Estimation of the exceedance of the European PM_{10} limit values in Belgian cities and streets during the period 2005 - 2010 - 2015

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1/ Context

Current EU legislation regulating the PM10 concentration in ambient air is given in the EU directive 1999/30/EC, the so-called 1st daughter directive. It states that for PM10 2 binding limit values are to be respected as from 1 january 2005:

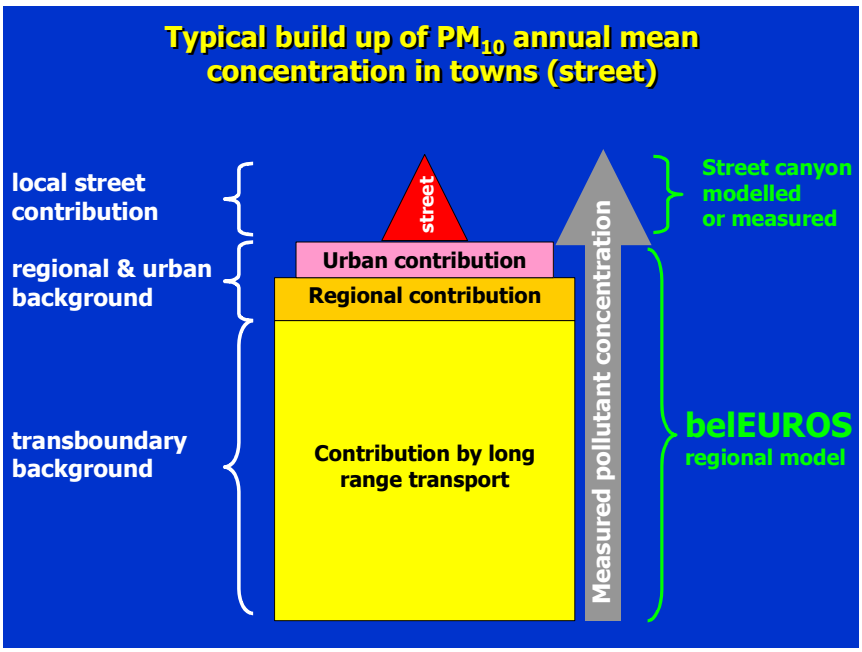
- a daily limit of 50 µg/m³ not to be exceeded on more than 35 days within a calendar year
- an annual mean value of 40 µg/m³

In all but one of the 40 Belgian PM10 measuring stations in 2005, the annual mean limit value (≤ 40 µg/m³) was respected. In 22 of the 40 stations the daily limit values was violated. This situation is the common situation in all neighbouring EU countries. In fact during the meetings of the Environmental working parties of the Council preparing the new Air Quality Directive, it was clear that the two limit values for PM10 (the daily limit and the annual limit) do not at all refer to the same reality of PM10 pollution in the EU countries. If the frequency distribution of the PM10 pollution was considered properly, an annual mean of 40 µg/m³ would correspond with some 70 days of exceedance of the 50 µg/m³ level, or 35 days of exceedances would correspond with an annual mean value of 31 µg/m³.

As it seems that in the new directive the Commission is not going to correct for this historical (statistical) mistake, all countries will still violate for a long time the daily limit value for PM10. The question is when and with what measures and efforts can this daily limit value be attained in Belgium.

2/ Analysis of the origin of the PM10 concentration levels in Belgian towns

It is known that an essential part of the PM10 pollution in towns and streets can be attributed to long range transport from abroad (specially the fraction of secondary PM10). Only recently this effect could be quantified by applying the BelEUROS model which was extended with a module to simulate PM10 (and also PM2.5) concentrations. By simply setting all Belgian emissions to zero it was seen that still 70 - 80% of the originally PM10 concentrations were still present in Belgium.
On top of this international contribution there is a regional (in the sense of the Belgian Regions) and a mean urban overall contribution, called the regional an urban background. This part is also accounted for by the BelEUROS model.
The street increment is due to specific local emissions by traffic in the streets. According to street characteristics (height, width, building size, ..) and the traffic characteristics (number of cars per day, speed, flux regime, …) it can vary considerably from one street to another. This contribution is not accounted or by the BelEUROS model but can be modelled by street canyons models (e.g. the CAR street model which will be implemented at community level in the Flemish Region).
The schematic representation below gives an idea of the origin distribution of PM10 annual mean concentrations in Belgian cities. Model areas are indicated to the right.

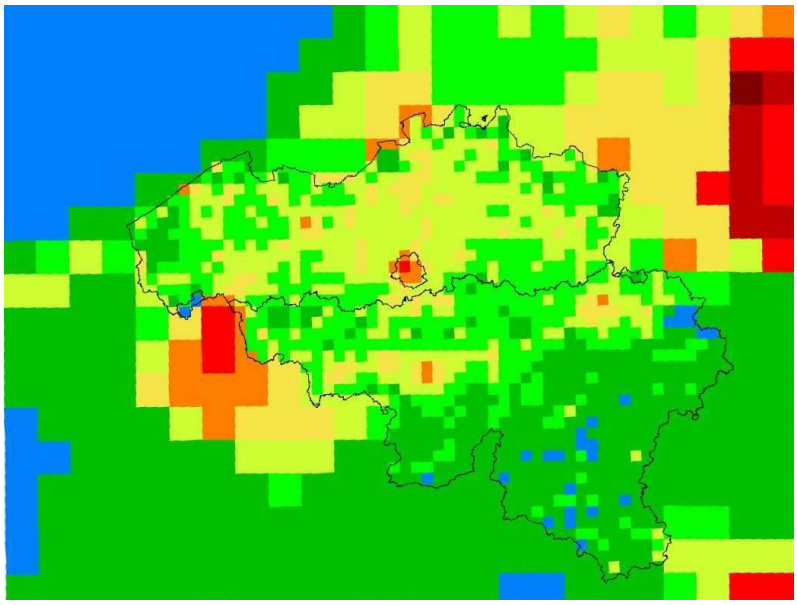


source: IRCEL-CELINE, 2006

The amount of PM10 concentration that is due to local street traffic (street increment) can be estimated from the study "Air Pollution at street level in European cities", EEA Technical report No 1/2005 which can be downloaded at
From this report which includes data for Antwerp and Brussels, we see from fig 4.13 that street increment annual values in 2000 for those 2 cities vary from 4 up to 13 µg/m³ depending on street category (narrow street canyon, square or wide street). From figure 4.17 we conclude that mean street increments of the annual value in the future (in 2030 according to the CLE scenario) will be about 5 µg/m³.

3/ Estimation by BelEUROS of the long range, regional and urban background levels of PM10

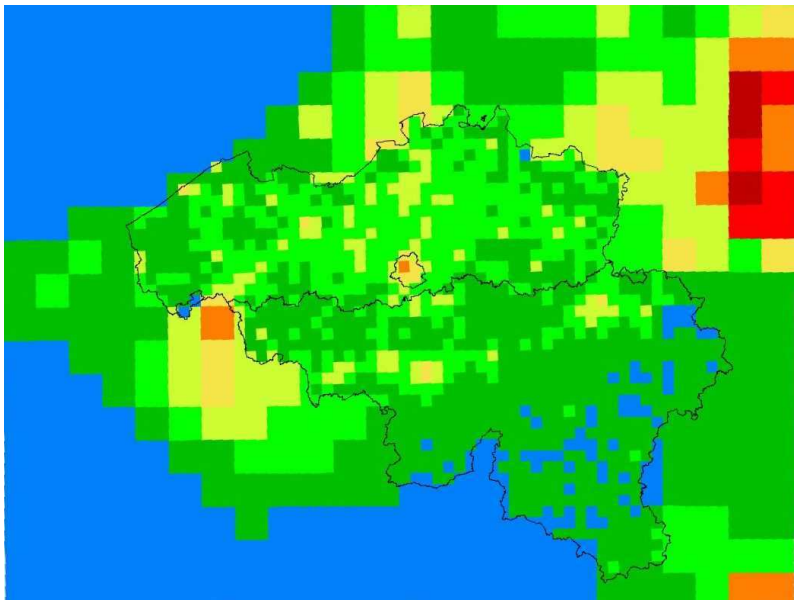
Emission input data for 2005, 2010 and 2015 are the data from the IIASA CLE scenario (Current Legislation) as presented in IIASA report nr. 6, June 2005.
Meteorological data for pollution transfer, chemical transformation and dispersion over the model area were chosen from the year 2002 (source : ECMWF) which can be classified as an “normal” meteorogical year.
In the PM_{10} model results a "tuning up" of the results was carried out to account for the "unmodelled fraction of the concentration" This unmodelled fraction is attributed to PM_{10} emissions from natural sources and resuspension which are not incorporated in the BelEUROS model. It was derived from the comparison of the mean (raw) model results with the observed data in 2005. For the whole model domain an "unmodelled" fraction of 5 µg/m³ PM_{10} was added to the raw modelled annual mean concentrations.
The BelEUROS model can estimate the long range contribution to the background by setting all Belgian emissions to zero. Up till now the model cannot distinguish between the regional and urban background but the outcome of the model accounts for both of them in addition to the long range contribution. The BelEUROS model result is then called the "background" concentration upon which the "street increment" should be added to obtain the simulation of the real (measured) concentration in the streets.
The standard graphical output of the model (grid size 15 x 15 km) has been treated by an algorithm based on population density, land cover and land use data to deliver a much higher resolution of a 5 x 5 km grid for the Belgian region which is fine enough to distinguish clearly cities and agglomerations in Belgium.



PM10 in 2005
Annual mean (µg/m³)

0 - 10
10 - 20
20 - 25
25 - 27.5
27.5 - 30
30 - 32.5
32.5 - 35
35 - 40
40 - 60
60 - 999

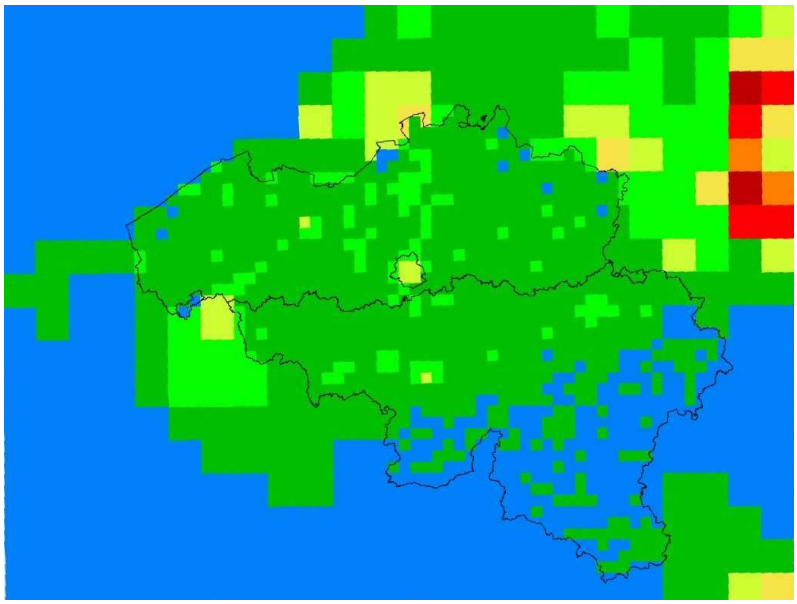
source: BelEUROS (IRCEL-CELINE)
August 2006



PM10 in 2010
Annual mean (µg/m³)

0 - 10
10 - 20
20 - 25
25 - 27.5
27.5 - 30
30 - 32.5
32.5 - 35
35 - 40
40 - 60
60 - 999

source: BelEUROS (IRCEL-CELINE)
August 2006



PM10 in 2015
Annual mean (µg/m³)

0 - 10
10 - 20
20 - 25
25 - 27.5
27.5 - 30
30 - 32.5
32.5 - 35
35 - 40
40 - 60
60 - 999

source: BelEUROS (IRCEL-CELINE)
August 2006

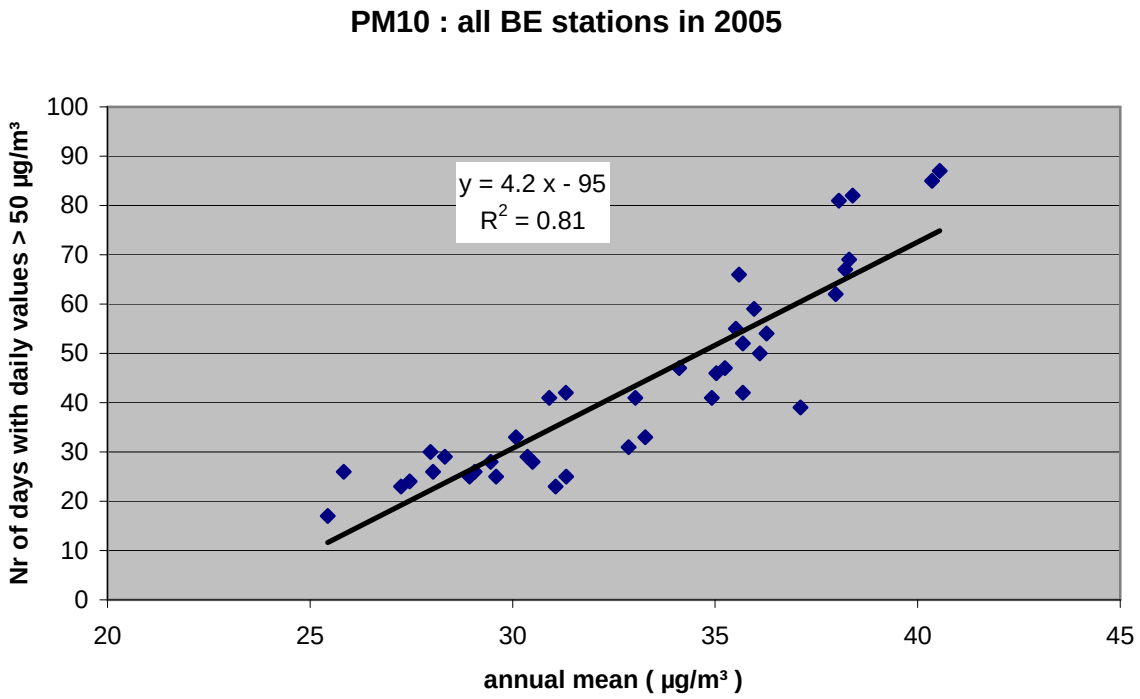
4/ Estimation of the number of days with exceedance of the 50 µg/m³ level

In the model simulation of the PM10 background concentrations for the years 2005, 2010 and 2015, (see maps above) it is seen that all major cities in Belgium belong to 2 annual mean concentration classes. Only the inner city of Brussels belongs to a single higher class. In table form:

year	background PM10 annual mean levels in major cities	background PM10 annual mean in inner city of Brussels
2005	30 -35 µg/m³	32.5 - 40 µg/m³
2010	27.5 - 32.5 µg/m³	30 - 35 µg/m³
2015	25 - 30 µg/m³	30 - 32.5 µg/m³

As was already referred to above the experimental distribution of the measured values in the 40 Belgian stations that measured PM10 in 2005 presents a rather robust correlation between the annual mean value and the number of days that the daily value of 50 µg/m³ was exceeded. At the IRCEL interregional database the following correlation was derived:

The **nr of days** with exceedance of 50 µg/m³ = [**4.2** times the **annual mean** value - **95**]



Source: Interregional Air Quality database (IRCEL)

The EU Directive 1999/30/EC allows as the daily limit value for PM10 35 days of exceedance of the daily value of 50 µg/m³. From the above graph it is seen more than half of the measuring stations violated this limit value in 2005, while all but one of them respected the annual mean limit value of 40 µg/m³. Anyway with the help of this graph, annual mean concentrations can be transposed to a number of exceedances of the daily limit value.
The above table can be extended as follows:

year	background PM10 annual mean in major cities	number of days on which the daily limit value for PM10 is exceeded in urban background locations
2005	30 -35 µg/m³	31 -52 days
2010	27.5 - 32.5 µg/m³	20 - 41 days
2015	25 - 30 µg/m³	10 - 31 days

This estimation shows that under CLE measures the EU daily limit value for PM10 (35 days with exceedances) will not be attained in all Belgian urban background locations before 2015. From 2010 on, the urban background in some cities may attain this goal.

5/ Estimation of the attainment of the daily PM10 value in busy streets of the Belgian cities

As stated before the "street increment" has to be added to the background annual mean concentrations which are calculated above. Street increments in narrow streets with heavy traffic may add up to 13 µg/m³ above the background annual mean in 2000 and will probably moderate under CLE to 5 µg/m³ in 2015.

The above table for "narrow busy street canyons" becomes then:

year	background PM10 annual mean in major cities	*street increment* in some narrow busy streets	annual mean in narrow busy streets	number of days on which the daily limit value for PM10 will be exceeded in narrow busy streets
2005	30 -35 µg/m³	10 µg/m³	40 -45 µg/m³	73 -94 days
2010	27.5 - 32.5 µg/m³	10 µg/m³	37.5 - 42.5 µg/m³	62 - 83 days
2015	25 - 30 µg/m³	5 µg/m³	30 - 35 µg/m³	31 - 52 days

This estimates show that in busy streets in Belgian cities the EU daily limit value for PM10 (35 days of exceedances) will not be attained under CLE measures not even in 2015.

7/ Efforts and costs for implementing the CLE scenario and additional efforts proposed in the EU Thematic Strategy:

According to the IIASA report "A final set of scenario's for the Clean Air for Europe (CAFE) programme", report n° 6, June 2005, the implementation in Belgium of *Current Legislation (CLE)* would represent a total cost of 1959 million EUR per year. This cost is to be considered as the total effort that has to be done by all sectors, agriculture, industries, house holdings and governmental initiatives. With this 2.000 Million EUR/year the daily limit value for PM10 will not be attained at all places in cities where people are living, only in urban background locations, the limit will be attained from 2010 on in some cities and in all urban background locations in 2015.

In its Conclusions on 9 March 2006 the Council adopted the *Thematic Strategy* which should be implemented in order to better protect human health and the environment. The additional costs for Belgium are estimated at some 300 million EUR per year, These cost (on top of the costs for the CLE scenario) are spread over the following sectors:

- agriculture: 37% = 111 million EUR per year
- traffic: 30% = 90 million EUR per year
- industry: 28% = 84 million EUR per year
- and house holdings: 5% = 15 million EUR per year

Although the fact that the Thematic Strategy will speed up some benefits with respect to the CLE scenario, those additional measures cannot guarantee that the daily PM10 limit value will be attained in 2010 in all cities in Belgium.

Estimation of the exceedance of the proposed European $PM_{2,5}$ limit values in Belgian cities and streets during the period 2005 - 2010 - 2015

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4 September 2006

1/ Context

Current EU legislation is not regulating the $PM_{2.5}$ concentration in ambient air. One of the aims of the new Air Quality directive is exactly the regulation of $PM_{2,5}$ concentrations in ambient air and the reduction of the population exposure to $PM_{2,5}$. In the current proposal -as presented at the Environmental Council Meeting on 27 June 2006, where a "general approach" was agreed between the Member States- the regulation will include:

- a non-binding target value for the $PM_{2,5}$ annual mean of 25 µg/m³ to be realised as far as possible on 1 January 2010
- a binding limit value of 25 µg/m³ for the $PM_{2,5}$ annual mean from 1 January 2015
- a reduction of the population exposure index by 20% in 2020 compared to the exposure in 2010

No target value nor limit value for the daily concentrations of $PM_{2,5}$ was proposed !

2/ Analysis of the origin of the $PM_{2,5}$ concentration levels in Belgian towns

Recently the BelEUROS model was extended with a module to simulate also $PM_{2,5}$ concentrations. As for the simulation of the PM_{10} concentration, the model accounts for the long range transport, for the regional and urban background contributions to the $PM_{2,5}$ concentrations.

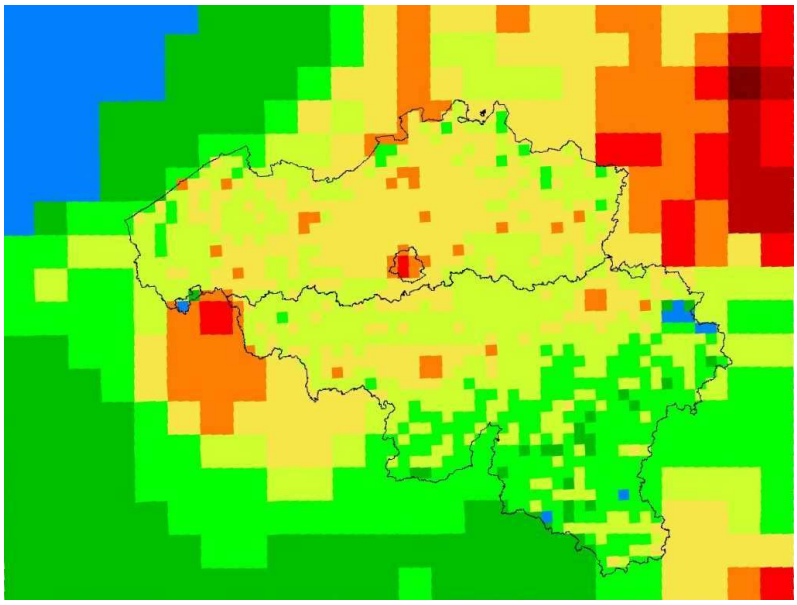
On top of these contributions there is a "street increment" which is due to specific local emissions by traffic in the streets. According to street characteristics (height, width, building size, ..) and the traffic characteristics (number of cars per day, speed, flux regime, …) it can vary considerably from one street to another. This contribution is not accounted for by the BelEUROS model but can be modelled by street canyons models (e.g. the CAR street model which will be implemented at community level in the Flemish Region).

The amount of $PM_{2,5}$ concentration that is due to local street traffic (street increment) can also be estimated from the study "Air Pollution at street level in European cities", EEA Technical report No 1/2005 which can be downloaded at
From this report (which includes data for Antwerp and Brussels) we see from fig 4.9 that street increment of the $PM_{2,5}$ annual values in 2000 for those 2 cities are between 8 and 9 µg/m³ for the narrow street canyon case. From figure 4.18 we conclude that mean street increments of the annual value of $PM_{2,5}$ in the future (in 2030 according to the CLE scenario) will be about 3 µg/m³. These data suggest that the street increment of the annual value for mean streets in 2005 and 2010 in Belgium can be estimated at 8 µg/m³ and the increment for narrow street canyons in 2015 at about 4 µg/m³.

3/ Estimation by BelEUROS of the long range, regional and urban background levels of $PM_{2,5}$

Emission input data for 2005, 2010 and 2015 are the data from the IIASA CLE scenario (Current Legislation) as presented in IIASA report nr. 6, June 2005.
Meteorological data for pollution transfer, chemical transformation and dispersion over the model area were chosen from the year 2002 (source : ECMWF) which can be classified as a “normal” meteorological year.

In the $PM_{2,5}$ model results a "tuning up" of the results was carried out to account for the "unmodelled fraction of the concentration" This unmodelled fraction is attributed to $PM_{2,5}$ emissions from natural sources and resuspension which are not incorporated in the BelEUROS model. It was derived from the comparison of the mean (raw) model results with the observed data. For the whole model domain an "unmodelled" fraction of 2 µg/m³ $PM_{2,5}$ was added to the raw modelled annual mean concentrations.

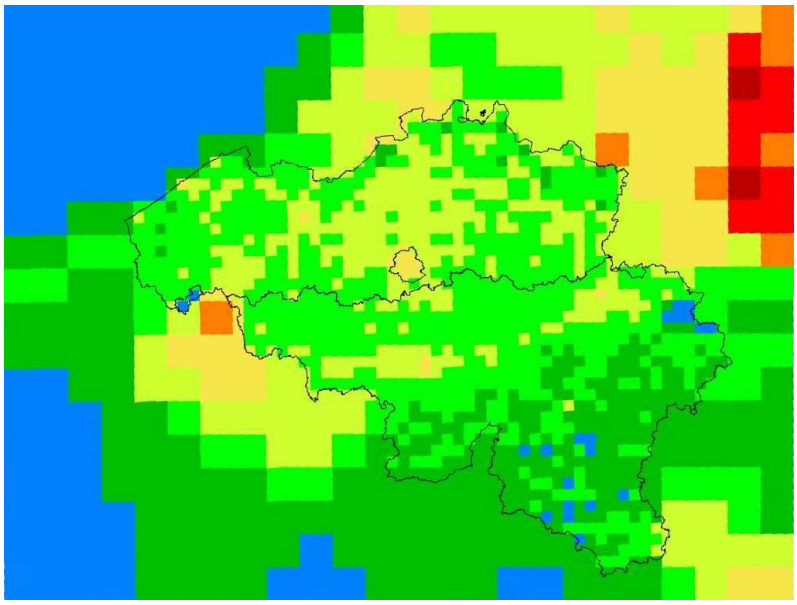


$PM_{2,5}$ in 2005

Annual mean (µg/m³)

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 17.5
- 17.5 - 20
- 20 - 22.5
- 22.5 - 25
- 25 - 30
- 30 - 40
- 40 - 999

source: BelEUROS (IRCEL-CELINE)
September 2006

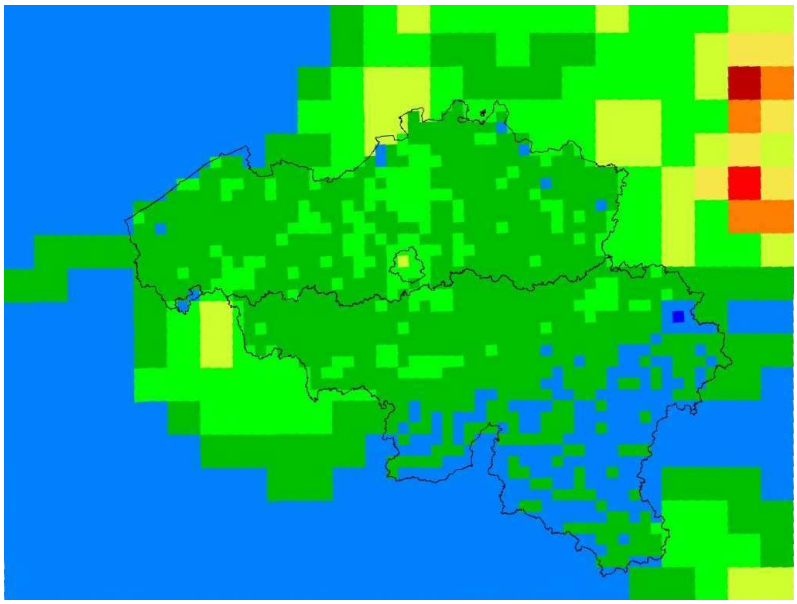


$PM_{2,5}$ in 2010

Annual mean (µg/m³)

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 17.5
- 17.5 - 20
- 20 - 22.5
- 22.5 - 25
- 25 - 30
- 30 - 40
- 40 - 999

source: BelEUROS (IRCEL-CELINE)
September 2006



$PM_{2,5}$ in 2015

Annual mean (µg/m³)

- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 17.5
- 17.5 - 20
- 20 - 22.5
- 22.5 - 25
- 25 - 30
- 30 - 40
- 40 - 999

source: BelEUROS (IRCEL-CELINE)
September 2006

In the model simulation of the $PM_{2,5}$ background concentrations for the years 2005, 2010 and 2015, (see maps above) it is seen that the major cities in Belgium belong almost all to the same annual mean concentration class Only the inner city of Brussels belongs to a single higher class. Covering the whole range in Belgian cities the figures can be summarised in the following table:

year	background $PM_{2,5}$ annual mean in major cities (*see maps above*)	*street increment* in some narrow busy streets	annual mean in narrow busy streets
2005	**22.5 -25** µg/m³	8 µg/m³	**30.5 - 33** µg/m³
2010	**17.5 - 22.5** µg/m³	8 µg/m³	**25.5 - 30.5** µg/m³
2015	**15 - 20** µg/m³	4 µg/m³	**19 - 24** µg/m³

This estimates show that even in busy streets in Belgian cities the proposed EU annual mean value for $PM_{2,5}$ (25 µg/m³) under CLE measures might be respected after 2010.

This means that the proposed target value (annual mean of 25 µg/m³ on 1 January 2010) might be attained in the majority of the Belgian cities with the exception of narrow busy street in cities.

The proposed limit value (annual mean of 25 µg/m³ on 1 January 2015) will most probably be respected everywhere in the Belgian cities.

As for the *reduction of the general urban exposure index* (20% in 2020 compared to 2010), model runs are still in progress in order to make an estimation of the attainability.