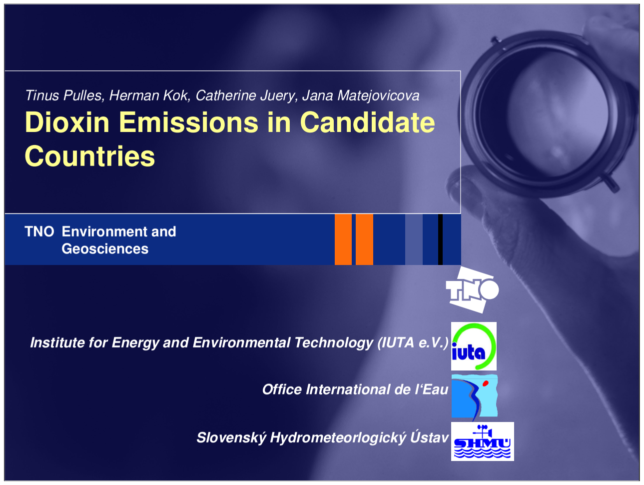

Presentation at the Workshop

Dioxins in the enlarged EU – is there a need for specific action

Brussels, February 2nd, 2005

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This handout contains some text fragments from the report.

To secure better protection of human health and of the environment from the effects of dioxins and PCBs, on 24th October 2001 the Commission adopted a « Communication on a Community Strategy for Dioxins, Furans and Polychlorinated Biphenyls » COM(2001)593. The Communication outlines the problem of dioxins and PCBs, the progress in addressing the problem, the remaining gaps, the basis for Community action and it develops a strategy to reduce the presence of these compounds in the environment, in feed and food. Dioxins are widely encountered toxic substances. They are found in all environmental compartments, are persistent and, being fat soluble, they tend to accumulate in higher animals - including humans. Their resistance to degradation and semi-volatility means that they may be transported over long distances and give rise to trans-national exchanges of pollutants.

As a result of the enlargement of the European Union (EU) to include Candidate Countries (CCs) the European Commission reckons with the possibility of increased average exposure to dioxins in the EU. However a harmonized dioxin emission inventory as exists for the current Member States is not available yet.

Against this background, the European Commission has commissioned a study “Dioxin Emissions in Candidate Countries” to a consortium lead by TNO (contract No B4-3040/2002/348064/MAR/C2). Other partners in the consortium were IUTA from Germany, IOW from France and SHMU from Slovakia.

The inventories

- **Air emission inventory**
  - Well developed and detailed
  - Uncertainty analysis
  - Projections until 2030
- **Water and Land emission inventory**
  - First estimate
  - Only limited information available

The project contains two major activities:

- Development of an emission inventory of dioxins for the candidate countries for emissions to air, water and land
- Carrying out of a series of supporting air emission measurements to improve the quality of the knowledge on dioxin emissions in the candidate countries.

These activities have as a secondary objective to support the development of capacities and expertise within the countries to a level that is needed for the EU policy in the field of dioxins. Both the development of the inventory and the carrying out of the measurements will therefore be achieved in close co-operation with the national experts. The results of the study can help countries to develop and complete a list (database) of dioxin sources and emission factors as well.

To achieve both goals for both activities a series of two workshops were organised in Bratislava (Slovak Republic). These workshops served to set the stage for the project, to agree on approaches and methods and to connect optimally with possible information available in the participating countries. We stress however that the results as presented in this report and its annexes is fully for the responsibility of the consortium. The participation of the countries' experts does not imply that the national authorities of these countries fully agree with the results.

The compilation of the dioxin emission inventory for the 13 countries in this study was a stepwise approach, aimed at making optimal use of both available expertise at the partners in the consortium and the knowledge and expertise in the countries.

A first draft release of a Candidate Countries dioxin emission inventory has been compiled and presented at a first workshop (Bratislava, March 10, 2003) to the national experts from the participating countries. The main purpose of this first draft inventory was to discuss the structure of the inventory in terms of sector definitions and data sources. The resulting emission estimates in this draft inventory were very preliminary and quite rough. The discussions at the workshop resulted in acceptance of the database structure and the mutual understanding between the partners in the consortium and the country experts on the availability, the possibilities and limitations of several data sets to be used.

The comments and information obtained from the countries at the workshop and afterwards have been incorporated into a second version of the inventory. This inventory was described in the project's Interim Report and was presented at the second workshop (again Bratislava, February 2 and 3, 2004). The discussions at the second workshop were more oriented towards the activity data, the emission factors and the resulting emission estimates and again comments, additions and corrections were received from the participating countries.

The dioxin air emissions inventory as presented in this report is the result of this procedure and contains an estimate of these emissions that is consistent between countries, based on data that have been checked by countries as far as possible and therefore might be regarded as the best estimate at this moment in time.

Inventory model

$$Emissions_{sector,fuel} = Activity_{sector,fuel} \times Emission\ Factor_{sector,fuel}$$

$$Emissions = \sum_{sectors,fuels} Emissions_{sectors,fuel}$$

Country data available
- Compare with other data
- We use it

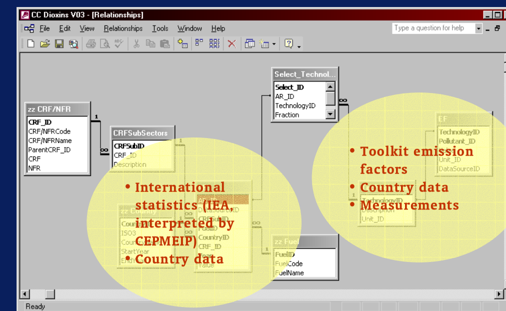
No country data available
- International data available
- TNO estimate using a proxy
- Conservative estimate

The method applied in compiling the air emission inventory for dioxins in the thirteen countries of this study, is the one generally applied in almost all emission inventories. For each relevant sector and fuel, the emission is calculated by multiplying an activity rate with an appropriate emission factor:

Please note that only combustion processes will use the specification of "fuel".

In compiling the emission inventory for a country, for each relevant sector and fuel activity data and appropriate emission factors must be collected. The total emission inventory database therefore will be a collection of activity data and emission factors for each country.

Database structure and data sources



To accommodate the method as described above, a relational database structure was developed for this project to store all relevant data. This structure is given in Figure 1:

- Activity data are stored in a table "AR", with reference to a country, a subsector of the CRF/NFR sector definitions and a fuel.
- Emission factors are stored as an additional property of a table of "Technologies". Each technology in this table can be applied for several activity and fuel combinations and different technologies could be available to choose between for each activity and fuel combination..
- A table "Select Technologies" connects at least one specific technology to each activity rate in every country. If more than one technology is used, the fraction of the activity connected to each technology can be entered in a special field.

This structure allows for application of different emission factors in different countries, related to the technologies applied. The table of technologies is build on top of the table of emission sources as defined in the UNEP Chemicals Toolkit. Each of the air emission factors provided in the Toolkit is interpreted as one technology that could be applied in one or more sectors.

Source sectors

Table 1 *Relevant CRF / NFR sector definitions in the dioxin emission inventory. Please note that all sector codes starting with "1.A" refer to combustion processes. The numbers indicate the number of activity / fuel combinations for each country.*

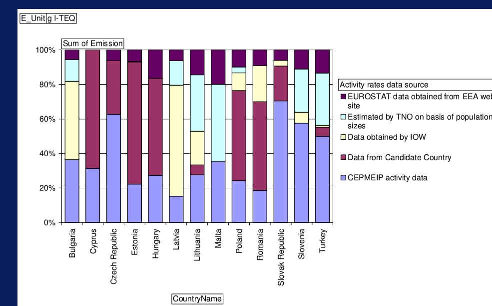
CRF/NFR Code	Crf/nfr description	Total number of emissions	BGR	CYP	CZE	EST	HUN	LTU	LVA	MLT	POL	ROM	SVK	SVN	TUR
1.A.1.a	Public electricity and heat production	56	6	2	5	4	5	3	3	2	5	6	5	5	5
1.A.2.b	Non-ferrous metals	1									1				
1.A.2.d	Pulp, paper and print	5	1			1	1				1	1			
1.A.2.f	Other (please specify in a covering note)	10	1			1	2	1	1		1	1	1	1	
1.A.3.b	Road transport	1		1											
1.A.4.b.i	Residential plants	63	6	2	6	5	6	4	5	1	4	8	5	6	5
1.B.1.b	Solid fuel transformation	9	1		1	1	1				1	1	1		1
2.A.1	Cement production	12	1	1	1	1	1	1	1		1	1	1	1	1
2.A.2	Lime production	13	1	1	1	1	1	1	1	1	1	1	1	1	1
2.A.6	Road paving with asphalt	1					1								
2.A.7	Other including non fuel mining & construction (please specify in a covering note)	3					3								
2.B	Chemical industry	1													1
2.B.5	Other (please specify in a covering note)	1					1								
2.C.1	Iron and steel production	1			1										
2.C.1.1	Steel	2					1				1				
2.C.1.2	Pig iron	3			1		1				1				
2.C.1.3	Sinter	8	1		1		1				1	1	1	1	1
2.C.2	Ferroalloys production	1			1										
2.C.3	Aluminium production	6			1		1				1	1	1		1
2.C.5	Other (please specify)	20	3		2		2				4	2	3	1	3
2.D.1	Pulp and paper	2					1								1
3.D	Other including products containing hms and pops (please specify in a covering note)	26	2	2	2	2	2	2	2	2	2	2	2	2	2
6.C	Waste incineration	67	5	4	6	4	6	6	5	4	7	6	5	5	4

Emission inventories in most countries now are compiled using a set of sector definitions that has been developed under the work of IPCC to be applied in emission inventories for the Climate Change convention (UNFCCC). Recently, the Convention on Long Range Transboundary Air Pollution (LRTAP) has also adopted a set of sector definitions that is fully consistent with these IPCC sector definitions [5] The IPCC set now is known as "CRF" sectors, whereas the LRTAP set is known as "NFR"

At the first workshop within this project, we proposed to also use these sector definitions in this project. This proposal has been accepted by the countries. In Table 1 all relevant CRF/NFR sectors are presented.

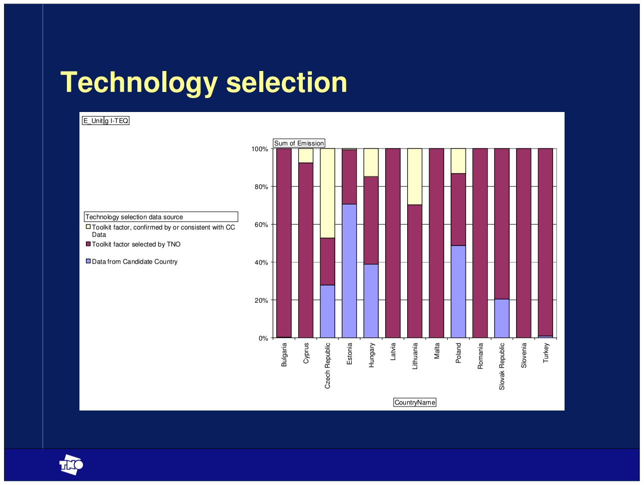
The table shows that for most countries, combustion processes are the most frequent sources of dioxin emissions. A second important source is the waste incineration.

Source of activity data



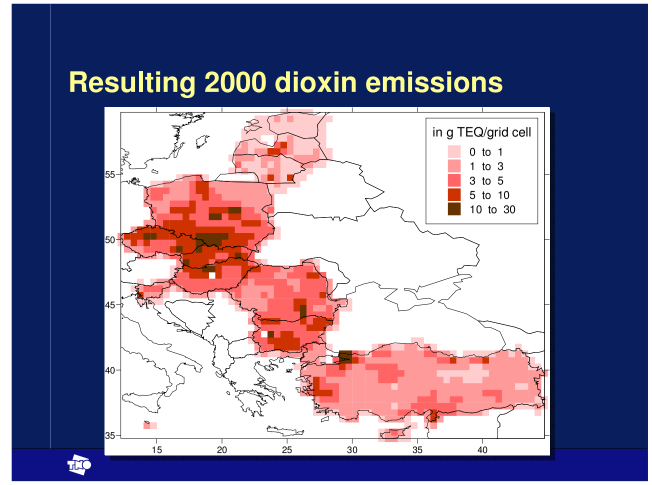
Activity data for the inventory were obtained from a series of data sources as presented in Table 4:

- The activity data used in the CEPMEIP-project to estimate particulate matter emissions in Europe [1], [2]. These data are derived from international statistics from IEA and other international organisations. For each relevant fuel combustion process, the IEA data set provides the amount of fuel combusted, both in mass terms and in energy terms. Attribution of the fuel combustion to source sectors is based on the sector descriptions ("flows") in the IEA dataset.
- Corrections, additions and updates of these data obtained from the national experts participating in the project; the corrections were used to overwrite the CEPMEIP interpretation of the IEA dataset.
- Additional data provided to IOW while collecting the water and land emissions inventory; these data were complimentary to the CEPMEIP and national data.
- TNO's estimate, based on a proxy approach. As a proxy population sizes and data for some countries as available in the European Dioxin Emission Inventory ([1], [2]) were used. Where this approach was used an averaged per capita emission factor was derived from the EU inventory and applied to the thirteen countries in this study:
    - Preservation of wood: an emission factor of 1 µg I-TEQ per inhabitant was assumed
    - Fires: an emission factor of 1 µg I-TEQ per inhabitant was assumed
    - Domestic waste burning: we assumed 10 kg of waste / inhabitant per year;
    - Incineration of hospital waste: 1.5 kg / inhabitant per year, based on an averaged value of 1.7 kg / inhabitant [per year for the EU15 countries; in the EU15 countries this value variaes over a factor of 4 between countries
- EUROSTAT data as published on the web site of the European Environment Agency (EEA, [6])



In the inventory we used emission factors according to the following approach:

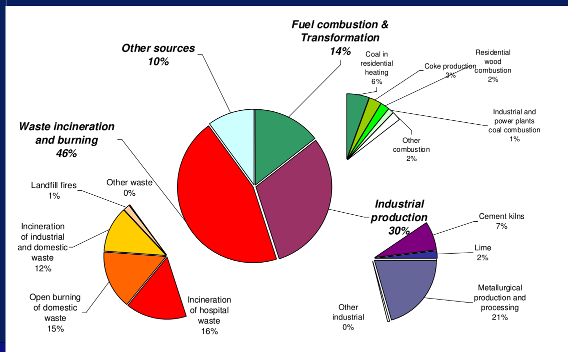
- If an emission factor given by a participating country differs less than a factor 3 from the corresponding Toolkit factor we used the Toolkit factor (in the assumption that less than a factor 3 difference is not relevant because differences between succeeding Toolkit factor usually are about a factor of 10).
- If an emission factor given by a participating country differs more than a factor 3 from the corresponding Toolkit factor we used the participating country factor for that country.
- For all activities, where the UN Chemicals Toolkit provides more than one emission factor, we selected the highest one, unless the country indicated that some kind of abatement technology was installed. In such cases a lower emission factor technology from the Toolkit was selected.
- For waste incineration (Category 1 in the UNEP Chemicals Toolkit) the highest but one emission factor was selected, unless better information was available. The highest emission factors here are applicable for fully uncontrolled incineration in open fires and were assumed to be too high for the countries in this study. For municipal solid waste incineration the highest but one emission factor is comparable to the one for uncontrolled waste burning of category 6 of the Toolkit. Comparable emissions factors for these types of incinerations seems to be sensible.
  This assumption however is very crucial for the inventory, since selecting the highest emission factors would result in dioxin emissions that are about a factor of five to ten higher in all countries, resulting in considerably higher total emissions (see also section 3.2.3)



In Figure 3 the geographical distribution of dioxin emissions in the thirteen countries, based on population densities, is presented. This map should be regarded as a preliminary estimate. The locations of individual sources are not known. The gridding has been performed assuming that the majority of activities takes place where people live at the geographical resolution applied (0.5 x 0.5 longitude latitude grid cells; typical size in this area 25 x 50 kilometres, depending on latitude).

Not surprisingly, in most countries the capital area appears to show highest emission densities. Furthermore the so-called black triangle (at the borders between Poland, Czech Republic and Slovak Republic) and the Istanbul area are the areas with high emission densities.

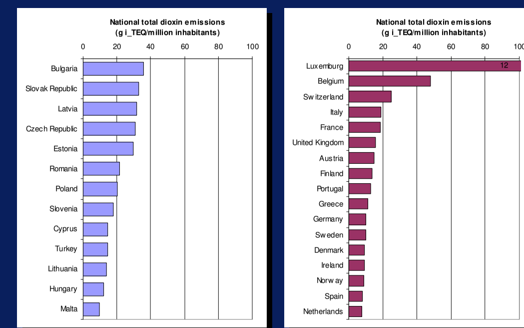
Source sector contributions



The contributions by different sectors to the total emissions are given in Figure 6. Important sources are in the waste sector, industrial production (metals and minerals). Minor contributions are from product use and fuel combustion.

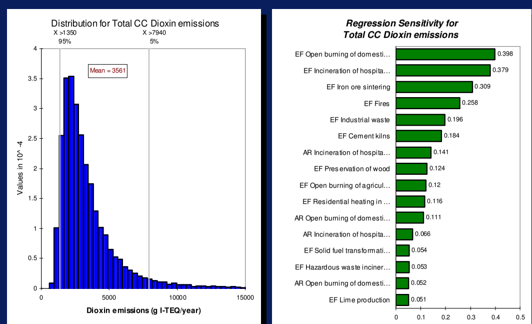
The sector contributions to the total dioxin emissions, as given above, are also given in the pie charts of Figure 7. The major sources of dioxin emissions to air in the thirteen countries are in waste incineration and burning and in the metallurgical industry. Waste burning and incineration amount to almost half of all emissions in the region. Within these, incineration of hospital wastes, of industrial and domestic waste and the open burning of domestic wastes have a similar contribution.

Compare CC with EU15



Emissions in the thirteen countries vary between 35 (Bulgaria) and 8 (Malta) g I-TEQ per one million inhabitants. As a comparison, Figure 5 presents the relative emissions in the Western European countries (the "old" EU 15 Member States, Norway and Switzerland). For these countries the emissions vary between 125 (Luxembourg) and 7.5 (Netherlands) g I-TEQ per one million inhabitants. The emissions in the majority of these countries are between 10 and 20 g I-TEQ per one million inhabitants.

Uncertainty analysis



A Monte Carlo uncertainty analysis[1] can be used to establish 95 % confidence intervals for each country and the thirteen countries in this study together. For such an analysis, both point estimates (the most probable or modal value) and uncertainty ranges for each activity rate and emission factor must be chosen. In our approach we assumed lognormal distributions for all variables and parameters.

As is shown in Figure 1, the 90 % confidence interval (5 % percentile to 95 % percentile) for the total emissions lies between 1.4 and 7.9 kg I-TEQ per annum. The median value in a lognormal distribution occurs around 2.8 kg I-TEQ. Since the distribution of values, obtained in the analysis is clearly skewed towards higher values, the arithmetic average, obtained in the analysis is around 3.5 kg I-TEQ per annum.

Figure 12 presents an analysis of the largest contributions to the uncertainty in the emissions, by means of a regression between sampled input values and the resulting output value. The higher the regression coefficient, the higher the influence of the input variable's uncertainty on the total uncertainty. The most important uncertainty is the uncertainty in the emission factor for open burning of domestic waste (correlation coefficient: 0.398, assumed uncertainty range: a factor of three). In this case we applied a value of 3000 g I-TEQ/ton, whereas the Toolkit provides values in the range between 525 and 40000.

[1] IPCC Good Practice Guidance and Uncertainty Managment (IPCC, 2000)

Projections

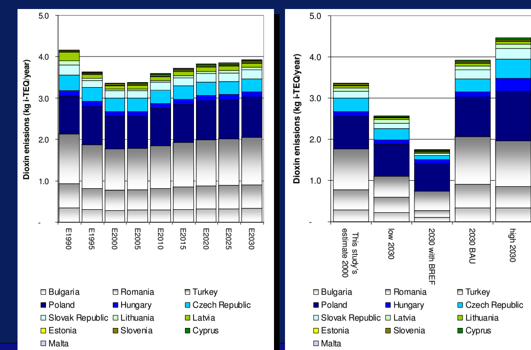
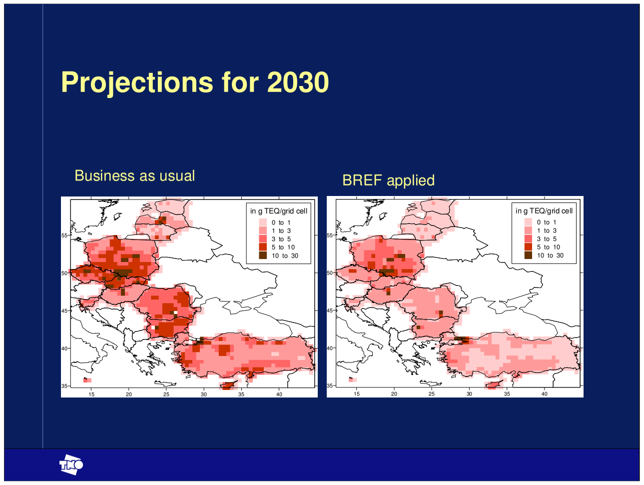


Figure 13 presents the projected dioxin emissions in each of the thirteen countries in this study, estimated as described above. It is shown that, according to this estimate, the dioxin emissions to air in the thirteen countries decreased from about 4.5 in 1990 to 3.6 kg I-TEQ per annum in 2000. The decrease is relatively largest in Slovakia and the Baltic states. This is due to the decrease of energy use, caused by the economic slow down occurring after the collapse of the planned economies in these countries over that period. This happened to a relatively lesser extent in the other countries. Please note that Bulgaria, Romania and Turkey follow the over all pattern. This might be an artefact of the method.

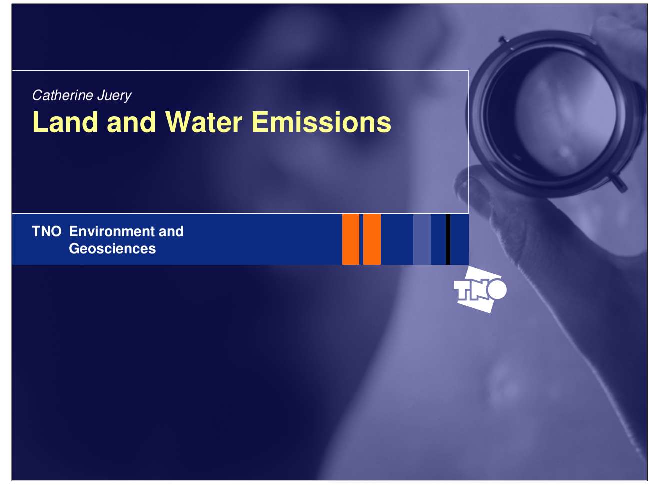
In the coming 30 years the emissions will, according to this scenario, again rise to 4.4 kg I-TEQ / year. A relatively large increase is expected in Poland, due to the assumed increase in use of biomass wastes and other solid fuels (OS1 and OS2) in this country.

The projection as presented above, assumes no changes in the emission factors. However it might be expected that in the coming 30 years the technologies involved will improve and emission factors will go down. Figure 15 shows that the introduction of better technologies indeed will decrease the emissions of dioxins well below the actual value. It is shown that, if all countries apply a technology that is one step better than the present one (see section 3.2.3 for an explanation) the emissions might go down from 3.4 kg I-TEQ now to 2.5 kg I-TEQ ("low estimate"). If all technologies comply with the IPPC requirements as given in the BREFs, a further decrease to 1.8 kg I-TEQ is possible.



From this analysis we conclude that

- Emissions of dioxins to air have decreased in the period 1990 to 2000, mainly due to the decrease of energy consumption in these countries.
- The increase in energy consumption, expected to occur according to the IIASA base line scenario, might lead to an increase of dioxin emissions to air of about one quarter in the period till 2030.
- When however in all countries the technologies used for all processes are improved to the ones already in use now in some of these countries by this date, the total emissions of dioxins to air might decrease with about 25 %.
- When all installations in the countries will comply with the requirements of the IPPC Directive, as given in the respective BREF documents, emissions might decrease by almost 50 % relative to the present emissions.



DIOXIN EMISSIONS IN CANDIDATE COUNTRIES

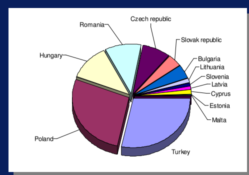
RELEASE OF DIOXINS TO LAND AND WATER

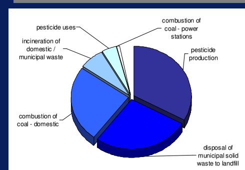
Catherine JUERY

Version October 15th 2004

Emissions to land

- **Larger countries: larger emissions**
  - Turkey
  - Poland
  - Hungary
  - Romania
  - Czech Republic
- **Major sources**
  - Pesticide production
  - Municipal waste disposal
  - Domestic combustion of coal





In the framework of this study, we used only bibliographical data and expert's opinion, no experimental ones(new) measurements. That means we did not introduce new emission factors in our estimation than above the currently existing ones.

No previous inventories of emission to land and/or water have been identified in the 13 studied countries.

The most important release to land could be attributed to Turkey and Poland responsible respectively for 29 and 28% of the total releases to land of this area as shown in the graph 1.

Even with the high level of uncertainty, we could reasonably consider that the distribution of dioxin release between the thirteen studied countries is correct, notably for the major contributors such as Turkey, Poland, Hungary and Romania.

The 3 most important sources of releases to land in the 13 candidate countries are :

- Pesticide production
- Disposal of municipal solid waste to landfill <<please check for factor of 1000 error!!!>>
- Combustion of coal – domestic

The most important source of releases to land seems to be pesticide production. But there is a great uncertainty about this value. The emission factor used ranges from 303,4 to 69085 µg I-TEQ/T. We also made the hypothesis that all the pesticides used in the country are produced in this country, it is probably not the case in all the countries.

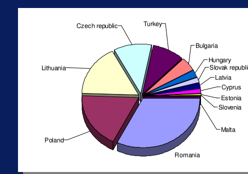
For disposal of municipal solid waste to landfill, the emission factor presents an uncertainty of a factor 12. But activity data come from EUROSTAT. This estimates could be considered as quite reasonable.

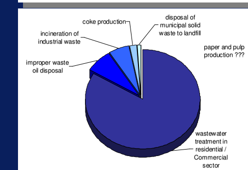
The emission factor used for domestic combustion of coal fluctuates from 41,21 to 5802,65 µg I-TEQ/T. So the uncertainty of releases from this activity could be important.

According to the pessimist hypotheses we made, notably about the fate of residues, we could presume that the real releases to land could be lower.

Emissions to water

- **Larger countries: larger emissions**
  - Romania
  - Poland
  - Lithuania
  - Czech Republic
  - Turkey
- **Major sources**
  - Waste water treatment
  - Improper waste disposal
  - Incineration of industrial waste





The most important contributors to releases to water in these 13 countries are Romania (33% of total releases to water), Poland and Lithuania (respectively 18 and 17%). We have to note that some sources are missing because of lack of data activity but could be significant: incineration of sludge from wastewater treatment, paper and pulp production

The main source of dioxin releases to water, according to the data collected, in the area covering the 13 candidate countries is wastewater treatment in residential / commercial sector responsible for around 83% of the estimates. But we have not enough data about incineration of sewage sludge from wastewater treatment (only available for Poland) to point out the contribution of this activity in this area.

Conclusions (1)

- **A between countries consistent emission inventory now is available, including**
  - uncertainty information.
  - An assessment of past and future emissions
- **Data and methods have been discussed with national experts**
- **Where no data were available a conservative approach was used**

The emissions have been estimated, using a method that is consistent for all countries in this study and the earlier EU Dioxin Inventory for the 15 "Old" EU Member States. The project has applied a conservative approach: where-ever detailed information was not available, the method chosen ensures a relatively high emission estimate. The resulting emission inventory therefore should be considered as a relatively high estimate.

The national inventories in this study has been discussed with national experts from each of the thirteen countries and all information obtained in this process has been included. Where national information was made available the estimate is no longer "conservative" but should be regarded as the best estimate, taking into account available national knowledge and data.

It is shown that the emissions to air in the thirteen countries in this study (the 10 "New" EU Member States (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak Republic, Slovenia) and the three EU Candidate Countries (Bulgaria, Romania, Turkey)) probably are comparable to those in the 15 "Old" EU Member States. This conclusion however is rather dependent on the assumption of the emission factors in waste incineration. An uncertainty analysis in the report shows that, if these assumptions are not correct, the emissions might be a factor of 4 to 5 higher.

The study also presents a first estimate of past and future dioxin emissions in these countries. It shows that future emissions could increase unless better technologies than the ones used now are implemented in the countries. If these better technologies in all countries are comparable with the best ones already implemented in some of these, the emissions could decrease in the next few decades. Since waste incineration is the major contributing sector in all countries, implementing improved technologies in these processes could greatly improve the situation. In other words: implementing the EU Waste Incineration Directive and the IPPC Directive in these countries is a crucial step in minimizing the dioxin emissions and contamination in these countries

Conclusions (2)

- **This emission inventory is good enough to draw the following conclusions**
  - No indication that dioxin emissions in the CC are different from the EU15
  - Due to small low sources, hot spots might occur in the countries. A detailed geographical study, including dispersion modelling and perhaps ambient air quality measuements is needed to assess this issue.

Given the rather high uncertainties in emission factors, caused by both

- extrapolation of the highly variable instantaneous emission factors as measured towards annual total mass flows
- limited availability of emission factors for specific process conditions

the emission inventory as derived in this project will be as good as can be achieved within a relatively limited budget. The uncertainties in emission factors outweigh those in activity data. So improving the inventory is only possible if much better emission factors or direct continuous emission measurements would be available. This would be a very expensive exercise.

About one third of the emissions of dioxins to air are due to non-industrial (area) sources, where low level emission occurs in large numbers of small equipment (stoves, cars, open waste burning). These emissions obviously occur in the direct neighbourhood where people live and hence will give rise to concentrations of dioxins in the direct surroundings of where people live. Industrial sources on the other hand tend to be larger sources with higher stacks. Depositions from these sources will be spread out over larger areas than for the small sources. The emission of each individual source however will be higher. The small, low sources might give rise to hotspots in densely populated areas, whereas the highest concentrations, caused by the larger elevated sources might occur at several kilometres from the stack.

The effects of these different dispersion behaviour of smaller - lower on the one hand and larger - higher sources on the other, is difficult to estimate in general terms. Detailed location information of all sources in a region is needed to run air pollution dispersion models to calculate dioxin concentrations in the air. Since however most industrial sources are located in the same areas (on a spatial scale of several kilometres) where people live, we do not expect that the geographic emission and concentration patterns are very different for both type of sources. The same is more or less to be expected in the fifteen EU Member States. So, given the high uncertainties in emissions, we do not expect the concentration levels in the thirteen countries to differ significantly from those in the "old" 15 EU Member States. More geographical information is needed to run air quality and effect models to investigate this issue.

On the basis of these results we conclude that there is no reason to assume that the concentrations of dioxins in the air in the thirteen countries are significantly higher than in the 15 "Old" EU Member States. This however does not exclude possible "hot spots", where relatively high concentrations could occur, due to for instance uncontrolled burning of chlorine containing wastes.

Conclusions (3)

- **Emission projections show**
  - Due to economic development, a “business as usual” scenario shows emissions to increase by 25 %
  - If IPPC – BREF and the Waste Incineration Directive are implemented, a decrease by 50% of the emissions might be expected by 2030
- **Illegal activities are not included in the inventory. Such activities (illegal burning of wastes) could change the picture.**

The implementation of the EU Waste Incineration Directive and the IPPC Directive in the thirteen countries will bring the emissions of dioxins down to a level that is comparable or even below the level in the “old” EU Member States. The major cause of uncertainties in our estimate is the emission factors for waste incineration. This uncertainty will also be decreased considerable if the requirements of this directive will be implemented. Since this might take some time, it might be worthwhile to perform air quality modelling studies for some areas within the thirteen countries. The preliminary geographical distribution, shown in Figure 3, suggests that such a study could be best performed for the so-called Back Triangle (Poland, Czech Republic, Slovak Republic border area) and for the surroundings of Istanbul.