OR 70/2011

Norsk institutt for luftforskning
Norwegian Institute for Air Research

Final Report: Air Quality Management Feasibility Study for Armenia

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Scientific report

Contents

Summary

NILU - Norwegian Institute for Air Research received funding from the Norwegian Ministry of Foreign Affairs (MFA) to perform a Feasibility Study to assess the Air Quality Management (AQM) situation in Armenia for the purpose of potentially preparing a future comprehensive project proposal for establishing an Air Quality Management Program (AQMP) for the country. The study was conducted in cooperation with local Armenian Environmental authorities (primarily the Environmental Impact Monitoring Centre – EIMC). The study evaluated the existing local monitoring network and performed a screening study in Yerevan based on passive samplers. This Final Report is an overall assessment of AQM in Armenia, and includes recommendations for future improvement.

According to available local air quality (AQ) reports from UNEP GEO, emissions in Armenia were drastically reduced since the Soviet-era and up to present due to the closing of many large industries in the area, although the transport sector has traditional been the largest emission source. Despite the significant industrial emission reductions, it appears that ambient air concentrations of nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter (PM) were not reduced in a similar manner implying that other emission sources than industry can be significant contributors. However, it is difficult to assess appropriately the contribution from different sources due to a general lack of emissions inventory information in the country.

Also according to available local air quality reports for 2008-2009, the measured concentrations of NO_2, O_3, PM and SO_2 show frequent exceedances of the Armenian air quality standards and WHO guidelines. The quality of some of the measured data is somewhat questionable, due to the poor maintenance state of the AQ monitoring network. Limited health studies have indicated that air quality related health indicators have improved since the Soviet-era, but it is evident that health issues related to AQ are still problematic and that better air quality assessment and management is needed.

There were 5 continuous monitoring stations operating in Yerevan in 2010. The continuous monitoring network for the entire country appears to be in dire need of repairs, and the network operators require extensive training in operational procedures and quality control. It seems that the local competence has adapted to marginally monitor AQ problems through a combination of extensive passive sampling in order to complement the failing performance of the continuous monitoring network.

Under this Feasibility Study we have carried out a passive sampling inter-comparison study for NO_2 for 40 stations in Yerevan. The results show that the EIMC NO2 measurements are about 39% lower in average than the measurements carried out by NILU with passive sampler. This is possibly due to a problem of saturation of the EIMC samplers. Thus, it is recommended for EIMC to use more absorption material or larger samplers for their passive sampling technique, or to ensure that exposure time is limited to avoid saturation of the samplers.

Currently overall AQM in Armenia appears to be solely concentrated on air quality monitoring, with little known efforts covering management such as regular reporting and planning, including mitigation investigations.

Specific recommendations for a successful AQMP in Armenia include **improving the monitoring network** (training and Quality Assurance / Quality Control- QA/QC), **establishment of an AQMP** (analyze AQM institutional framework), **need for AQM tool** (database, emission/dispersions/exposure models, mitigation planning), and **exploring research opportunities with international collaboration**.

Final Report:
Air Quality Management Feasibility Study for Armenia

1 Introduction

This Feasibility Study was performed to assess the Air Quality Management (AQM) situation in Armenia for the purpose of potentially preparing a future comprehensive project proposal for establishing an Air Quality Management Program (AQMP) for the country. The study was financed by the Norwegian Ministry of Foreign Affairs (MFA), and conducted by NILU - Norwegian Institute for Air Research, in cooperation with local Armenian Environmental authorities in Yerevan (primarily the Environmental Impact Monitoring Centre - EIMC).

1.1 Objectives

The objectives of the Feasibility Study were to:

1. Evaluate the existing local monitoring network and collaborating institutions.
2. Evaluate the present AQ in Yerevan based on a passive sampler screening study.
3. Give an overall assessment of AQM in Armenia.
4. Give recommendations for the future AQMP in Armenia.

An additional part of the Feasibility Study was to understand the official structure and responsibilities for managing local air quality, as well as to ascertain information regarding local capacity for operating/maintaining monitoring equipment, and to investigate which local institutions are processing data concerning local emissions, air quality, and meteorology.

1.2 Activities

The activities for the Feasibility Study included:

1. Mission 1: to perform the initial AQM assessment (see Liu and Tønnesen, 2010).
2. Mission 1: to perform the passive sampling campaign (see Liu and Tønnesen, 2010).
3. Mission 2: to assess the monitoring network .
4. A final assessment and recommendations for the future.

It was evident during Mission 1 that some minor adaptations to the Feasibility Study design and activities would have to be made. These adaptations included:

- Since local authorities were performing regular passive sampling campaigns, the passive sampling campaign during Mission 1 was turned into a comparison study between local methods and NILU methods for NO_2 measurements.
- Since the local monitoring network was in such a poor state, the network analysis during Mission 2 also included detailed instrumentation repairs and improvements for a selected number of stations.

2 Background

Armenia is a small (30,000km^2) landlocked republic in the Caucasus region of Eurasia with a total population of 3.2 million people (Figure 1). The capital, Yerevan, holds 1/3 of the country's population. The city is surrounded by mountains on three sides, which lends for regular meteorological inversions in the autumn and winter seasons. The overall climate of Armenia is classified as dry continental, with long hot summers, and a majority of precipitation falling in spring and autumn seasons.

Figure 1: Location of Armenia and capital Yerevan (Source: Google Earth)

Yerevan is the centre of economic activities of the country, in which during the Soviet-era the city was highly polluted with uncontrolled emissions from chemical and construction industries. After the Soviet collapse, light manufacturing and food industries became the prevailing industries in Yerevan, where this change resulted in an overall 51% reduction of industrial emissions from the Soviet-era to the post Soviet-era (Liu and Tønnesen, 2010).

2.1 Emissions

The major emission sources in Yerevan include:

1. Stationary sources (point sources)
    - Power plants
    - Industries
    - Heat Only Boilers (HOBs)
2. Transport (line sources)
    - Private cars
    - Public transport (busses, etc.)
    - Airplanes
    - Indirect emissions of dust from re-suspension
3. Domestic (area sources)
    - Emissions from stoves in private and public buildings

According to available an available report compiled by UNEP (Daneilayan et al., 2007*)*, industrial activities (point sources) produce a fairly high amount of emissions in Yerevan, but the recent emission quantities appear to be small in comparison to Soviet-era emissions in the city (Table 1) most likely due to the restructuring and other economic variables.

Table 1: Emissions in Yerevan from point sources for 1990 and 2000-2005. (unit: tons/year).

Pollution/year	1990	2000	2001	2002	2003	2004	2005
SO_2	23269	302	263	274	299	407	474
NO_2	14783	1021	766	507	581	573	854
CO	124826	512	476	428	530	462	423
Dust	3755	176	156	281	273	301	651

Source: UNEP GEO Yerevan, 2004-2006 summary report (Daneilayan et al., 2007).

However, the transport sector (line sources) are most likely the largest emissions contributor with the greatest impact to poor air quality in Armenia (Table 2).

Table 2: Fuel type and consumption in transport sector in Armenia, 2001-2005.

Years	2001	2002	2003	2004	2005
Petrol	66%	57%	52%	54%	47%
Diesel oil	24%	28%	30%	26%	29%
Compressed gas	10%	15%	17%	20%	24%
Total consumption (1000 tons)	285	312	366	401	391

Source: Sustainable urban transport in the city of Yerevan, Ministry of Nature Protection of Armenia (Tsarukyan et al., 2006).

While select emissions data are available through two known studies *(Daneilayan et al., 2007; Tsarukyan et al., 2006)*, a complete emission inventory has not been performed for the country nor any of the cities. It is therefore difficult to make a comprehensive assessment of the overall emissions and related sources in Armenia.

2.2 Concentrations

As previously mentioned, with the limited data available, the total emissions in Yerevan seem to have been considerably reduced since the Soviet-era (especially from the industrial sector), however the measured concentrations (ambient air quality) seem not to have improved to the same degree as the emissions from industry decrease (Table 3).

Table 3: % Emission reduction from industries and improvement of air quality in Yerevan between 1990 and year 2004-2005.

Pollutants	Reduction of emissions	Improvement of concentration levels
NO_2	96	8
SO_2	98	31
Dust	72	44

Source: UNEP GEO Yerevan, 2004-2006 summary report (Daneilayan et al., 2007).

Table 4 presents a summary of air quality measurements for 2008 and 2009 in Yerevan as reported by EIMC. While some parts of this table are unclear (see footnote below) as well as the quality of the data should be questioned due to the local monitoring methods (see Section 3), it seems to indicate that Yerevan has generally air quality values exceeding national standards and international guidelines.

According to Table 4, NO_2 exceeded the Armenia air quality standard (24 hours limit value: 40 µg/m^3) 115 times in 2009, which is a very stringent standard in comparison to international guidelines such as WHO.

EIMC reported also O_3 maximum concentrations in Yerevan from 2008-2009 in Table 4. It is not clear from the reports what is the averaging times of these maximums, but it seems to be 24 hours, for comparison with the national limit value. The maximum monthly average for ozone was around 70 µg/m^3 (Li and Tønnesen, 2010). The Armenian limit value of 30 µg/m^3 for 24 hours average is therefore very often exceeded. This limit value is very stringent, compared with the WHO guideline of 100 µg/m^3 for 8-hours running mean, but the WHO guideline is also expected to be often exceeded on the basis of the measured concentrations.

“Dust” (PM) concentrations are difficult to evaluate in relation to international standards and guidelines due to the local measurement methods. This is because “dust” is assumed to be Total Suspended Particles (TSP) minus PM1, due to the local monitoring technique of measuring particles with a diameter larger than 0.95 µm. The local 24 hours limit value of 150 µg/m^3 for PM is never the less often exceeded, especially in the spring season with monthly averages up to 320 µg/m^3 in March 2008 (Liu and Tønnesen, 2010) and often above 150 µg/m^3.

The national limit value for SO_2 concentrations (50 µg/m^3 for 24 hours mean) is also very often exceeded, as monthly averages are often on that level. The limit value is considerably higher than the WHO guideline of 20 µg/m^3 for SO_2 24 h mean, so exceedances of the WHO guideline are very frequent in Yerevan. A list of known Armenian limit values can be found in Appendix A where these are compared to EU and WHO limit values.

Table 4: Overview of concentrations of air quality parameters in Yerevan, 2008-2009.

Criteria components	Maximum concentration[1] (µg/m^3)	Average monthly concentration (µg/m^3)	Armenian Limit value (µg/m^3)
			24-hours
Dust	640	130	150
Sulfur Dioxide	380	50	50
Carbon Monoxide	-	2350	30000
Nitrogen Dioxide	307	90	40
Nitrogen Monoxide	190	40	60
Ground Level Ozone	70	48	30
Benzene	178	15	100
Toluene	679	8	600
Xylene	157	13	200

Source: Air quality annual report 2009, Environmental Impact Monitoring Center (EIMC), Ministry of Nature Protection, Armenia.

[1] It is not clear what the maximum concentration refers to. It is assumed that to a maximum monthly average for O3 and a maximum 24-hour average for SO2.

The combination of high temperatures in summer and autumn, in addition to strong irradiation levels in Yerevan provide suitable conditions for photochemical processes leading to the formation of ozone. The level of observed ozone concentrations in Yerevan are consistent with this fact. The topography and corresponding meteorology of the city also lends to inversion periods which can trap gasses and particulate matter over the city for extended periods. This can partly explain the high level of exceedances to limit values.

2.3 Human Health

WHO estimates that over 2700 deaths/year can be attributed to outdoor air pollution in Armenia (WHO, 2009), and a local study has compiled the amount of deaths attributed to various respiratory diseases (Table 5). Average concentrations of the standard pollutants described in the previous section indicate possible exceedances of WHO recommended standards, which inevitably potentially imply poor health conditions for the residents of Yerevan.

There is little evidence available to us indicating the existence of systematic scientific research conducted for environmental health topics in Armenia in recent decades (Daneilayan et al., 2007). Some studies have confirmed that AQ and environmental health indicators have improved since the polluted Soviet-era in Yerevan (Gharibyan, 2004; Kurkjian & Flegal, 2003), but the specifics of the current environmental health situation is limited. In addition, very little is known about the concentrations of other AQ indicators in Yerevan such as heavy metals or PAHs.

Table 5: Dynamics of morbidity of select nosologies from 2000-2005.

Nosology/year	2000	2002	2003	2004	2005
Tuberculosis of respiratory apparatus	218	322	292	248	314
Acute infections of upper respiratory tract	39949	21395	30602	27694	32468
Acute enteric infections	671	674	1219	802	942

Source: UNEP GEO Yerevan, 2004-2006 summary report (Daneilayan et al., 2007).

3 Results

The results from the Feasibility Study comprise an analysis of the monitoring network, passive sampling data inter-comparison, and an assessment of local AQ management in Armenia.

3.1 Monitoring Network

The complete monitoring network for Armenia was initially assessed during Mission 1 (see Liu and Tønnesen, 2010), where it was found that the EIMC uses a combination of active and passive sampling, as well as continuous monitoring to monitor the air quality in the country. The map of the continuous monitoring network for Yerevan can be seen in Appendix B, where there are 5 continuous monitoring stations. Mission 2 was performed to further analyze the continuous monitoring stations, where the following tasks were completed:

- Serviced and calibrated two ozone monitors which performed very well on the calibration and linearity test.
- Serviced a NOx monitor and tested its performance without calibrating. Cleaned the reaction cell and changed necessary parts for normal operation.
- Investigated the normal problems with NOx monitors.
- Investigated and analyzed SO_2 and CO monitors.
- Began the creation of a system for quality control and maintenance of API monitors.

Through the course of Mission 2 analysis, specific future needs and necessary actions for the network were determined to be as follows:

- Station operators should make a folder for each instrument so they have control over the performance of the instrument.
  - This should include historical log of the instrument with the chronological history of the instrument. When it is operating normal in the field, when it fails, when it's being serviced and so on. Then they know when they should do routine maintenance.
  - Service notes and calibration papers should be routinely reported. Systematic documentation of the work they are doing on the instrument should be enforced. Which parts they have changed or cleaned, how it behaves after service, calibration results, etc.
  - Necessary documentation from API is needed, including technical documentation, manuals.
- Equipment for calibrating all the API monitors should be procured. It is suggested that an API 700E calibrator with the option for O_3 calibration, and the API 701 zero air generator with the option of a CO scrubber.
- Obtain appropriate gas bottles with NIST certificate to connect to the calibrator and be able to calibrate the monitors.
- Establish a system for regularly calibrating the monitors and for servicing the monitors to avoid problems and breakdowns in the field.
- Establish a good system for buying spare parts.

It should also again be noted that PM is monitored in Yerevan with a non-standard method where particles larger than 0.95 µm are measured. The measurement of "dust" represents therefore the total mass concentration of suspended particles with a particle diameter larger than 0.95 µm. It is recommended that more modern internationally certified PM measurement are considered in order to include more accurate measurements of PM_{10} and $PM_{2.5}$.

3.2 Passive Sampling Comparison

In addition to the 5 continuous monitoring stations in Yerevan, passive sampling is regularly conducted on a weekly basis at up to 45 permanent stations in the city alone. An inter-comparison NO_2 passive sampling campaign was conducted in Yerevan during Mission 1 in February 2010, for specific methods and additional information see Liu and Tønnesen (2010). The purpose of the campaign was to compare the NILU and EIMC passive sampling methods, equipment, and analysis results.

Samplers were placed at a total of 40 sites using both techniques at every site (40 NILU samplers with NILU lab analysis, and 40 EIMC samplers with EIMC lab analysis). In addition 40 extra NILU samplers were placed at the same sites to be analyzed using the EIMC lab[2].

The results from the NILU passive sampling campaign (using NILU samplers and analysis at NILU's lab) can be seen in Figure 2, where NO_2 concentrations ranged from 4 µg/m^3 to 69 µg/m^3. The EIMC campaign results (using local samplers analysed at EIMC lab) can be seen in Figure 3, where NO_2 concentrations ranged from 5 µg/m^3 to 39 µg/m^3.

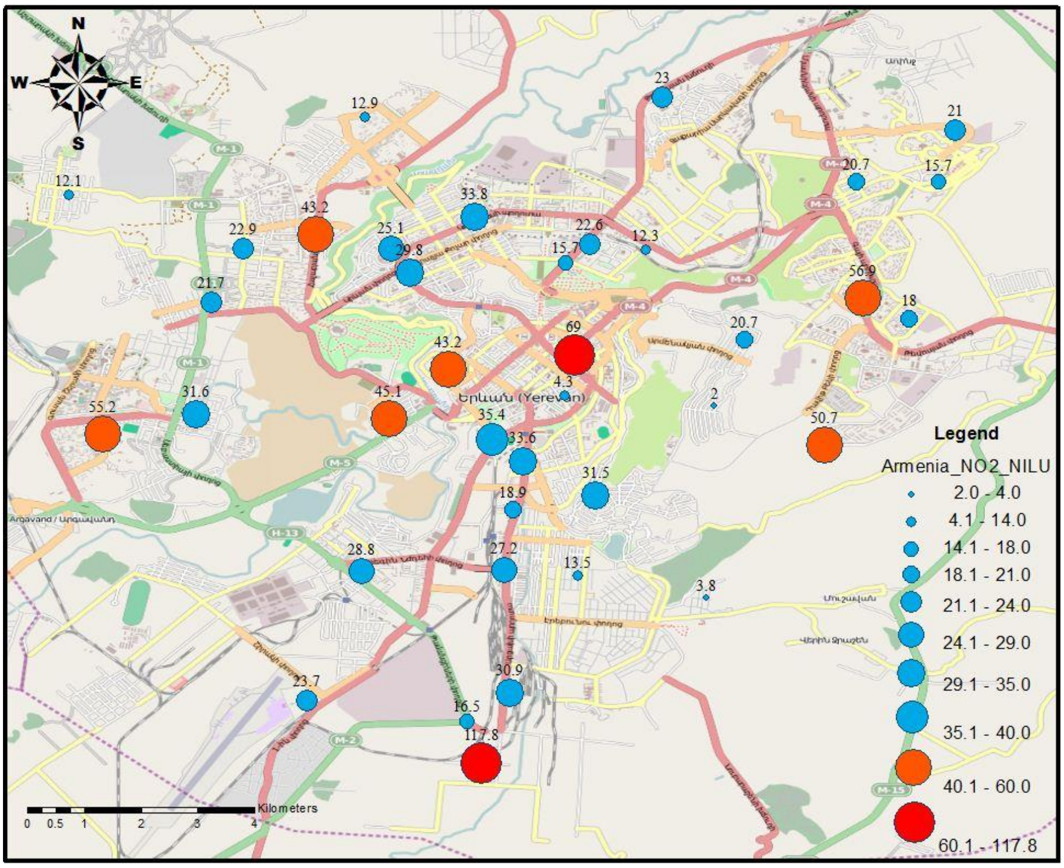

Figure 2: NO_2 Concentrations from Passive Sampling in Yerevan February 2010, using NILU Technique (NILU samplers and lab analysis). Note: Sites 32 and 41 are not recorded on this map due to lack of geographical reference information.

[2] This third data set was missing at time of report preparation, so this third extra comparison is not reported here. It is recommended to undergo a similar comparison to the first two data-sets presented here, if this data is located in the future.

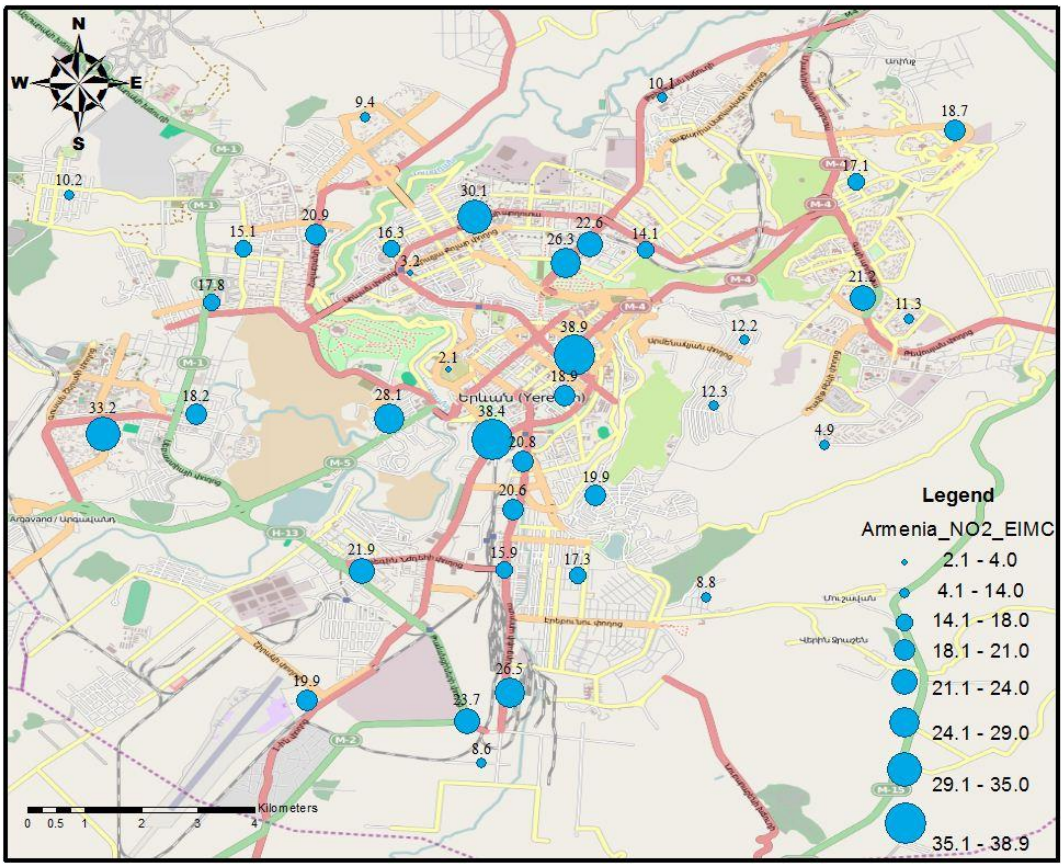

Figure 3: NO_2 Concentrations from Passive Sampling in Yerevan February 2010, using EIMC Technique (EIMC samplers and lab analysis). Note: Sites 32 and 41 are not recorded on this map due to lack of geographical reference information, and Site 19 was missing data.

A comparison of the two data sets (Figure 4) shows that the EIMC passive sampling method yields an average of 16 $\mu g/m^3$ lower values (39% lower) than the NILU technique, where 31 of the compared 40 sites had lower values for EIMC data. This difference can be due to the fact that the EIMC samplers contained less absorption material and became saturated during the campaign period. The NILU passive sampling method has been verified through continuous monitoring studies (Appendix C) (Denby and Sundvor, 2008).

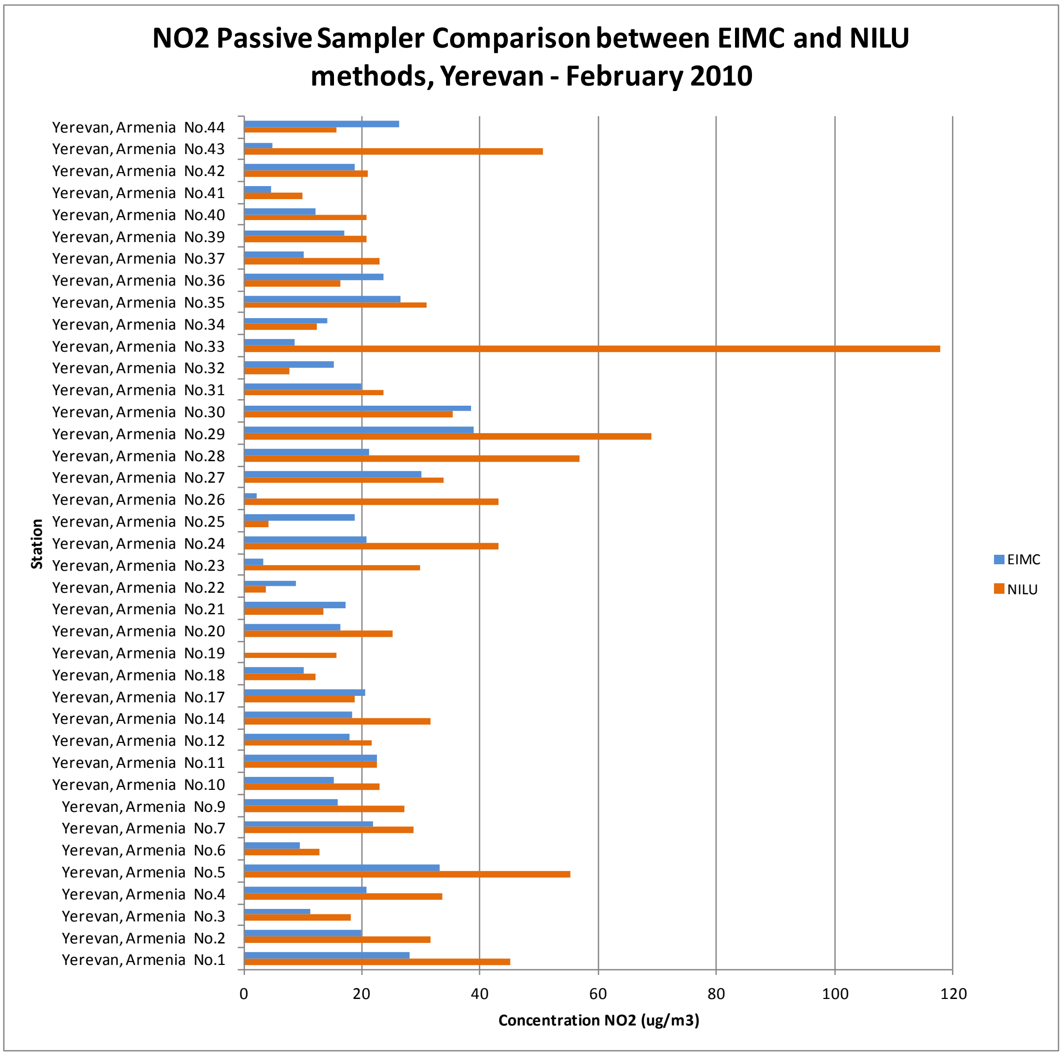

Figure 4: NO_2 passive sampling comparison between the EIMC and NILU results.

It is recommended for EIMC to use more absorption material or larger samplers for their passive sampling technique, or to ensure that exposure time is limited to avoid saturation of the samplers.

3.3 Air Quality Management

As previously mentioned, the Feasibility Study indicated a lack of comprehensive emissions data available from reports and literature (Section 2.1), and questionable reported concentration values (Section 2.2). Overall it appears that there are few efforts to establish a concrete and comprehensive AQMP for the country, in order to perform proper air quality reporting, planning, and mitigation activities. However, with proper training and tools, this can be attainable since there is a fairly adequate competence capability within the national authority experts.

4 Recommended Roadmap

Based on the results of the Feasibility Study in Armenia, a roadmap with the necessary steps to achieve a successful AQMP is proposed for Armenia. Figure 5 gives a figurative description of the proposed roadmap for the implementation of an AQMP in Armenia. The specific roadmap elements and steps for implementation are described in Table 6.

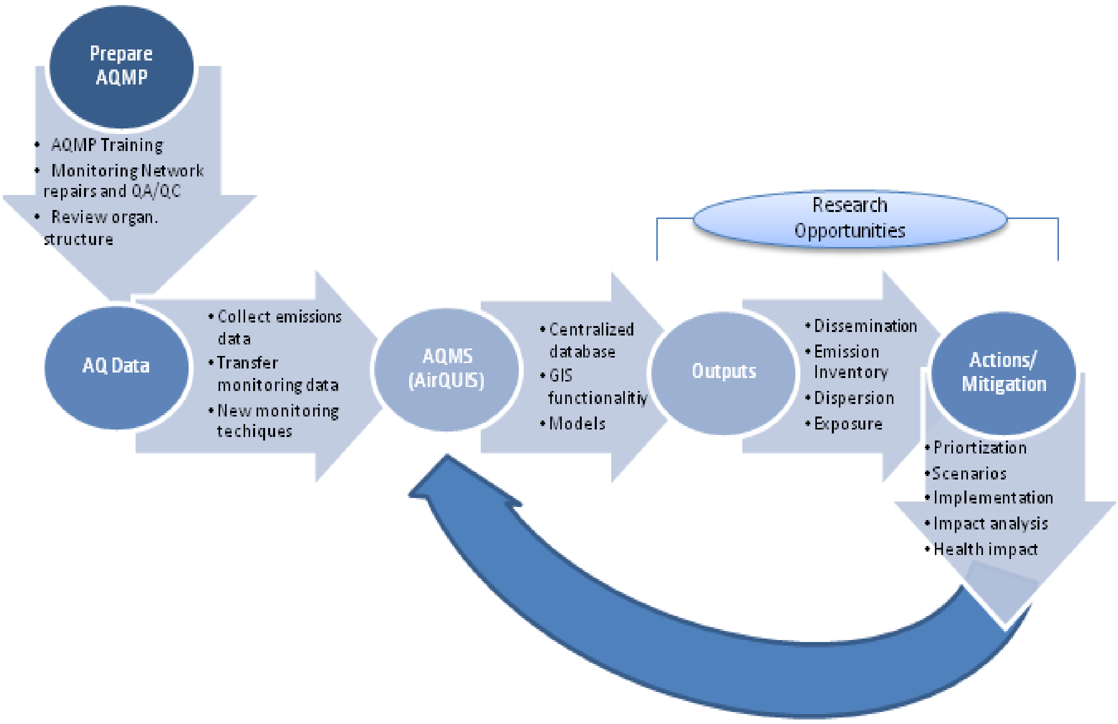

Figure 5: Roadmap for the successful implementation of an AQMP in Armenia.

The central key to a successful AQMP is a solid air quality management system (AQMS). The NILU developed AirQUIS (http://www.airquis.com) is an example of such an AQMS and is the one proposed for Armenia. AirQUIS is a GIS based system which can be used for managing and assessing monitoring data, as well as air quality management, including estimating environmental impacts from planned measures (see system assessment schematic Appendix D). The system contains the following modules:

- Automatic Data Acquisition System (ADACS)
- On-line measurement system
- Statistical and Graphical Presentation Tools
- Emission Inventory
- Emission Model
- Meteorological Model
- Dispersion Model
- Exposure Model

Table 6: Specific Elements and steps for the implementation of an AQMP for Armenia.

Element			Action	Comments
PREPARE AQMP	1	Institutional framework and organization	The institutional framework and organizational structure will have to be analyzed.	Identify functions and people needed to undertake AQM in Armenia.
	2	AQMP and AQMS Training	Training in the entire AQMP process will be needed by all involved experts.	This will be a result of Element #1 above.
	3	Improve monitoring stations	Assist with necessary repairs for existing stations.	Need support from Instrument experts.
	4	QA/QC system and training	Prepare new QA/QC system, protocols, Standard Operation Procedures (SOP) and documents. Undertake training and hands-on onsite support.	Training and system linked to instruments used!
AQ DATA	5	Collect emissions data	Collect and compile country-wide and city-wide emission data for line, point, and areas sources.	Cooperation with many agencies will be needed to collect this data. This element includes training.
	6	Data acquisition/ transfer	Monitoring station data (AQ and met data) should be prepared for automatic data transmission to database.	Installation of an Automatic Data Acquisition Systemwill be needed at each station.
	7	New AQ, emissions and exposure monitoring techniques	Explore and test new monitoring techniques such as personal samplers, satellite imagery, and infra-red cameras.	These techniques can give important complementary information on emissions, concentrations and population exposure at relatively low-cost.
AQMS	8	New central database and AQM platform	Install central database (AirQUIS) and planning system.	Training has to be part of the installation programme, see "Outputs".
	9	Data Import	Import of historical data to the new central database.	Will require some data reformatting.
	10	AirQUIS training	Training in use of AirQUIS for data dissemination (reporting), emissions, monitoring, dispersion and exposure modelling.	This training should be extensive, and over a long period.
OUTPUTS	11	Information dissemination	Support with monthly, quarterly, and yearly data reporting.	This element will come in the form of training and templates.
	12	Improve the emission inventory and its capability	Detailed emissions inventory training (including top-down and bottom-up methods). Support the compilation of a complete emissions inventory.	Most data for this element should be collected in element #5.
	13	Prepare models for Armenia	Introduction to modelling, the needs and use of dispersion and exposure models to be applied in Armenia.	The models should be linked to the AQM GIS based database and planning tool.
ACTIONS	14	Identify reduction measures and mitigation actions	Identify, specify, and prioritize various measures and actions needed to reduce the emissions of air pollutants.	Estimate emission scenarios for future developments in Armenia's transport, industry and other source sectors.
	15	Estimate impact	Use dispersion and exposure models to estimate exposure and impacts of different alternative emission scenarios	Use exposure estimates with dose/response functions to evaluate health impacts.
	16	Cost-effective actions	Evaluate cost/benefit or cost-effectiveness for alternative actions.	Cost of actions as well as cost of reduced impacts have to evaluated.
RESEARCH	17	Identify Research and Publication Opportunities	Collaborate with international institutions on local research projects and writing manuscripts for peer-reviewed publication.	Research and publication experience will increase competence and raise local AQMP to international interest and standards.

5 Conclusion

The Feasibility Study conducted by NILU in Armenia has collected available data on the state of AQM in Armenia.

According to available UNEP and local government reports, emissions of air pollutants have been substantially reduced in Armenia since the Soviet-era due to decreased industrial activity. The reports also indicate that the emissions from the transportation sector make up a majority of the emissions in the country. However, it is difficult to appropriately assess the emissions and contributing sources due to the lack of existing consistent emissions inventory information for Yerevan, or Armenia as a whole.

There were 5 continuous monitoring stations operating in Yerevan in 2010. The continuous monitoring network for the entire country is in dire need of repairs, and the network operators require extensive training in operational procedures and quality control. It appears that local competence has adapted to marginally monitor AQ problems through a combination of extensive passive sampling (45 passive sampling stations in Yerevan) to complement the failing continuous monitoring network. This Feasibility Study has carried out a passive sampling inter-comparison study for NO_2 for 40 stations in Yerevan. The results show that the EIMC method underestimates the NO2 concentrations in comparison with NILU results, possibly due to saturation of the samplers. Thus, it is recommended for EIMC to use more absorption material or larger samplers for their passive sampling technique, or to ensure that exposure time is limited to avoid saturation of the samplers.

The measured concentrations of the criteria pollutants NO_2, O_3, PM and SO_2 show frequent exceedances of the Armenian air quality standards and WHO guidelines. The quality of some of the data may be questionable, due to the poor maintenance state of the AQ monitoring network.

Currently overall AQM in Armenia appears to be solely concentrated on air quality monitoring, with little known efforts covering management such as regular reporting and planning, including mitigation investigations. In addition, almost no AQM research in Armenia has been published in international scientific journals. Due to this lack of AQM and associated published research, it is difficult to make any additional assessment on AQ and potentially related health impacts.

In conclusion, emissions from the different source sectors are poorly quantified in Armenia, and criteria pollutant concentrations frequently exceed national standards and international guidelines. Further air quality management is lacking. This Feasibility Study proposes a roadmap with the necessary steps to achieve a successful Air Quality Management Program in Armenia for the improvement of local air quality and the reduction of air pollution impacts on health.

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Appendix A

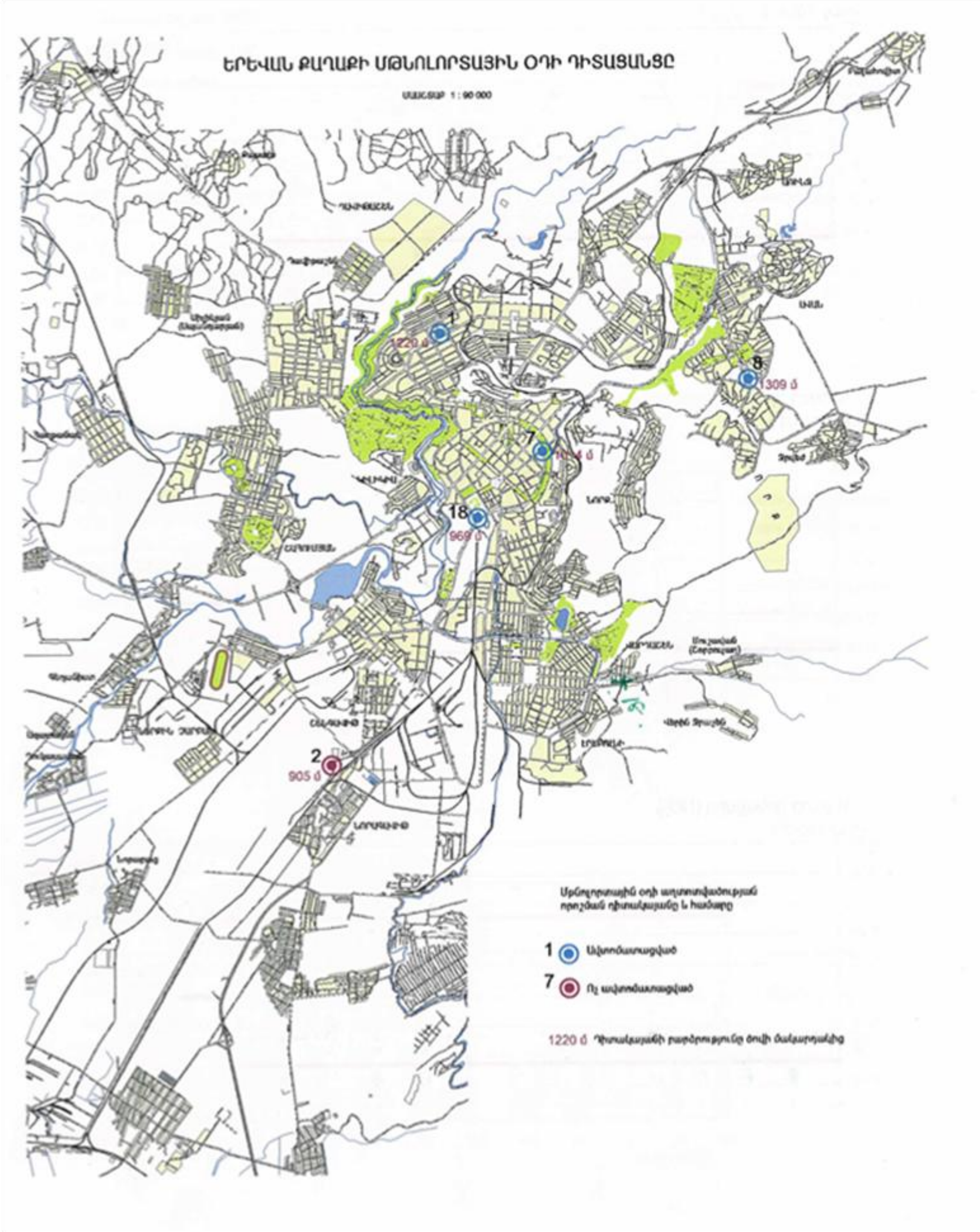
AQ Limit Values for Armenia

Limit and Guideline values for Armenia, WHO and EU for some ambient air pollutants.

Pollutant	Averaging Time	Armenia (μg/m^3)	WHO (μg/m^3)	EU (μg/m^3)
Carbon Monoxide (CO)	15 minutes	-	100000	-
	30 minutes	50000	60000	-
	1 hour	-	30000	-
	8 hour	-	10000	10000
	24 hours	30000	-	-
Nitrogen Dioxide (NO_2)	1 hour	-	200	200 (not to be exceeded more than 18 times in one year)
	24 hours	40	-	-
	Year	--	40	40
Nitrogen Monoxide (NO)	1 hour	-	-	-
	8 hours	-	-	-
	24 hours	60	-	-
Ground Level Ozone (O_3)	1 hour	-	-	-
	8 hours	-	120 (Maxmum daily 8 hourly mean)	120 (Maxmum daily 8 hourly mean not to be exceeded more than 25 days per year averaged over 3 years)
	24 hours	30	-	-
Sulfur Dioxide (SO_2)	10 minutes	500	500	-
	1 hour	-		350 (not to be exceeded more than 3 times in one year)
	24 hours	50	20	125 (not to be exceeded more than 3 times in one year)
	Year			20 (protection of vegetation)

Appendix B

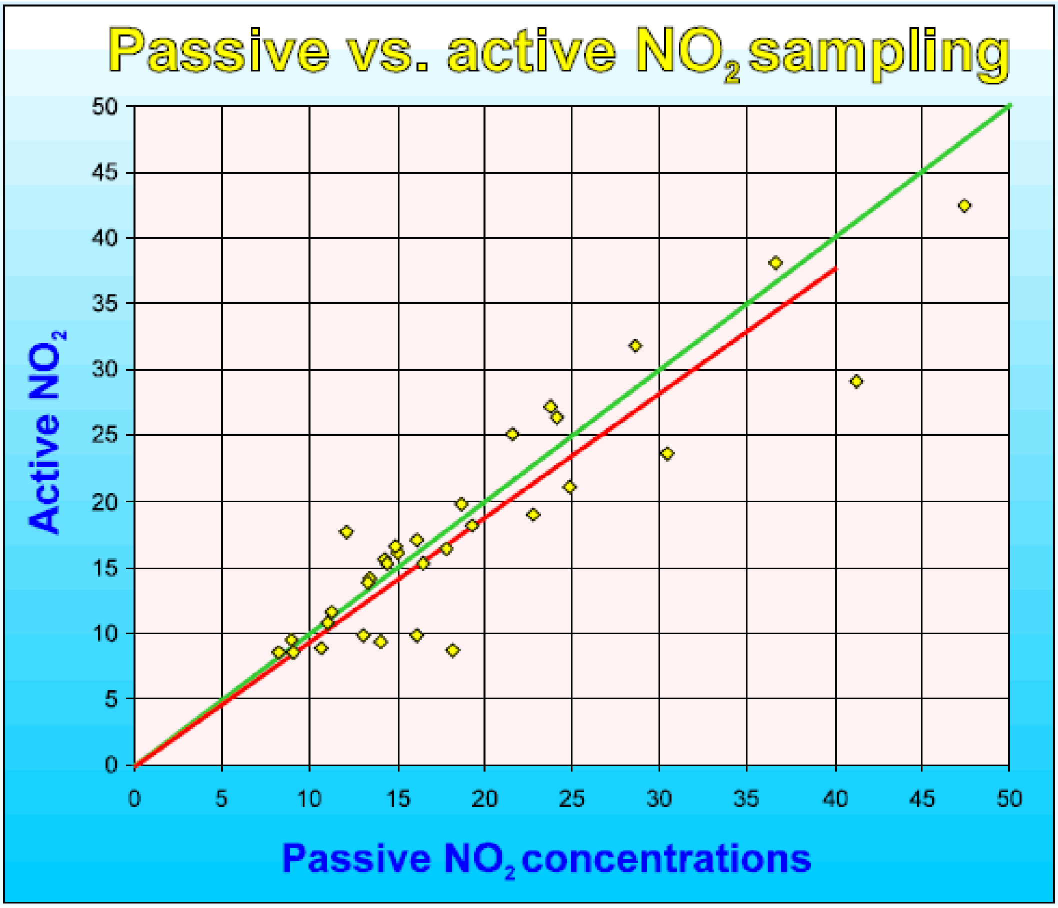
Continuous Monitoring Station Locations in Yerevan


ԵՐԵՎԱՆ ՔԱՂԱՔԻ ՄԹՆՈԼՈՐՏԱՅԻՆ ՕԴԻ ԴԻՏԱՑԱՆՑԸ
1 : 90 000
1
1220 մ
8
1309 մ
7
18
969 մ
2
905 մ
1 Ավտոմատացված
7 Ոչ ավտոմատացված
1220 մ

Appendix C

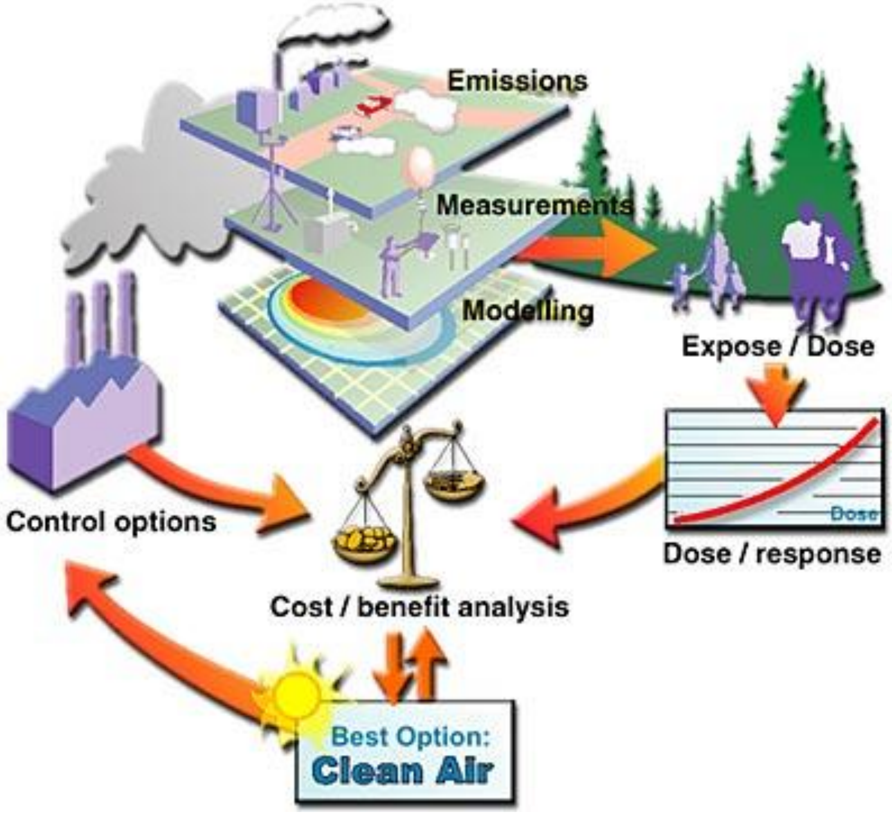
NILU Passive Sampling Verification Graph

NILUs passive sampling technique was compared to a continuous (active) monitor for NO_2. As seen from the scatter plot below, the two data sets are fairly well correlated, suggesting high confidence in NILUs passive sampling technique and the corresponding results. (Source: Denby and Sundvor, 2008)



Appendix D

AirQUIS Assessment Schematic



For more information visit: http://www.airquis.com

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Norwegian Institute for Air Research

REPORT SERIES SCIENTIFIC REPORT	REPORT NO. OR 70/2011	ISBN: 978-82-425-2463-8 (print) 978-82-425-2464-5 (electronic) ISSN: 0807-7207	
DATE 21.12.2011	SIGN.	NO. OF PAGES 24	PRICE NOK 150.-
TITLE Final Report: Air Quality Management Feasibility Study for Armenia		PROJECT LEADER Dag Tønnesen	
		NILU PROJECT NO. O-109121	
AUTHOR(S) Scott Randall, Dag Tønnesen and Li Liu		CLASSIFICATION * A	
		CONTRACT REF. ARM 09/013	
QUALITY CONTROLLER: Cristina Guerreiro			
REPORT PREPARED FOR Ministry of Foreign Affairs PO box 8114 Dep. N-0032 Oslo			

ABSTRACT

A Feasibility Study has been performed to assess the Air Quality Management (AQM) situation in Armenia for the purpose of potentially preparing a future comprehensive project proposal for establishing an Air Quality Management Program (AQMP) for the country. The study was conducted in cooperation with local Armenian Environmental authorities (primarily the Environmental Impact Monitoring Centre - EIMC) to evaluate the existing local monitoring network and collaborating institutions, in addition to performing a screening study in Yerevan based on passive samplers. Results from the study indicate that Armenia needs technical support and training in order to establish a comprehensive AQMP. Recommendations, including a detailed roadmap, are presented as suggestions for the framework of a future proposal to establish a successful AQMP in Armenia.

NORWEGIAN TITLE

Sluttrapport: Mulighetsstudie for luftkvalitetsforvaltning i Armenia

KEYWORDS		
Air quality	Environmental Monitoring	

ABSTRACT (in Norwegian)

En mulighetsstudie har blitt utført for å vurdere forvaltning av luftkvalitet i Armenia for å forberede et potensielt fremtidig omfattende prosjektforslag for å etablere et luftkvalitetsprogram for landet. Studien ble gjennomført i samarbeid med lokale armenske miljømyndigheter (primært Environmental Impact Monitoring Centre - EIMC) for å evaluere eksisterende lokal overvåkingsnettverk og samarbeidende institusjoner, i tillegg til å utføre en screeningundersøkelse i Yerevan basert på passive prøvetakere. Resultatene fra studien indikerer at Armenia trenger teknisk støtte og opplæring for å etablere et omfattende luftkvalitetsprogram for landet. Anbefalinger, og et detaljert veikart presenteres som forslag for rammen til et fremtidig forslag om å etablere et vellykket luftkvalitetsprogram i Armenia.

** Classification*	*A*	*Unclassified (can be ordered from NILU)*
	B	*Restricted distribution*
	C	*Classified (not to be distributed)*

REFERENCE: O-109121
DATE: DECEMBER 2011
ISBN: 978-82-425-2463-8 (print)
978-82-425-2464-5 (electronic)

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