Road Transport Health risk assessment – as a tool for Public Health Protection

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Aims

- Do health risk assessment and HIA for road transport system in Ostrava City in the target years 2010 and 2020 with D47 and without D47
- Comparison health risks coming from road transport and risk coming from another anthropogenic sources in region
- Decision making position for public health protection.
Method

HEALTH RISK ASSESSMENT
- Identification of hazards from transport
- Dose –response assessment
- Exposure assessment
- Risk characterisation
Hazards identification I (chemical factors)

- Car exhaust a lot of substances in the air - (CO), (NOX), dust particles (PM10, PM 2.5), heavy metals, soot, organic compounds (PAU, Benzene, Nitro-pyren, 1.3-butadien etc.).
- HRA our case was based on the model – trace compounds:
  - one threshold NO2 and
  - one stochastic - benzene.
- Risk studies were based on conclusions from WHO, US EPA epidemiologic studies and TNO 1994 methodology respectively.
Hazard identification II

- Emise NO$_2$ and theirs impact on health
- Emise VOC ( benzene and it’s impact )
- Noise from traffic
- Fine bust particles - PM 2,5
Dose - response assessment

• Dose response assessments were done for:
  • Possible acute risk - short term exposure to higher concentrations and noise levels
  • Possible chronic risk - long term daily average concentration exposure, noise levels respectively.
Toxicology data from literature - NO$_2$

- [http://www.epa.gov/iaq/no2.html#Health%20Effects%20Associated%20with%20Nitrogen%20Dioxide](http://www.epa.gov/iaq/no2.html#Health%20Effects%20Associated%20with%20Nitrogen%20Dioxide)
NO$_2$ (Nitrogen oxides)

- LOAEL (Lowest Observed Adverse Effect Level) cca 400 - 600 ug.m$^{-3}$
- IH$_d$ 100 ug.m$^{-3}$  IH$_k$ 200 ug.m$^{-3}$  IH$_r$ 80 ug.m$^{-3}$
- WHO daily average concentration 150 ug.m$^{-3}$ recommended year average concentrations 40 - 50 ug.m$^{-3}$, hour limit 200 ug.m$^{-3}$
- EU 98 -hour limit 200 ug.m$^{-3}$
NO$_2$ ( oxidě dusíku )

- For quantification has been Aunan’s predictive formulas used. This formulas are based on met analysis of epidemiologic date and published in NILU (1995)
NO$_2$  Acute respiratory syndromes – adults

- Daily concentration NO$_2$ are in relation with increasing acute respiratory syndromes.

- The **odds ratio (OR)** is a measure of **effect size** particularly important in Bayesian statistics and logistic regression. It is defined as the ratio of the odds of an event occurring in one group to the odds of it occurring in another group, or to a sample-based estimate of that ratio. These groups might be men and women, an experimental group and a control group, or any other dichotomous classification. If the probabilities of the event in each of the groups are $p$ (first group) and $q$ (second group), then the odds ratio is:

\[
\frac{p/(1-p)}{q/(1-q)} = \frac{p(1-q)}{q(1-p)}.
\]

- **OR = exp ($\beta$..C), where $\beta$ - regression coefficient 0,0014 (95%CI 0,0010-0,0017) and C is daily concentration NO$_2$ v $\mu$g.m$^{-3}$. (Aunan 1995)**

- The limit is 4,6 %.
NO$_2$  *Acute respiratory symptoms - children*

- OR = exp (β. C), where β - regression coefficient 0.0055 (95% CI 0.0026-0.0088) a C annual concentration NO$_2$ v µg.m$^{-3}$. (Aunan 1995)

- Is possible to use it for prevalence increasing more than 2% - limit
NO$_2$ Incidence of asthma atacs within children

- OR = exp (β..C), where β - regression coefficient 0.016 (95%CI 0.002-0.0308) and C annual concentration NO$_2$ v µg.m$^{-3}$. (Aunan 1995)
- Limit is 6.0 %.
**NO₂ acute effects**

**1 hour conc.**

- 200 - 400 µg.m⁻³
- 401 - 900 µg.m⁻³
- 901 - 1600 µg.m⁻³
- 1 601 - 1 800 µg.m⁻³

**Health adverse effects**

- S.P. within people with asthma and bronchitis
- Light spastic manifestation within sensitive population.
- More serious health adverse affects within sensitive population together with others determinants – physical activity, could, humidity etc. Low probability of asthma attack.
- Higher probability of asthma attack.
Benzene toxicology

- Common known
- Man-made sources
- Smoking
Benzene exposure in Ostrava 1998

- Clean area 24 hours from 0,014 µg.m-3 /d.l./ till 0,92 µg.m-3 (95 percentile),
- Industrial area 24 hours 0,014 µg.m-3 till 9,15 µg.m-3 (95 percentile).
- Transport influenced areas cca 12,8 do 15,6 µg.m-3 benzenee,
- Heavy influenced area (coke oven + transport) 53,6 µg.m-3 (personal information fy. ELCOM Ostrava s.r.o. in cooperation with NILU Oslo).
**Benzene**

- IARC human carcinogen group. 1
- US EPA human carcinogen group A
- NIOSH human carcinogen
- CZE standard (ambient air) 15,0 $\mu$g.m$^{-3}$
- dle
- WHO 4,0 E-06 ($\mu$g.m$^{-3}$) - 1,0 $\mu$g.m$^{-3}$
- RBC US EPA 0,22 $\mu$g.m$^{-3}$ - risk E-06
Noise

**Noise - $L_{Aeq}$**

- Hypertension
- Ischemic CVD
- IM
- Quality of sleeping
- performance next day
- Mood next day

- $L_{Aeq}$ 6-22 70 dB(A)
- $L_{Aeq}$ 6-22 70 dB(A)
- $L_{Aeg}$ 6-22 70 dB(A)
- $L_{Aeg}$ noc 40 dB(A)
- $L_{Aeg}$ noc < 60 dB(A)
- $L_{Aeg}$ noc < 60 dB(A)
Exposure assessment

- Rout transport system – selection based on capacity of routes (cca 400 km Ostrava)
- Exposed person is anyone living in the belt 30 m from side of routes
- Ambient air concentrations NO₂ and benzene were model in Car International (TNO) and ISCT ST(EPA)
- Noise was model in CZE modele Koláře a Liberka
Car International Model

- Simple parametric model
- Takes in calculation geometry of routes
- Model concentrations in 5 – 30 m distance from axis of route
- Model annual concentration or percentiles
- Model was recommended for using in EC
Car International Model

- Model is able to give (calculate):
- City background concentration level
- Rout emission
- Proportion of local transport
- Annual average concentration
Car International Model

- Emision variable „Specific emissions for basic car categories and given running mode ÚVMV Praha 1995‟
  - S 1 – average speed 13 km/h, lane with traffic jam
  - S 2 - average speed 22 km/h, street with speed limit 50 km/h
  - S 3 - average speed 44 km/h, street with speed limit 70 km/h
  - S 4 - average speed 100 km/h – highway
Car International Model

- Streets and lane were divided into 807 segments in Ostrava city:
- Intensity of transport
- Proportion of heavy transport
- Speed
- Geometry of street or lane
- Input data into model were from City Ostrava development plan „Zpracování modelového zatížení výhledové komunikační sítě města Ostravy objemy dopravy roku 2010 a 2020“(UDIMO s.r.o. arch.č: II-1.3/180/96)
Case of Ostrava city

- EIA (legal obligation)
- Exposure of citizens – distance < 200 m, total length D 47 - 10 km
- No. of inhabitants several thousands

- HRA (PH wish)
- Exposure of citizens residential suburbs< 30 m resp.60, length 440 km
- No. of inhabitants 38 000, including age stratification
- Identification of high exposed buildings (hot spots)
GIS application (MIC)

• No. of inhabitants living in the distance 30 and/or 60 m from axis or side of the street

• Identification of health care facilities, school, kindergartens, houses for aldey etc..
Charakteristika rizika

• HRA NO₂ 1 h. and 24 h. exposition with D 47 and without D 47,

• HR for benzene was assessed in Lifetime Individual Cancer Risk
Risk characterisation noise I

- Schulze (1983) predict (within 2 500 exposed adults) increasing of hypertension is about 2% and ICVD about 4% Babische (1992,1993) and Manikowského (1995) can be increasing of IM from 1.2 to 1.7 x.

- We did not possibility of noise exposure prevention measurements.
Risk characterisation for noise

- HRA was done as No. of exposed inhabitants and IM predication.
General results

• Situation with and without D47 will be in the health risk level NO2, benzene the same in 2010
• In 2020 is the same (little be better for D47)
• In noise exposure were three hot spot identified with D47 scenario.
• The HR coming from traffic in Ostrava city is comparable with another industrial cities.
HRA uncertainties I

- Using of the dispersin models (Car International, ISC ST)
- Using emissions data from sources REZZO I,II
- Quality of predicted data about traffic density
- Quality of the car emissions data
- Quality of the dose – response data
HRA uncertainties

- Demographic data about inhabitants (MIS) Ostrava
- Health status data – routine statistics společnosti
- Epidemiology studies results
**Discussion**

- HRA as a HIA tools for decision
- D 47 is build, we will see
- In the late 90ties it was nice case study for municipality management of HR
Conclusions and recommendations

- Comparison of the HR from traffic needs very broad concept of HRA or HIA
- In our case the highway doesn’t bring any increasing health risk
- Realisation of the highway D47 doesn't bring decreasing risk in the existing downtown