Report 2 – External costs about transport

Particles emitted by vehicles
Consequences of these particles
Which particles have most consequences

Particles emitted by vehicles :

| | |
|---|---|
| $NO_X$ | Nitrogen oxide |
| $SO_2$ | Sulphur dioxide |
| VOC | Volatile Organic Compounds |
| CO | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| Pb | Lead |
| $PM_{10}$ | Particulate matter with a diameter of less than 10µm |

Talking march 3rd

Comment déterminer la repartition du traffic entre les deux ponts etant donné que l'un est, pour l'instant, hypothétique.
On pourrait couper verticalement la ville en deux, entre les deux ponts.
Idée : regarder quelles sont les rues où il y a le plus de traffic pour voir d'où les gens viennent.

Introduction about Toruń.

Toruń is divided in two part by a river, from west to east. The old town center is located on the north shore. Two conditions increase the traffic in the center :

- There is only one brigde enables people to cross the river.
- There isn't road arround the city for the vehicles which only cross the city.

So there is a lot of trafic on the bridge and in the streets near from it. More, at peak, there is congestion. Also this traffic induces a lot of pollution.

This studie's object is to know if it could be interesting to build a new bridge, a few kilometers west of the actually one. This built could be interesting for the city if it decrease the external costs from transport. So we need to calculate the difference between external costs of the two situations (with and without a new bridge).

**The actually scenario**

We know the traffic and the emissions of the different vehicles and in the different streets of the city.

## *Equation*

We use the methodology called Simple Uniform World Model.

$$\underline{D = S_{DR} \iint \rho(x) \, . \, c(x) \, dxdy}$$

Removal velocity :

$$k\,(x) = F(x) / c(x) \qquad => \qquad c(x) = F(x) / k\,(x)$$

Replaced in the equation :

$$D = S_{DR} \iint \rho(x) \, . \, F(x) / k(x) \, dxdy$$

ρ and k are constants. So :

$$D = S_{DR} \, . \, \rho / k \iint F(x) \, dxdy$$

By conservation of mass : $\iint F(x) \, dxdy = Q$

Also :

$$D = \frac{S \times Q \times \rho}{k}$$

With D => Damages in Yoll (or Chronic bronchitis or days) per second or kilometer
S => Reponse function Slope in Yoll.m$^3$ / (s.pers.g), one per couple pollutant-consequence
Q => Emission in g/km or g/s
ρ => density population = 115 pers/m$^2$
k => Depletion velocity in m/s

In this situation, we have :

- **S**

| | Mortality | Chronic bronchitis | Restricted activity days |
|---|---|---|---|
| PM | 1,24E-05 | 1,24E-06 | 6,28E-04 |
| SO2 | 1,69E-07 | | |
| Sulfates | 1,24E-05 | 1,24E-06 | 6,28E-04 |
| Nitrates | 6,18E-06 | 6,22E-07 | 3,14E-04 |

- **Q**

| Emission | cars | trucks | buses | coaches | lorries | motocycles | Lightweighted motorcycles |
|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **PM** | g/km | 0,014208 | 0,12536 | 0,69998 | 0,63006 | 0,61418 | 0 | 0 |
| **SO2** | g/km | 0,041101 | 0,18596 | 0,85841 | 0,75352 | 0,56076 | 0,01222 | 0,0053854 |
| **NOx** | g/km | 0,69678 | 1,1859 | 15,299 | 11,022 | 7,0949 | 0,14276 | 0,01 |

- **ρ = 155 pers/m2**

- **k**

| | **m/s** |
|---|---|
| $PM_{10}$ | 8,60E-03 |
| $SO_2$ | 8,90E-03 |
| Sulfates | 1,98E-02 |
| Nitrates | 1,29E-02 |

## *Emission per vehicles and per distance*

With this formula, we calculate the damages for the differents vehicles for one kilometer :

| | cars | trucks | buses | coaches | lorries | motocycles | Lightweighted motorcycles | |
|---|---|---|---|---|---|---|---|---|
| PM10 - Mortality YOLL [Pope 2002] | 2,35E-09 | 2,07E-08 | 1,16E-07 | 1,04E-07 | 1,02E-07 | 0,00E+00 | 0,00E+00 | **YOLL/km** |
| PM10 - Chronic Bronchitis [Abbey 1995] | 2,36E-10 | 2,08E-09 | 1,16E-08 | 1,05E-08 | 1,02E-08 | 0,00E+00 | 0,00E+00 | **cb/km** |
| PM10 - net Restricted activity days [Ostro 1987] | 1,19E-07 | 1,05E-06 | 5,88E-06 | 5,29E-06 | 5,16E-06 | 0,00E+00 | 0,00E+00 | **days/km** |
| | | | | | | | | |
| SO2 - Mortality YOLL [Anderson/Toulomi 1996] | 8,99E-11 | 4,07E-10 | 1,88E-09 | 1,65E-09 | 1,23E-09 | 2,67E-11 | 1,18E-11 | **YOLL/km** |
| Sulfates - Mortality YOLL [Pope 2002] | 2,95E-09 | 1,34E-08 | 6,17E-08 | 5,41E-08 | 4,03E-08 | 8,78E-10 | 3,87E-10 | **YOLL/km** |
| Sulfates - Chronic Bronchitis [Abbey 1995] | 2,97E-10 | 1,34E-09 | 6,20E-09 | 5,44E-09 | 4,05E-09 | 8,82E-11 | 3,89E-11 | **cb/km** |
| Sulfates - net Restricted activity days [Ostro 1987] | 1,50E-07 | 6,78E-07 | 3,13E-06 | 2,75E-06 | 2,04E-06 | 4,46E-08 | 1,96E-08 | **days/km** |
| | | | | | | | | |
| Nitrates - Mortality YOLL [Pope 2002] | 3,84E-08 | 6,54E-08 | 8,43E-07 | 6,08E-07 | 3,91E-07 | 7,87E-09 | 5,51E-10 | **YOLL/km** |
| Nitrates - Chronic Bronchitis [Abbey 1995] | 3,86E-09 | 6,57E-09 | 8,48E-08 | 6,11E-08 | 3,93E-08 | 7,91E-10 | 5,54E-11 | **cb/km** |
| Nitrates - net Restricted activity days [Ostro 1987] | 1,95E-06 | 3,32E-06 | 4,28E-05 | 3,08E-05 | 1,98E-05 | 3,99E-07 | 2,80E-08 | **days/km** |

## *Emission and cost for Torun for a year*

We know the annual emission from transport in Toruń :

| | TORUN | |
|---|---|---|
| PM | 34 022 000 | **g/yr** |
| $SO_2$ | 54 510 000 | **g/yr** |
| $NO_x$ | 694 920 000 | **g/yr** |

From these informations, we can calculate the damages for a year for the city :

| | Consequences | | Cost | |
|---|---|---|---|---|
| PM10 - Mortality YOLL [Pope 2002] | 5,63 | **YOLL/yr** | 105 773,06 | eur/year |
| PM10 - Chronic Bronchitis [Abbey 1995] | 0,57 | **cb/yr** | 5 315,77 | eur/year |
| PM10 - net Restricted activity days [Ostro 1987] | 285,64 | **days/yr** | 17 452,56 | eur/year |
| | | | | eur/year |
| SO2 - Mortality YOLL [Anderson/Toulomi 1996] | 0,12 | **YOLL/yr** | 3 363,32 | eur/year |
| Sulfates - Mortality YOLL [Pope 2002] | 3,92 | **YOLL/yr** | 73 607,94 | eur/year |
| Sulfates - Chronic Bronchitis [Abbey 1995] | 0,39 | **cb/yr** | 3 699,27 | eur/year |
| Sulfates - net Restricted activity days [Ostro 1987] | 198,78 | **days/yr** | 12 145,31 | eur/year |
| | | | | eur/year |
| Nitrates - Mortality YOLL [Pope 2002] | 3,83E+01 | **YOLL/yr** | 720 159,67 | eur/year |
| Nitrates - Chronic Bronchitis [Abbey 1995] | 3,85E+00 | **cb/yr** | 36 192,64 | eur/year |
| Nitrates - net Restricted activity days [Ostro 1987] | 1,94E+03 | **days/yr** | 118 706,32 | eur/year |
| | TOTAL | | **1 096 415,86** | **eur/year** |

Do you think it is necessary to use coefficient provided by Rabl to take into account that emissions are at the ground level?? There is a table later in the lecture with this?
Which coefficient ? Nie rozumiem...

In this last table, we can see :

- The nitrates are the most expensive pollutant (80% of total). Compared with the others pollutants, it doesn't have more consequence for the same emission but it is one that is issued in greatest quantity
- The YOLL are the most expensive consequence (82% of total)

## The hypothetical scenario

The difference with the previous scenario isn't about the quantity of emission but about the place of these emissions. *(except for the emissions due to congestion. But do we know them ?)*

The goal is to estimate what the emissions will be in the bridge after built a new one.

We don’t have informations about the vehicles but about the streets. So we can’t know where a vehicle is from and where is going.

Also we can’t know the routes most used and count which ones should be shorter by the new bridge.

We have to focus on the streets and not on the routes.

It is logical to vehicles will use the nearest brigde. So it might be thought that a vehicles which is in the west of the city will use the old brigde. On the other hand, a vehicle which is in the east part of the city will likely use the new bridge.

Then, we could separate the city in two parts by a midline. But we can’t say that half vehicles will use a brigde and the other half the second bridge. Because there isn’t the same traffic in the both halves of the town.

Also, I think we could calculate the percentage of traffic in the both parts. For exemple 75% in the west part and 25 % in the east part.

With that, we could know about how many vehicles will use the both bridges. In this same exemple, 75% will use the old and 25% will use the new.