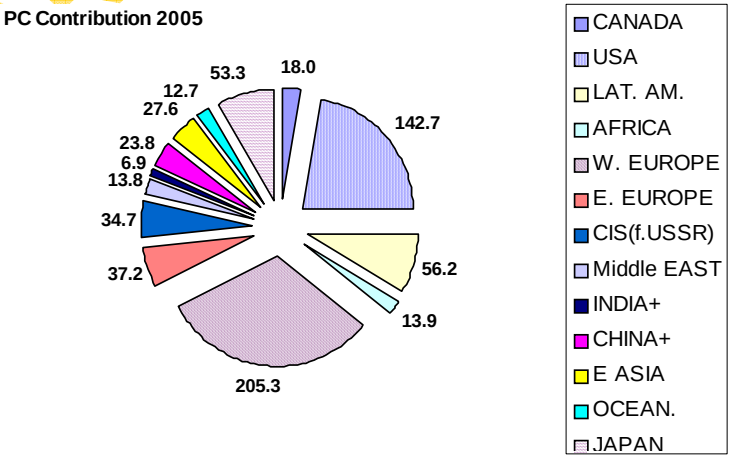

Figure 4: Contribution of different countries to passenger cars in 2005

The trend for worldwide passenger cars in use is shown as an example in figure 5.

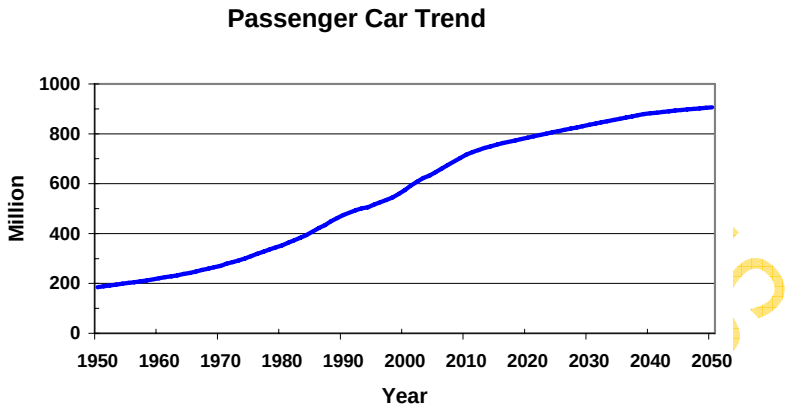

Figure 5: Passenger Cars in use: Trend from 1950 to 2050

The bottom up approach for mobile source emissions is based on the number of registered passenger cars, see figure 5 and duty vehicles (not shown in this abstract), the average annual mileage, see figure 6 for passenger cars and the relevant emission factors for each region. Emission factors are known from numerous measurements especially in Germany, Switzerland and USA over the last 2 decades. Emissions for coming years were calculated with foreseeable exhaust gas standards and vehicle technologies improvements.

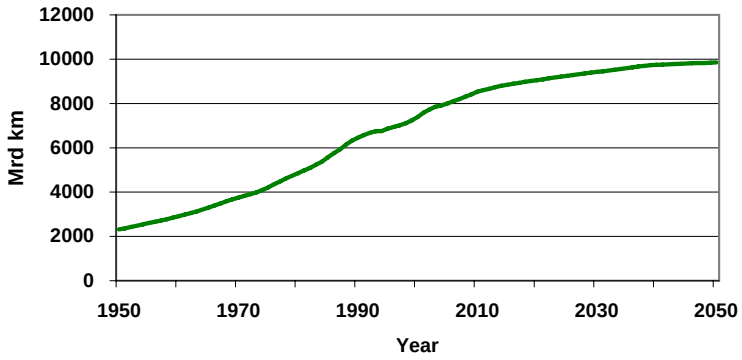

Figure 6: Trend of world wide passenger car mileage

The multiplication per vehicle category and per country lead to the relevant emission values. Adding all vehicle categories and all regions the worldwide emissions are obtained.
CO emissions of road transport remains at the level of 200 Million tons. The top down approach give slightly higher values compared with the bottom up approach. For NMVOC, comming from road transport, only a small increase could be seen, slightly higher for the bottom up approach. Road transport NOx is almost constant, due to the evolution of duty vehicles with higher

estimates for the top down approach. Figure 7 shows the NOx emission trend for passenger cars alone, which is decreasing.

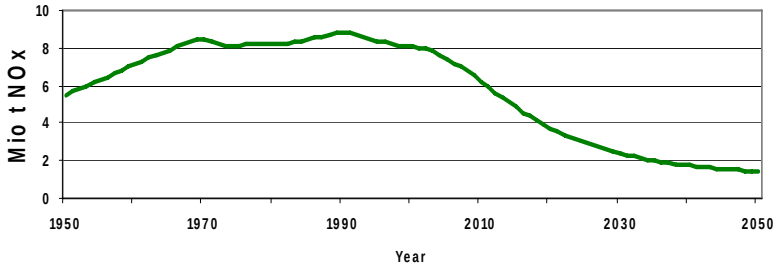

Figure 7: Trend of world wide NOx emission from passenger cars

PM from road transport is stagnating. Its contribution is about 10 % from total PM in all years. Results for CO, HC, PM and other vehicle categories will be presented in the paper itself.

DISCUSSION AND CONCLUSION

Industrial countries contribute less and less to worldwide emissions while emerging and developing countries increase their contribution. Emission standards will be introduced to a later stage so that twenty years ahead also in those countries no further increase will happen.

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