EU4Environment in Eastern Partner Countries:
Water Resources and Environmental Data (ENI/2021/425-550)

ASSESSMENT OF AQ NETWORKS

Technical Report

Funded by
the European Union

EU4Environment
Water and Data in Eastern Partner Countries

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Activity 2.3.2 Further improving air quality monitoring and related data services

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ABOUT THIS REPORT

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ABOUT EU4ENVIRONMENT – WATER RESOURCES AND ENVIRONMENTAL DATA

This Programme aims at improving people's wellbeing in EU's Eastern Partner Countries and enabling their green transformation in line with the European Green Deal and the Sustainable Development Goals (SDGs). The programme's activities are clustered around two specific objectives: 1) support a more sustainable use of water resources and 2) improve the use of sound environmental data and their availability for policy-makers and citizens. It ensures continuity of the Shared Environmental Information System Phase II and the EU Water Initiative Plus for Eastern Partnership programmes.

The Programme is implemented by five Partner organisations: Environment Agency Austria (UBA), Austrian Development Agency (ADA), International Office for Water (OiEau) (France), Organisation for Economic Co-operation and Development (OECD), United Nations Economic Commission for Europe (UNECE). The action is co-funded by the European Union, the Austrian Development Cooperation and the French Artois-Picardie Water Agency based on a budget of EUR 12,75 million (EUR 12 million EU contribution). The implementation period is 2021-2024.

https://eu4waterdata.eu

CONTENTS

List of abbreviations

AAQD ..... Ambient Air Quality Directive

AQ..... Air Quality

CO ..... Carbon Monoxide

DoA..... Description of Action

DG NEAR ..... Directorate-General for Neighbourhood and Enlargement Negotiations of the European Commission

EaP ..... Eastern Partners

EC..... European Commission

EEA..... European Environment Agency

EECCA ..... Eastern Europe, the Caucasus and Central Asia

EMBLAS..... Environmental Monitoring in the Black Sea

EU ..... European Union

EUWI+..... European Union Water Initiative Plus

GEF..... Global Environmental Fund

IOW/OIEau ..... International Office for Water, France

NESB ..... National Executive Steering Board

NFP ..... National Focal Point

NGOs..... Non-Governmental Organisations

NO..... Nitrogen Oxide

NO_2 ..... Nitrogen Dioxide

NPD..... National Policy Dialogue

OECD..... Organisation for Economic Cooperation and Development

PM ..... Particulate Matter

Reps ..... Representatives (the local project staff in each country)

ROM..... Result Oriented Monitoring

SDG ..... Sustainable Development Goal

SO_2 ..... Sulphur Dioxide

ToR..... Terms of References

UBA..... Umweltbundesamt GmbH, Environment Agency Austria

UNDP ..... United Nations Development Programme

UNECE..... United Nations Economic Commission for Europe

UNEP..... United Nations Environment Programme

Country Specific Abbreviations Armenia

EMIC ..... Environmental Monitoring and Information Centre (until January 2020)

HMC..... Hydrogeological Monitoring Centre (since February 2020)

MNP..... Ministry of Nature Protection

SCWS..... State Committee on Water Systems

SWCIS..... State Water Cadastre Information System of Armenia

WRMA ..... Water Resources Management Agency

Country Specific Abbreviations Azerbaijan

Azersu JSC..... JSC Water Supply and Sanitation of Azerbaijan

MENR..... Ministry of Ecology and Natural Resources

WRSA ..... Water Resources State Agency of Ministry of Emergency Situations

Country Specific Abbreviations Georgia

MENRP..... Ministry of Environment and Natural Resources Protection

NEA ..... National Environment Agency

NWP..... National Water Partnership

Country Specific Abbreviations Moldova

AAM..... Agency “Apele Moldovei”

AGMR..... Agency for Geology and Mineral Resources

AMAC..... Association of Apacanals

ANRE..... National Agency for Economic Regulation of the Energy Sector (also regulates WSS)

EAM ..... Environment Agency Moldova

MoAgri..... Ministry of Agriculture (of the Republic of Moldova)

MoENV..... Ministry of Environment (of the Republic of Moldova)

Moldova..... Republic of Moldova

SHS..... State Hydrometeorological Service

Country Specific Abbreviations Ukraine

MENR..... Ministry of Ecology and Natural Resources

NAAU ..... National Accreditation Agency of Ukraine

SAWR ..... State Agency of Water Resources

SEMS..... State Environment Monitoring System

UkrHMC ..... Ukrainian Hydrometeorological Center

1. Introduction

Background: The Description of Action foresees that for each country the current status of air quality monitoring network and data services is reviewed, including the availability and use by policymakers, institutions and the public. This report summarises the review.

1.1. Objectives of air quality monitoring

An air quality monitoring system serves various purposes at the same time. In general, the main objectives are the following ones:

- Determining compliance status with national or international AQ standards and guidelines;
- Identifying threats to natural ecosystems and environment in general (e.g. climate change, influence on glaciers, ozone layer depletion, acidification, eutrophication);
- Population exposure and health impact assessment;
- Informing the public about air quality and establishing alert systems;
- Identifying relevant pollution sources and source apportionment;
- Providing objective input to environmental management and to transport, land-use and industrial planning;
- Validate air quality models;
- Developing policies, strategies, standards and setting priorities for clean air action plans;
- Developing and validating tools such as models and GIS;
- Quantifying trends to identify future problems or progress in achieving targets.

1.2. EU legislation

The legal requirements regarding ambient air quality monitoring in the European Union are laid down in the following legislation:

- Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe[1]

[1] http://data.europa.eu/eli/dir/2008/50/oj, last checked on 6 April 2023

- Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air[2]
- Commission Directive (EU) 2015/1480 of 28 August 2015 amending several annexes to Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council laying down the rules concerning reference methods, data validation and location of sampling points for the assessment of ambient air quality[3]
- 2011/850/EU: Commission Implementing Decision of 12 December 2011 laying down rules for Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council as regards the reciprocal exchange of information and reporting on ambient air quality[4]

In addition, a number of guidance documents have been published by and on behalf of the European Commission to support the harmonised implementation of these requirements.[5]

Furthermore, the work is supported and guided by groups such as AQUILA[6], the network of national reference laboratories and FAIRMODE[7], the Forum for Air quality Modeling.

Several reports for the European Parliament provide an overview of the legal requirements and the implementation (Schneider et al. 2014; Nagl et al. 2019; Karamfilova 2021).

It is worth noting, that in November 2024, the revised Ambient Air Quality Directive (EU) 2024/2881 was published.[8]

Next to air quality networks that have been installed to fulfil these requirements, EU Member States operate rural background stations under the UNECE Air Convention[9] within EMEP[10].

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[2] http://data.europa.eu/eli/dir/2004/107/oj, last checked on 6 April 2023

[3] http://data.europa.eu/eli/dir/2015/1480/oj, last checked on 6 April 2023

[4] http://data.europa.eu/eli/dec_impl/2011/850/oj, last checked on 6 April 2023

[5] https://environment.ec.europa.eu/topics/air/air-quality/assessment_en, last checked on 6 April 2023

[6] https://joint-research-centre.ec.europa.eu/about-aquila/aquila-role-and-tasks-national-reference-laboratories_en, last checked on 6 April 2023

[7] https://fairmode.jrc.ec.europa.eu/, last checked on 6 April 2023

[8] https://eur-lex.europa.eu/eli/dir/2024/2881/oj, last checked on 8 May 2025

[9] Convention on Long-range Transboundary Air Pollution, LRTAP (Air Convention), https://unece.org/environmental-policy-1/air, last checked on 6 April 2023

[10] Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (inofficially 'European Monitoring and Evaluation Programme' = EMEP), https://emep.int/, last checked on 6 April 2023

1.2.1. Number of stations

In Europe, the number of monitoring sites per zone and agglomeration is laid down in the Ambient Air Quality Directive (AAQD)[11], which can be used a rule of thumb for the final number of stations in the pilot city (Nagl et al. 2019). Annex V A.1 of the AAQD determines the minimum number of fixed monitoring stations for air pollutants[12] (for the protection of human health) per zone with respect to **diffuse** (i.e. non-industrial) **sources**, see Table 1 and Table 2. The minimum number of monitoring stations per zone depends on the pollution level in relation to the assessment thresholds (specified in Annex II of the AAQD) and the population of the zone.

Table 1: Minimum numbers of sampling points for fixed measurement of gaseous pollutants (source: https://eur-lex.europa.eu/eli/dir/2008/50/oj).

Population of agglomeration or zone (thousands)	If maximum concentrations exceed the upper assessment threshold	If maximum concentrations are between the upper and lower assessment thresholds
0-249	1	1
250-499	2	1
500-749	2	1
750-999	3	1
1000-1499	4	2
1500-1999	5	2
2000-2749	6	3
2750-3749	7	3
3750-4749	8	3
4750-5999	9	4
≥ 6000	10	4

[11] http://data.europa.eu/eli/dir/2008/50/oj, Annex V A. 2 provides criteria for industrial monitoring sites; Annex V B. sets out monitoring requirements for the $PM_{2.5}$ exposure reduction target; Annex V C. sets out criteria for monitoring sites targeting natural ecosystem and vegetation protection. These three types of monitoring stations are not covered in this study.

[12] SO_2, NO_2, NO_x, particulate matter (PM_{10} and $PM_{2.5}$), Pb in PM_{10}, CO, and benzene

Table 2: Minimum numbers (sum of PM_{10} and $PM_{2,5}$) of sampling points for fixed measurement of gaseous pollutants (source: https://eur-lex.europa.eu/eli/dir/2008/50/oj).

Population of agglomeration or zone (thousands)	If maximum concentrations exceed the upper assessment threshold (sum of PM_{10} and $PM_{2,5}$ sites)	If maximum concentrations are between the upper and lower assessment thresholds (sum of PM_{10} and $PM_{2,5}$ sites)
0-249	2	1
250-499	3	2
500-749	3	2
750-999	4	2
1000-1499	5	3
1500-1999	7	3
2000-2749	8	4
2750-3749	10	4
3750-4749	11	6
4750-5999	13	6
≥ 6000	15	7

The higher the pollution level and population are, the higher the number of monitoring sites required per zone. According to Article 7(3) of the AAQD, the number of monitoring sites may be reduced if air quality assessment is supplemented by modelling or indicative measurements. Where pollution is below the lower assessment threshold, no monitoring sites are required, and the assessment may be based on modelling or objective estimation alone.

Specific requirements call for a fairly equal distribution of traffic-orientated and urban background monitoring sites, i.e. between 0.5 and 2 respectively. These requirements are laid down in footnote 1 to the table in Annex V A 1 of the AAQD.

Further specific requirements provide for a fairly even distribution of PM_{10} and $PM_{2.5}$ monitoring sites, i.e. between 0.5 and 2 respectively. These are laid down in footnote 2 to the table in Annex V A 1.

Annex IX sets out the minimum numbers for **ozone** monitoring sites per zone.

Article 6.5 of Dir. 2008/50/EC requires one **rural background** sampling point for $PM_{2.5}$ and its chemical speciation per 100 000 km². Sampling can be combined with monitoring under EMEP. In addition,

common stations can be set up with adjoining Member States. The European Commission provides a guidance document for setting up common stations.[13]

Table 3: Minimum number of sampling points for fixed measurement of ozone (source: https://eur-lex.europa.eu/eli/dir/2008/50/oj).

Population of agglomeration or zone (thousands)	Agglomerations (urban, suburban) (1)	Other zones (suburban, rural) (1)	Rural background
< 250		1	1 station/50 000 km² as an average density over all zones per country (2)
< 500	1	2	
< 1000	2	2	
< 1500	3	3	
< 2000	3	4	
< 2750	4	5	
< 3750	5	6	
> 3750	One additional station per 2 million inhabitants	One additional station per 2 million inhabitants	

(1) At least one station in suburban areas, where the highest exposure of the population is likely to occur. In agglomerations at least 50 % of the stations shall be located in suburban areas
(2) One station per 25 000 km² for complex terrain is recommended

The AAQD is less specific for **point sources**. It requires "*For the assessment of pollution in the vicinity of point sources, the number of sampling points for fixed measurement shall be calculated taking into account emission densities, the likely distribution patterns of ambient-air pollution and the potential exposure of the population*." The European Commission provides a guidance document on air quality assessment around point sources.[14]

1.2.2. Siting of monitoring stations

The location of the future AQ monitoring stations should be in line with the criteria of the AAQD. The AAQD foresees two set of criteria. The first, more general ones are the so-called to **macro-scale siting criteria**. These criteria are applied for setting the type of the monitoring site, i.e. to distinguish between traffic, urban or rural background and industrial sites. The more specific **micro-scale siting criteria** apply for all types of monitoring sites and describe how the immediate vicinity and the air inlet should look like.

[13] https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/8e52192e-5017-4a96-a70a-bf908c1abc13/details, last checked on 6 April 2023

[14] https://circabc.europa.eu/ui/group/cd69a4b9-1a68-4d6c-9c48-77c0399f225d/library/28d776e8-55eb-4ef3-89a6-e84f0f7ba40d/details, last checked on 6 April 2023

Macro-scale siting criteria according to the AAQD provide minimum requirements on the types of locations where measurements to assess air quality have to be performed. It requires that areas are covered where the highest pollution levels are to be expected, as well as areas that are representative for the average exposure of the population. The former are mainly (urban) traffic sites or industrial sites, the latter are urban or sub-urban sites.

According to the AAQD sampling points shall in general be sited in such a way as to avoid measuring very small micro-environments in their immediate vicinity. This means that a sampling point must be sited in such a way that the air sampled is representative for a street segment no less than 100 m length at **traffic-orientated sites** and at least 250 m × 250 m at **industrial sites**.

Urban background sites shall be located so that their pollution level is influenced by the integrated contribution from all sources upwind of the station. The pollution level should not be dominated by a single source unless such a situation is typical for a larger urban area. Those sampling points shall, as a general rule, be representative for several square kilometres.

Rural background sites shall not be influenced by agglomerations closer than 20 km or industrial sites, motorways or other built-up areas closer than five kilometres.

Industrial monitoring sites shall be installed down-wind of the source in the nearest residential area. Where the background concentration is not known, an additional sampling point shall be situated within the main wind direction.

In addition, macro-scale siting criteria also provide a basis for establishing the **spatial representativeness** of monitoring sites, so that they are representative of similar locations not only in their immediate vicinity.

Sampling points targeted at the **protection of vegetation and natural ecosystems** shall be sited more than 20 km away from agglomerations or more than 5 km away from other built-up areas, industrial installations or motorways or major roads with traffic counts of more than 50 000 vehicles per day, which means that a sampling point must be sited in such a way that the air sampled is representative of air quality in a surrounding area of at least 1 000 km². To protect particularly vulnerable areas a sampling point might be sited at a lesser distance or might be representative of air quality in a less extended area.

Micro-scale siting criteria shall ensure free airflow around the sampling inlet – as a basic requirement for ensuring measurement representative for a defined area – and provide minimum requirements for sampling near major roads. The selection of locations for monitoring sites has to take into account the major emission sources, the main pollutants and the maximum number of stations.

In detail, the **flow around the inlet** sampling probe shall be unrestricted (in general free in an arc of at least 270° or 180° for sampling points at the building line) without any obstructions affecting the airflow in the vicinity of the inlet (normally some metres away from buildings, balconies, trees and other obstacles and at least 0.5 m from the nearest building in the case of sampling points representing air quality at the building line).

In general, the **inlet sampling point** shall be between 1.5 m (the breathing zone) and 4 m above the ground. Higher siting may also be appropriate if the station is representative of a large area.

The inlet probe shall **not** be positioned in the **immediate vicinity of sources** in order to avoid the direct intake of emissions unmixed with ambient air. In addition, the sampler's exhaust outlet shall be positioned so that recirculation of exhaust air to the sampler inlet is avoided.

Traffic-orientated sampling probes shall be at least **25 m from the edge of major junctions** and **no more than 10 m from the kerbside**.

Even though it is highly recommended to apply these criteria, they are not mandatory. There might be situations in densely built-up areas where not all criteria can be completely fulfilled. Nevertheless, such a station can and should be used for compliance checking.

Ambient air quality should be assessed in all areas throughout the country that fulfil the criteria for a potential air quality monitoring site.

1.2.3. Quality management requirements

Article 8 and Article 11 of Directive 2008/50/EC refer in general to reference methods for measurements. Annex VI describe these in more detail and has been updated in Commission Directive (EU) 2015/1480.[15] Annex VI describes further quality assurance requirements such as demonstration of equivalence, standardisation, which are necessary to ensure accuracy of measurements and compliance with the data quality objectives.

Annex I.C of Directive 2008/50/EC, which has been updated by Commission Directive (EU) 2015/1480 as well, describes the quality assurance requirements regarding data validation. In short, Annex I.C states:

- measurements are traceable in accordance with the requirements set out in the harmonised standard for testing and calibration laboratories,
- institutions operating networks and individual stations have an established quality assurance and quality control system,
- the quality system shall be reviewed as necessary and at least every five years by the relevant National Reference Laboratory,
- a quality assurance/quality control process is established for the process of data collection and reporting,
- the institutions appointed actively participate in quality assurance programmes,
- a National Reference Laboratory is appointed
- the National Reference Laboratory takes part in quality assurance programmes,

[15] Commission Directive (EU) 2015/1480 of 28 August 2015 amending several annexes to Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council laying down the rules concerning reference methods, data validation and location of sampling points for the assessment of ambient air quality, https://eur-lex.europa.eu/eli/dir/2015/1480/oj, last checked on 13 April 2023

1.2.4. Reporting requirements

Reporting of air quality data to the public and the European Commission is laid down in Chapter V of Directive 2008/50/EC. Article 26 states that Member States shall ensure that the public and appropriate organisations are informed about ambient air quality well in time and free of charge by any accessible media.

Article 27 and in more detail Commission Implementing Decision[16] 2011/850/EU describe in more detail the up-to-date and validated data that has to be submitted to the European Commission. This includes a substantive set of metadata. All the data is transmitted via the European Environment Agency (EEA) to the European Commission with the help of the so-called e-reporting scheme. A detailed guidance, the Member States' and European Commission's Common Understanding of the Commission Implementing Decision, is available at the Commission website.[17]

EEA maintains the European Air Quality Portal where all the data and metadata can be found.[18]

In addition, EEA together with NILU developed the so-called RAVEN software, which is a simplified version of the e-reporting scheme to support non-EU countries in submitting and reporting air quality data to EEA.[19] RAVEN also includes an auto data validation functionality.

1.3. Agreements with EU

An overview of the EU cooperation with Eastern partners is provided the EU Neighbours East website and the European Commission website about European Neighbourhood Policy and Enlargement Negotiations.[20] Regarding environment, there is a dedicated EU4Environment website.[21]

1.3.1. Armenia

The "Comprehensive and enhanced Partnership Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and the Republic of

[16] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2011.335.01.0086.01.ENG, last checked on 13 April 2023

[17] https://www.eionet.europa.eu/aqportal/doc/IPR%20guidance_2.0.1_final.pdf, last checked on 13 April 2023

[18] https://aqportal.discomap.eea.europa.eu/, last checked on 13 April 2023

[19] https://www.nilu.com/2020/04/raven-sharing-air-quality-data-across-a-growing-number-of-borders/, https://git.nilu.no/eea-tools/raven, last checked on 13 April 2023

[20] https://euneighbourseast.eu/, https://neighbourhood-enlargement.ec.europa.eu/european-neighbourhood-policy/countries-region_en, last checked on 13 April 2023

[21] https://www.eu4environment.org/, last checked on 13 April 2023

Armenia, of the other part" (CEPA) was published on 26 January 2018 in the Official Journal of the European Union.[22] Chapter 3 under Title V covers environment. The CEPA also calls for cooperation between the countries to develop strategies (including timetables, milestones, responsibilities, financing) *inter alia* for air quality.

1.3.2. Azerbaijan

The EU-Azerbaijan Partnership and Cooperation Agreement is in force since 1999.[23] In addition, there is an Action Plan of the Republic of Azerbaijan with the Council of Europe, for which a new version has been published for the period 2022 to 2025.[24]

1.3.3. Georgia

According to the DG NEAR website[25], the EU cooperates with Georgia in the framework of the European Neighbourhood Policy and its eastern regional dimension, the Eastern Partnership. Relations between the European Union and Georgia are based on the EU-Georgia Association Agreement[26] of 2014. Annex XXVI of the agreement covers Environment in general and the approximation towards the air quality related legislation in particular.

1.3.4. Republic of Moldova

An Association Agreement between the EU and Moldova was signed in 2014 (Council Decision 2014/492/EU).[27] Chapter 16 of Title IV and Annex XI cover environmental issues, including air quality. An

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[22] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.023.01.0004.01.ENG, last checked on 31 March 2023

[23] https://neighbourhood-enlargement.ec.europa.eu/european-neighbourhood-policy/countries-region/azerbaijan_en, last checked on 31 March 2023

[24] https://coe.mfa.gov.az/en/content/43/cooperation-with-the-council-of-europe, https://rm.coe.int/action-plan-azerbaijan-2022-2025-eng/1680a59aa3, last checked on 13 April 2023

[25] https://neighbourhood-enlargement.ec.europa.eu/european-neighbourhood-policy/countries-region/georgia_en, last checked on 6 April 2023

[26] https://eur-lex.europa.eu/legal-content/en/TXT/PDF/?uri=CELEX:22014A0830(02), last checked on 6 April 2023

[27] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014D0492, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:22014A0830(01), last checked on 4 April 2023

overview about the air quality related legislation in Moldova is provided at the website of the Environmental Agency.[28]

1.3.5. Ukraine

As of 23 June 2023 Ukraine was granted candidate status for membership in the EU.[29] This requires Ukraine to implement all the EU legislation as shortly described in section 1.2.[30]

[28] https://am.gov.md/ro/node/165, last checked on 6 April 2023

[29] https://neighbourhood-enlargement.ec.europa.eu/european-neighbourhood-policy/countries-region/ukraine_en, last checked on 6 April 2023

[30] see also https://neighbourhood-enlargement.ec.europa.eu/system/files/2022-06/Ukraine%20Opinion%20and%20Annex.pdf, last checked on 6 April 2023

2. Status of air quality monitoring networks

The following chapter provides an overview of the status of air quality monitoring and reporting in the different countries. It is based on available literature, websites and information provided by the countries.

Reporting of data is currently restricted to national institutions and websites. This means that data is not reported e.g. to the European Environment Agency (EEA) even though Air Quality Index website[31] of the EEA includes the location of stations in Georgia.

2.1. Armenia

The status of the air quality monitoring network in Armenia is described in a recent "Concept for improving air quality monitoring in Armenia", which was developed under an UNDP project (Buxbaum et al. 2023).

The concept does describe the necessary numbers of stations in general based on EU Ambient Air Quality Directives (AAQDs) but does not provide a specific number for Armenia. A rough estimate can be based on the number of inhabitants in Armenia, which is around 3 million inhabitants and the main cities, which are Yerevan (1 million inh.) and Gyumri (120 000 inh.). Furthermore, it is assumed that pollutant levels are above the upper assessment thresholds according to the AAQDs. Given the number of inhabitants of the main cities, there should be one agglomeration of more than 250 000 inhabitants (Baku); the remaining territory might be divided in zones as appropriate.

For Yerevan, this would result in four stations, for Gyumri one station. The remaining territory could be covered by five stations. This results in about 10 stations; the exact number depends on the actual pollutant levels and the delimitation of the zones.

Air quality monitoring in Armenia has undergone significant changes during the last 2-3 decades. The air quality monitoring network was quite extensive during the Soviet Union, but was significantly impacted by the collapse of the Soviet Union (EEA 2011; Liu and Tønnesen 2010).

A "Hydrometeorology Monitoring Center" (State Non-Commercial Organisation – SNCO) was established under the Government of the Republic of Armenia in 2020 as a successor of the "Environmental Monitoring Information Center" (EMIC), "Hydrosphere Service of Active Influence on Events" and "Forest Monitoring Center".

Similarly to the recent concept for air quality monitoring, a Norwegian project took place in 2010, which resulted in a number of recommendations (Liu and Tønnesen 2010) inter alia the following ones:

- On-spot training of the staff in the instrument laboratory, establishing a QA/QC routine for the automatic monitoring network in Yerevan.
- Both a data acquisition and an air quality information distribution system are needed in Yerevan.

[31] https://airindex.eea.europa.eu/Map/AQI/Viewer/, last checked on 4 April 2023

- Knowledge transfer would be essential. Knowledge of building up an integrated air quality management system can be transferred through the establishment of an AirQUIS system for air quality management in Armenia.
- Software, such as the AirQUIS system, for analysing both emission and measurement data and presenting data with GIS is needed for Yerevan.
- Instruments and software for data transfer are needed.
- More monitoring stations and instruments are needed at Yerevan and it is recommended to have a moveable station.
- It is possible and beneficial for EIMC to combine the project and existing EMEP activities in Armenia through the instrument maintenance and training.

2.1.1. Parameters monitored in Armenia

Table 4 below shows the parameters that are monitored by automated stations, non-automated stations, as well as passive samplers. In addition, chemical analysis of certain indicators in precipitations is performed.

Table 4: Air quality parameters and measurement methods.

Not-automated method	Automated method	Passive sampling
Dust	Carbon monoxide	Sulphur dioxide
Sulphur dioxide	Sulphur dioxide	Nitrogen dioxide
Nitrogen dioxide	Nitrogen oxides (monoxide, dioxide, total oxides)	
Nitrogen oxide	Ground-level ozone	
Ground-level ozone		
Aromatic hydrocarbons		

Until 2009 for most of the parameters, the samples were collected 3 times a day; since 2010, the daily average was obtained.

The website of the HMC[32] provides average monthly data, summarised data from passive samplers, as well as detailed information from the air quality monitoring stations.

The on-line data provided is compared to the corresponding Maximum Allowable Concentrations (MAC) and for better visualisation provides also graphics.

[32] http://www.armmonitoring.am, last checked on 28 March 2023

2.1.2. Current air quality monitoring stations

Air quality (AQ) monitoring in the Republic of Armenia is done by HMC. The AQ network consists of 15 active sampling stations (Table 5), one regional background station within the EMEP programme[33] to monitor transboundary air pollution and 214 passive sampling points. Figure 1 shows the air quality monitoring stations in Yerevan[34].

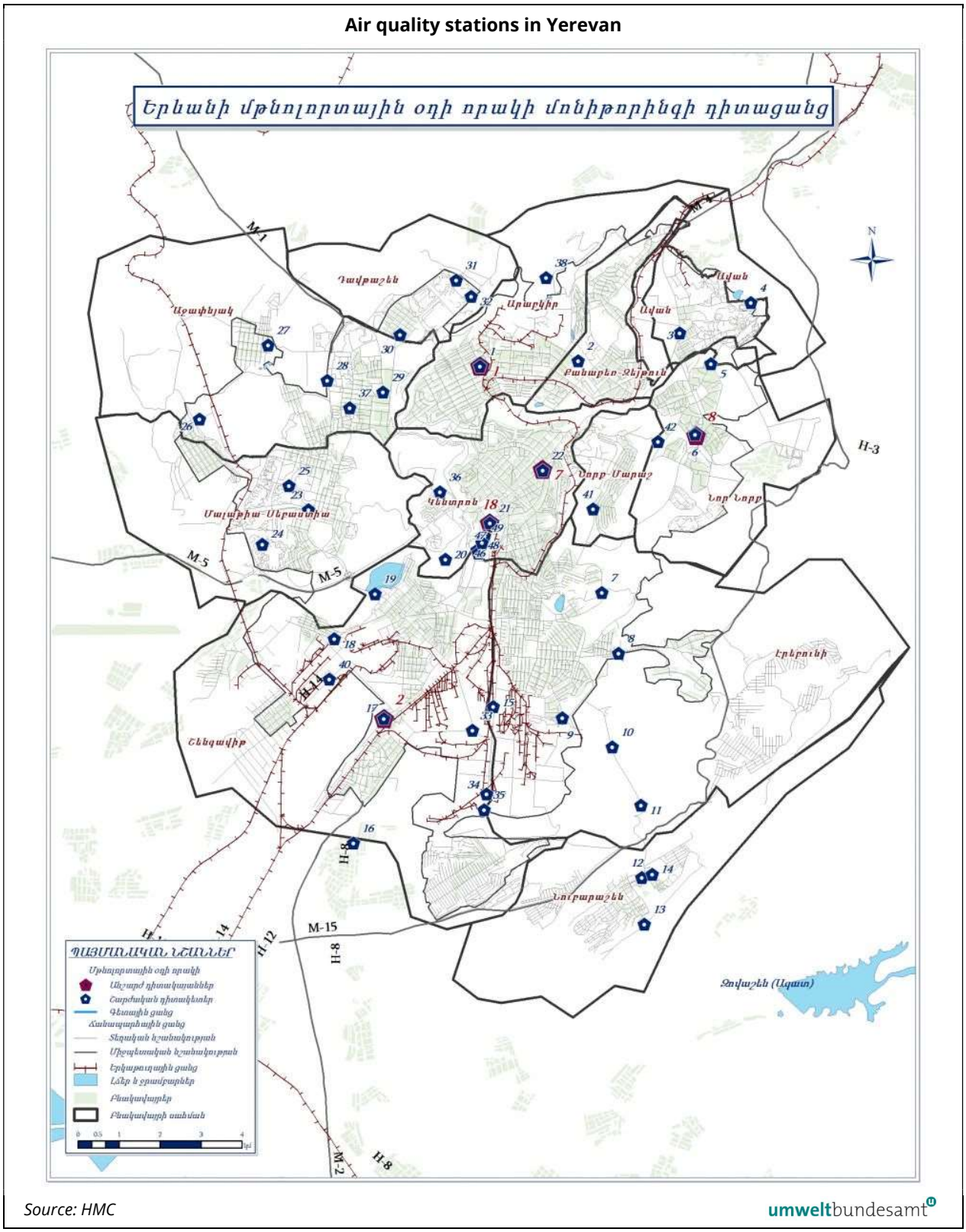
Table 5: Air quality monitoring stations in the Republic of Armenia

Marz	City	Number of station	Geographical coordinates	
			Latitude	Longitude
Yerevan	Yerevan	1	40.20602	44.50543
		2	40.12840	44.47842
		7	40.18342	44.52350
		8	40.19103	44.56747
		18	40.17154	44.50842
Ararat	Ararat	1	39.84528	44.70159
Kotayq	Hrazdan	1	40.54867	44.77135
	Tsaghkadzor	1	40.53748	44.71850
Shirak	Gyumri	1	40.80620	43.84835
Lori	Alaverdi	1	41.09881	44.64245
		2	41.09145	44.65378
		3	41.09944	44.67538
	Vanadzor	1	40.80320	44.51606
		2	40.80468	44.49322
		3	40.81444	44.47146
Aragatsotn	Amberd (EMEP station)	1	40.384231	44.260042

[33] Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe, https://www.emep.int/, last checked on 28 March 2023

[34] http://armmonitoring.am/page/61, last checked on 28 March 2023

Figure 1: Air quality monitoring network in the Yerevan City (active sampling: red dots, passive sampling: blue dots)



Source: HMC

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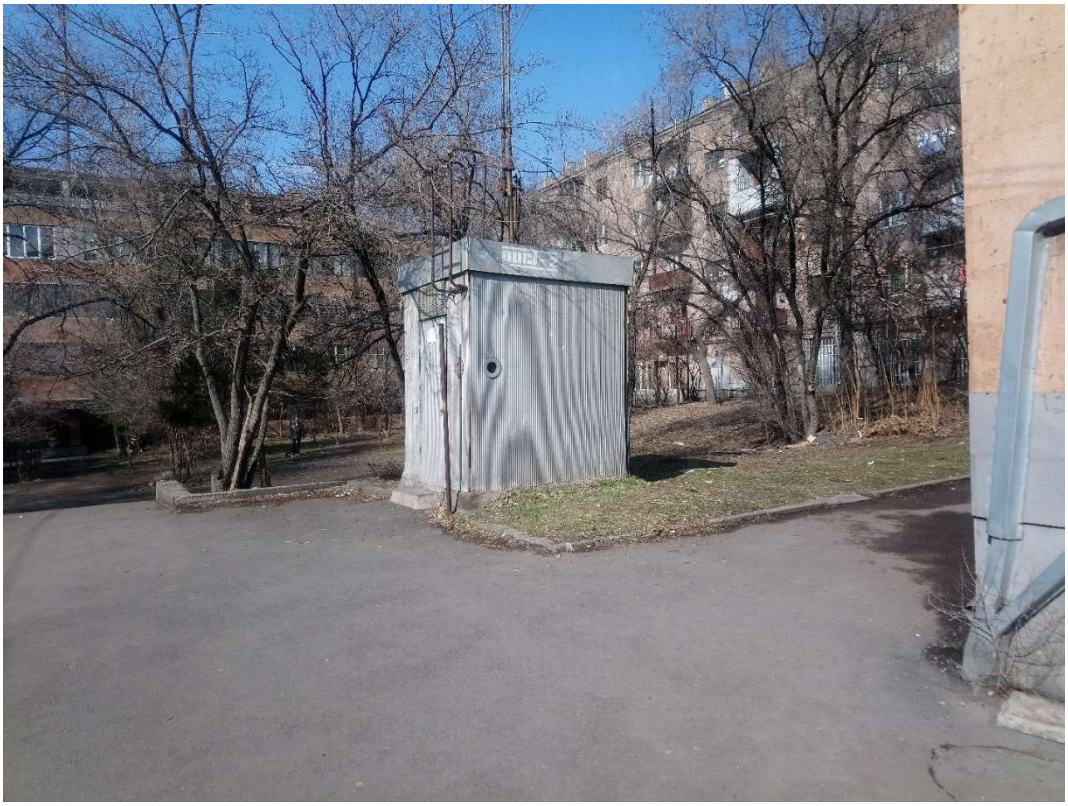
The following figures show some photos of the current air quality monitoring stations in Yerevan.

Yerevan air quality station no 1



Source: HMC

Yerevan air quality station no 2

Source: HMC

Yerevan air quality station no 7

Source: HMC

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Yerevan air quality station no 8

Source: HMC

Yerevan air quality station no 18

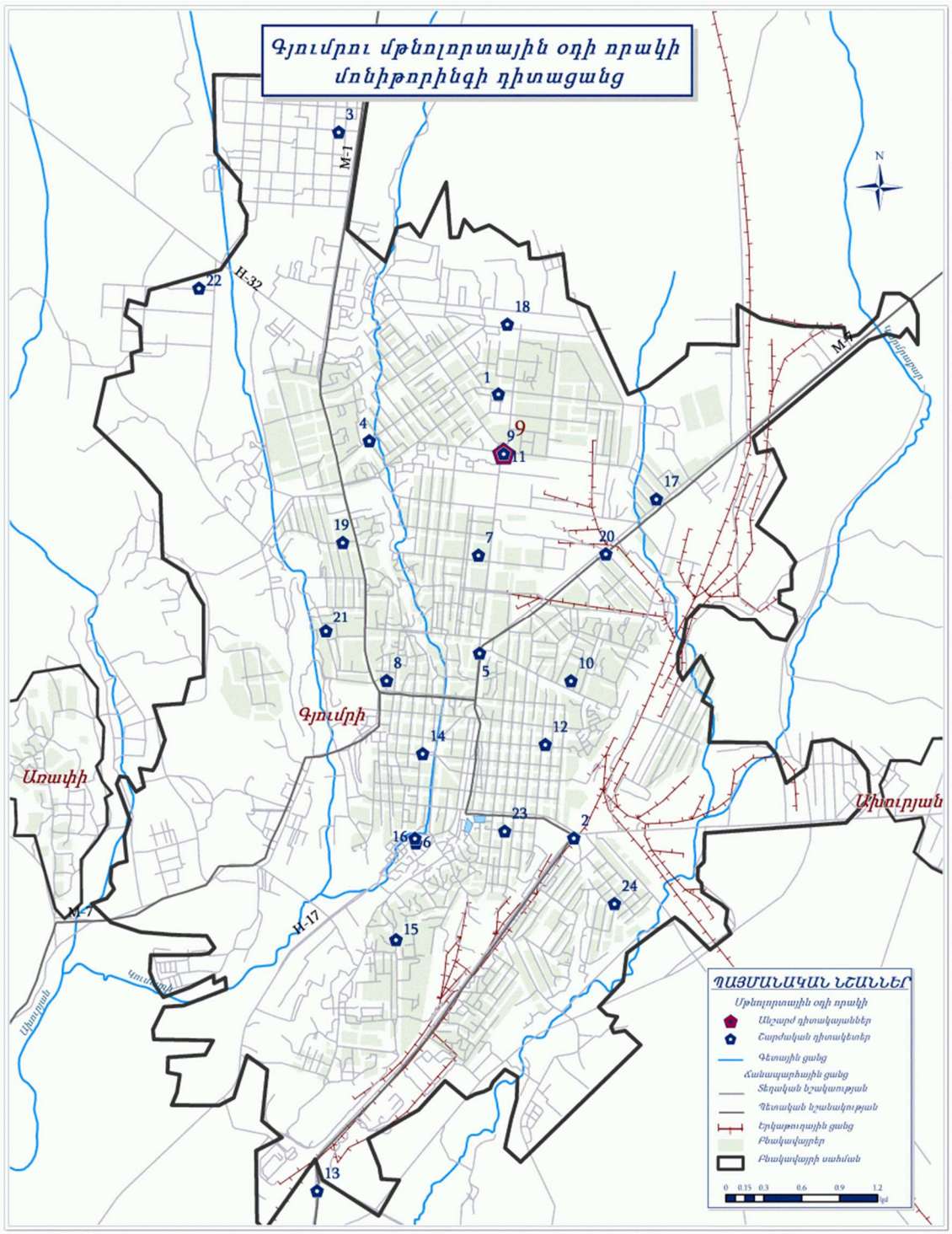
Source: HMC

umweltbundesamt

Figure 2 shows the locations of the air quality monitoring stations in Gyumri.

Figure 2: Air quality monitoring network in Gyumri (active sampling: red dots, passive sampling: blue dots).

Air quality monitoring stations in Gyumri



Source: HMC

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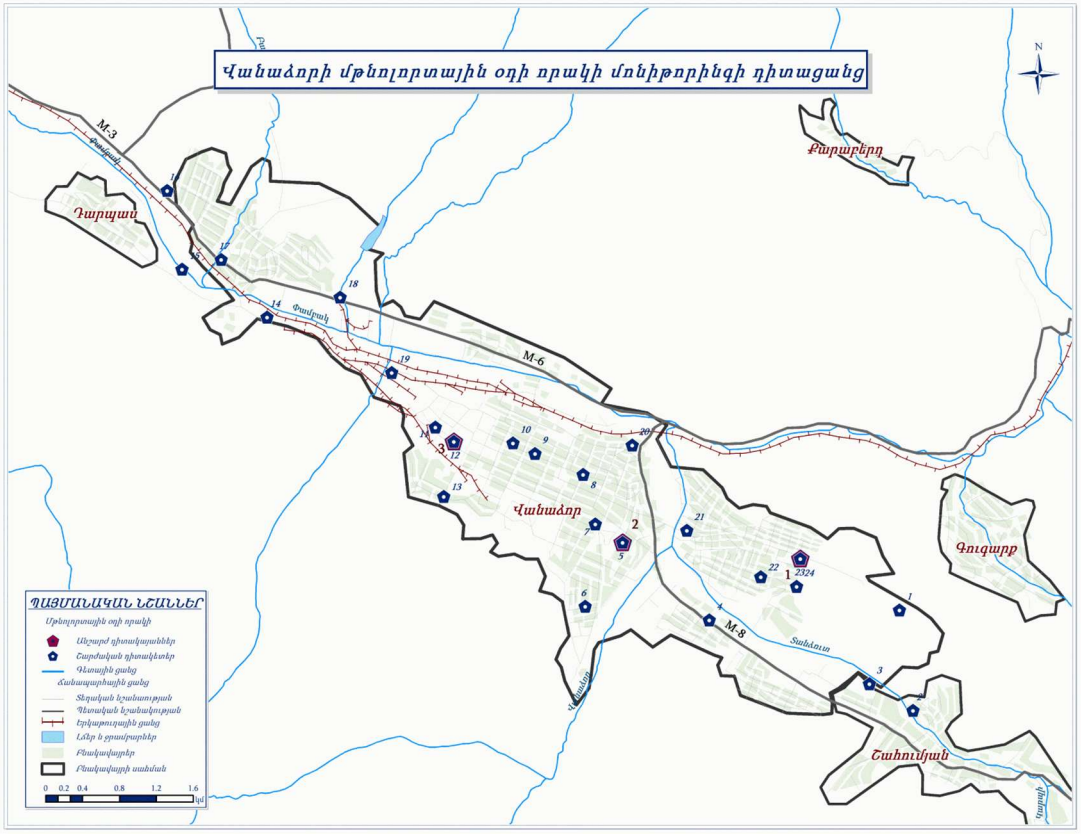
Figure 3: Air quality monitoring network in Vanadzor (active sampling: red dots, passive sampling: blue dots).

Air quality monitoring network in Vanadzor



Source: HMC

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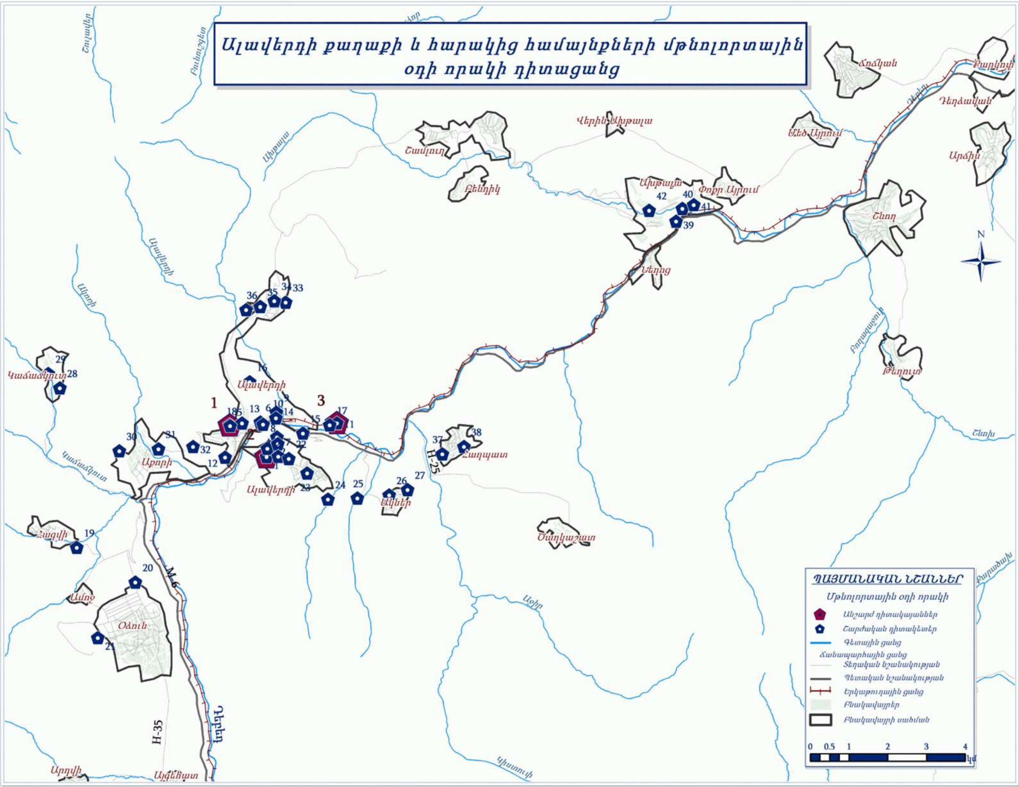
Figure 4: Air quality monitoring network in Alaverdi (active sampling: red dots, passive sampling: blue dots).

Air quality monitoring network in Alaverdi



Source: HMC

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Alaverdi N3 station

Source: HMC

umweltbundesamt

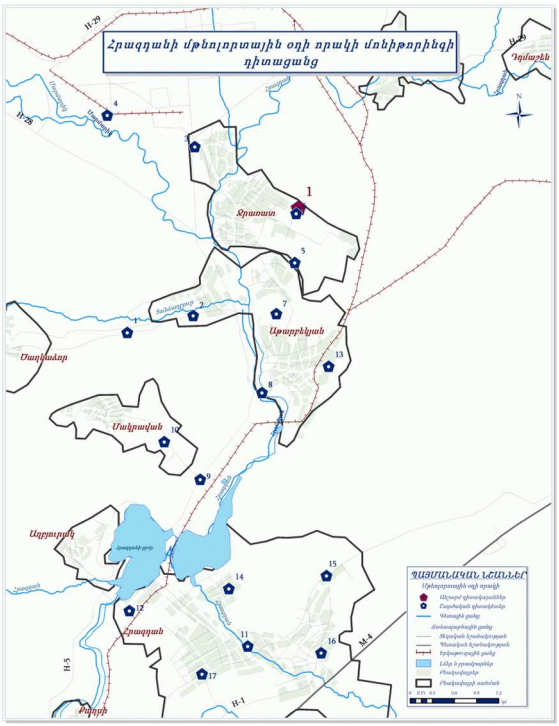
Alaverdi N 1 station

Source: HMC

umweltbundesamt

Figure 5: Air quality monitoring network in Hrazdan (active sampling: red dots, passive sampling: blue dots).

Air quality monitoring network in Hrazdan



Source: HMC

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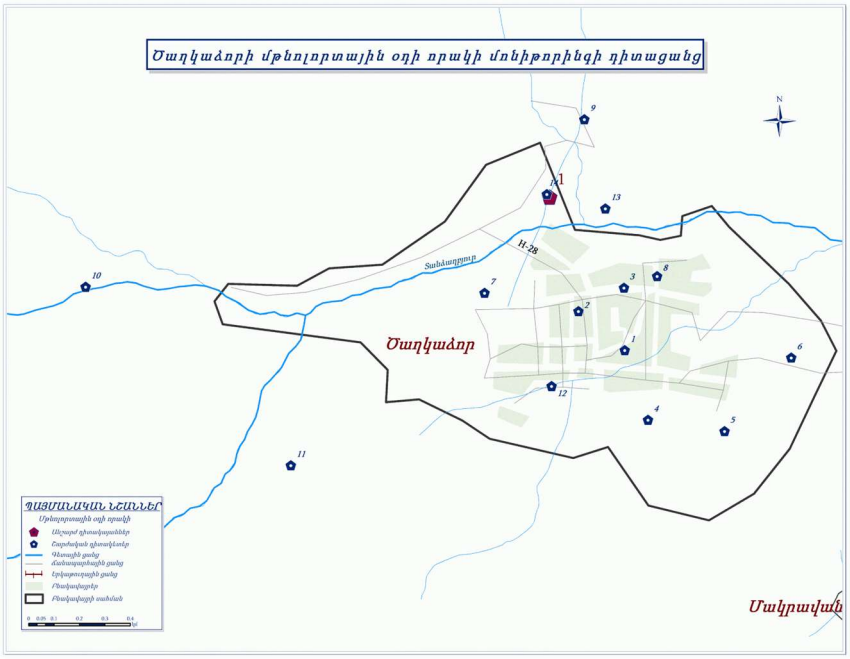
Figure 6: Air quality monitoring network in Tsaghkadzor (active sampling: red dots, passive sampling: blue dots).

Air quality monitoring network in Tsaghkadzor



Source: HMC

umweltbundesamt

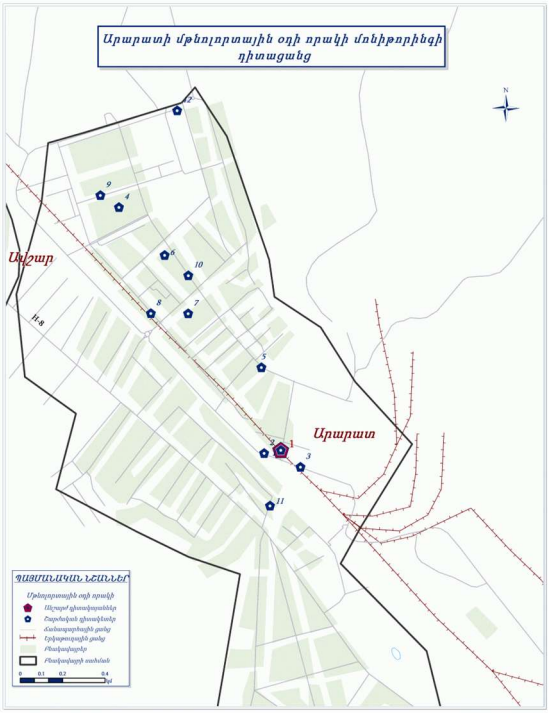
Active sampling monitoring station in Tsaghkadzor

Source: HMC

umweltbundesamt

Figure 7: Air quality monitoring network in Ararat (active sampling: red dots, passive sampling: blue dots).

Air quality monitoring network in Ararat

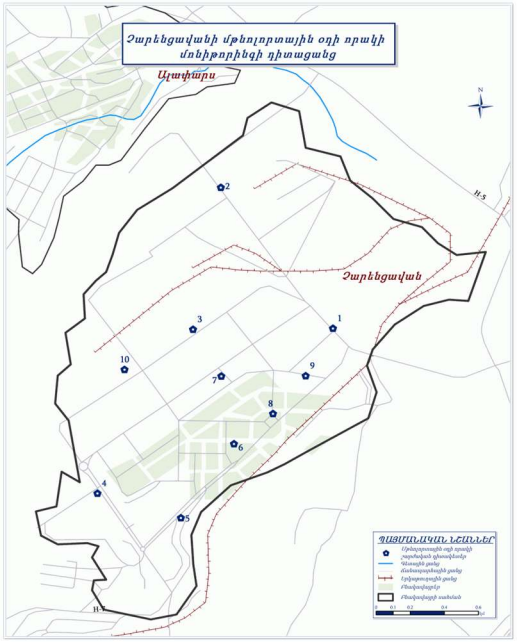


Source: HMC

umweltbundesamt

Figure 8: Air quality monitoring network in Charetsavan (passive sampling stations: blue dots).

Air quality monitoring network in Charetsavan



Source: HMC

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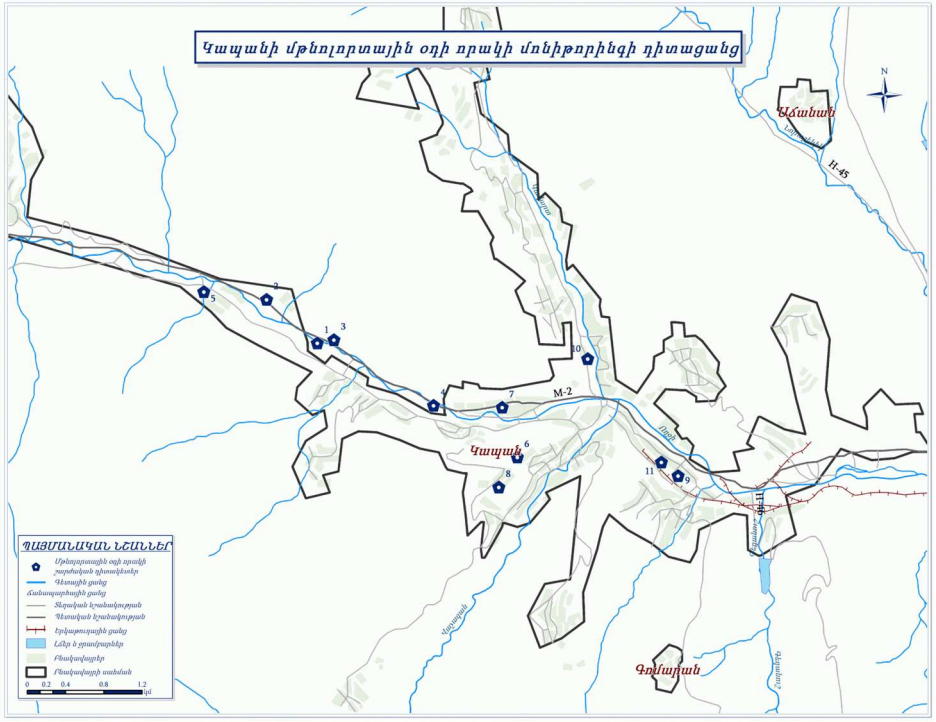
Figure 9: Air quality monitoring network in Kapan (passive sampling stations: blue dots).

Air quality monitoring network in Kapan



Source: HMC

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Figure 10: Air quality monitoring network in Kajaran (passive sampling stations: blue dots).

Air quality monitoring network in Kajaran

Source: HMC

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2.1.3. Description of current manual sampling methods

ACTIVE SAMPLING

Monitoring is mainly done by manual sampling based on either wet chemical methods or passive sampling. Within the 15 active sampling stations (Table 5) air quality monitoring is carried out daily throughout the year. The sampling systems consists of a pump, electronic or membrane gas meters and glass tubes impregnated with different reagents (Figure 12). These reagents are available for NO_2, SO_2 and ozone. Similarly, dust (total suspended particles, TSP) is sampled with specific filter material (AFA), which is also used for chemical analysis of heavy metals.

Figure 11 shows as an example the sampling system of station N 1 in Yerevan.

Figure 11: Air sampling system in Station N 1 in Yerevan.

Air sampling system in Station N 1 in Yerevan

Source: HMC

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Figure 12: Fritted glass tube for active sampling of NO_2, SO_2 or O_3 concentrations in ambient air.

Fritted glass tube with reagents for active sampling

Source: HMC

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After sampling, the reagents within the glass tubes is analysed in the chemical laboratory. No recent comparison is available between this manual sampling method and automatic samplers according to European Standards (EN 14212:2012 for SO_2, EN 14211:2012 for NO_2 and NO_x, EN 14625:2012 for ozone).

The following parameters are monitored at these 15 stations (Table 6).

Table 6: Parameters of the active sampling stations (source: HMC).

City	Number of station	Parameters
Yerevan	1	NO_2, SO_2, dust, O_3, heavy metals
	2	NO_2, SO_2, dust, O_3, heavy metals
	7	NO_2, SO_2, dust, O_3, heavy metals
	8	NO_2, SO_2, dust, O_3, heavy metals
	18	NO_2, SO_2, dust, O_3, heavy metals
Ararat	1	Dust, heavy metals
Hrazdan	1	NO_2, SO_2, dust, heavy metals
Tsaghkadzor	1	NO_2, SO_2, dust, heavy metals
Gyumri	1	Dust, heavy metals
Alaverdi	1	NO_2, SO_2, dust, heavy metals
	2	NO_2, SO_2, dust, heavy metals
	3	NO_2, SO_2, dust, heavy metals
Vanadzor	1	NO_2, SO_2, dust, heavy metals
	2	NO_2, SO_2, dust, heavy metals
	3	NO_2, SO_2, dust, heavy metals

PASSIVE SAMPLING

Passive (also called diffusive) sampling is done for NO_2 and SO_2 at 214 locations in the cities listed in Table 5. The samples are changed on a weekly basis and analysed in the chemical laboratory after exposure.

LABORATORY EQUIPMENT FOR CHEMICAL ANALYSIS

The chemical laboratory of HMC was updated in 2019 within the EUWI+ initiative[35]. Table 7 lists the instruments that are currently in use at the HMC chemical laboratory.

Table 7: Current equipment of the HMC chemical laboratory used for ambient air quality sampling (source: HMC).

Instruments	**Operated since**
Inductively coupled plasma mass-spectrometer: ICP-MS, Perkin Elmer ELAN 9000	2003

[35] https://euwipluseast.eu/en/, last checked on 28 March 2023

Ion chromatograph: DIONEX ICS -1000	2007
Ion chromatograph: Metrohm 940 Professional IC Vario	2019
Spectrofotometer: Specord 210 PLUS, Analytik Jena	2020
Spectrofotometer: Specord 205, Analytik Jena	2010
Spectrophotometer Lambda 35 UV/VIS, Perkin Elmer	2008
Multiparameter field Instrument: YSI 556 MPS, YSI Professional Plus, OXY 340i/SET	2019
TOC Analyzer Elementar	2011
Gas Chromatograph-Mass-spectrometer: GC/MS Agilent 7890A/5975C	2010
Gas Chromatograph: Perkin Elmer Clarus 400, GC-FID	2008
Handheld X-ray fluorescence analyzer: XRF- Olympus vanta	2019
Microwave digestion system: Berghof Speedwave MWS-3+	2010
Analytical Balances: Voyager Shimadzu AP224W	2019

The instruments are in principle suitable for the analysis of air quality samples for heavy metals and ions as well. However, the status of the standards and calibration of instruments is not known yet. In addition, it has to be noted, that concentrations can be rather low at some locations, which require high purity materials and adequate sampling handling for trace analysis.

DEFUNCT AUTOMATIC MONITORS

Around 15 years ago, selected AQ monitoring stations in Yerevan and Alaverdi were equipped with automatic gas analysers for SO_2, NOx and CO (Horiba, Teledyne). Due to a lack in funding for maintenance, calibration, and spare parts, currently only CO is monitored by automatic samplers (Teledyne) at Yerevan station N7. However, the reliability of the measured concentrations has not been validated in recent years.

2.1.4. Data reporting

Data is provided at the website of the Hydrometeorology and Monitoring Center[36], in weekly bulletins[37], quarterly and annual reports[38]. In addition, the website provides maps of the monitoring stations.

2.2. Azerbaijan

2.2.1. Introduction

The website of the National Hydrometeorological Service describes nicely the current status of air quality monitoring in Azerbaijan.[39] In addition, the activities are summarised in the annual report of the Ministry.[40]

Atmospheric air pollution monitoring is carried out in accordance with the Cabinet of Ministers decision No. 90 dated July 1, 2004 "On the rules of state monitoring of the environment and natural resources".[41] Air quality monitoring is done with stationary and mobile stations.

The air quality monitoring network is currently modernised to replace manual stations by automatic ones according to EU Ambient Air Quality Directives. This alignment is part of the Action Plan of the Republic of Azerbaijan with the European Union. The first automatic instrument was installed in 2016 at the premises of the National Hydrometeorological Service in Baku. The optical instrument (OPSIS) provides daily concentrations of PM_{10}, NO_2, SO_2, benzene, toluene, xylene, and ozone.

2.2.2. Draft air quality monitoring network modernisation plan

A Twinning project, which took place from November 2016 until April 2019, drafted a modernisation plan for air quality monitoring network (FMI 2018). In addition, the twinning project provided for monitoring of $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO and ozone via a so-called transmitter from Vaisala.[42]

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[36] http://meteomonitoring.am/page/5, last checked on 12 April 2023

[37] http://meteomonitoring.am/posts/33, last checked on 12 April 2023

[38] http://meteomonitoring.am/public/admin/ckfinder/userfiles/files/texekanq/eramsjak/IV-Eramsyak-od-2021.pdf, last checked on 12 April 2023

[39] https://meteo.az/index.php?ln=az&pg=84, last checked on 28 March 2023

[40] http://eco.gov.az/index.php?ln=az&pg=762, last checked on 28 March 2023

[41] an overview on air quality related legislation can be found at this website: http://www.ppi.az/publication/air-quality-in-azerbaijan/, last checked on 28 March 2023

[42] https://www.vaisala.com/en/industries-applications/urban-weather-environment/air-quality, last checked on 28 March 2023

The Twinning project also proposed the number of stations that would be required to fulfil EU Ambient Air Quality Directives. For the main pollutants (NO_2, PM, SO_2, CO) overall 23 stations would be required for Azerbaijan. The number would be lower for ozone, heavy metals and PAH.

2.2.3. Current air quality monitoring network

Since 2019 a mobile laboratory and 5 stationary automatic stations for atmospheric air monitoring were purchased. Three of these stations were installed in Baku, and one in Ganja and Sumgait. The stations in Baku are situated in a way to monitor urban background concentrations, traffic and industrial emissions.

Automatic air quality stations in Azerbaijan

Bakı ş. Nərimanov rayonu , H.Əliyev pr.10

Ünvan: Gəncə şəhəri, H.Əliyev parkının ərazisi

Source: National Hydrometeorological Service

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2.2.4. Parameters

The stations monitor the following pollutants:

- PM_{10} and $PM_{2.5}$
- NO_x
- SO_2
- CO
- H_2S
- BTX
- Ozone

An EMEP rural background station is operated in the Altyagac National Park since 2012. The stations monitors ozone and $PM_{2.5}$, as well as anions and cations (SO_4^{2-}, NO_3-, Na^+, K^+, Mg_2^+, Ca_2^+, NH_4^+) in precipitation.

EMEP air quality station in Altyagac National Park

Source: National Hydrometerological Service

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2.2.5. Database and reporting

Data from the stations are collected in a central database. The data is used for air quality assessment and other purposes.

The monitoring results are reported at the website of the Ministry.[43]

Furthermore, annual data is available at the website of the State Statistical Committee.[44]

2.3. Georgia

2.3.1. Air quality network

The status of the Georgian air quality monitoring network is described at the air quality portal[45] of National Environmental Agency (NEA) under the Ministry of Environmental Protection and Agriculture.[46] In addition, a presentation at the national workshops following the regional webinar "Clean Air Day: How municipalities take action and talk about it"[47] in September 2023 provided a comprehensive overview of the air quality management system in Georgia (Akhalaia 9/27/2023). Modernisation of the previous manual stations began in 2013; currently, NEA operates eight automatic stations in Tbilisi, Chiatura and Batumi, and one mobile stations. The network includes four gravimetric samplers.

2.3.2. Parameters

Automatic monitoring includes the following pollutants:

- NOx
- SO_2
- CO
- O_3

[43] http://eco.gov.az/az/nazirlik/xeber?newsID=16895, last checked on 28 March 2023

[44] https://www.stat.gov.az/index.php, https://www.stat.gov.az/source/environment/en/010_9en.xls, , last checked on 12 April 2023

[45] https://air.gov.ge/en/, last checked on 28 March 2023

[46] https://air.gov.ge/en/pages/14/14, last checked on 28 March 2023

[47] https://eu4waterdata.eu/en/events/277-reg-webinar-%E2%80%9Cclean-air-day-how-municipalities-take-action-and-talk-about-it.html, last checked on 10 April 2024

- PM_{10}, $PM_{2.5}$
- Pb

In addition, NEA carries out indicator measurements of NO_2, SO_2, O_3 and benzene four times a year for two weeks at specific locations. The samples are analysed in an accredited laboratory in the UK. Heavy metals (As, Cd, Ni, Pb), MnO_2 and benzo(a)pyrene are monitored as well.

2.3.3. Number of stations

The required number of stations is not available; the optimum number of stations is 28 according to the presentation of Georgian experience at workshop[48]. A rough estimate can be based on the number of inhabitants in Georgia, which is around 4 million inhabitants and the main cities, which are Tbilisi (1.1 million inh.), Batumi and Kutaisi (150 000 inh. each). Furthermore, it is assumed that pollutant levels are above the upper assessment thresholds according to the AAQDs. Given the number of inhabitants of the main cities, there should be one agglomeration of more than 250 000 inhabitants (Tbilisi); the remaining territory might be divided in zones as appropriate.

For Tbilisi, this would result in four stations. The remaining territory could be covered by six or seven stations. This results in ten to eleven stations; the exact number depends on the actual pollutant levels and the delimitation of the zones. As of 2023, 8 monitoring and one mobile station are operated; four gravimetric monitors are available. Passive sampling is performed in 30 cities.[48]

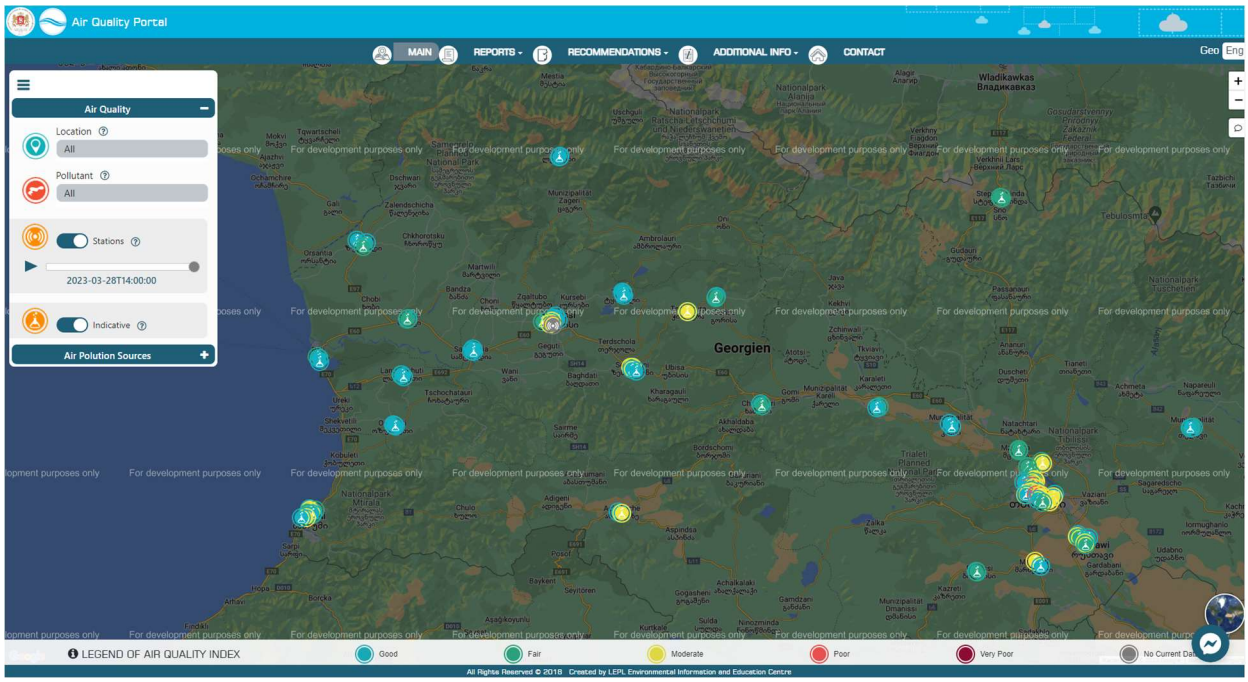
2.3.4. Data reporting

Data from the automatic stations is continuously stored in a database and reported at the air quality portal.[49] The colour codes are the same as for the EEA air quality index.[50] A number of manual stations are still in operation. In principle, up-to-date data is reported to EEA and shown at the website, which is however, currently not working due to changes in the RAVEN software. Talks are on-going with NILU and EEA to update the Georgian software.

[48] EU4EnvWD Regional workshop on air quality monitoring, air quality management and awareness raising, online, 11 May 2023.

[49] https://air.gov.ge/, last checked on 13 April 2023

[50] https://www.eea.europa.eu/themes/air/air-quality-index, last checked on 28 March 2023



NEA also publishes annual air quality reports for specialists. The latest is available for 2017 (in Georgian).[51]

For the purpose of determining atmospheric air quality in Georgia, indicator measurements are carried out four times a year since 2015. According to the methodology, indicator tubes are placed for a certain period of time (two weeks) in a pre-selected places of different settlements. It takes samples of different pollutants (nitrogen and sulfur dioxides, ozone and benzol). The following piles are analyzed in Accredited Laboratory of United Kingdom. The assessment of the concentrations of accepted concentrations is carried out by the harmonized system with the EU atmospheric air quality indexes.

Air quality legislation is provided at the website as well (in Georgian).[52]

2.3.1. Quality assurance / quality control system

QA/QC was developed in the project "Enhancing Air Quality Management Capacities in Georgia (I-II phases)", supported by SIDA and UNDP, which took place from 2019 to 2021. The project including the following activities: [48]

- Guidance for Maintenance of the Ambient Air Quality Monitoring Network was elaborated;

[51] https://air.gov.ge/reports_page, last checked on 28 March 2023

[52] https://air.gov.ge/en/pages/3/5, last checked on 28 March 2023

- Air quality monitoring related 21 international and EU standards were adapted;
- Air Monitoring Data Verification and Validation Procedure was prepared;
- Air quality monitoring data validation software has been introduced;
- Capacity development activities/trainings for the Department of Environmental Pollution Monitoring were conducted to strengthen data processing capacities of NEA;

2.4. Moldova

2.4.1. Introduction

The Inspectorate for environmental protection states in the most recent annual report (IPM 2022):

„It is necessary to ensure the compatibility of national normative acts with the legislation of the European Union through the harmonization procedure, the elimination of contradictions and the establishment of the legal framework based on principles, ambitious standards.

It is necessary to improve the monitoring and assessment of air quality and to guarantee the provision of information on atmospheric air quality to the public, in accordance with the provisions of the European Directives. A National System for Monitoring and Integrated Management of Air Quality throughout the territory of the Republic of Moldova is missing, which makes it impossible to identify the economic agents (based on data on the quality of the air basin), as a result of whose activity air pollution occurs."

2.4.2. Air quality network

In 2019, the German Gesellschaft für Internationale Zusammenarbeit (GIZ) published a concept for implementing an air quality network (GIZ 2019).

Under the International Climate Initiative (IKI), the German state of Saxony-Anhalt donated one air quality station to Moldova in 2021.[53] This station in Chișinău is only automatic one in Moldova. The station was put into operation in July 2022. The data is reported at the website of the Environment Agency.[54]

In addition to the automatic station in Chișinău, there is an EMEP station close to the city of Leova at the border to Romania.[55] The station is equipped with filter packs, wet only samplers, high-volume and low-volume aerosol samplers.[56] However, even though the station is listed in the latest EMEP-CCC report, no data from this station is provided in the report (EMEP/CCC 2022).

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[53] https://www.international-climate-initiative.com/en/iki-media/news/making_air_quality_measurable_in_moldova/ , last checked on 31 March 2023

[54] https://am.gov.md/ro/node/216, last checked on 6 April 2023

[55] https://projects.nilu.no/ccc/sitedescriptions/md/md0013.html, last checked on 6 April 2023

[56] http://ebas.nilu.no/DataSets.aspx?stations=MD0013R&fromDate=1970-01-01&toDate=2022-12-31, last checked on 6 April 2023

2.4.3. Number of stations

The required number of stations is not available. A rough estimate can be based on the number of inhabitants in Moldova, which is around 2.6 million inhabitants and the capital Chișinău (650 000 inh.), which is the only city above 250 000 inhabitants. Furthermore, it is assumed that pollutant levels are above the upper assessment thresholds according to the AAQDs. Given the number of inhabitants Chișinău, there should be one agglomeration of more than 250 000 inhabitants; the remaining territory might be divided in zones as appropriate.

For Chișinău, this would result in two stations. The remaining territory could be covered by five or six stations. This results in seven to eight stations; the exact number depends on the actual pollutant levels and the delimitation of the zones.

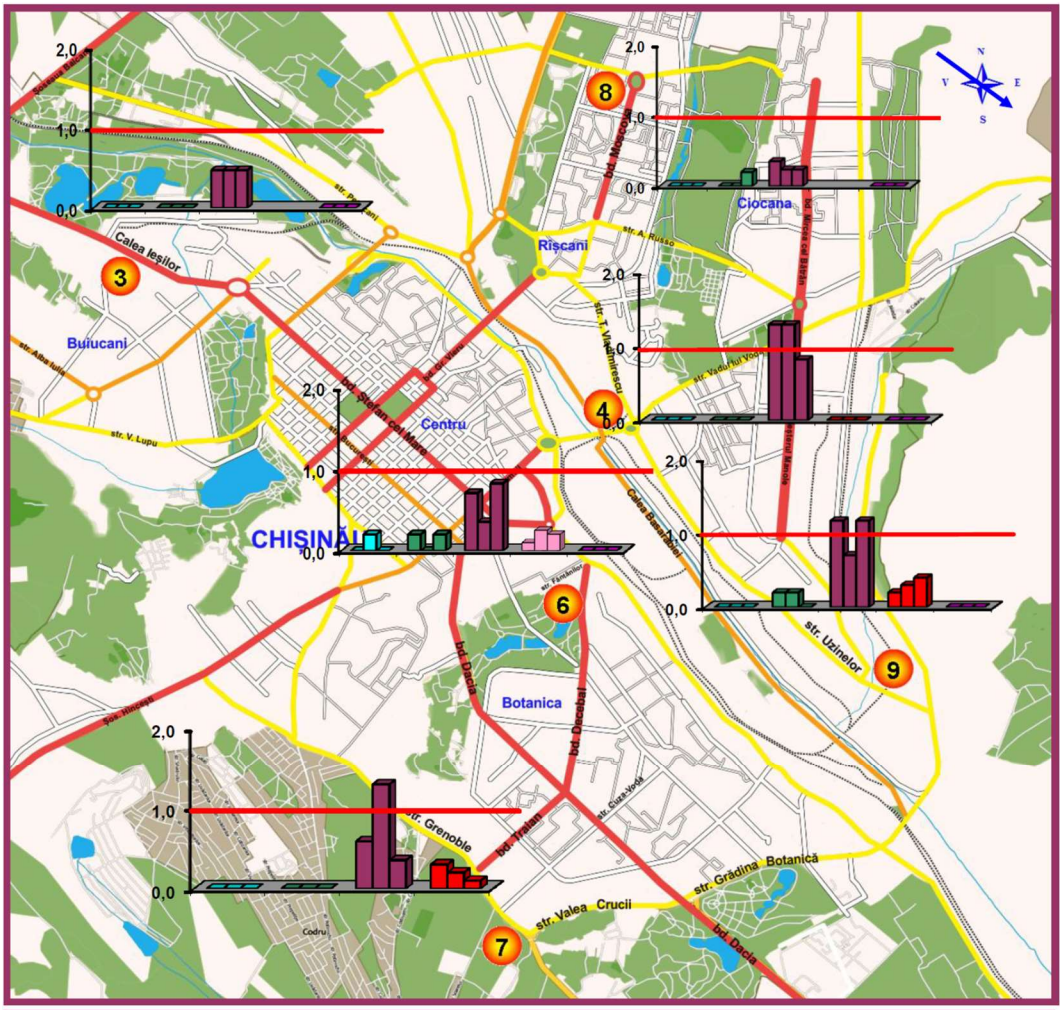
2.4.1. Data reporting

The Environmental Agency publishes daily reports.[54] The automatic station provides the following parameters

- PM_{10}
- SO_2
- Ozone
- NO_2
- CO

Further parameters such as phenol and formaldehyde are reported from manually operated stations.

Example for an air pollution map



Source: Environmental Agency

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In addition, the Inspectorate for Environmental Protection publishes weekly and annual reports.[57]

2.5. Ukraine

The 2015 UNEP survey about air quality policies in Ukraine does not contain information about air quality monitoring, standards and policies.[58]

Comprehensive information is provided in a recent scientific article (Zaporozhets et al. 2020) as well as in a report developed within an EU International Partnership project, and a presentation provided during the EU-Ukraine PHOENIX Dialogue on Air Quality on 25 April 2024 (Ministry of Environmental Protection and Natural Resources of Ukraine 4/25/2024).

2.5.1. Current air quality monitoring network

Coordination and organisation of air quality monitoring is in general the responsibility of the Ministry of Environmental Protection and Natural Resources. The requirements are laid down in general in the law "On Protection of the Natural Environment", and in particular in the law "On Atmospheric Air Protection", which provides a basis for state monitoring in Ukraine. The latter law was amended by law of Ukraine No. 2973-IX "On Amendments to Certain Legislative Acts of Ukraine Regarding the State Environmental Monitoring System, Information on the State of the Environment (Environmental Information) and Information Support for Environmental Management", which implements Directive 2008/50/EC. Resolution No. 827 of 14 August 2019 RD 52.04.186–89 regarding state monitoring of air determines the competent authorities, sets standards, lays down requirements for zones and agglomerations, as well as for monitoring and reporting.[59] Monitoring is mainly done by the State Hydrometeorological Service, additionally by regional public health centres and local administrations e.g. the City of Kyiv and Sevastopol. Monitoring of air pollutants in Ukraine is mainly based on manual methods (Zaporozhets et al. 2020). Samples are taken two to four times a day at specific times.

Some automatic stations are operated by within local networks by different cities and regions (Ministry of Environmental Protection and Natural Resources of Ukraine 4/25/2024). However, due the war against Ukraine by Russia, some of the automatic monitoring stations have been destroyed, especially in the Eastern part of the country.

Furthermore, a number of low-cost air quality sensors are operated by citizens in various cities.[60]

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[57] https://ipm.gov.md/ro/rapoarte-saptam%C3%A2nale, last checked on 4 April 2023.

[58] https://www.unep.org/resources/policy-and-strategy/air-quality-policies-ukraine, last checked on 7 April 2023.

[59] https://zakon.rada.gov.ua/laws/show/827-2019-%25D0%25BF#Text, last checked on 11 April 2023.

[60] https://eco-city.org.ua/, last checked on 11 April 2023.

2.5.2. Parameters

Overall, 22 air pollutants are determined by manual methods for which maximum permissible concentrations (MPC) are defined (Zaporozhets et al. 2020):

- TSP
- SO_2
- Soluble sulfate
- CO
- NO, NO_2
- Ammonia
- Formaldehyde
- Phenol
- HCl
- H_2S
- HF
- Benzo(a)pyrene
- Aniline
- Heavy metals

In addition, meteorological parameters are determined at all stations (wind direction, wind speed, temperature, humidity and atmospheric pressure).

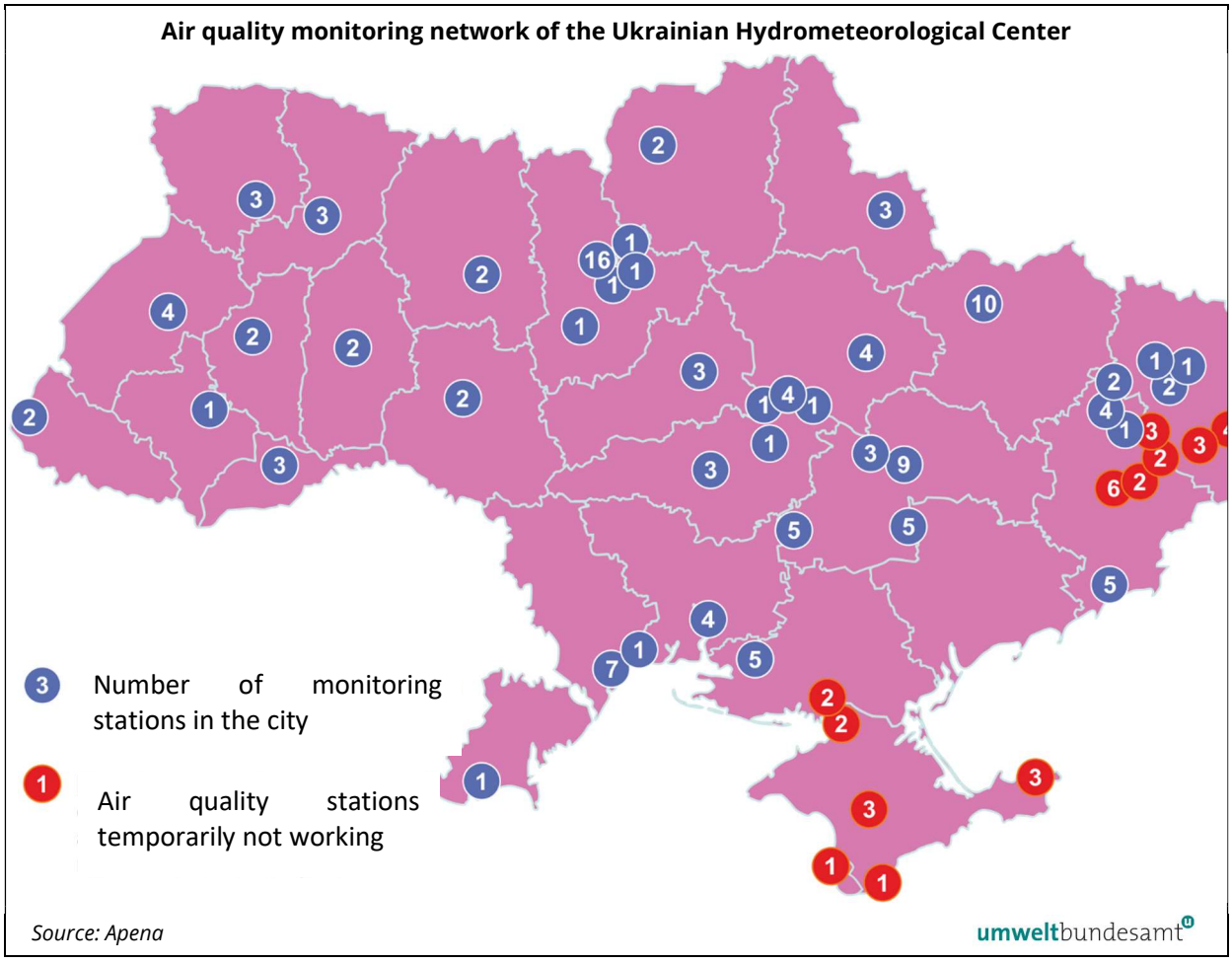
2.5.3. Number of stations

129 air quality stations of the Hydrometeorological Service are situated in 39 cities (Zaporozhets et al. 2020). There are also two cross-border posts. The samples are analyzed in 27 laboratories.

However, some of the stations are currently not working due to the war of Russia against Ukraine.

The City of Kyiv operates 5 automatic air quality stations; the Public Health Institute operates one PM monitor at their headquarter.[61]

[61] http://asm.kyivcity.gov.ua/, https://www.saveecobot.com/platform/kyivcity_gov_ua, last checked on 24 April 2023.



According to a preliminary assessment, overall 158 air quality monitoring stations are required throughout the country that use reference methods (Ministry of Environmental Protection and Natural Resources of Ukraine 4/25/2024). Arsenic, cadmium, nickel, and benzo(a)pyrene should be sampled at 56 sampling points. In addition, a national reference laboratory and calibration laboratories have to be installed. Overall, an investment of 17.5 € is estimated to be needed, in prices of 2019.

2.5.4. Data reporting

An air quality index, which is based on the US EPA index[62], is reported via an environmental monitoring dashboard of the Ministry of Environmental Protection and Natural Resources.[63]

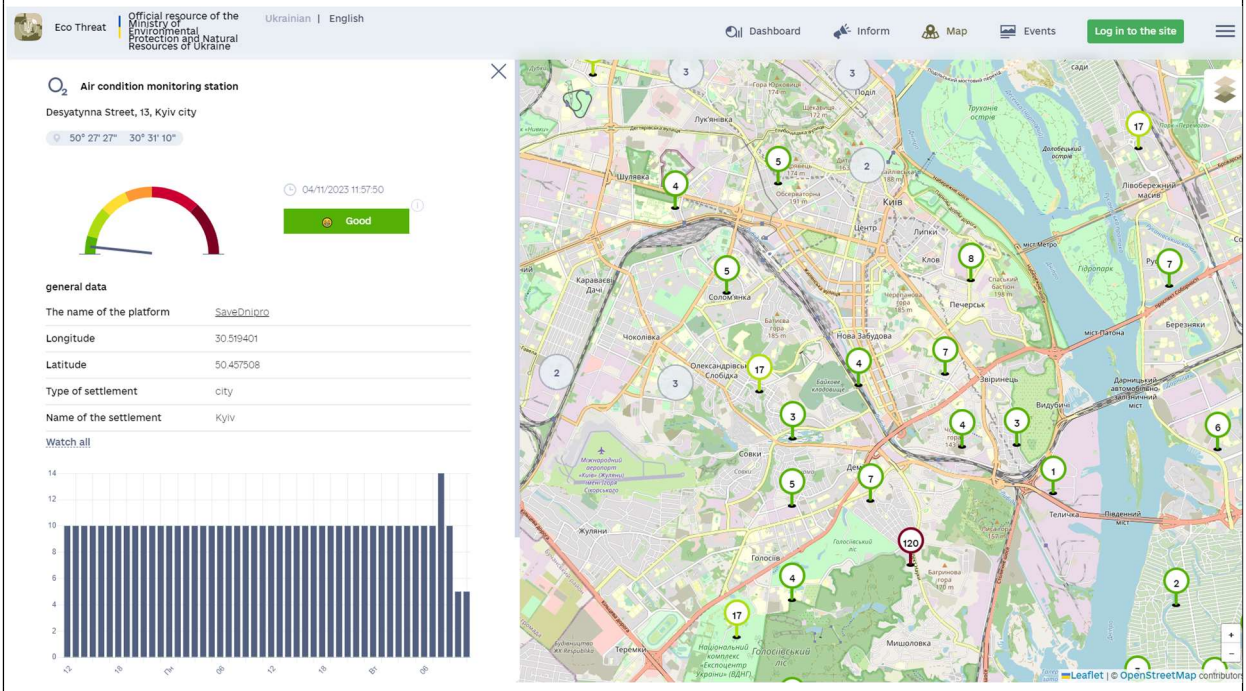
[62] https://www.airnow.gov/aqi/aqi-basics/, last checked on 11 April 2023

[63] https://ecozagroza.gov.ua/, last checked on 11 April 2023

In addition, there is a Facebook page for air quality in Kyiv[64] as well as specific websites for some other cities and regions[65].

A specific website (SaveEcoBot) collects air quality data of different providers and present those at its website.[66]

Example for an air quality index map



Source: Ministry of Environmental Protection and Natural Resources

umweltbundesamt

2.5.5. Quality assurance / quality control system

The quality management system, including a national reference laboratory and calibration laboratory still needs to be installed and the personnel need to be trained accordingly (Ministry of Environmental Protection and Natural Resources of Ukraine 4/25/2024).

64 https://www.facebook.com/CGO.Official/?comment_id=Y29tbWVudDo0ODcxODc1MzYxOTA4MTNfNDkxNjMzMjcyNDEyOTA2, last checked on 24 April 2023

65 https://zapcgm.com.ua/pollution, https://www.facebook.com/pgdcherkasy, last checked on 24 April 2023.

66 https://www.saveecobot.com/, last checked on 24 April 2023.

2.6. Overview

2.6.1. Required vs. installed and operating stations

The EU AAQDs require a certain number of sampling points for diffuse sources dependent on pollutant levels, inhabitants per zones and agglomerations, and pollutant, see section 1.2. Further sampling points might be necessary around point sources.

Pollutant levels are currently not known throughout the countries. In addition, delimitation into zones and agglomerations has not yet been finalised, and no information is available about necessary monitoring around point sources. Therefore, the following table provides only a rough estimate of the number of stations, which needs to be updated when further information is available.

Table 8: Estimate of necessary number of air quality monitoring stations under the assumption of concentrations above upper assessment thresholds in all zones and agglomerations (source: Umweltbundesamt).

	AM	AZ	GA	MD	UA
Required	10	23	10 to 11	5 to 6	158*
Actual	0	6	8 (+1 mobile)	1	113#

* according to the preliminary assessment (Ministry of Environmental Protection and Natural Resources of Ukraine 4/25/2024).
# number for 2023, including manual sampling points (Ministry of Environmental Protection and Natural Resources of Ukraine 4/25/2024).

2.6.2. Parameters in place / missing

Table 9 shows the parameters that are currently monitoring in the different countries.

Table 9: Parameters monitored (source: Umweltbundesamt).

	AM	AZ	GA	MD	UA
PM_{10}		✓	✓	✓	✓
$PM_{2.5}$		✓	✓		✓
NO_x, NO_2	✓	✓	✓	✓	✓
SO_2	✓	✓	✓	✓	✓
CO	✓	✓	✓	✓	✓
O_3	✓	✓	✓	✓	✓
As			✓		✓
Cd			✓		✓
Ni			✓		✓
Pb			✓		✓
PAK			✓		✓ (B(a)P)
Benzene		✓ (BTX)	✓		
PM constituents		✓			

VOC	(✓)			(✓)	✓ (Phenol)

2.6.3. Data reporting

The following table provides an overview of data and metadata provide by the countries.

Table 10: Reporting of air quality data and metadata (source: Umweltbundesamt)

	AM	AZ	GA	MD	UA
up-to-date data			✓		✓
annual reports	✓	✓	✓		
metadata			(✓)	(✓) monthly	(✓)
Air Quality Index			✓		✓
App					
EEA			(✓)		

3. Levels of PM_{10}, $PM_{2.5}$, health risks

One focus of the EU4EnvWD project is to raise awareness about health impacts of PM pollution. Therefore, this chapter summarises available information about concentration levels in the five countries. The overview is hampered by the fact that air quality monitoring networks have not been established in all countries yet, or cover the whole country.

Near-real-time information from low-cost sensors is available for Armenia, Georgia, Moldova and Ukraine at a website supported by UNEP.[67]

Some global estimates of PM levels are available, however, those are too coarse to provide reliable information for individual countries (Hammer et al. 2020; Karagulian et al. 2017).

Almeida et al. conducted from 2014 to 2015 monitoring campaigns and $PM_{2.5}$ source apportionment studies in different countries and cities, inter alia in Chisinau (Almeida et al. 2020). $PM_{2.5}$ concentrations at an urban background site in Chisinau from July 2014 to 27 December 2015 were around 15 µg/m³.

A global source apportionment analysis found $PM_{2.5}$ concentrations of around 15 µg/m³ for 2010 for the Ukrainian region (Karagulian et al. 2017).

3.1. Monitoring data

PM_{10} and/or $PM_{2.5}$ data from automatic stations are mainly available for Georgia.

3.1.1. Azerbaijan

Annual data is available from the website of the State Statistical Committee.[44]

Table 11: Annual mean PM_{10} and $PM_{2.5}$ levels from automatic stations in Azerbaijan (in µg/m³. Source: State Statistical Committee of the Republic of Azerbaijan)

	City	2017	2018	2019	2020	2021
PM_{10}	Baku	44	44	49	49	41
$PM_{2.5}$	Baku	x	x	27	x	27
	Ganja	x	x	28	x	28
	Sumgait	x	x	22	x	22

$PM_{2.5}$ levels correspond well with the values used for SDG 11.6.2 by WHO (see section 3.4).

[67] https://www.iqair.com/unep, last checked on 7 April 2023

3.1.2. Georgia

Data is provided via the air quality portal; furthermore, statistical indicators (A-2: Ambient air quality in urban areas) are provided via the National Statistics Office[68]; monthly bulletins and yearbooks are published by NEA[69]. Air quality is also part of the State of Environment Report. Table 12 shows as an example annual mean PM_{10} levels for some cities.[70]

Table 12: Annual mean PM_{10} levels from automatic stations in urban areas in Georgia (in µg/m³. Source: National Statistics Office of Georgia).

City	2017	2018	2019	2020	2021
Tbilisi	39	38	39	32	33
Kutaisi	-	40	49	30	29
Batumi	-	44	38	34	27
Rustavi	-	-	63	58	63

3.2. WHO air quality database

WHO developed a global air quality database; which was last updated in 2022.[71] The database includes data for Georgia and Ukraine. Levels in recent years were below the current standards of the AAQD; however, well above the WHO air quality guideline levels (WHO 2021).

Table 13: PM annual mean levels provided in the WHO database (source: Ambient Air Quality Database, WHO, April 2022).

	City	Year	$PM_{2.5}$	PM_{10}	Reference	Type*
			µg/m³			
GA	Abastumani	2014		27.8	Ministry of Environment and Natural Resources Protection of Georgia	Unknown

[68] https://www.geostat.ge/en/modules/categories/565/environmental-indicators, last checked on 20 June 2023

[69] https://nea.gov.ge/En/, last checked on 20 June 2023

[70] https://geostat.ge/media/53253/A-2_Ambient_air_quality_in_urban_areas_ENG.XLS, last checked on 20 June 2023

[71] https://www.who.int/data/gho/data/themes/air-pollution/who-air-quality-database, last checked on 6 April 2023

	Tbilisi	2014	29	55.2	Ministry of Environment and Natural Resources Protection of Georgia	Unknown
	Tbilisi	2015	24.5	47.5	Ministry of Environment and Natural Resources Protection of Georgia	Unknown
	Tbilisi	2017	20	39	Government of Georgia	UT
UA	Kyiv	2018	22.8	37.8	O.M. Marzeiev Institute for Public Health of the National Academy of Medical Science of Ukraine	UB
	Kyiv	2019	23.4	31.2	O.M. Marzeiev Institute for Public Health of the National Academy of Medical Science of Ukraine	UB

* UT: urban traffic; UB: urban background

3.3. Global Burden of Disease

The Global Burden of Disease series of studies provides among other data the health risks due to ambient particulate matter air pollution.[72]

For the EU4EnvWD countries, the following numbers are provided for 2019.[73]

Table 14: Number of deaths due to PM ambient air pollution in 2019 (source: Global Burden of Disease Study 2019)

	All cause mortality - Ambient particulate matter pollution
Armenia	3 091
Azerbaijan	7 860
Georgia	3 112
Republic of Moldova	2 102
Ukraine	42 916

[72] https://vizhub.healthdata.org/gbd-results/?params=gbd-api-2019-public/e31b75887386d423974ba571878a7f36, last checked on 6 April 2023

[73] Source: Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2020. Available from https://vizhub.healthdata.org/gbd-results/, last checked on 6 April 2023

3.4. SDG 11.6.2

The Sustainable Development Goals (SDG) indicator 11.6.2 provides "*Annual mean levels of fine particulate matter (e.g. $PM_{2.5}$ and PM_{10}) in cities (population weighted)*".[74] WHO is the custodian of this indicator.[75] WHO calculates these concentrations for all countries for different areas and provides these data at the website. The methodology is based on modelling using data integration from satellite remote sensing, population estimates, topography and ground measurements (Shaddick et al. 2018). For the countries of this study the values for 2019 are provided in Table 15.

NB: the metadata does not describe the delimitation of the different areas (rural, towns, urban, cities).[76] It states that "*the definition of urban/rural may greatly vary by country*".

Table 15: $PM_{2.5}$ concentrations in different areas for 2019 (in µg/m³. Source: WHO)

Country	Rural	Towns	Urban	Cities	Total
Armenia	28.4	33.2	36.2	38.3	34.1
Azerbaijan	23.4	24.3	26.2	27.2	24.6
Georgia	16.9	18.6	20.9	21.7	19.1
Republic of Moldova	12.1	12.3	12.7	13.6	12.4
Ukraine	12.2	13.1	14.5	15.2	13.5

3.5. Public information and awareness raising activities

Georgia provides public access to the air quality data via a dedicated portal (Akhalaia 5/11/2023).[77] The portal includes inter alia a general overview and an air quality index, more specific information on station level as well as time series and recommendations. In addition, monthly bulletin are published by NEA.

[74] https://unstats.un.org/sdgs/, last checked on 12 April 2023

[75] https://www.who.int/data/gho/data/themes/air-pollution/modelled-exposure-of-pm-air-pollution-exposure, last checked on 12 April 2023

[76] https://unstats.un.org/sdgs/metadata/files/Metadata-11-06-02.pdf, last checked on 12 April 2023

[77] https://air.gov.ge/, last checked on 10 April 2024

4. Publication bibliography

European Commission, Directorate-General for Environment (2022a): Study to support the impact assessment for a revision of the EU Ambient Air Quality Directives. Final report. Edited by Publications Office of the European Union. Luxembourg (KH-09-22-586-EN-N). Available online at https://op.europa.eu/en/publication-detail/-/publication/a05c2e91-54db-11ed-92ed-01aa75ed71a1, checked on 10/28/2022.

European Commission, Directorate-General for Environment (2022b): Systematic assessment of monitoring of other air pollutants not covered under Directives 2004/107/EC and 2008/50/EC. with a focus on ultrafine particles, black carbon/ elemental carbon, ammonia and methane in ambient air. Service Request No 15 under Framework Contract No ENV.C.3/FRA/2017/0012. With assistance of C. Nagl, A. Bleeker, L. Ntziachristos, M. Georgakaki, I. Buxbaum, W. Spangl. Edited by Publications Office of the European Union. Luxembourg (KH-03-22-098-EN-N). Available online at https://op.europa.eu/en/publication-detail/-/publication/1c9b2b51-54dd-11ed-92ed-01aa75ed71a1, checked on 10/28/2022.

Ministry of Environmental Protection and Natural Resources of Ukraine (2024): Air Quality and Pollution in Ukraine. Legislative Framework and Investment Needs. EU-Ukraine PHOENIX Dialogue on Air Quality. Online, 4/25/2024.

Umweltbundesamt (2021): Austria's National Air Emission Projections 2021 for 2020, 2025 and 2030. Pollutants: NOx, SO2, NMVOC, NH3 and PM2.5 Scenario: With Existing Measures (WEM). With Additional Measures (WAM). 15 March 2021. With assistance of M. Anderl, S. Haider, T. Krutzler, C. Lampert, S. Poupa, M. Purzner et al. Edited by Umweltbundesamt. Wien (Reports, REP-0769). Available online at https://www.umweltbundesamt.at/studien-reports/publikationsdetail?pub_id=2385, checked on 3/22/2022.

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