Global climate change
Climate change and road transportation sector

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Abstract
My aim in this article is to prove the connection of CO_2 emission and climate change and to estimate the CO_2 emission of the transport section. We have to clarify the emission of the transport sector in order to get information of externalities, which is a further step to a sustainable society. The sustainable development is a development, where the pace of technical development, the satiation of increasing supply and the raw materials and resources of Earth are poised so that the rate of living and opportunities of the next generations need not to be worse. One of the most emphasized goals of the transport policy of the European Union is sustainable mobility. For this reason transportation systems must be developed and standardized, the effectiveness of transportation service must be increased, while the environmental pollution must be decreased or prevented. Decoupling motorization from environmental pollution is the task for engineers. Decoupling the increase of economical activity from mobility is a task for economists.
Keywords: climate change, diesel oil, petrol, decoupling, motorization,

1. INTRODUCTION

In the last two or three hundred years there was an explosion in the development of industrial and technical sector, which gave people a multiplied set of tools to encroach nature. The motorization has been developed so dynamically that the air, soil, water pollutions are considerable to the amounts of air, soil, water of Earth. The sustainable development is a development, where the pace of technical development, the satiation of increasing supply and the raw materials and resources of Earth are poised so that the rate of living and opportunities of the next generations need not to be worse.

Transportation cannot be replaced because it is the part of the production chain. Societies are horizontally and vertically differential. The manpower, the stock, the semi finished and finished products must be transported. The importance of the transportation sector is indicated by the sector production which is 10% of the GDP of the European Union and more than 10 million people are working in this sector. One of the most emphasized goals of the transport policy of the European Union is sustainable mobility. For this reason transportation systems must be developed and standardized, the effectiveness of transportation service must be increased, while the environmental pollution must be decreased or prevented.

2. CONNECTION BETWEEN CLIMATE CHANGE AND TRANSPORTATION

With common statistical tools the hypothetical trend can be discovered with the elimination of cycle effects. It means that we can apprehend not the individual, short phenomenon, but the long ranged, complex effects. Examining the glass-house effect we assumed that we do not need to examine the whole atmosphere, but only the relevant CO_2 component. That is why we have examined only the average CO_2 concentration in air and the average temperature of the Earth. The time series can be divided into growing and into falling periods.

In the periodic analysis of average temperature of Earth we are going to analyze the decrease and increase of average temperature of Earth. The total times series can be separated into 4

periods. All of them can be separated into a rising and a falling part. They can be compared (Fig 1).

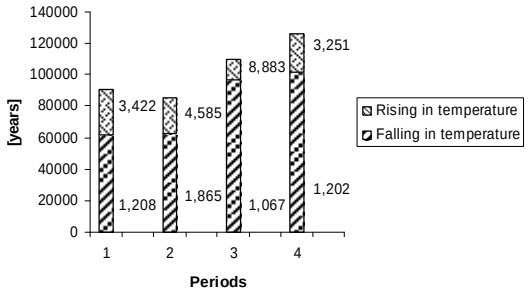

Fig 1. The bars of risings and fallings in temperature

From the results the increase of the periodic time can be estimated but because of the small amount of data rising and falling periods cannot be compared further more. Next to the bar chart the gradient of the risings and fallings can be seen in [°C/10 000 years]. (Table 1.)

Gradient of rising and fallings in temperature
[°C/10 000 years]
Table 1.

	Rising	**Falling**
Maximum	1,865	8,883
Minimum	1,067	3,251
Average	1,336	5,035
Deviation	0,359	2,633

From the data it can be seen that the risings of temperature before the human impact were 3 to 5 times faster than the fallings.

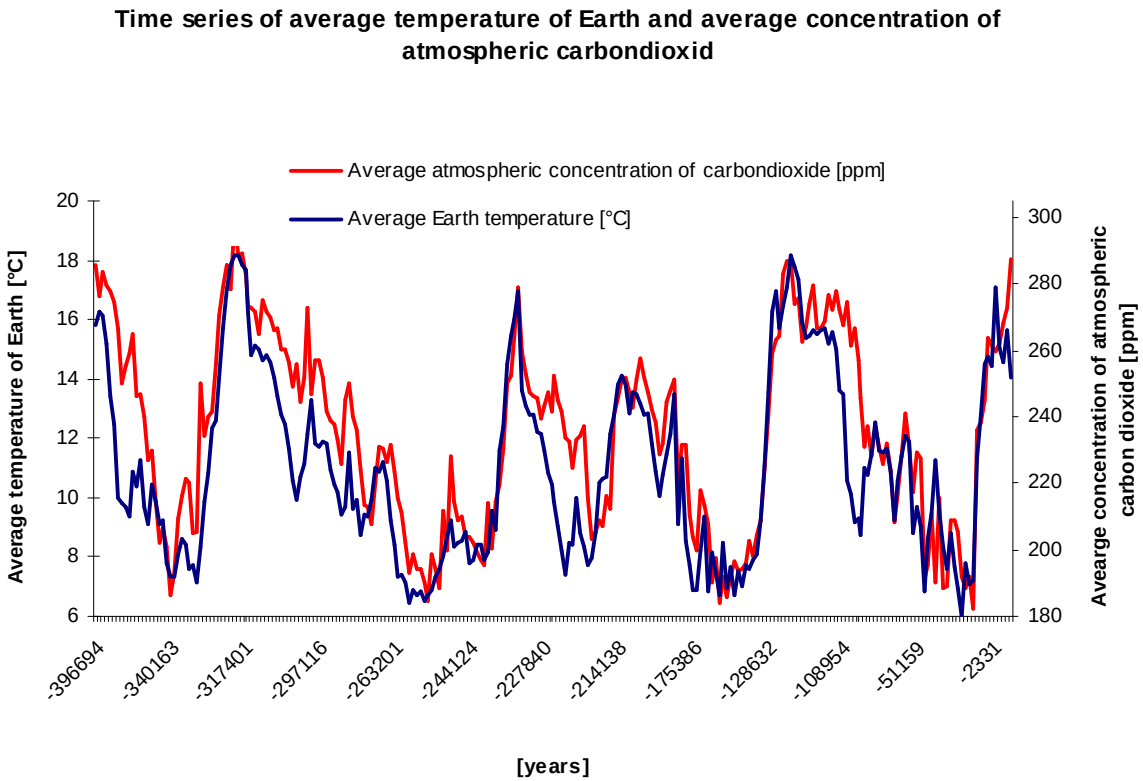

Fig. 2. Normalised time series of CO_2 and temperature before human impact

My hypothesis is that there is relation between the concentration of CO_2 and the average temperature of Earth based on Fig. 2. I will justify the acceptability of my hypothesis by $\chi 2$ test. My H_0 hypothesis: There is a relation between atmospherical CO_2 concentration and average temperature of Earth. My H_1 anti-hypothesis: There is no relation between atmospherical CO_2 concentration and average temperature of Earth. With $\chi 2$ test I tested the normalised values, we got that:

$$\chi^2 = \sum_{i=1}^{m} \frac{(f_i - f_{ti})^2}{f_{ti}} = 118{,}67 \quad (1)$$

$$\chi^2_{crit(0{,}05;238)} = 247{,}98 \quad (2)$$

where
f_i : values of atmospheric CO_2 concentration
f_{ti}: values of average temperature of Earth [2]

The value of χ^2 less than the $\chi^2_{crit}(0{,}05;238)$ (significancy level of α=5 %, freedom of 238), (the probability of false reject of the null hypothesis is exactly 0,05). It can be declared that there is relation between the normalised values of atmospheric CO_2 concentration and the normalised values of average temperature of Earth.
It was a great opportunity to analyse large time series, 238 data of atmospheric CO_2 concentration and average temperature of Earth. I have considered the fact that my hypothesis can be accepted only when the value of χ^2 less than the$\chi^2_{crit}(0{,}05;238)$. I have analysed the fact that my hypothesis would be correct if we had only 95 data of atmospheric CO_2 concentration and average temperature of Earth instead of 238 with the same level significancy (the probability of false reject of the null hypothesis).

As I have continued my analysis I looked for the correlation between CO_2 in atmosphere and global average temperature.

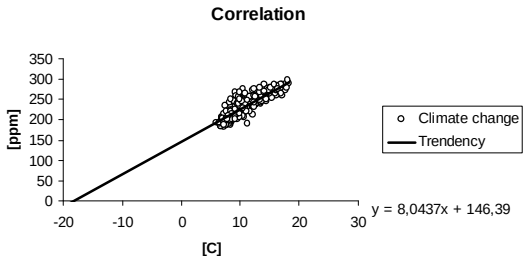

Fig 3. Atmospheric CO_2 concentration in the relation of average temperature of Earth

So there is a strong correlation between atmospheric CO_2 concentration and the average temperature of Earth. (r=0,8657, Fig 3) Nowadays with the great human impact, that is considerable to the size of atmosphere, the relation can be changed. The CO_2 emission caused by humanity raises the global temperature. More than the quarter of the total emission of CO_2 caused by the humanity is produced by road transportation [3]. So the road transportation contributes to climate change. (Fig. 4)

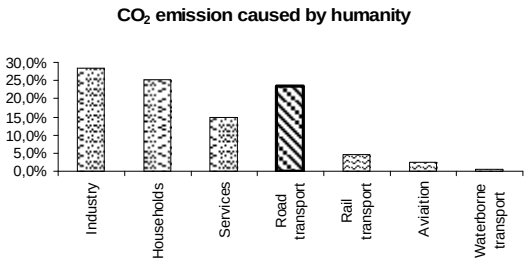

Fig. 4. The road transportation contributes to climate change

There is a common, social will to protect the Earth and the environment. Climate change causes the crescendo of climate extremity in Hungary. There is a strong connection between environment and road transportation. Road transportation has effect on environment by emitting pollutants and greenhouse gases, but environment has also effect on road transportation through climate change. In this point of view transportation has to hold on in this dynamic space. It has to fulfil the challenge of environment, society and economy.

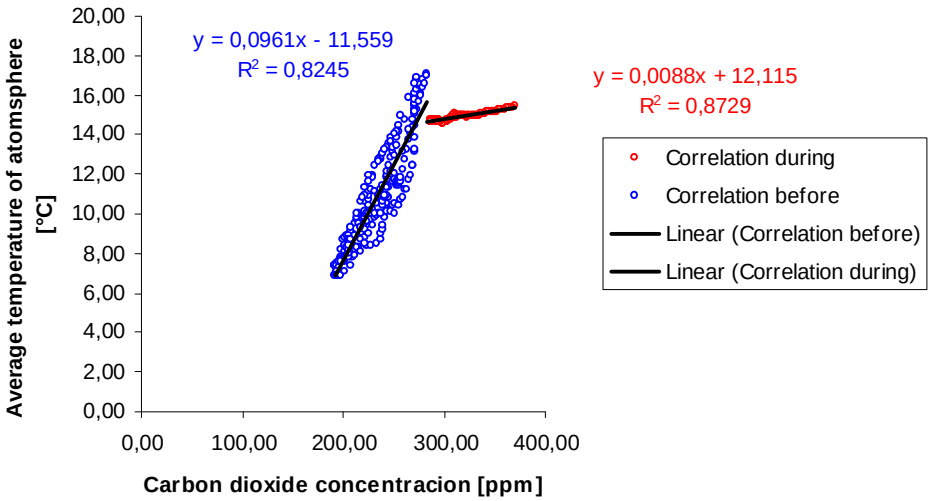

Fig. 5. Correlation between CO_2 concentration and average temperature of atmosphere before and during the human impact

3. LINKAGE BETWEEN ECONOMIC ACTIVITY, AIR POLLUTION AND MOTORIZATION

There is a great disharmony between the modern society that requires more and more mobility and the common will of protecting our environment. The increase of economic activity – presented by GDP [USD/persons/year] causes mobility demand – presented by motorisation [PCU[1]/1000 inhabitant] and increases in environmental pollution – presented by [tC/inhabitant/year]

The time series data were available from International Monetary Found, Energy Information Administration, and Eurostat (For the modeling data of Austria, Belgium, Finland, France, Greece, Netherlands, Luxemburg, Germany, Italy, Portugal, Spain, Hungary between 1993 and 2003 has been used). I have made the average by nations to get the trend of the phenomenon. Regarding the correlation analysis, there is a strong correlation between the

[1] PCU: passenger car unit

GDP and motorisation (r=0,7877), and in the linear regression analysis I got the result that the elasticity of GDP to motorisation is: 0,0094 (Fig. 6.).

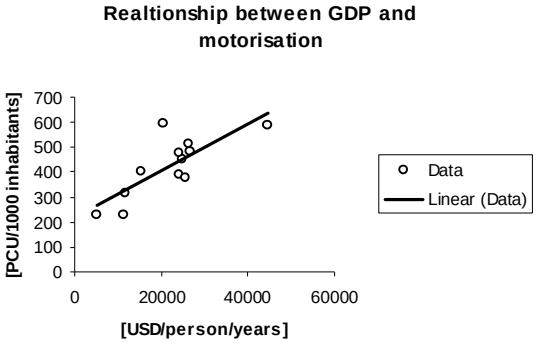

Fig. 6. Relationship between GDP and motorisation

I have found that there is a strong correlation between economic activity and environmental pollution. That means that the increasing economic activity has positive effect on living of standards and negative effect of environmental pollution as well (Fig. 7.)

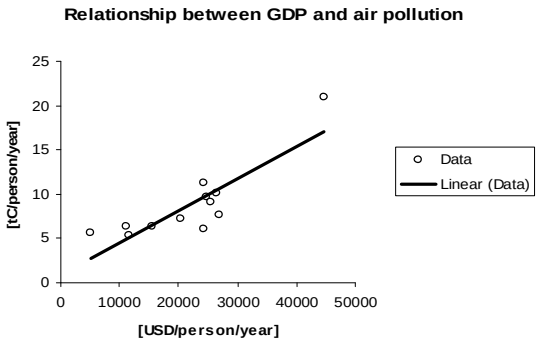

Fig. 7. Relation between GDP and air pollution

I have found that the elasticity of environmental pollution on motorisation is: 0,019. That means 1% change in motorisation in the observed countries causes 0,019 % change in total carbon emission (Fig. 8.).

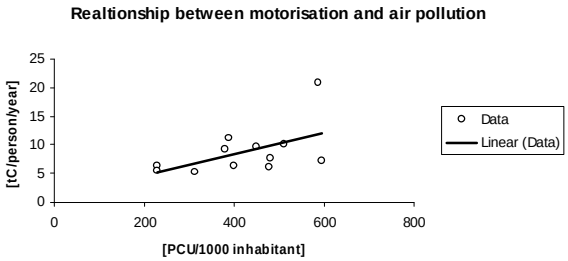

Fig. 8. Relationship between motorization and air pollution

4. CONCLUSION

The high ratio of road transportation in CO_2 emission caused by the humanity made reasonable the research of relation between the road transportation and climate change.

There is a justifiable demand by the society to moderate the environmental impacts caused by road transportation. Before human impact on atmosphere there was relation between the concentration of atmospherical CO_2 and global average temperature.

Nowadays with the human impact to the atmosphere the relation can be modified and that causes changes in our climate

Nowadays there are approved scientifical techniques to calculate social marginal cost of road transportation and to bring equilibrium between transport modes. However the most flexible way of transportation is the road transportation, the marginal social cost of road transportation is high and needs to be monetarised in a harmonised way and shifted to the users.

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