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Adriatic Common Indicators
Methodology sheet (October 2004)

Climate change and air quality

3.1 CO2 emissions by sectors
3.2 24 hours average of concentration of PM10

3.1 CO2 emissions by sectors

Headline indicator: CO2 emission per capita

Measurement: CO2 equivalent emissions (total value and variation)

1. Definitions

- **CO2 equivalents:** refers to anthropogenic emissions of Carbon Dioxide and Methane. This indicator seeks to measure such emissions within an area of local authority control.
- **Local activities** to be considered for measurement of such emissions should cover those which include the use of fossil fuels (coal, petroleum, natural gas) for energy purposes (including transport) and local waste management.
- **Variation** is the CO2 equivalent emission trend and is calculated on the basis of 1990 figures.

At the Kyoto Conference, 38 industrialised countries signed an agreement prescribing a reduction of 5,2% in six greenhouse gases, including carbon dioxide (the most important greenhouse gas, contributing to 80% of total EU emissions) and methane (contribution approx. 9%) (with respect to 1990 levels) by 2008-2012.

Many sectors are responsible for the emission of greenhouse gases.
According to the methodology of the Intergovernmental Panel on Climate Change (IPCC), sectors which must be taken into account in order to arrive at a complete analysis of emissions include the energy sector, industrial processes, the use of solvents, agriculture and waste management as well as the removal ("absorption") of carbon through forest management (also called "carbon sinks").

The Kyoto Protocol covers Carbon Dioxide CO2, Nitrous Oxide N2O, Methane CH4, Sulphur Hexafluoride SF6, Hydrofluorocarbons HFCs and Perfluorocarbons PFCs.
These are thegases that we should manage.

CO2 emissions attributable to the energy sector (including energy production and energy consumption by industry, households, transport, etc.) are by far the most important factor responsible for the greenhouse effect (industrialised countries' contribution to total emissions is about 80% of the total).

The energy sector , together with the waste management sector,represent the main focus for action by the local authority.

On these grounds, an indicator correlated with CO2 emissions due to local energy consumption and CH4 emissions due to local waste management activities, is likely to be the best way of measuring the greenhouse effect at a local level.

Considering "debt emissions" and "credit emissions"
Greenhouse gases do not only have a local effect, but also affect the environment at global level.

Usually, when considering traditional contaminants affecting ambient air quality, the activities responsible for emissions in the area are inventoried and related emissions generated inside the same area calculated.

This approach has some limits when considering greenhouse gas emissions. In this case, the above mentioned inventory of activities still has to be taken , but it is good practice to calculate the related emission, considering not only the ones that actually are generated in the area, but also those generated outside the area itself, wherever they are, so long as they can be traced back to the activities listed.

In other words, the geographical principle is replaced by the responsibility principle.

The responsibility principle requires that emissions deriving from the use of final energy due to the activities located in the selected area shall be considered, be they generated within the area considered or outside its borders.

It is clear that the larger the area, the more the two calculation methodologies are similar. At national level, the difference can be of no importance. Instead, as we move to relatively small areas, as is the case of a city, the difference can be very large.

Some examples are reported that explain the concept:

- the city uses electricity that is produced with fossil fuel outside its boundaries: the emissions related to this production have to be accounted as due to the city itself;
- the city makes use of natural gas that is produced elsewhere and transported up to the end users: the emissions related to the production and transportation activities have to be accounted as due to the city itself;
- the city produces waste that is disposed of in a landfill outside its boundaries: the emissions related to such waste disposal have to be accounted as due to the city itself.

It can be useful to think of external emissions due to the import of energy vectors or to the export of waste as "debt" emissions that have to be added to local emissions.

On the other hand, the city may export energy vectors to and/or import waste from other cities. Thus, emissions related to these activities should be subtracted from total domestic emissions. Again, it can be useful to think of local emissions due to the export of any energy vector or to the import of waste, as "credit" emissions that have to be subtracted from domestic ones.

The concept of "credit" emissions can be pushed a bit further to take all actions performed by the city into account, even if they do not reduce the emissions due to the city itself, but contribute to the reduction of overall emissions. This is, for example, the case of a city whose electricity consumption is entirely produced by means of renewable primary energy and that performs actions to save electricity. We can suppose that the renewable energy spared can be used in another site, replacing fossil fuel energy. In this case, spared emissions should be deducted from the emission accounting of the city.

This extension of the concept of "credit" is a way to account for actions that otherwise could not be considered in terms of emission reduction.
Summarising, the CO2 indicator for a city is evaluated considering emissions generated inside its boundaries (like typical national balances), plus "debt" emissions, minus "credit" emissions.

If we limit the analysis to those emissions generated inside city boundaries, the emission accounting can be compared to national emission accounting according to the IPCC methodology, at least for the sectors and greenhouse gases considered here.

Analysis of the variations over time (with reference to 1990)
Following the Kyoto protocol, the political debate concerning greenhouse gases mainly regards the need to adopt and meet certain targets relating to their variation.

Naturally, the absolute values (tonnes of emissions, overall or per capita) are important for assessing the European and local dynamics, but the possibility of making a comparison between cities through the quantity of their emissions (for example, annually) should be given serious consideration.

There are, in fact, many important conditions for determining the absolute value of the emissions; to a greater or lesser extent, these may or may not depend on local policies (for example, on the existence of such local renewable sources of energy as hydropower, or on climatic conditions). All these external parameters should be considered in order to make a reliable comparison.

The optimal indicator for making comparisons between the cities should, therefore, refer to the comparison between steps actually taken in order to reduce the emissions of greenhouse gases. Thus, rather than venturing a comparison between different cities on the basis of the absolute values of emissions, it is preferable to make a comparison between different cities on the basis of the variation of the indicator over time.

The overall calculation of CO2 equivalents at a local level (as above described) must be calculated with regard to a reference year. According to the Kyoto protocol, the reference year is 1990, but one should bear in mind that, on a local level, data regarding this year may be unavailable.

Disaggregating energy consumption by sector/vector
The starting point to calculate the CO2 indicator is the analysis of energy consumption. Such data can account for emissions within the city area and due to the city's activities, as well as for "debt" emissions due to the same activities (of course "credit" emission cannot be accounted for by means of consumption data).

Total energy consumption is the result of different activity sectors (e.g. residential, commercial, industrial, transportation, etc.). It is very useful, especially in order to give a particular direction to local actions, to analyse the contribution of CO2 according to this sectorial disaggregation. This allows the behaviour of each sector to be clarified.
The sectorial disaggregation suggested for the CO2 equivalent indicator in the energy sector is:

- residential;
- commercial;
- industrial;
- transportation.

Another item has to be added to include "credit" emissions.
A further disaggregation with reference to the energy vector is a useful information to drive local actions.

2. Question

To what extent are the local authority and the local community able to reduce the emissions of greenhouse gases as a local contribution to fighting global climatic change?

3. Context

A sustainable community takes responsibility for the welfare of the next generation and contributes to the reduction of global environmental problems. Therefore, it is important to fight global climatic change and to avoid or to reduce the consumption of finite resources.

At a local level this means promoting energy saving, the use of renewable, fossil-free energy resources, reducing the use of landfill.

Sustainability principles covered: 1, 3, 4, 5

4. Targets

At the Kyoto Conference 38 industrialised countries signed an agreement envisaging a 5.2% reduction in greenhouse gases (with respect to the 1990 level) by 2008 – 2012.

The European Union agreed on a reduction of 8%. In relation to this, different reduction quotas were defined for each EU member state. Without major new developments in the areas of energy consumption and transportation, worldwide use and combustion of oil, coal and gas will continue to increase, causing emissions of the most important greenhouse gas to rise.

In this case, EU CO2 emissions are expected to show a 4% increase by 2010.

Therefore, in order to achieve the above mentioned percentage reduction successfully, several reduction targets have been drawn up by national and local authorities.

5. Unit of measurement

tons per year and % variation (with respect to a reference year, preferably 1990).

6. Frequency of measurement

Annualy.

7. Data collection method and sources

Consumption data from the energy sector is essential. Calculations of CO2 emissions shall make use of the following disaggregation of energy, reflecting end use:

- electricity
- gas
- gasoline
- diesel oil
- .....

When performing energy accounting, some data are immediately available with a proper disaggregation level; this is usually the case with electricity, gas and district heating. For other energy vectors, on the contrary, local availability is not always possible.

Usually, theavailability of such data is possible at a broader territorial level (regional or national).

In this case, the use of a top-down approach can help, starting from the upper territorial level and using proxy variables (see examples below).

The top-down approach involves disaggregating the territorial superior level of energy consumption at the local level through the use of proportionality indicators for a particular sector/activity occurring in the specified local area as follows:

Cloc,I = Cup,I * Sloc,I/Sup,I

where:

Cloc,I = local consumption amount related to the activity I;
Cup,I = upper territorial level consumption amount related to the activity I;
Sloc,I = local statistic related to the activity I;
Sup,I = upper territorial level statistics related to the activity I.

As regards simple proxy variables for each sector, the following suggestions could be considered:

- residential - number of families;
- commercial - number of employees (further disaggregation into subsectors is suggested according to data availability);
- industrial - number of employees (further disaggregation into subsectors is suggested according to data availability, and also disaggregation into white-collar and blue-collar workers, since very different specific consumption is usually associated with the two kinds of employees);
- transportation - number of kilometres covered by different kinds of vehicles, e.g. private car, motorcycle, collective transport (see indicator N° A.3), scaled by the ratio between the specific consumption (consumption per kilometre and per vehicle) related to the different driving patterns (urban, rural, highway).

It must be borne in mind that the use of proxy variables is necessary when direct data is lacking. If the latter is instead available, the methodology based on proxy variables can be used for comparison.

The CO2 emission factors (tonnes of CO2 per unit of energy) can be derived from the IPCC Guidelines and from local and national data (especially for electricity generation**).** In some countries, software (if scientifically validated) and IPCC emission factors adaptations to the national context are used; which thus allow to consider the specifics of local energy systems and, in some cases, to consider "indirect emissions".

Data regarding waste management (production and disposal) is usually available from the local authority.

Information on emission data and emission factors can be found on **http://atcae.eionet.eu.int/etc-ae/index.htm** (and through the national bodies responsible for producing emissions balance sheets at provincial level every 5 years).

[The spreadsheet contains standard IPCC and AIRES coefficients for the calculation of local and external emissions that are to be used whenever real coefficients – i.e. calculated with respect to your specific context - are not available. In case real coefficients are available with a certain degree of reliability, these have to be used instead of the standard ones].

8. Form of reporting/presentation

Yearly total emissions, differentiated by sector.
Yearly per capita emissions.

9. Examples of similar applications

There are several initiatives on an international/national level to reduce CO2 emissions by the voluntary commitment of member communities. On a local level, the administration needs to work out strategies on the basis of a political decision. In the city of Heidelberg, Germany, for example, the concept of climate protection involves:

- introducing local energy management;
- funding a programme to promote energy conservation by targeting house and apartment owners;
- establishing an "energy round table";
- introducing the Heidelberg heating certificate;
- ecological low energy construction standards for council housing.

10. Questions to address/Future development

The CO2 indicator is affected by different levels of accuracy depending on the availability of data. For future development it is important to establish systems allowing for a better control on data availability by working together with all the local energy suppliers and the major industrial and commercial energy consumers.

Once a good database is available, the CO2 equivalent indicator oriented to the energy and waste sectors can be replaced by the CO2 equivalent indicator covering all sectors and all gases.

Sub indicators related to each sector may prove useful in understanding particular phenomena and especially in understanding the relevance of critical sectors.

11. Keywords

global climatic change, CO2 emissions, greenhouse gases, fossil fuels.

3.2 24 hours average of concentration of PM10

Headline indicator: PM10 net overcomings

Measurement:

a) Number of times that the limit values for selected air pollutants are exceeded
b) Existence and level of implementation of air quality management plan

1. Definition

Ambient air quality depends on the level of some pollutants (gases or particulate matter) that are known to be hazardous to human health and well being, or to induce adverse effects on natural ecosystems, when exceeding risk or threshold levels.

In order to limit the risk of acute episodes of pollution and to reduce long term exposure levels to such pollutants, the World Health Organisation defines and periodically revises recommended guideline values to each pollutant, based on epidemiological and controlled exposure studies.

The standards of air quality in terms of levels not to be exceeded are defined in European directives, or by national and/or local bodies. The European directives set out that in zones

and agglomerations where one or more pollutants exceed the limit values , a plan or programme for attaining such limit values must be prepared.

(The European directive 96/62/EC and related daughter directives define limit values taking into account the margins of tolerance. The margin of tolerance, which has been specified individually for each pollutant, decreases with time,so that by the date when limit values must be attained, the margins of tolerance are zero for all pollutants.)

In zones and agglomerations where such limits are not exceeded there is a requirement to maintain air quality.

"Local" refers to the administrative area following within the local authority's competence: municipality.

2. Question

- **a)** How many times in a year does the local air quality exceed limit values?
- **b)** Has the local authority prepared and implemented an air quality management plan?

3. Context

This indicator focuses on the main sources of air pollution in urban areas, mainly linked with combustion processes in mobility, heating systems and industries.

The main pollutants emitted directly or as by-products of successive chemical reactions are sulphur dioxide; nitrogen dioxide; carbon monoxide; volatile organic compounds (benzene, for example); particulate matter, ozone and lead.

These have negative impacts on humans, cultural artefacts and the ecosystem.
Breathing polluted air can cause a range of medical problems, from asthma to cancer.

Indirectly air pollution causes loss of local work force and increased medical expenditures as well as loss of productive and protected ecosystems.

Air quality is therefore an essential aspect of sustainability.

In accordance with the European directive 96/62/EC, the management of air quality involves the assessment of ambient air quality and the preparation and implementation of a plan or programme indicating the measures or projects that must be adopted to achieve the limit values for the areas where these are exceeded.

The management plan/programme shall include measures for the main pollution sources. They may include measures directly related to mobility management (including measures regarding passengers and goods transportation, individual use of cars, collective transportation, introduction of alternative vehicles), heating systems (promoting, where feasible, alternative energy sources like solar thermal energy or, where possible, the use of district heating) or industrial processes.

The management plans/programmes may, depending on the individual case, provide for measures to control and, where necessary, suspend activities, including motor-vehicle traffic, contributing to limit values being exceeded.

Sustainability principles covered: 1, 3, 5, 6

4. Targets

As indicated in the Community Framework Directive on Ambient Air Quality (96/62/EC) the related daughter directives establish limit values intended to avoid, prevent or reduce harmful effects on human health and the environment as a whole.
The first daughter directive (1999/30/EC) defined limit values for concentration in ambient air of sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead.

Directive 2000/69/EC established limit values for carbon monoxide and benzene and directive 2002/3/EC established limit values for troposphere ozone.

As requested by directive 96/62/EC, limit values must also be fixed for poly-aromatic hydrocarbons, cadmium, arsenic, nickel and mercury.

The limit values laid down in the above Directives are minimum requirements, allowing Member States the possibility of introducing more stringent protective measures and stricter limit values.

The limit values fixed by the daughter directives correspond with the guide values recommended by the WHO2 (In *Guidelines for Air Quality, W*orld Health Organisation, 2000).

European directive, 1999/30/EC, 2000/69/EC and 2002/3/EC 3

(Considering only the pollutants for which limit values are fixed for daily, 8 hour period or hourly concentration.)

Pollutant	Averaging period	Air quality standards and objectives	Date by which limit value is to be attained	Data: minimum capture of measurement and uncertainty	Legal status
SO_2	24 hours	125 µg/m3 not to be exceeded more than 3 times a year *(concentration equivalent to WHO guide value)*	1 January 2005	90% 15%	1
NO_2	1 hour	200 µg/m3 not to be exceeded more than 18 times a calendar year *(concentration equivalent to WHO guide value)*	1 January 2010	90% 15%	1
PM_{10}	24 hours	50 µg/m3 not to be exceeded more than 35 times a calendar year	1 January 2005	90% 25%	1
CO	max daily 8-hour mean concentrati on	10 mg/m3 *(concentration equivalent to WHO guide value)*	1 January 2005	90% 15%	2
Ozone	max daily 8-hour mean concentration	120 µg/m3 not to be exceeded more than 25 days per calendar year *(concentration equivalent to WHO guide value)*	2010	75% (18 daily 8-hour means)	3

NOTE:
1) **Directive 1999/30/EC of 22 April 1999;**
2) **Directive 2000/69/EC of 16 November 2000;**
3) **Directive 2002/3/EC of 12 April 2002.**

In accordance with directive 96/62/CE (*Annex IV, Information to be included in the Local, Regional or National Programmes for improvement in the Ambient Air Quality*), the management plans/programmes must include, among other things, the details of those measures or projects adopted with a view to reducing pollution, as follows:

a) listing and description of all the measures set out in the project;
b) timetable for implementation;
c) estimate of the improvement of air quality planned and of the expected time required to
d) attain these objectives.

Please note that:

Due to the improving harmonisation of national legislation with the EU directive, in case participants do not have the possibility to report overcomings of EU targets, overcomings of national limits are to be reported (clearly specifying to what specific national limits they are referred to).

5. Unit of measurement

a) Number of times that the limit values for selected air pollutants are exceeded: The basic data is the number of times the limit value is exceeded for each selected air pollutant.
The number of times is calculated in accordance with the period defined by the limit value: daily (if the limit value is based on daily concentration), 8 hour period (if it is based on 8 hours mean concentration) and hourly (if it is based on 1 hour concentration). Only those fixed sampling points that respect the minimum data capture and the uncertainty of assessment methods laid down by the 96/62/EC daughter directives must be taken into consideration (see section 4 for more details).
If more than one fixed sampling point is available for a single pollutant in the same zone or agglomeration, the one that observes, during the year, the highest number of exceedances must be used. Therefore, for each selected air pollutant, the indicator corresponds to the number of times the limit value has been exceeded less the number of times admitted by the 96/62/EC daughter directives (see section 4 for more details) in the calendar year.
In case the number of times that the limit value is exceeded is lower than the number of times allowed, the indicator will be zero.

b) Existence (yes/no) and level of implementation of air quality management plan/programme (%)

6. Frequency of measurement

a) the selected air pollutants are measured hourly by fixed sampling points and the results are then reported annually.
b) (1° part) annually
b) (2° part) every three years.

7. Data collection method and sources

Directive 96/62/EC defined at European level the basic principles of a common strategy that defines objectives for ambient air quality in the Community "*designed to avoid, prevent or reduce harmful effects on human health and the environment as a whole*", assesses the ambient air quality on the basis of common methods and criteria, obtains adequate information on ambient air quality and ensures that this is made available to the public and maintains ambient air quality where it is good and improves it in other cases.

Different options were defined for assessing the air quality depending on population concentration and/or density and the existing levels of each pollutant.

(In brief, the options are:

- the assessment of ambient air quality based on measurement is mandatory in the agglomerations (zone with a population concentration in excess of 250.000 inhabitants or, where the population concentration is 250.000 inhabitants or less, a population density per km² which for the Member States justifies the need for ambient air quality to be assessed and managed), zones in which levels are between the limit values and the upper assessment threshold, and other zones where levels exceed the limit values.
- a combination of measurements and modelling techniques may be used to assess ambient air quality where the levels over a representative period (at least five years) are below the upper assessment threshold.
- the sole use of modelling or objective estimation techniques for assessing levels shall be possible where for a representative period (at least five years) the levels are below the lower assessment threshold.

Annexes of directives 1999/30/EC, 2000/69/EC and 2002/3/EC specify criteria that are to be used to determine the testing station pattern and criteria for the definition of the necessary minimum sampling points.

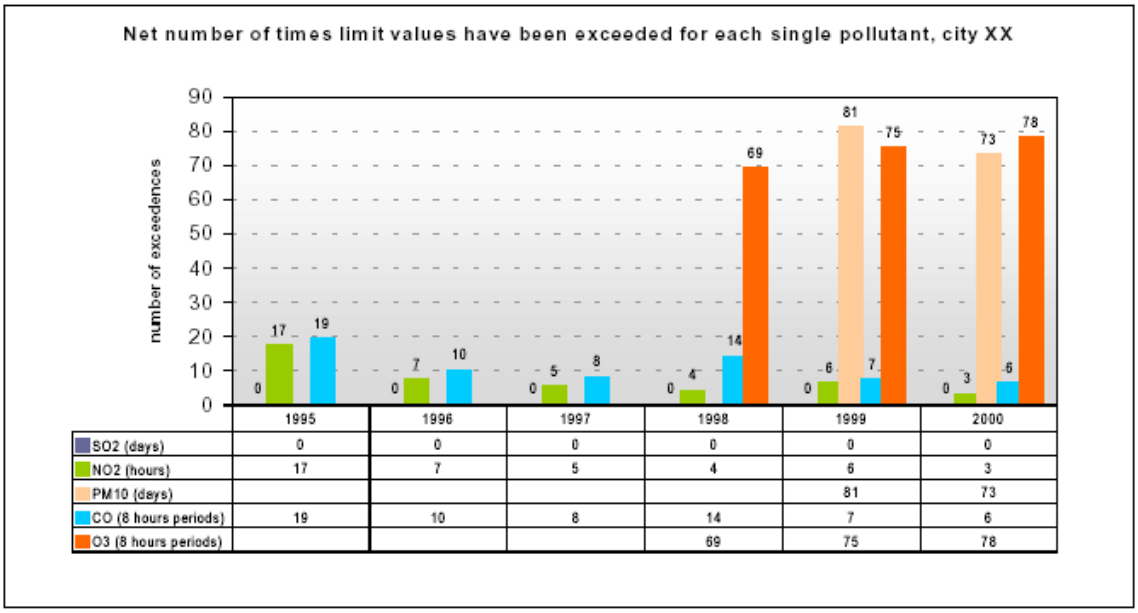
The classification of each zone or agglomeration shall be reviewed at least every five years (on the basis of concentrations during the previous five years or on the basis of combined measurement campaigns of short duration with emission inventories and modelling).

Classification shall be reviewed earlier in the event of significant changes in activities relevant to ambient concentrations of the pollutants.)

Where pollutants have to be measured, the measurements shall be taken continuously at fixed sites or by random sampling; the number of measurements shall be sufficiently large to enable the levels observed to be determined.

8. Form of reporting/presentation

a) Number of times that the limit values for selected air pollutants are exceeded: the data must be reported using bar graph in which each bar corresponds to the number of times limit values have been exceeded (less the number of times allowed by the directives) for a single pollutant over the year. The graphs must be well identified: net number of times limit value is exceeded for each single pollutant (see example below).



	1995	1996	1997	1998	1999	2000
SO2 (days)	0	0	0	0	0	0
NO2 (hours)	17	7	5	4	6	3
PM10 (days)					81	73
CO (8 hours periods)	19	10	8	14	7	6
O3 (8 hours periods)				69	75	78

b) Existence and level of implementation of air quality management plan/programme:
In the first year: "yes, an air quality management plan exists", or, "no, there is no air quality management plan".

Then every three years, figures corresponding to the percentage of the level of implementation for each single measure/project identified in the management plan/programme, using a two-column table:

Measure/project	Level of implementation (%)
1. …	
2. …	

The method used for assessing the air quality should be described.

9. Examples of similar applications

The *Air Management Information System* developed by the WHO Healthy Cities Programme, provides for the exchange of information on air quality management between countries and cities. For example, data collection and publication of conventional pollutants (SO_2, NO_2, CO, O_3, PTS, PM_{10}) is organised by annual mean, number of days on which the WHO air quality guidelines are exceeded and 95° percentile.
The *Urban Audit* (European Commission, Directorate General for Regional Policy) includes three air quality indicators: Winter Smog: number of days SO_2 exceeds 125µg/m^3 (24 hour averaging time); Summer Smog: number of days Ozone O_3 exceeds 120µg/m^3 (8 hour averaging time); Number of days per year that NO_2 concentrations exceed 200mg/m^3 (1 hour averaging time).

The *Transport and Environment Reporting Mechanism* (European Environment Agency and European Commission) and the *European Local Transport Benchmarking Initiative* (European Commission, Directorate General for Transport and Energy) both use exceedance of air quality standards as an indicator at city level. The first measures exceedance of EU air quality standards for benzene, carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3) and particulate matter (PM_{10}).

The *Environmental Headline Indicators* (jointly by the Member States, the European Commission and the European Environment Agency) includes an air quality indicator: "average number of exceedance days for selected air pollutants in urban areas" focusing on PM_{10}, O_3, SO_2 and NO_2.

The *Environmental Signals Report* (European Environmental Agency) on its Air Pollution chapter includes a reference on the number of exceedance days for O_3 and for PM_{10}.

10. Questions to address/Future development

This indicator considers outdoor air quality only; it does not address indoor air quality problems.

11. Keywords

ambient air quality, outdoor air quality, air pollution, risk level, threshold level, limit value, benzene, carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, management plan/programme.