UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE
COMMITTEE ON ENVIRONMENTAL POLICY

Working Group on Environmental Monitoring and Assessment
in cooperation with the Executive Body for the Convention on Long-range Transboundary Air Pollution and the European Environment Agency

WORKSHOP ON INTERACTION BETWEEN AIR-QUALITY MONITORING AND AIR-PROTECTION STRATEGIES IN COUNTRIES OF EASTERN EUROPE, CAUCASUS AND CENTRAL ASIA

Geneva, 11 June 2007

DRAFT STRATEGY FOR THE USE OF AIR QUALITY MONITORING AS AN ENVIRONMENTAL POLICY TOOL IN COUNTRIES OF EASTERN EUROPE, CAUCASUS AND CENTRAL ASIA

Submitted by the Secretariat[1]

Introduction

1. The aim of this document is to provide guidance to EECCA countries in revising their air-quality monitoring programmes by making monitoring a practical tool for environmental policy development and target setting, pollution abatements strategies and measures, and for assessing progress in achieving policy targets and effectiveness of abatement measures.

2. This document focuses on EECCA countries as a group but takes also into account country specific issues given mostly by geographical conditions, specifics of national economies and by political diversification (certain EECCA countries expressed their willingness to become member states of the European Union in the future).

3. This document is mainly influenced by the developments in the European Union and the United States of America, as both of them have developed and implemented coherent systems of air-quality assessment and management, but takes also into account other relevant international activities (e.g. EMEP, WMO/GAW, WHO, ISO, EEA and IIASA).

I. LINKING AIR-QUALITY MONITORING TO ENVIRONMENTAL POLICY DEVELOPMENT

4. The EECCA Environmental Strategy[2], as approved by the 5th Ministerial Conference "Environment for Europe" (Kiev, 2003), provides, amongst key objectives and areas of

[1] Prepared with the assistance of Mr. Vladislav Bizek, Consultant to the Secretariat.

action, for strengthening of environmental monitoring systems: prioritization of monitoring programs by targeting principal pollutants; strengthening self-monitoring and reporting; and coordinating monitoring and data management to develop a national monitoring system. Under the objective "Reduction of Urban Air Pollution", the EECCA Strategy specifies the following problems related to air-quality assessment and management:

(a) Urban air pollution, particularly from mobile sources, has a major impact on the human health,
(b) Weakness of air quality control systems,
(c) Excessively strict ambient air quality standards,
(d) Weak technological capacity, resulting in higher emissions,
(e) Lack of economic incentives for facilities to reduce their emission intensity per unit of output,
(f) Inadequacies of regulation of road transport emissions.

5. These problems are recommended to be solved or at least mitigated by the following planned actions:

(a) Optimization of standards, accounting for environmental and combined health impacts (based on WHO criteria),
(b) Introduction of standards for products that directly affect the environment in the course of their use (road vehicles, fuels, etc.),
(c) Implementation of Best Available Techniques and best practices,
(d) Development of a mechanism for accounting for local conditions and technological capacity in the course of setting emission limit values.

6. The progress made in EECCA since 2003 in air-quality management is generally considered very limited (see boxes 1 and 2). Emissions of most of air pollutants have increased as a result of economic recovery in EECCA not connected with adequate abatement measures. The levels of air pollution in the majority of big cities are high and in some cases have increased over the last years. Particulate matter (PM), nitrogen dioxide and benzo(a)pyrene represent the major issue. High percentage of population in EECCA countries (estimated between 50 and 100 million of inhabitants) is exposed to the concentrations of pollutants which are much higher than the WHO guidance levels.

Box 1: Problems with in air-pollution control in EECCA

There is no evidence of accelerated progress on air pollution control. Overall, the problems identified in the EECCA Environment Strategy persist. EECCA countries still face a large environmental policy and institutional reform agenda. Institutions suffer from weak authority, scarcity of resources. Outdated management, high turnover of professionals and frequent restructuring, thereby lacking both the incentives and means to ensure the achievement of environmental results. Policies in general and specifically the air quality protection related are not generally aimed at achieving specific targets, rely on unreformed or poorly combined instruments and are often dominated by revenue-raising objectives. Environmental legislation is extensive but inconsistent and unenforceable. And compliance levels are rather low.

Source: Belgrade Assessment report 2007, Sub-chapter 2.1: Air quality, Final draft

[2] *Environmental Strategy for Countries of Eastern Europe, Caucasus and Central Asia* (ECE/CEP/105/Rev.1).

Box 2: Air-quality in EECCA

Lack of monitoring data of sufficient quality precludes an in-depth assessment of the state of air quality in the EECCA countries, but both available data and modeling indicate that concentrations of pollutants in the atmosphere routinely exceed maximum allowed concentrations – for example, recent WHO analyses indicate that 47 million Russians are exposed to NO_2 concentrations double the WHO guideline level and in Azerbaijan authorities report that 27 % monitored samples breach the allowed limits. While the precise extent of air pollution in the EECCA countries is unknown, the main culprit is also thought to be PM – mostly related to transport emissions. In addition to primary PM emissions (mostly from combustion processes), it is important to control emissions of other pollutants that contribute to the production of PM like as SO_2, NO_X and NH_3.
Air pollution is set to worsen. Transport-related emissions, which may be responsible for over 80 % of air pollution in the EECCA cities, are rapidly increasing. Industrial and power-generation sources declined in importance but remained significant and difficult to address, and emissions are increasing with resumed economic growth. In Central Asia, concentrations of PM (from desertification, desert dust and the dried Aral Sea bed) enhance the impact of particulates from cheap, low quality coals used for power generation and from the road transport. Trans-boundary sources are also relevant (e.g. only 19 % of $PM_{2.5}$ levels in Georgia are "homemade").

Source: Progress in Environmental Management in EECCA, OECD 2007, ENV/EPOC/EAP (2007) 1

7. Air quality is on the top of environmental policy agendas worldwide. Major attention is paid to particulate matter (PM_{10} and especially $PM_{2.5}$) and ground-level ozone. Air pollution by fine particles represents the highest risk to the public health in the UNECE region. The health risk due to air pollution by fine particles is at least an order of magnitude higher than of the other pollutants. The loss of lives due to current levels of air pollution by fine particles is assessed as comparable to the loss of lives due to car accidents (see box 3).

Box 3: Health and Environmental Impacts of Air Pollution

Concerning health impacts, currently in the EU there is a loss in statistical life expectancy of over 8 months due to PM in air, equivalent to 3.6 million life years lost annually.

Source: Communication from the Commission to the Council and the European Parliament: Thematic Strategy on air pollution, COM (2005) 446final.

8. Both the European Union and the United States of America have developed and implemented comprehensive air quality assessment and management systems which could serve as useful reference points for EECCA countries. In the European Union, air pollution is considered one of the priority environmental issues (6th action program *"Environment 2010: Our future, our choice"* and subsequent CAFÉ – Clean Air for Europe - programme). Recently, The EU Thematic Strategy on air pollution was launched[3]. This strategy focuses on the reduction of exposure by ozone and particulate matter with special attention paid to $PM_{2.5}$. In the United States of America, the Strategic Plan of the Environmental Protection Agency (EPA) for 2006 – 2011[4] sets "Clean Air and Global Climate Change" as one of its 5 goals. Ozone, $PM_{2.5}$ and "air toxics" are selected as priorities.

[3] Communication from the Commission to the Council and the European Parliament: Thematic Strategy on air pollution, COM (2005) 446final.
[4] See www.epa.gov.

9. EECCA countries, that have not yet done so, are recommended to **develop strategies to establish comprehensive air-quality assessment and management systems** (see box 4) **with a focus on priority pollutants**, particularly ground-level ozone, PM_{10} and $PM_{2.5}$. Within it, a realistic approach to enhancing monitoring (focusing on both ambient air and emissions monitoring) should be developed.

Box 4: Basic elements of air quality assessment and management system

Institutional setting

- Central competent authority responsible for air quality issues which coordinates activities of all relevant authorities and institutions (generally, a ministry of environment)
- Relevant public administration institutions at national, regional and local levels
- Supporting institutions (mainly hydro-meteorological service)

Policy level document setting:

- Objectives
- Priorities
- Targets (both national targets and targets related to relevant international commitments)

Technical level

- Standards (emission limit values, ambient air limit values, emission ceilings, fuel standards, product standards)
- Technical requirements (operation of emission sources, measurement of emissions by operators, monitoring etc.)
- Economic and market-based instruments (taxation, pollution charges, product charges, emission trading, incentives, etc.)
- Voluntary instruments (ISO 14 000, codes of conduct, voluntary agreements etc.)
- Information instruments (public information and awareness raising)

Operational level

- Operation of air-quality information system (emission inventories and projections, air quality monitoring and modeling, reporting)
- Permitting (including environmental impact assessment (EIA) and strategic environmental assessment (SEA))
- Regional approach (zoning)
- Application of instruments / implementation of measures
- Enforcement
- Feed-back mechanisms (mechanisms to update policy and technical levels)

Subsystems

- National air-quality information system
- National core air-quality monitoring system (a part of national air-quality information system).

Source: UNECE.

10. It should be taken into account that priority pollutants are either fully (ground-level ozone) or partially (PM) created via precursors (nitrogen oxides, volatile organic compounds, sulphur dioxide) which makes abatement measures uneasy comparing to other pollutants. It should be also taken into account that the majority of measures to reduce emissions of air pollutants and to improve the quality of ambient air leads also to the reduction of emissions of green house gases (GHGs) and vice versa. Most measures to reduce GHG emissions, e.g. energy savings, energy efficiency measures, use of "non-combustion" renewable energy

sources, lead to the reduction of emissions of air pollutants and to the improvement of air quality.

11. EECCA countries are therefore recommended to **coordinate** the development of their air-quality assessment and management systems **with** their **strategies** in the field **of climate change abatement** (reduction of GHG emissions).

12. The air-quality assessment and management system should **include clearly defined institutional setting**, including one central competent authority responsible for the coordination of all activities within this system.

13. As a part of the air- quality assessment and management system, well developed air-quality monitoring system is a **basic precondition for priority and target setting,** for the **preparation of instruments and measures** as well as for **the assessment of their effectiveness.**

14. In general, the basic rule for air-quality assessment and management policy is: **"What is regulated, must be monitored – what is monitored, can only be regulated effectively".** In addition, monitoring can also be used as an "early warning" and scientific instrument to understand complex systems and their developments better before starting regulation.

15. The main message of this document is that**:** Air quality monitoring systems should become an **integral part of national and international air-quality assessment and management systems** and should therefore be designed, developed and interpreted in broader policy and scientific context. In general, air-quality assessment and management system should **include other types of data and information** (emission inventories, sector activities, emission and sector projections)**, data processing tools** (modelling, projections)**, objectives, priorities and targets** (air quality standards, emission limit values, emission ceilings, technical requirements)**, policy instruments** (environmental impact assessment, permitting, compliance assessment, reporting, public awareness-raising, information and warning, economic and market-based instruments, voluntary instruments), **enforcement** and **institutional setting** (see box 4).

A. Integrating air-quality monitoring data with emission inventories and modelling activities

16. All EECCA countries operate air-quality monitoring networks, which had generally been established in 1970s and 1980s in accordance with former USSR standards. These networks are mainly based on manually operated stations and most of them have incomplete or reduced measurement programs (see box 5). Recently, certain EECCA countries have started to upgrade existing stations and to establish additional new stations (Armenia, Belarus, Georgia, Moldova, Russian Federation, Tajikistan, Ukraine and Uzbekistan) or have announced their plans or, at least, their willingness to do so.

17. The most developed air-quality monitoring system is operated in the city of Moscow based on 28 automatic stations which monitor the concentrations of the most important pollutants, including PM_{10} and ground-level ozone. Elsewhere in the EECCA countries, concentrations of PM_{10} and ground-level ozone are being monitored rarely (Belarus).

Box 5: Monitoring stations in EECCA countries

Country	Year	Total number	Automated	Cities covered	Parameters measured
Armenia	2005	13	-	6	Up to 11
Azerbaijan	2006	27	-	8	2 – 18
Belarus	2005	56	1	16	6 – 32
Georgia	2006	15	-	6	2 - 8
Kazakhstan	2003	47	-	20	Up to 16
Kyrgyzstan	2005	14	-	5	3 – 7
Republic of Moldova	2005	17	-	5	Up to 8
Russian Federation	2005	755	57	251	5 – 25
Tajikistan	2003	4	-	2	5 – 8
Turkmenistan	1998	18	-	7	4 – 11
Ukraine	2005	169		53	7 – 33
Uzbekistan	2005	59	-	33	3 - 22

Source: Adaptation of Monitoring Networks in Eastern Europe, Caucasus and Central Asia: Air Quality Monitoring *(UNECE, 2006) (ECE/CEP/AC.10/2006/3).*

18. All EECCA countries collect at least certain information on emissions of basic pollutants into the air. These emission inventories often do not include all important pollutants and do not cover all sources of emissions. Certain EECCA countries indicate problems with the assessment of emissions from road transport and other mobile sources (collection of emission data according to statistical forms on air emissions seems to be incomplete in many countries). Modelling of atmospheric dispersion and of transport of pollutants in the atmosphere is almost missing in EECCA countries.

19. An effective air-quality assessment and management system, as a part of environmental policy formulation and implementation, should **fit the DPSIR** (driving force, pressure, state, impact, response) **framework.** Especially the relation between emissions (pressure) and ambient air quality (state) is of utmost importance.

20. Modelling serves as a helpful bridge between emissions and ambient air quality (i.e. between pressure and state) due to the following reasons:

(a) No network of monitoring stations is able to represent the concentration fields of pollutants totally,
(b) The emission inventory by itself, however exact it is, is not able to provide sufficient information about the impact of particular emission sources on the quality of ambient air,
(c) Modelling serves as a feedback between monitored ambient air quality and emission inventory,
(d) Modelling is the only tool to predict the impact of measures on quantity of emissions reduced and on the quality of air.

21. EECCA countries, which have not yet done so, are recommended to:

(a) Update mechanisms to create and operate **national emission inventories** on a regular basis; these inventories should **cover the most important pollutants** which are being regulated (what is regulated, must be monitored and inventoried),

(b) Include the assessment of **emissions from mobile sources and small stationary sources** (mainly de-centralized local heating, small businesses) into emission inventories,

(c) Apply the **EMEP/CORINAIR** Air Emissions Inventory **Guidebook** as the methodological tool,

(d) Arrange for the preparation of **emission projections** on a regular basis (these projections should at least cover those pollutants which are being regulated),

(e) **Coordinate** preparation of emission inventories and projections for "classic" air pollutants **with the preparation of emission inventories and projections for GHG**,

(f) **Apply air-quality modelling** correlating the results of emission inventories with the results of air quality monitoring.

B. Revising air-quality standards and harmonizing them with international standards and guidelines

22. Air-quality standards play static, dynamic and international role in environmental policy in the field of air-quality assessment and management:

(a) Static role – actual concentrations of pollutants in ambient air – can be understood as a measure of impact under the DPSIR framework (both human health and environmental effects);
(b) Dynamic role – both year-by-year change and longer-term trend – represents the measure of air-quality development;
(c) International role lies in serving for inter-country comparisons and for reporting to international institutions.

23. At present, air-quality standards in EECCA countries are mostly based on the former Soviet Union's ones (MACs – maximum allowable concentrations). These standards are different from those which are being used worldwide (EU, USA, Japan, WHO). Major differences between MACs and the EU or the US air-quality standards lie in the following:

(a) MACs are set for a higher number of pollutants,
(b) MACs are too strict for practical application,
(c) A huge number of MACs, in combination with their strictness, make it difficult to enforce them,
(d) Timing of measurements is different,
(e) No MACs for PM_{10} or $PM_{2.5}$ are set (with the exception of PM_{10} standard introduced in Belarus),
(f) MACs are only health-based.

24. This difference does not jeopardize the dynamic role of standards (development in time can be measured by any method, if constant in time), but does not allow international comparisons and limits the assessment of impacts (i.e. limits the application of health impact studies, cost-benefit analyses and other relevant studies).

25. **The EU set of air-quality standards** (see annex 1) **may be one of the options** for the EECCA countries not only due to geographical reasons (certain EECCA countries are fully or partially located in Europe) but also, and mainly, due to the fact that these standards represent the negotiated compromises between the health and/or environmental effects of particular

pollutants and estimated pollution abatement costs, and that these negotiations obviously reflect both geographical and economic differences among the countries. **The US set of air-quality standards** (see annex 1) **represents another option** for EECCA countries, especially for the large ones with lower population density. These standards also represent the negotiated compromises between the health and/or environmental effects of particular pollutants and estimated pollution abatement costs.

26. The major differences between the EU and US sets of air-quality standards are as follows:

(a) The EU set of standards does not include $PM_{2.5}$ (adoption of such standard is expected in a short time period),
(b) The US basic set of standards (criteria pollutants) does not include benzene, arsenic, nickel, cadmium and benzo(a)pyrene,
(c) The EU limit values are more stringent (in absolute values) than the US ones,
(d) The US compliance criteria are often more stringent than the EU ones (in the case of short-term limit values),
(e) The US compliance timing is more flexible than that in the EU (where the same flat deadlines are set for all Member States).
(f) Averaging periods are different in certain cases,
(g) The US secondary standards (limit values for the protection of vegetation, ecosystems) cover more pollutants than the EU limit values and take into account visibility and protection of man-made materials).

27. EECCA countries which are thinking about future membership in the European Union may switch from their existing air-quality standards (MACs) to those which are in force in the EU. EECCA countries which are not thinking about future membership in the EU can be more flexible. They can make choice to switch from existing air-quality standards (MACs) either to those which are in force in the EU or to those which are in force in the US. Combination of both sets could also be possible in this case. Due to practical reasons, **a step-wise approach is recommended** with sufficient transition period.

28. Current **air-quality standards should be updated or discontinued and new ones set** by the central- level competent authority which is responsible for the coordination of national air-quality assessment and management systems. Where it is not practical in the short term, the same central-level competent authority should participate actively in the process of air-quality standards updating and setting governed by the ministry responsible for public health.

29. It is recommended to **introduce alert thresholds** for sulphur dioxide, nitrogen dioxide and ozone and information threshold for ozone. In the second phase, other pollutants could be added depending on their impact on air quality in a particular EECCA country and limit values for the protection of vegetation (secondary standards) could be introduced as well. In the later stages, standards for $PM_{2.5}$ (average exposure indicator, exposure reduction target, concentration cap) could be introduced (if not introduced earlier). Developments within the EU may be followed (the US standard of 15 $\mu g/m^3$ seems to be too stringent even for the EU Member States).

30. In updating their current air-quality standards and developing new ones, EECCA countries may use relevant background information (e.g. health impact studies, cost-benefit analyses etc.) available at the international level. EECCA countries should also decide on

compliance deadlines for their updated or newly introduced ambient air-quality standards (following, for instance, the EU flat approach or the US flexible approach). Without compliance deadlines, these standards would remain at the level of statements without any real power.

C. Better using air-quality monitoring data

1. Permitting

31. Air quality monitoring data are an important basis for the implementation of environmental policy in the field of air-quality management. All EECCA countries have introduced **permitting procedures** for activities which may have an impact on the environment, including air quality.

32. In respect to permitting, results of air-quality monitoring, preferably in combination with modelling, are necessary to decide on the location of a new potentially polluting object on a given site or in the case of a substantial change of existing source which may lead to an increase in emissions. Results of air-quality monitoring are taken into account during the process of environmental impact assessment (EIA) or similar procedure (as a background information for air-dispersion study which should estimate the incremental concentration of pollutants caused by the realization of the construction project assessed).

33. It is recommended to EECCA countries to take into account the results of air- quality monitoring also **in permitting of construction projects which are not subject to EIA or similar procedure.**

2. Compliance with ambient air-quality standards

34. Once ambient air-quality standards are adopted, reliable air-quality monitoring data are the only way how to monitor compliance. Without this data, standards remain at the level of formal statements. Therefore, **all pollutants should be monitored for which air-quality standards have been set**. The national legislation should clearly impose responsibilities on actors responsible for monitoring of specific sets of standards.

3. Modelling

35. It should be taken into account that the data from monitoring stations are not sufficient to assess compliance. Therefore, it is recommended to EECCA countries, that have not yet done so, to **develop modelling tools** extrapolating the monitoring data **to cover all territories** where the compliance with the standards is required (and correlating the air quality monitoring data with the emissions from specific sources).

36. For setting environmental policy objectives, priorities and targets and for developing abatement policies and measures, the information on the type of pollution and its extent is crucial. Such information (e.g. contribution of particular emission sources to the pollution levels, assessment of zones with exceedances of air-quality standards) can only be obtained via air quality monitoring data processed together with the data from emission inventories by modelling.

37. As a first step, past and actual situation should be assessed (processing of time series of monitoring data) to define background for setting targets and proposing suitable policies and measures to achieve them. As a second step, modelling should be carried out to predict future developments in air quality and to check whether the proposed targets are achievable and whether the policies and measures are likely to achieve them.

4. Reporting

38. Most EECCA countries publish state-of-the-environment reports. In addition, they report regularly to relevant international bodies (governing bodies of multilateral environmental agreements, UNSD, UNECE, WMO, etc). The international bodies obviously set the requirements which include types of pollutants, data format, additional information etc. Therefore, the **compliance with these technical requirements and quality of the data reported** is crucial.

39. National (state) environmental reports are mainly produced for policy makers as well as a broader public in given country. Due to this reason, the **data on air quality should be accompanied by their detailed interpretation**. Such interpretation should cover at least the following issues:

(a) Population living in areas with increased concentrations of pollutants,
(b) Areas of environmental importance (e.g. national parks or other protected areas) with increased pollution levels,
(c) Potential risks for human health and for the environment,
(d) Origin of air pollution (both sectoral and territorial distribution of emission sources),
(e) Trends in air pollution,
(f) Policies applied and measures taken.

This information cannot not be made available in full without monitoring, modelling and emission inventory results.

5. Public information and warning: urgent actions

40. In the case of certain pollutants, increased concentrations may lead to immediate health risk for sensitive groups or even for population as a whole. If so, **public should informed or warned**. The role of reliable air quality monitoring system is clear and very important in such a case. Air quality monitoring systems should be able **not only to detect** such situations immediately **but also to predict** them (on the basis of meteorological predictions). In addition, contingency plans should be implemented in such cases. These may include restrictions on traffic or specific stationary sources of pollution.

41. In the EU, for instance, “the alert thresholds” (limit values above which population must be warned) have been set for sulphur dioxide, nitrogen dioxide and ozone. In the case of ozone, “the information threshold” (limit value above which population must be informed) has been established.

6. International targets

42. At present, there is no explicit international quantitative target for EECCA countries in terms of compliance with binding ambient air-quality standards. In the EU, ambient air-

quality standards for certain pollutants (PM_{10}, sulphur dioxide, nitrogen dioxide and nitrogen oxides, lead, benzene and carbon monoxide, ozone) are legally binding and are to be (or were to be) complied with by given deadlines (2005 or 2010) throughout the whole territory of all Member States. In the case of heavy metals (As, Cd and Ni) and polycyclic aromatic hydrocarbons (PAHs) expressed as benzo(a)pyrene, the target values set should be complied with by a given deadline (2013) in the case that all necessary measures not entailing excessive costs are taken.

43. In the United States of America, the country is divided into three categories (attainment areas, non-attainment areas and unclassifiable areas). For the non-attainment areas, the compliance deadlines for primary pollutants (sulphur dioxide, nitrogen oxides, ozone, lead, carbon monoxide, PM_{10} and $PM_{2.5}$) are differentiated in accordance with the pollution levels (marginal, moderate, serious or severe).

44. EECCA countries considering future membership in the EU may develop their air-quality assessment and management systems having in mind a future need of monitoring compliance with the EU targets/obligations. Other EECCA countries could be more flexible but the **introduction of compliance deadlines for air quality standards** is recommended strongly in any case (without this, standards would probably remain at the level of statements without any real effect).

II. IMPROVING COORDINATION OF NATIONAL AIR-QUALITY MONITORING PROGRAMS

45. Air-quality monitoring networks and/or individual monitoring stations (groups of stations) can be (and obviously are) operated by different institutions - hydro-meteorological services, environmental inspectorates, sanitary/health inspections, territorial authorities, municipal authorities, enterprises or specialized companies. Due to different reasons (e.g. location of monitoring stations, monitoring frequencies), the results often differ in scope of pollutants monitored, in parameters of measurements, in timing of measurements, in data treatments as well as in quality of data and information obtained.

46. In many EECCA countries, a national core air-quality monitoring network operated by an authorized institution (mostly hydro-meteorological service) generates the background picture of air quality in the country while the stations operated by other institutions are more specialized and often serve as a supplementary source of information on air quality. The authorized institution should have the **power to coordinate all monitoring activities** in the country.

III. MODERNIZING AND UPGRADING NATIONAL AIR-QUALITY MONITORING NETWORKS AND INFORMATION SYSTEMS

47. Within the framework of the development of national air-quality assessment and management systems, EECCA countries are recommended to prepare and implement their **national programmes for modernization of and upgrading, their air-quality monitoring networks and information systems**. The main objective of these programmes is to create modern air-quality information and monitoring systems that respond to information and policy-making needs of EECCA countries and operate on the basis of best available technologies, methodologies and good practices available in the UNECE region. Respect to country specific issues is unavoidable indeed.

48. Development of a **complete national core air-quality monitoring network** as a part of air-quality information system should be the main specific target of these programmes. The following issues should be covered by these programs:

(a) Sampling points, their location and densities,
(b) Parameters measured,
(c) Technical capacities, particularly automated measurements,
(d) Reliability of measurements and analyses,
(e) Data management,
(f) Mobilization of funds from various domestic and external sources.

Step-wise approach is recommended taking into account financial and technical possibilities of particular EECCA countries.

49. In the preparation of these programmes, a **policy decision on air-quality standards** should be taken **both as for the scope of regulated pollutants and as for the type of regulation** (limit values, target values, long-term objectives, concentration caps, critical levels, exposure, alert/information thresholds, different approach to human health and to ecosystems/vegetation), as "what is regulated, must be monitored – what is monitored, can only be regulated effectively". This policy decision on the scope of regulated (and monitored) pollutants and on the type of regulation should be codified in the legislation together with the values of respective air-quality standards (and deadlines for compliance). It is also recommended to **set basic rules for air-quality assessment** similar to the lower and upper assessment thresholds as, for instance, provided for by the EU legislation (that requires the application of modelling techniques).

50. Technical recommendations presented in the sections that follow are based, among others, on the current practice in the European Union[5] and are mainly related to the establishment of national core air quality monitoring networks. The *EMEP Manual for sampling and chemical analyses* could be another source of information for EECCA countries but it should be taken into account that the EMEP network of stations is not intended to substitute national air-quality monitoring networks.

A. Sampling points, their location and densities

51. The number of sampling points seems to be insufficient in many EECCA countries (e.g. the Russian Federation operates 755 stations, Ukraine operates 169 stations) while in the EU Member States these numbers are much higher - the Czech Republic, for instance, operates 230 stations from which 125 are automated). In addition, the siting of sampling points is obviously focused on highly populated areas while sampling points in natural areas are rather rare in EECCA countries.

52. It is recommended to EECCA countries to observe the following **rules related to siting and equipment of sampling points**:

(a) Sampling points should be sited in such a way to provide data on the concentrations of pollutants both in highly populated areas (impact on human health) and in the rural areas

[5] Proposal for a Directive of the European Parliament and of the Council on ambient air quality and cleaner air for Europe (COM (2005) 447 final).

which are not much influenced by anthropogenic pollution (impact on vegetation and ecosystems).
(b) Siting of sampling points is given by the type of station (traffic, industrial or background), the type of area (urban, suburban or rural) and the characterization of area (residential, commercial, industrial, agricultural or natural).
(c) In general, sampling points should be sited in such a way to avoid measuring very small micro-environments and to be representative for air-quality monitoring in their reasonable vicinity, which is different for different types of stations and areas (from hundreds of square meters in the case of traffic or industrial sites to thousands of square kilometres in the case of stations targeted at obtaining the information related to the protection of vegetation).
(d) Sampling points targeted at obtaining the information related to the protection of vegetation should be located more than 20 km from agglomerations (250 or more thousand inhabitants) or more than 5 km from other built-up areas, industrial installations or motorways.
(e) From the micro-scale point of view, sampling points should be located in such a way to ensure unrestricted flow of air around the inlet, obviously in the height between 1.5 m and 4 m.
(f) Minimum number of sampling points in populated areas should be from one in the case of smaller cities to 5 - 10 (agglomerations of 6 and more million inhabitants) depending, besides the number of population, on typical concentrations of relevant pollutants.
(g) In the case of stations targeted at obtaining the information related to protection of vegetation, at least one sampling point per 20 – 40 thousand km^2 is recommended depending on typical concentrations of pollutants.
(h) Additional sampling points should be established to measure pollution related to the important point sources of emissions.

53. In the case of ozone, minimum numbers of sampling points can be slightly lower than those for other pollutants but 50 % of ozone sampling points should measure nitrogen dioxide and at least one sampling point per country for measuring ozone precursors should be in place. In the case of heavy metals (As, Cd, Ni) and benzo(a)pyrene, one background sampling point should be installed every 100 thousand km^2.

54. In the case of large EECCA countries with a low density of population, the numbers of sampling points sited outside highly populated areas could be lower than that proposed in paragraphs 52 and 53.

B. Parameters measured

55. As for the pollutants monitored in EECCA countries, it can be seen that measurements of PM_{10}, ozone, VOCs and PAHs are very rare. On the contrary, measurement of meteorological parameters at certain stations is rather frequent. It is recommended to EECCA countries **to monitor**, generally, **a core set of pollutants for which standards have been or will be set** (sulphur dioxide, nitrogen dioxide, carbon monoxide, lead, PM_{10}, benzene and ozone), starting in the biggest cities and highly populated agglomerations. In addition, it is recommended in countries, where it has not yet done, to start monitoring, at least at selected monitoring stations, $PM_{2.5}$, additional heavy metals (As, Cd, Ni) and PAHs (benzo(a)pyrene).

56. In countries, where it has not yet done, besides the concentration of pollutants, meteorological parameters should be measured at selected stations, representative with respect to monitoring data assessment, as follows:

(a) Wind velocity and direction,
(b) Wind direction,
(c) Temperature 10 m above terrain and 2 m above terrain,
(d) Relative air humidity,
(e) Atmospheric pressure,
(f) Precipitation amount,
(g) Global radiation.

At selected representative stations, precipitation quality (chemical composition) and atmospheric deposition should be monitored as well.

C. Technical capacities, particularly automated measurements

57. Technical capacities in the field of automated monitoring stations are underdeveloped in EECCA countries. With the exception of the Russian Federation (57 automated stations in 2005) and Belarus (1 automated station in 2005), none of EECCA countries operated any automated station in 2005.

58. For the establishment of a national core air quality monitoring network, the **stepwise establishment of automated monitoring stations** is recommended (starting with the biggest cities and highly populated agglomerations and continuing "top-down"). A national core air-quality monitoring network based on automated stations could be supplemented by manual monitoring stations and by passive monitoring devices.

D. Reliability of measurements and analyses

59. Sampling strategies implemented in most EECCA countries have many shortcomings both as for the methodology and as for the technical obstacles. Quality assurance and control (QA/QC) is being introduced slowly.

60. Application of internationally recognized **reference sampling and measurement methods** is recommended to EECCA countries. The International Organisation for Standardization (ISO) is standardizing tools for air quality characterization of ambient air, in particular measurement methods for air pollutants[6] and for meteorological parameters, measurement planning, procedures for quality assurance/quality control and methods for the evaluation of results, including the determination of uncertainty. ISO also outlines the general principles to take into account when assessing the accuracy of measurement methods and results, and in applications, and to establish practical estimations of the various measures by experiment.[7] EU relevant standards are presented in box 6. Data quality objectives are

[6] 21 ambient atmospheres standards/projects of TC 146/SC 3 and 11 general standards and/or guides of TC 146/SC 4 (www.iso.org).
[7] *1993 Guide to the Expression of Uncertainty of Measurements* and guidance for the accuracy of the measurement and for testing laboratories (ISO 5725-1-8:1994-1998 and ISO 17025:2005) (www.iso.org).

recommended to be defined by three variables: uncertainty, minimum data capture and minimum time coverage[8].

Box 6: EU sampling and reference methods

EN 14212:2005 for sulphur dioxide
EN 14211:2005 for nitrogen dioxide and oxides of nitrogen
EN 14902:2005 for heavy metals
EN 12341:1999 for PM_{10}
EN 14907:2005 for $PM_{2.5}$
EN 14662:2005 for benzene
EN 14626:2005 for carbon monoxide
EN 14625:2005 for ozone
ISO 12884 for benzo(a)pyrene and other polycyclic aromatic hydrocarbons

Source: European Commission..

E. Data management

61. Owing to a general lack of coordination in EECCA countries, the results obtained from various air-quality monitoring activities in a country are frequently not comparable or complementary. There is no interpretation of close relationships between different data sets. Current air quality monitoring networks are generally unable to link air pollution levels with emission patterns and to identify activities that lead to increased pollution levels. In addition, there is no centralized or inter-connected distributed electronic network for transmission of air quality monitoring data in EECCA countries. The lack of common data interpretation and exchange of air quality monitoring results makes a full assessment of air quality difficult. Finally, air quality monitoring data are rarely used in developing environmental policy plans and programs.

62. It is recommended, therefore, that the national air-quality information system, as a sub-system of national air-quality assessment and management system, should implement the **following main tasks**:

(a) Collection of meteorological and climatic data,
(b) Collection of data on quality of precipitation,
(c) Collection of data on air quality (core network, specialized networks and individual stations),
(d) Processing of the data (quality control),
(e) Modelling of concentration fields of pollutants,
(f) Assessment and modelling of trends in air quality,
(g) Reporting (both national and international).

The air-quality information system should be closely linked operationally with:

(a) Compliance assessment (exceedances of limit values or other relevant standards),
(b) Collection of data on emissions (emission cadastre),
(c) Preparation of emission projections.

[8] In the EU legislation, for instance,different values of some of these variables are set for particular pollutants (e.g. uncertainty of fixed measurement is 15 % for sulphur dioxide, nitrogen dioxide and oxides of nitrogen and carbon monoxide while 25 % for benzene and particulate matter.

63. **National air-quality information systems** are recommended to be established within those institutions which operate the national core air-quality monitoring network (mostly hydro-meteorological institutes). Such air-quality information systems are being operated successfully in many EU countries (e.g. in the Czech Republic, the Czech Hydro-meteorological Institute operates the national core air quality monitoring network and the Ministry of Environment acts as a central competent authority responsible for the coordination of national air-quality assessment and management system).

F. Mobilization of funds from various domestic and external sources

64. The major part of the expenditures related to modernizing and upgrading national, regional or local air-quality monitoring systems is to be funded from national, regional and municipal budgets and the air-quality information system is to be financed from the state budget. Nevertheless, it is recommended to the EECCA counties to apply for financial support from external sources (e.g. GEF, trust funds under the Convention on Long-range Transboundary Air Pollution (CLRTAP), EU TACIS, USAID, bilateral cooperation). Optionally, private companies could bear a part of the costs related to the modernizing of and upgrading, air-quality monitoring system, either voluntarily (promoting their corporate social responsibility) or through legal requirements (mandatory self-monitoring stations included in the state monitoring system).

IV. BETTER EXPLOITING LINKAGES AND SYNERGIES BETWEEN VARIOUS INTERNATIONAL INITIATIVES ON AIR-QUALITY MONITORING AND DATA COLLECTION

65. At present, there are a number of international (global and regional) initiatives and programmes related to air-quality monitoring, assessment and management coordinated by certain international bodies which could be useful for EECCA countries in their efforts to develop their national air-quality assessment and management systems (including upgrading and modernizing their air-quality monitoring networks and related information systems). The majority of EECCA countries do not seem to make full use of cooperation with these international initiatives and programmes.

66. The CLRTAP together with its 8 protocols is the most important pan-European framework for air-quality assessment and management activities (see box 7).

Box 7: EECCA countries participation in CLRTAP

Nine EECCA countries are Parties to the CLRTAP (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Ukraine). Three EECCA countries (Belarus, Russian Federation and Ukraine) are Parties to the EMEP Protocol and two protocols dealing with sulphur and nitrogen oxides. Moldova is Party to the Protocol on Persistent Organic Pollutants (POPs) and to the Protocol on Heavy Metals.

Source: UNECE.

67. EECCA countries (who did not yet so) are recommended to consider **becoming Parties to CLRTAP and to its protocols, especially to the EMEP Protocol**. EMEP (CLRTAP Protocol on Cooperative Program for Monitoring and Evaluation of the Long-

range Transmission of Air Pollutants in Europe) is the major source of information and inspiration for EECCA countries due to the following reasons:

(a) EMEP coordinates the operation of its huge network of air-quality monitoring stations, divided into 3 levels. Operation of the EMEP stations is subject to the *Manual for the Sampling and Chemical Analysis* (available in Russian).
(b) 8 EMEP stations are located in EECCA countries (4 in Russian Federation, 2 in Ukraine, 1 in Belarus and 1 in Moldova).
(c) Additional EMEP stations are expected to be established in the near future (Armenia, Belarus, Georgia, Kazakhstan, Moldova, Ukraine).
(d) EMEP has developed chemical transport models focused on atmospheric dispersion and deposition of pollutants (MSC models).
(e) EMEP operates the international emission database (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation and Ukraine included).
(f) As for emissions inventory methodology, EMEP is regularly publishing the joint *EMEP/CORINAIR Atmospheric Emission Inventory Guidebook*, which is intended to serve in conjunction with the *Emission Reporting Guidelines* (ECE/EB.AIR/80).

68. Recently, the EMEP Monitoring Strategy and Measurement Program 2004 – 2009 has been adopted, which provides for the following items relevant for EECCA countries:

(a) It is essential to extend the program over Eastern Europe and Central Asia, starting with level 1,
(b) New stations should be established in areas not sufficiently covered, in particular in the eastern part of the EMEP region, Central Asia and the eastern Mediterranean,
(c) Level 1 activities (long-term basic chemical and physical measurements of the traditional EMEP parameters) would be the first priority when extending the network to areas not covered by measurements up to now (Mediterranean regions, Eastern Europe and Central Asia),
(d) All Parties to the EMEP protocol with an area larger than 10 000 km^2 are requested to operate at least one level 1 site,
(e) All Parties to the EMEP protocol with an area larger than 50 000 km^2 are requested to operate at least one level 2 site (level 1 plus additional parameters).

69. Global Atmospheric Watch program, established by the World Meteorological Organisation (WMO/GAW) coordinates global monitoring of aerosols, ozone, greenhouse gases, UV radiation, selected reactive gases and precipitation chemistry. WMO/GAW have developed guidelines for aerosols measurements and for measurements of chemical composition of precipitations. Several background stations under WMO/GAW program are operated in certain EECCA countries (Belarus, Kazakhstan, Russian Federation, Uzbekistan).

70. World Health Organisation (WHO) is publishing Air Quality Guidelines for Europe (available in Russian), which may be a useful reference material for revising national air quality standards in EECCA countries. These guidelines cover 32 pollutants that represent hazard for human health.

71. ISO provides standardizing tools for air quality characterization of ambient air, in particular measurement methods for air pollutants and for meteorological parameters, measurement planning, procedures for quality assurance/quality control (QA/QC), and methods for the evaluation of results, including the determination of uncertainty.

72. The European Environment Agency (EEA) operates the European Air-quality Database and generates many important studies dealing with air-quality assessment and management issues. All EECCA countries, and especially those who think about future membership in the European Union, are recommended to broaden and strengthen their cooperation with the EEA in the field of air-quality monitoring and assessment.

73. International Institute for Applied System Analyses (IIASA) has developed a model RAINS (Regional Air Pollution Information and Simulation), which enables to calculate emission projections for sulphur dioxide, nitrogen oxides, VOCs, ammonia, TSP, PM10 and PM2.5 till 2020 using several different scenarios. At present, certain projections are available for Ukraine and the Russian Federation. Recently, a new model GAINS (Greenhouse Gas – Air Pollution Interaction and Strategies) has been introduced. It does not cover any EECCA country. It is recommended to EECCA countries to start cooperation with IIASA to include them into the RAINS and GAINS models.

Annex

COMPARISON OF THE EU AND US AIR-QUALITY STANDARDS

Limit Values for the Protection of Human Health (EU) / Primary Standards (US)

Pollutant	Value		Averaging period		Compliance criterion – not to be exceeded more than:	
	EU	US	EU	US	EU	US
Sulphur dioxide	-	80 µg/m^3	-	Annual mean	-	0 x per year
	125 µg/m^3	365 µg/m^3	24-hour	24-hour	3 x per year	1 x per year
	350 µg/m^3	-	One hour	-	24 x per year	-
Nitrogen dioxide	40 µg/m^3	100 µg/m^3	Calendar year	Annual mean	0 x per year	0 x per year
	200 µg/m^3	-	One hour	-	18 x per year	-
PM_{10}	40 µg/m^3	50 µg/m^3	Calendar year	Annual mean	0 x per year	0 x per year
	50 µg/m^3	150 µg/m^3	24-hour	24-hour	35 x per year	1 x per year
$PM_{2.5}$	-	15 µg/m^3	-	Annual mean	-	0 x per year
	-	65 µg/m^3	-	24-hour	-	98th percentile
Ozone	-	235 µg/m^3	-	Max. daily one –hour average	-	1 x per year
	120 µg/m^3	157 µg/m^3	Max 8-hour mean	4th max daily 8 –hour average	25 days per year	Three year average
Carbon monoxide	10 mg/m^3	10 mg/m^3	8-hour	8-hour	0 x per year	1 x per year
	-	40 µg/m^3	-	One-hour	-	1 x per year
Lead	0.5 µg/m^3	1.5 µg/m^3	Calendar year	Max. quarterly average	0 x per year	0 x per quarter
Benzene	5 µg/m^3	-	Calendar year	-	0 x per year	-
Arsenic	6 ng/m^3	-	Calendar year	-	0 x per year	-
Cadmium	5 ng/m^3	-	Calendar year	-	0 x per year	-
Nickel	20 ng/m^3	-	Calendar year	-	0 x per year	-
Benzo(a)pyrene	1 ng/m^3	-	Calendar year	-	0 x per year	-

Notes: In the case of sulphur dioxide and nitrogen dioxide, alert thresholds (high concentrations which require immediate action) are set by the EU legislation. In the case of ozone, additional long-term objectives, information threshold and alert threshold are set by the EU legislation.

Limit Values for the Protection of Vegetation / Ecosystem (EU) / Secondary Standards (US)

Pollutant	Value		Averaging period		Compliance criterion	
	EU	US	EU	US	EU	US
Sulphur dioxide	20 µg/m^3	1.3 mg/m^3	Calendar year and winter	3 hours	0 x per year (per winter)	1 x per year
Nitrogen dioxide	-	100 µg/m^3	-	Annual mean	-	0 x per year
Nitrogen oxides	30 µg/m^3	-	Calendar year	-	0 x per year	-
PM_{10}	-	50 µg/m^3	-	Annual mean	-	0 x per year
	-	150 µg/m^3	-	24-hour	-	1 x per year
$PM_{2.5}$	-	15 µg/m^3	-	Annual mean	-	0 x per year
	-	65 µg/m^3	-	24-hour	-	98th percentile
Ozone	18 000 µg/m^3.h	235 µg/m^3	AOT40 on 1 hour values (May to July)	Max. daily one –hour average	0 x per 5 years (averaged)	1 x per year
	-	157 µg/m^3	-	4th max daily 8 –hour average	-	Three year average
Lead	-	1.5 µg/m^3	-	Max. quarterly - average	-	0 x per quarter

Note: The US Secondary Standards take into account not only the impacts of pollution on vegetation and ecosystems but also that on visibility and manmade materials.